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Abstract: The paper analyzes the time variation in volatility in Doha Securities Market and examines the presence of structural changes in GARCH-based conditional volatility during the period 2002-2008. This issue is related to the market liberalization reforms permitting foreign investors to enter the equity market in 2005.The analysis reveals that there is a high risk in return equation. It also indicates that the return is positively and more significantly related to the risk. The GARCH-Mean model shows that the volume term has a more significant parameter in both return and risk equations, and that the information flow provided to the market comes from the risk and return variables. There is a high persistence of the shocks in the volatility, but it was less in the first sub-period compared to its persistence after the entry of foreign investors.

Keywords: Doha Securities Market, EGARCH, Qatar, Return, Volatility.

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1 Introduction

The study of volatility is of concern to investors, regulators and policy makers for many reasons. Financial market volatility can have a wide repercussion on the economy because of the link between financial market uncertainty and public confidence. Market estimates of volatility are used as an indicator of the vulnerability of financial markets. Excessive volatility weakens the usefulness of stock prices as signal about the true intrinsic value of the firm. It is expected that extreme volatility in equity market could hinder the functioning of the financial system and lead to the introduction of structural and regulatory changes (Joshi and Pandya, 2008). One of the changes adopted by many emerging economies in Latin America and Asia is the opening the market for foreign investors.

Excessive speculation and the focus on short term profits have resulted in market volatility which has become the subject of mutual concern for investors and policy makers. To cope with such volatility, the management of Doha Securities Market (DSM) has introduced different measures and structural changes. One of these changes is opening the market for foreign investors i.e. market liberalization. Prior 2005, foreigners other than Gulf Cooperation Council countries citizens were not allowed to own shares in DSM listed companies. In April 3, 2005 the market has gone a major liberalization has taken place[i].

It was expected that such a decision will lead to an increase in the flow of investments from inside and outside Qatar. It was also believed that the decision will introduce more liquidity to the DSM with the entry of resident expatriates to the equity market. Moreover, such a decision was hoped to improve market efficiency and the performance of the stock market and lead to the increase of share prices which were so low before the implementation of the decision. However, at point in time the entry of foreigners into the market was cited as one of the reasons that have led to the increase in market volatility.

The purpose of this paper is to analyze the varying-time volatility in DSM during 2002-2008. The market volatility is traced before and after the liberalization of the market and examine if there has been an increase in volatility persistence on account of the process of financial liberalization in Qatar.

The paper is organized as following: Section 2 outlines a brief literature review. In section 3, the GARCH-M model is exhibited. The data and the basic descriptive statistics are reported in section 4. The empirical results of the GARCH model are presented in Section 5. Section 6 concludes the paper.

2 A brief literature review

There are many studies that examine the impact of market liberalization on volatility in emerging and developing markets. However, the results have been mixed and inconclusive. Many studies report that the cost of capital has declined after opening the domestic stock market to foreign investors (Bekaert & Harvey, 2000; Cunado et al., 2006). Their findings support the proposition that market liberalization reduced market volatility in emerging markets.

One of the benefits is the reduction of cost of capital after market liberalization. The justification of that according to Durnev, Morck & Yeung (2004) is that opening the stock market to foreign investors allows firms in developing countries to draw from the global pool of capital to undertake investments that generate profits and employment and reduce the cost of capital. The reduction in cost of capital can also be achieved via better international risk sharing which lowers equity premium and hence reduces the cost of capital in the economy. Chari & Henry (2004) found that about two fifth of the total stock price revaluation following liberalization is due to the reduction in the systematic risk of investing firms in the liberalizing country.

Another benefit that may occur as a result of market liberalization relates to the fact that the openness of local stock markets to foreign portfolio investment enhances the governance of local corporations and can help resolve agency problem via higher quality reporting (Durnev, Morck & Yeung, 2004). Moreover, it was found that financial liberalizations are associated with declines in the volatility ratio of consumption growth to GDP growth, implying improved risk sharing across countries (Bekaert et al., 2006).

At the same time there is some concern among policy makers and investors that complete openness to foreign capital can result in some problems. One of the arguments is that border movement of portfolio capital causes excessive booms and thus busts volatility and instability in the financial markets. For example, Miles (2002) and Levine & Zervos (1998) reached contrasting results that indicated that market volatility increases after market liberalization. Kawakatsu & Morey (1999) find that liberalization does not improve efficiency and market liberalization could be costly to stock markets in newly liberalized countries, because they might have to cope with the increased volatility and financial instability likely to cause economic turmoil such as the Asian crises during the 1990s (Stiglitz, 2000).

The inclusive results have been documented by Jayasuriya (2005) in arguing that market volatility in emerging markets may increase, decrease or remain stable after the liberalization period depending on the specific characteristics of the market under study.

3 The GARCH-M model

When the expected return on an asset is related to the expected asset risk (conditional variance), the ARCH in mean is more appropriate. This notion justifies the introduction of an heteroskedasticity term (σ_t) in mean equation. The idea from Engle et al. (1987) was consequently used to estimate the conditional variances in GARCH and then the estimations will be used in the conditional expectation's estimation. This is so called ARCH in mean i.e. ARCH-M model.

Let r_t be a covariance-stationary return process of a broad market index and σ_t^2 be the conditional variance specified in a GARCH (1, 1) model[ii]. The augmented GARCH-M model, pioneered by Duan (1997), has the formula as follows:

$$\begin{cases} r_t = \mu_t + g(\sigma_t) + \varepsilon_t = \left(\sum_{i=1}^{5} \tau_i d_i + \sum_{i=1}^{3} \mu_i r_{t-i} + \theta v_t \right) + \lambda \sigma_t + \varepsilon_t \\ \sigma_t^2 = \omega_0 + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \omega v_{t-1} \end{cases} \quad (1)$$

$\alpha > 0$, $\beta > 0$ and $\alpha + \beta < 1$ (Stability condition). d_i represents the dummy day variable. The parameters α and β are the ARCH and GARCH effects respectively (Bollerslev, 1986). If the sum of these coefficients is very close to one, so the results indicate that the volatility shocks are quite persistent.

$$\begin{cases} r_t = \mu_t + g(\sigma_t) + \varepsilon_t = \left(\sum_{i=1}^{5} \tau_i d_i + \sum_{i=1}^{3} \mu_i r_{t-i} + \theta v_t \right) + \lambda \sigma_t + \varepsilon_t \\ Ln(\sigma_t^2) = \omega_0 + \alpha \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \beta \sigma_{t-1}^2 + \omega v_{t-1} \end{cases} \quad (2)$$

$\gamma < 0$ (Asymmetry condition)

$$\varepsilon_t \mid \Psi_{t-1} \sim i.i.d.(0; \sigma_t)$$

where $g(\cdot)$ is a known parameter function which designs the risk premium.

The expression (1) and (2) represent respectively the GARCH (1,1) and EGARCH (1, 1) models, the second equation of each expression shows the conditional volatility. These models are estimated with the maximum likelihood method (Engle et al., 1987; Engle et al., 1993 and Bollerslev et al., 1992).

When the returns indicate an autocorrelation of the first order, there are various possibilities to model these autocorrelations. We consider two important models (GARCH, EGARCH) in different versions. These models are easy to be interpreted economically, a time dependent risk premium implying an autocorrelation of the returns which corroborates to the usual assumption of a risk averse attitude.

Asymmetric GARCH model takes into account the asymmetry of volatility effect. In practice, good and bad news haven't the same effect on the volatility in this model. In particular by stock returns in that the volatility increases more after bad news than after good news. This so called leverage effect appears firstly in Black (1976).

4 Data and basic descriptive statistics

The data used in this paper are the daily series of the DSM value weighted price index over the period from July 10-2002 to September 3-2008. DSM Price index was launched with the base year of 1997-1998 with base value of 100 and was modified in 2002 to the base value of 1000. The index comprises 20 listed companies covering all economic sectors and it is a market value weighted average index. These companies are selected on the basis of market capitalization, volume of turnover and the strength of the companies' fundamentals. During this period many changes have taken place such as full electronic trading, the emergence of brokerage firms, changes in price limits, the modification DSM Price index calculation and the entry of foreign investors. These changes might have influenced the behavior of the pattern of volatility and is therefore instructive to study market performance during this period.

The ARCH modeling allows us to estimate a model for the daily Stock Exchange Index (at the end of the day) and permits to test the hypothesis that the return rate volatility is highly persistent. Furthermore, the GARCH model will be adjusted to study the stock market conditional volatility structure and how that structure may have changed after the foreigners start to trade in DSM. Therefore, the estimation of a GARCH model offers an empirical analysis of the proposed relationship between volatility and information.

The endogenous variable is the daily logarithmic return, calculated by the first difference of logarithmic close as a good approximation of an increase rate. The descriptive statistics are reported for the closing price and volume variables in Table 1. All variable in level and in first difference seem to be more leptokurtic[iii], only the variable LCLOSE shows platykurtic distribution relative to the normal (K=3). For all variables the Jarque-Bera statistic strongly rejects the hypothesis of normal distribution. The results indicate negative skewness to the normal (S=0) i.e. that the distribution of all variables in level and in first difference, except LCLOSE, has mainly a long left tail.

The Figures 1.1 to 1.4 of daily logarithmic return and logarithmic variation of daily value of share traded, respectively show volatility clustering. The variance specification is more important, which should have an appropriate form regarding the distribution of residuals. Our contribution consists to test the influence of the entry of foreign investors to the volatility of returns in Doha Securities Market by using the ARCH methodology. For testing the impact of the foreign investors, the models (1) and (2) are used on two sub periods before and after 3-Apr-2005, which is the date of the entry of foreign investors.

Table 1 Descriptive Statistics:

Entire Period	LVOLUME	LCLOSE	DLVOLUME	DLCLOSE
Mean	18.823	8.880	0.005	0.0012
Median	19.011	9.124	-0.004	0.0016
Maximum	22.181	9.658	3.594	0.050
Minimum	9.2103	7.559	-3.793	-0.038
Std. Dev.	1.1938	0.578	0.407	0.008
Skewness	-3.9376	-0.709	-0.098	-0.495
Kurtosis	24.405	2.399	27.448	6.737
Jarque-Bera	32837.88	149.98	37709.26	942.98
Probability	0.0000	0.0000	0.0000	0.0000
Observations	1515	1515	1514	1514

Sub-Period 1	DLVOLUME	DLCLOSE	Sub-Period 2	DLVOLUME	DLCLOSE
Mean	0.0105	0.0018		-0.0004	0.0006
Median	0.0011	0.0025		-0.0081	0.0011
Maximum	3.576	0.034		3.5939	0.0504
Minimum	-3.380	-0.038		-3.7935	-0.0373
Std. Dev.	0.483	0.009		0.3369	0.0079
Skewness	-0.090	-0.708		-0.1493	-0.3071
Kurtosis	18.620	5.9604		43.378	7.789
Jarque-Bera	6785.85	299.36		57543.04	822.78
Probability	0.0000	0.0000		0.0000	0.0000
Observations	667	667		847	847

Figure 1.1

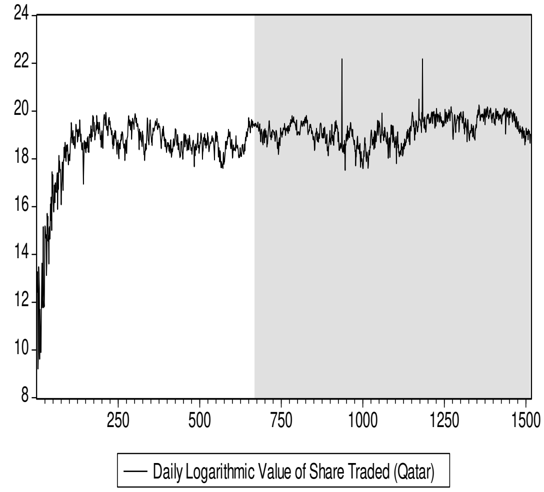


Figure 1.2

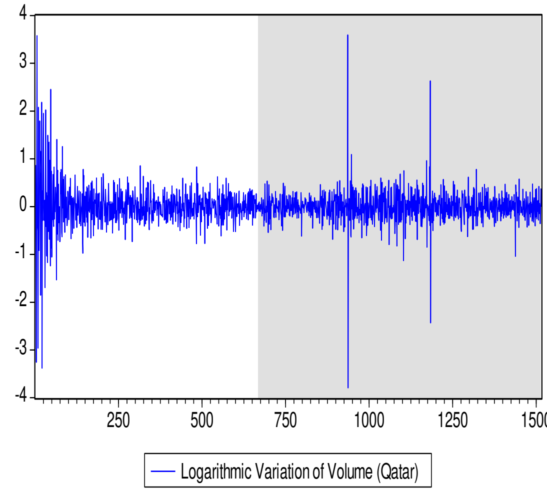


Figure 1.3

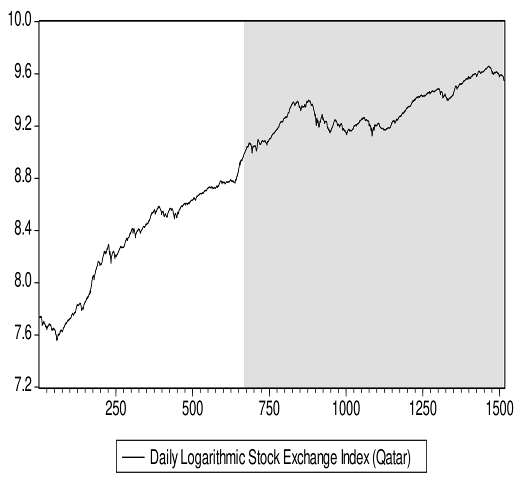
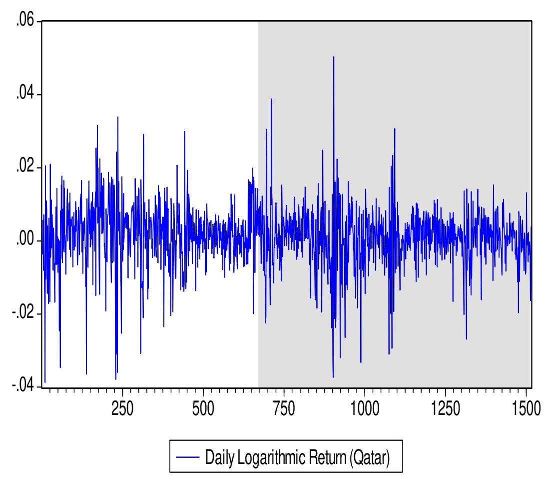


Figure 1.4



To test the order of integration of variables standard tests for unit root such as the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests are often used. However, these tests are not generally reliable in small samples, because of their poor size and power properties i.e. they tend to over-reject the null hypothesis when it is true and under-reject it when it is false, respectively (Harris, 2003).

The Dickey-Fuller generalised least square (DF-GLS) de-trending test proposed by Elliot et al. (1996) and the Ng-Perron (MZ_a) test following Ng and Perron (2001) have been proposed to address these problems. Ng and Perron (2001) also address the problem of sensitivity of unit root testing to choice of lag. They propose a new information criterion, the modified information criteria (MIC)[iv]. In the first implementation of unit root tests, the maximum lag is employed by using the following formulae (Hayashi, 2000):

$$k_{\max} = \text{int}\left[12\left(\frac{T}{100}\right)^{0.25}\right]$$

With too small a lag, the test may not detect serial correlation at high-order lags. However, with too large a lag, the test may have low power since the significant correlation at one lag may be diluted by insignificant correlations at other lags. In our application $k_{\max} = 23$ days, the tests indicate that the lag 5 gives plausible results. This seems to be the number of opening regular period in Doha Securities Market in Qatar. The results of ERS-GLS & NP Tests are shown below. The results indicate that the variables volume (v_t)and return (r_t) are stationary in the first difference.

Unit Root Tests (with constant and trend)[v]

	LVOLUME	DLVOLUME	LCLOSE	DLCOLSE
DF-GLS	-0.924409	-4.098430**	-0.592031	-11.45901**

	LVOLUME	DLVOLUME	LCLOSE	DLCOLSE
MZ_a[vi]	-2.11317	-18.9098*	-1.32834	-47.4539**

5 Empirical results

The volatility of risk-return and information-return relationship is tested by using a GARCH-Mean model. The information arrival to the market v_t is introduced both in the return and risk equations. The risk return equation is represented by GARCH (1, 1) and EGARCH (1, 1). Four versions of GARCH in mean and variance equation are considered regarding to the contribution of the pertinent variables. These versions are shown in Tables 2. Tables 2.1 and 2.2 present the result of the GARCH and EGARCH for the entire period, while Tables 2.3 and 2.4 display the results of the two sub periods. The lag order of return is close to be three according to the global significance and the Akaike criterion. The major interpretation of estimation results are summarized in the following points.

In mean equation, the risk measured by the standard deviation error turns out to be positively related with return. This result indicates a high risk in return equation. Also, the lagged return has a positive coefficient, explaining the dynamic behavior of the transactions mainly in the first and the third day which exhibit pertinent information content.

The five days effects turn out to be significant individually and jointly. The day dummies effects depend on the daily pattern which is influenced by the stock market. The Monday (last Saturday) dummy is negatively related to return, but the rest of days have positive coefficients. This result comes from the settlement mode (t+1 or t+2) in the DSM: the payments of the shares are made one or two business days (Wednesday or Thursday) after the transaction is made off (Saturday or Monday). The first implication of this settlement is that on Saturday or Monday (The dummies of Saturday and Monday have high positive effects than the other three days) the already accrued profit is realized where sales are mostly made on these two days. The second implication is that the purchases on Wednesday or Thursday turn out to be higher than other days.

The volume v_t permits to enhance the global significance in the model 4 mainly in lagged returns. Its positive effect increases the daily information effects, and appears to be more important than the day of the week effects. Also, the return is positively and more significantly related to the risk. The increase in risk has a determinant effect on the return. The effect of variable r_{t-2} becomes significant, because its information content is increased by volume. The information content of v_t is already captured by the variable r_{t-j}. It seems that the volume has both a positive direct effect and negative indirect effect (via the information content at time $t-1$) on return. Then, the information flow determines the risk and return in the market. The individual impact of risk on return indicates imperfect information in the market. This result implies that the investors make their choices in imperfect information universe.

Furthermore, the information arrival beside the market inherent stock risk affects return through the risk equation. This means that the increase in the volume is felt in the volatility of the market and appears to be one of the factors of risk, which determines return in the market. It is found that there is a positive risk-return relationship when volume is introduced to both return and risk equation. In contrast, there is a negative volume-risk relationship which indicates that the a priori information could reduce a risk in variance equation.

Table 2.1: Various GARCH-GARCH models[vii]
Applied to DSM Returns 2002-2008

Mean Equation GARCH^{½}	**All period 1 1512**			
	Model 1	Model 2	Model 3	Model 4
σ_t	0.114 (1.60)	0.188 (2.45)	0.229 (3.28)	0.191 (2.46)
d_1	0.002 (5.01)	0.001 (1.97)	0.0008 (1.54)	0.002 (2.85)
d_2	-0.001 (-1.48)	-0.002 (-3.07)	-0.002 (-3.73)	-0.002 (-3.32)
d_3	0.002 (3.24)	0.001 (1.99)	0.0008 (1.54)	0.001 (1.71)
d_4	0.001 (2.22)	0.0001 (0.18)	-0.0002 (-0.31)	$5.2\ 10^{-5}$ (0.09)
d_5	0.0006 (1.24)	$-7.3\ 10^{-5}$ (-0.13)	-0.0003 (-0.51)	-0.0004 (-0.73)
r_{t-1}		0.195 (6.83)	0.205 (7.07)	0.187 (7.15)
r_{t-2}		0.011 (0.36)	0.013 (0.43)	0.070 (2.72)
r_{t-3}		0.044 (1.60)	0.050 (1.81)	0.045 (1.82)
v_t	0.007 (15.93)			0.007 (16.97)
Variance Equation GARCH				
1	$4.1\ 10^{-6}$ (4.23)	$3.5\ 10^{-6}$ (3.91)	$2.9\ 10^{-6}$ (5.54)	$5.3\ 10^{-6}$ (4.47)
e_{t-1}^2	0.276 (6.24)	0.244 (6.44)	0.222 (9.37)	0.278 (5.90)
σ_{t-1}^2	0.694 (19.51)	0.723 (20.75)	0.738 (40.14)	0.660 (15.86)
v_{t-1}	$-3.8\ 10^{-6}$ (-0.78)		$-1.2\ 10^{-5}$ (-14.06)	$-9.0\ 10^{-6}$ (-2.01)
$\beta_1 + w_1$	0.970	0.967	0.960	0.938
ll	5423	5350	5345	5456
Arch Test	0.906	0.798	0.733	0.969

In the parenthesis, there is the T-statistic based on the Maximum Likelihood Asymptotic Standard Error.

Table 2.2: Various GARCH-EGARCH models
Applied to DSM Returns 2002-2008

Mean Equation GARCH$^{1/2}$	**All period 1 1512**			
	Model 1	Model 2	Model 3	Model 4
σ_t	0.102 (1.53)	0.174 (2.15)	0.172 (2.14)	0.212 (2.63)
d_1	0.003 (5.59)	0.0007 (1.22)	0.0007 (1.27)	0.0009 (1.64)
d_2	-0.0006 (-1.25)	-0.002 (-3.42)	-0.002 (-3.40)	-0.002 (-3.87)
d_3	0.002 (3.72)	0.0008 (1.25)	0.0008 (1.26)	0.0005 (0.81)
d_4	0.001 (2.71)	-0.0003 (-0.43)	-0.0002 (-0.39)	-0.0005 (-0.86)
d_5	0.0007 (1.48)	-0.0003 (-0.60)	-0.0003 (-0.58)	-0.0008 (-1.48)
r_{t-1}		0.247 (8.56)	0.244 (8.45)	0.231 (8.90)
r_{t-2}		0.034 (1.21)	0.034 (1.20)	0.089 (3.56)
r_{t-3}		0.070 (2.64)	0.067 (2.52)	0.070 (3.00)
v_t	0.007 (15.66)			0.007 (17.10)
Variance Equation EGARCH				
1	-1.076 (-5.79)	-1.365 (-6.16)	-1.334 (-6.05)	-1.773 (-6.80)
$\lvert e_{t-1}/\sigma_{t-1}\rvert$	0.441 (8.98)	0.373 (7.47)	0.374 (7.50)	0.405 (7.51)
e_{t-1}/σ_{t-1}		-0.174 (-6.39)	-0.164 (-5.71)	-0.196 (-5.86)
$Ln(\sigma_{t-1}^2)$	0.924 (53.68)	0.892 (43.35)	0.895 (43.72)	0.854 (34.67)
v_{t-1}	-0.195 (-2.09)		-0.094 (-0.85)	-0.136 (-1.40)
ll	5427	5369	5370	5472
Arch Test	0.905	0.987	0.987	0.944

The GARCH-Mean model shows that the volume term has a more significant parameter in both return and risk equations, and that the information flow provided to the market comes from the risk and return variables. The first variable σ_t exhibits the sign of the trends in the model. The effect of negative second dummy variable is dominated by a positive trend effect (GARCH or EGARCH effect). It seems that the trend is more accentuated comparatively to the second sub-period. The negative effect is also dominated by a positive GARCH effect. The return information becomes more important after the entry of foreign investors in DSM: the memory of series return is increased and implies more sensibility to the recent past information.

The explanatory variables in the risk equation have positive signs and satisfy all conditions of parameters. This implies that the process is stable and the conditional variance is positive. In the variance equation[viii], the variable e_{t-1}^2 indicates the ARCH effect. In the first sub-period the ARCH effect is less comparatively to all period. This suggests that the entry of foreign investors increases the ARCH effect. The ARCH test concerning the residuals of return equations: It is clear that the second sub-period has more ARCH effect in residuals than the first sub-period. There is less ARCH effect in the residuals in the first sub-period (0.834) comparatively to the second sub-period (0.621). This result shows that the foreign shares increase the volatility in the DSM.

There is a high persistence of shocks in the volatility. This persistence, measured by $(\alpha_1 + \beta_1)$, in the GARCH model is in each case close to 1. There is a high persistence of the shocks in the volatility, but in the first sub-period it becomes less than the persistence in the second sub-period. This implies that the entry of foreign investors boost the persistence on the volatility. This finding is often observed in the high frequency financial data.

The EGARCH specification of the volatility describes the data ultimately better than the GARCH-M models. The EGARCH model has a priority for asymmetry, since it has a better fit to the data when the same number of parameters is considered. The global significance seems to be enhanced. There exists a leverage effect: the corresponding parameters in the EGARCH model have the appropriate negative signs i.e. shocks increase the volatility more than positive shocks. The standardized innovation e_{t-1}/σ_{t-1} indicates a negative correlation. This leads shareholders, who bear the residual risk of the firm, to perceive their future cash flow stream as being relatively more risky. The leverage effect has the appropriate sign; this result proves that a negative shock mainly in the second sub-period increases the volatility more than a positive shock.

Table 2.3: Various GARCH-GARCH models
Applied to DSM Returns on Sub periods

Mean Equation GARCH$^{1/2}$	**Sub period 1 688**				**Sub period 689 1512**			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
σ_t	0.216	0.265	0.264	0.205	-0.009	0.093	0.125	0.144
	(2.03)	(2.20)	(2.16)	(1.69)	(-0.09)	(0.88)	(1.31)	(1.35)
d_1	0.003	0.002	0.002	0.002	0.003	0.0009	0.0008	0.001
	(3.03)	(2.02)	(1.99)	(2.24)	(4.38)	(1.33)	(1.17)	(2.05)
d_2	-0.001	-0.002	-0.002	-0.002	-0.0004	-0.001	-0.002	-0.002
	(-1.35)	(-2.26)	(-2.22)	(-1.89)	(-0.54)	(-1.73)	(-3.27)	(-2.45)
d_3	0.002	0.0009	0.0009	0.001	0.002	0.001	0.001	0.001
	(1.93)	(0.94)	(0.89)	(1.45)	(2.94)	(2.08)	(1.96)	(1.31)
d_4	0.0003	-0.0007	-0.0008	-0.0003	0.002	0.0009	0.0007	0.0005
	(0.40)	(-0.73)	(-0.76)	(-0.29)	(2.98)	(1.13)	(1.04)	(0.71)
d_5	0.0007	$-4.3\ 10^{-5}$	$-7.7\ 10^{-5}$		0.0009	0.0002	$-7.1\ 10^{-5}$	-0.0005
	(0.81)	(-0.04)	(-0.08)		(1.41)	(0.26)	(-0.11)	(-0.73)
r_{t-1}		0.191	0.196	0.185		0.199	0.195	0.190
		(4.48)	(4.60)	(4.78)		(5.04)	(5.27)	(5.27)
r_{t-2}		0.016	0.019	0.076		-0.0007	0.0008	0.051
		(0.38)	(0.44)	(2.06)		(-0.02)	(0.02)	(1.40)
r_{t-3}		0.005	0.004	0.018		0.072	0.070	0.069
		(0.13)	(0.09)	(0.50)		(1.95)	(1.85)	(2.00)
v_t	0.006			0.007	0.007			0.007
	(10.66)			(11.24)	(11.56)			(12.03)
Variance Equation GARCH								
1	$4.4\ 10^{-6}$	$3.7\ 10^{-6}$	$3.8\ 10^{-6}$	$6.9\ 10^{-6}$	$3.9\ 10^{-6}$	$4.2\ 10^{-6}$	$2.2\ 10^{-6}$	$5.1\ 10^{-6}$
	(2.69)	(2.43)	(2.48)	(2.92)	(3.39)	(3.37)	(3.04)	(3.52)
e_{t-1}^2	0.257	0.202	0.201	0.257	0.290	0.299	0.210	0.304
	(3.88)	(4.17)	(4.11)	(3.59)	(5.05)	(5.02)	(5.05)	(4.69)
σ_{t-1}^2	0.721	0.763	0.763	0.669	0.669	0.654	0.764	0.627
	(14.06)	(15.86)	(15.81)	(9.97)	(14.19)	(12.24)	(21.64)	(11.30)
v_{t-1}	$1.1\ 10^{-6}$		$-6.6\ 10^{-6}$	$-1.2\ 10^{-5}$	$-7.4\ 10^{-6}$		$-1.2\ 10^{-5}$	$-8.1\ 10^{-6}$
	(0.13)		(-0.76)	(-1.85)	(-1.28)		(-4.00)	(-1.25)
$\beta_1 + w_1$	0.978	0.965	0.964	0.926	0.959	0.953	0.974	0.931
ll	2414	2370	2370	2426	3018	2990	2995	3037
Arch Test	0.985	0.923	0.917	0.986	0.826	0.666	0.516	0.833

Table 2.4: Various GARCH-EGARCH models
Applied to DSM Returns on Sub periods

Mean Equation GARCH½	**Sub period 1 688**				**Sub period 689 1512**			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
σ_t	0.211 (2.07)	0.307 (2.27)	0.302 (2.24)	0.282 (2.18)	0.0004 (0.004)	0.013 (0.12)	0.176 (0.16)	0.138 (1.24)
d_1	0.003 (3.48)	0.001 (1.01)	0.0012 (1.08)	0.001 (1.09)	0.003 (4.55)	0.001 (1.43)	0.001 (1.44)	0.001 (1.43)
d_2	-0.0008 (-1.08)	-0.003 (-2.59)	-0.003 (-2.55)	-0.003 (-2.46)	-0.0003 (-0.49)	-0.001 (-1.62)	-0.001 (-1.67)	-0.002 (-2.83)
d_3	0.002 (2.16)	0.0001 (0.10)	0.0002 (0.15)	0.0003 (0.33)	0.002 (3.21)	0.002 (2.03)	0.002 (1.99)	0.0006 (0.80)
d_4	0.0006 (0.74)	-0.0016 (-1.37)	-0.002 (-1.34)	-0.001 (-1.23)	0.002 (3.11)	0.0008 (1.06)	0.001 (1.08)	$5.4\ 10^{-5}$ (0.07)
d_5	0.0008 (0.90)	-0.0006 (-0.55)	-0.0006 (-0.52)	-0.0008 (-0.80)	0.0009 (1.45)	0.0002 (0.28)	0.0002 (0.25)	-0.0008 (-1.15)
r_{t-1}		0.252 (5.52)	0.249 (5.49)	0.235 (5.86)		0.235 (6.14)	0.229 (5.96)	0.231 (6.57)
r_{t-2}		0.054 (1.29)	0.054 (1.26)	0.101 (2.80)		-0.003 (-0.08)	-0.004 (-0.11)	0.060 (1.72)
r_{t-3}		0.042 (1.02)	0.038 (0.92)	0.049 (1.41)		0.093 (2.62)	0.090 (2.54)	0.093 (2.89)
v_t	0.007 (10.58)			0.007 (11.36)	0.007 (11.59)			0.007 (13.14)
Variance Equation EGARCH								
1	-1.022 (-3.74)	-1.706 (-3.94)	-1634 (-3.86)	-2.167 (-4.56)	-1.174 (-4.52)	-1.204 (-4.83)	-1.214 (-4.80)	-1.543 (-5.16)
$\lvert e_{t-1}/\sigma_{t-1}\rvert$	0.418 (5.81)	0.377 (4.67)	0.375 (4.68)	0.441 (4.97)	0.455 (6.85)	0.329 (5.26)	0.338 (5.31)	0.315 (4.65)
e_{t-1}/σ_{t-1}		-0.169 (-3.94)	-0.158 (-3.56)	-0.188 (-3.46)		-0.199 (-5.29)	-0.185 (-4.40)	-0.242 (-4.89)
$Ln\left(\sigma_{t-1}^2\right)$	0.926 (35.94)	0.856 (20.71)	0.863 (21.34)	0.813 (17.67)	0.917 (38.52)	0.907 (39.79)	0.906 (39.10)	0.873 (31.41)
v_{t-1}	-0.298 (-2.22)		-0.066 (-0.49)	-0.298 (-2.47)	-0.088 (-0.57)		-0.174 (-0.84)	0.157 (0.69)
ll	2419	2377	2377	2433	3018	3005	3006	3051
Arch Test	0.991	0.706	0.721	0.834	0.851	0.340	0.312	0.621

6 Conclusions

The economy of Qatar has been passing through important phase of economic development. In the last few years a number of policy initiatives were ushered in covering all significant segments of the economy including the financial sector in general and the stock market in particular. Some of the policy issues have an impact on the stock market functioning and prices volatility. This study provides some insights regarding the behavior of volatility in Doha Securities Market.

It is found that there is a positive risk-return relationship when volume is introduced to both return and risk equation. In contrast, there is a negative volume-risk relationship which indicates that the a priori information could reduce a risk in variance equation.

The results of the study reveal that DSM exhibits volatility clustering and persistence. Our empirical results from the GARCH-M and EGARCH models for conditional volatility tests show that foreign investor's participation in the equity market not only increases the volatility in DSM but it also boost its persistence. The EGARCH specification of the volatility describes the data ultimately better than the GARCH-M models. The EGARCH model has a priority for asymmetry, since it has a better fit to the data when the same number of parameters is considered.

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Notes

[i] A law was issued amending some provisions of Law number 13 of the year 2000 regulating the foreign investment in the economic activities. The amendment allows non-Qatari's to invest in all companies listed at the DSM at a rate not exceeding 25% of the traded shares.

[ii] Daily returns are identified as the logarithmic difference of the closing index value (as daily price) for the two consecutive closing days. The return variable is defined as $Ln(close_t) - Ln(close_{t-1}) := r_t$ and the information volume variable v_t expressed the logarithmic variation of daily value of share traded.

[iii] Under leptokurtic distribution of variables, the appropriate distribution such Student-*t* is used (because the unconditional variance does not exist) as a distribution of innovations in the GARCH model.

[iv] The distinction between the MIC and the standard information criteria such as the Akaike and the Schwartz Bayesian criteria is that the former takes into account the fact that the bias in the sum of the autoregressive coefficients is highly dependent on the number of lags.

[v] The critical values at 1%, 5% and 10% are -3.48, -2.89 and -2.57 respectively (Elliott-Rothenberg-Stock, Table 1, 1996). The lag length 5 is based on Modified AIC.

[vi] The critical values at 1%, 5% and 10% are -23.80, -17.30 and -14.20 respectively (Ng-Perron, Table 1, 2001). The lag length of all variables is 5 except for DLCLOSE which is 16. All lags are based on Modified AIC.

[vii] When we have estimated previously a GARCH (1, 1) model with the data, the standardized residual showed evidence of excess kurtosis. To model the tick tail in the residuals, we will assume that the errors follow a Student t-distribution.

[viii] The results of risk equation are more comparable with the earlier empirical works on emerging markets (Floros, 2008).