Testing Dynamic Dependency Behavior of Stock Prices in the Doha Securities Market

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Abstract

This paper investigates the dynamic behavior of individual shares quoted on the Doha Securities Market (DSM). Weekly individual prices over the time span from January 2002 to October 2004 were applied. Robinson's semi-parametric Lagrange Multiplier testes were conducted in search of evidence patterns consistent with long-memory in stock prices. Statistical findings did not support the random walk hypothesis, and would seem to lend support for weak-form efficiency in the DSM.

Key Words: homogeneous expectations, random walk hypothesis, fractional integration, heteroskedastic increment.

Introduction

The issue of market efficiency in general and the dynamic behavior of individual stocks, in particular, have been an important subject for both developed as well as emerging financial markets. It could be argued that the issue of market efficiency is of great importance for both resource allocation and portfolio investment reasons. While developed equity markets are characterized by high liquidity, a sufficient number of market traders and few institutional barriers, emerging markets on the other hand, are characterized by thin trading, low liquidity and uninformed of traders with incomplete information and high volatility. Therefore, the efficiency of the market is dependent upon the volume of trading, which makes it difficult for traders to react to new information. A condition for a market to be efficient is that it must be complete, in the sense that the size of the market must be fairly large, and the individual agents in the market must have homogeneous expectations and similar attitudes toward the trade-off between risk and return (Samuels, 1981). Thus, since the issue of efficiency is of some importance, both for domestic and foreign investors, as well as for the allocation of scarce resources within the Qatari economy, addressing this question will help out understanding not only the extent of capital formation within the domestic economy, but also of the behavior features of investors within the market more generally. However, in a small market, such as the DSM, supply limitation, thin trading, coupled with the absence of investment funds, preclude investors from constructing a well balanced portfolio. Consequently, small changes in investors' demands in these markets, can cause large price swings and a significant deviation of share prices from their intrinsic values.

The focus of this paper then is to investigate the dynamic behavior of individual shares quoted on the DSM. In doing so, we assess the possibility that the process which generates their dynamics lacks mean dependence and, more specifically, is a random walk. We also shed light on the nature of the departure from the random walk hypothesis by looking at the fractional integration. For the theory tells us that if stock prices follow a random walk, the market can be deemed efficient in the sense that it discounts all available information (Fama, 1965).

This paper is organized as follows. In the next section , we provide a brief overview of the market microstructure and some features of the DSM.. Section 3 reviews the literature on market efficiency. The research objectives and testable hypotheses will be explained in section 4. While section 5 describes the methodology of the research, section 6 reports the test results for our sample, and section 7 concludes the paper with some remarks and policy implications.

Doha Securities Market Microstructure:

Joint stock companies are a recent phenomenon in Qatar and date back to 1957 when the Qatar National Navigation & Transportation Company was established. Prior to the establishment of the DSM, trading occurred through unlicensed dealers, with each dealer setting prices and controlling turnover.

In 1995, Law No. 14 was decreed establishing the DSM which was empowered to regulate and develop the trading in financial instruments. A market committee was established as per Council of Ministers resolution on 17th July, 1996. Upon finalizing the necessary framework and procedures, the DSM was officially opened on 26th May 1997.

Despite its short years of existence, the market is playing an active role as an instrument for increasing liquidity of the capital market and for facilitating the mobilization of domestic savings and the channeling of financial resources. Over the period 1998 to 2003, the DSM has achieved remarkable progress in terms of trading volume, number of listed companies and market capitalization as the following table indicates. Concerning the trading mechanism, it started manually in its inception, then turned semi-electronic with the accomplishment of the central registration project in the second stage. On 11th March, 2002, DSM turned fully electronic with the implementation of the Trading, Settlements and Central Registration Systems.

Table (1) : DSM Major Indicators

End of period	1998	1999	2000	2001	2002	2003
No of brokerage firms	7	7	7	8	8	8
No of shares traded(mn)	31.2	28.2	31.6	51.6	80	190
Value of shares traded(QRmn)	970	1232	869	1504	3215	-
No. of contracts(000)	7.75	13.96	12.23	15.80	29.8	135
Market cap.(QRmn)	13968	20310	18860	26700	38250	97200
Change in index %	35.1	-0,76	-14.74	37.3	37.2	69.8
Listed companies	19	21	22	22	24	28

Source: DSM, Annual Report, Different Issues.

As the above Table shows, the number of companies listed increased from 19 in 1998 to 28 in 2003. While the number of traded shares increased from 31 million in 1998 to 190 million in 2003. Market capitalization jumped from QR (Qatari Riyal) 13968 million to QR 97200 million for the same period. As far as the general index is concerned, the table shows a fluctuation from year to another, with a rapid growth in 2003.

DSM activities were mainly restricted for Qatari citizens. Gulf Cooperation Council citizens are allowed to hold up to 25% of Qatari shares in all firms listed on the DSM, with the exception of banks and finance companies. Currently, non-Qatari are allowed to own and trade shares of Qatari Telecom (Q-Tel), but conditions are gradually relaxed for GCC citizens.

Concerning the instruments traded, only common stocks are dealt with in the market, and activities are mainly restricted for Qatari citizens. Plans are underway to open the market to expatriates and, in due course, to other investors possibly through the medium of mutual funds. As in most capital markets, securities traded on the DSM are subject to daily price limit (10% limit up and 5% limit down) in order to deter speculative investments.

Literature Review

There is recent interest on the market efficiency of emerging capital markets as market data of these countries are becoming available from both public and private sources. It is worth mentioning that most of these studies have focused on examining the behavior of developed stock exchanges in developed countries, and very few have dealt with emerging markets.

For developed markets, the investigation of the dynamic behavior of individual stocks has given a noticeable attention recently, see for examples: Fama (1970), Hong (1978), D'Ambrosio (1980), Cooper (1983), Shiller and Perron (1985), Lawrence (1986), Liu and He (1991), Harvey (1993), Claessens et al. (1993), Poon (1995), Urrutia (1995), Mase (2000), Lewellen (2000), Dockery et al (2001), and Ding et al (2004).

For emerging markets, studies are quite few, see for example: Butler and Malaikah (1992) for Kuwait and Saudi Arabia, Panas (1990) for Greece, El-Erian and Kumar (1995) for Turkey and Jordan, Campell (1995) for Latin America, and Al-Sulaiti (2004) and Al-Sulaiti et al. (2005) for Qatar.

The investigation was generally focusing on studying different aspects of dynamic behavior of individual stocks, namely, the predictability of short-horizon stock prices returns along with analyses, and in particular, the possibility that the individual stock prices process generating their dynamics lacks mean dependence and, more specifically, is a random walk process. Some lights were given on the nature of the departures from the random walk hypothesis by looking at long-range mean dependence or fractional integration with second-order moment allowed.

It is well-known, (see for example Fama ,1965), that if stock prices follow a random walk process, then the market can be deemed efficient in the sense that it discounts all available information. This theoretical hypothesis has been widely tested in both developed and emerging markets; see for examples D'Ambrosio (1980), Shiller and Perron (1985), Liu and He (1991), Harvey (1993), Claessens et al. (1993), Poon (1995), and Urrutia (1995). The evidence, in overall however, has been somewhat mixed. For example, Fama (1970) finds no evidence of patterns in stock prices, while Hong (1978), Cooper (1983), and Lawrence (1986) lend support to the random walk hypothesis.

Objectives and Testable Hypotheses:

The focus of this paper is to investigate the dynamic behavior of individual shares quoted on the DSM. In doing so, we assess the possibility that the process generating their dynamics lacks mean dependence and, more specifically, is a random walk. It is hoped that our analysis will go some way in explaining whether the institutional and legal changes can be associated with an efficient DSM.

For the purpose of our research, a statistical model will be formulated, and the methodology adopted in this paper, will be similar to the one applied by Dockery et al (2001). However, the following testable hypotheses will be examined:

H_1: The price behavior of the DSM follows a random walk with homoskedastic increments.

H_2: The price behavior of the DSM follows a random walk with heteroskedastic increments.

It could be argued that studying the presence of long-memory or fractionally integrated components may yield important implications for conventional economical aspects. For instance, optimal consumption, savings and investment decisions may become sensitive to time if stock returns revealed such a dependence. Therefore, identifying the type of dependence prevalent in the DSM would further help in predicting investors' behavior. Thus we conduct testing the following hypotheses:

H_3: The price behavior of the DSM has dependency at short lags of times.

H_4: The price behavior of the DSM has a presence of long-memory dependency.

Methodology

Cochrane (1988) and Lo and MacKinlay (1988), considered testing the presence of random walk behavior in (log) stock prices through exploiting the stationarity property of the returns process (as a log price difference), they showed that the variance of the k-period return is simply *k* times the variance of the 1-period return.

Let P_t is the current price of an stock, then the rate of return on this stock is

$= 100(\ln P_t - \ln P_{t-1})$.

Using Wold's (1938) decomposition theorem, the error term $\varepsilon_t$in the returns process R_t, that can be written as

$$R_t = \mu + \varepsilon_t$$

where ε_t is a white noise sequence, can be decomposed as

$$\varepsilon_t = \Sigma \; \psi_t {}^{*\,oo} {}_{t\text{-}i}$$

It can then be shown, see Hamilton (1994), Chapter 17 for details, that as the number of available observations, T, increases,

$$^{\lim} \text{Var}\,(R^k_t) = \sigma^2\,[\psi(1)],$$

where, R^k_t represents the k-period return. It follows that, under the null hypotheses of random walk in stock prices, the *variance ratio*

$$\text{VR}\,(k) \equiv \text{Var}(R^k_t)\,/\,[k * \text{Var}(R_t)]$$

$$= 1, \quad \text{as } k \text{ increases.}$$

Now, given a sequence of T (log) stock price differences, $R_1, R_2, \ldots, R_T$, and let

$$\text{Var}\,(R^k_t) = \Sigma\,(R^k_t - k \cdot \bar{R})^2\,/\,(T\text{-}1),$$

$$\text{Var}\,(R_t) = \Sigma\,(R_t - \bar{R})^2\,/[{}^{(T-k+1)*(1-k/T)}],$$

and

$$V(k) = {}_T * \Sigma^{[2(k-i)/k]^2} * \Sigma^{(R_{t-i} - \bar{R})^2 / [\Sigma^{(R_t - \bar{R})^2}]^2},$$

then, following Lo and MacKinlay (1988), under the hypotheses that the price process is a random walk with homoskedastic increments, the variance ratio estimator is normally distributed with mean 1 and variance $2(2k-1)(k-1)/(3k/T)$. Therefore, it follows that the random variable given by:

$$Z_1(k) = [\text{VR}\,(k) - 1]\,/\,[2(2k-1)(k-1)\,/\,(3k/T)]^{1/2}$$

is asymptotically normally distributed with mean 0 and variance 1.

Since it is well known that the conditional variance of most stock returns is not constant over time; see Hamao et al (1990), Theodassiou and Lee (1993) and Koutmos et al (1994), it follows that heteroscedasticity would lead to a rejection of tests performed using $Z_1(k)$ even though the aspect of interest in testing the random walk hypothesis is dependence in conditional means.

Similarly, under the hypotheses that the price process is a random walk with heteroscedastic increments, the random variable given by:

$$Z_2(k) = [\text{VR}\,(k) - 1]\,/\,[V(k)\,/\,T)]^{1/2}$$

is also asymptotically normally distributed with mean 0 and variance 1, would led to a heteroscedasticity-consistent variant of the variance ratio test, Lo and MacKinlay (1988) advance.

To investigate the behavior of long-term dependency in stocks, Robinson (1991) considers semi-parametric Lagrange Multiplier procedure in the time domain to test considers the null hypothesis of a white noise process against the alternative of fractional white noise, as an autoregressive fractional integrated moving averages of order 0, *d*, and 0, ARFIMA(0,*d*,0). The stock price returns, R_1, R_2, ..., is said to be generated by a fractionally differenced of order *d* , see Granger and Joyeux (1980) and Hosking (1981), if it satisfies the following form:

$$(1 - L)^d R_t = \mu + \varepsilon_t ,$$

where *L* is the lag operator, and ε_1, ε_2, . . . consists a sequence of identically independent normally distributed random variables with mean 0 and constant variance. It can be shown, Robinson (1991), that the random variables $\lambda_1$and λ_2 given by:

$$\lambda_1 = \Sigma\ [C_i/(C_o * i)]\ /\ [\Sigma(1/i)^2 / T]^{1/2},$$

under the homoscedasticity assumption, and

$$\lambda_1 = \Sigma(C_i / i)\ /\ [\Sigma K_i * (1/i)^2 / T]^{1/2},$$

under the heteroscedasticity assumption, where,

$$C_i = \Sigma\ (R_t - \bar{R}) * (R_{t-i} - \bar{R}) / T ,$$

and

$$K_i = \Sigma\ (R_t - \bar{R}) * (R_{t-i} - \bar{R})^2 / T ,$$

are both asymptotically normally distributed with mean 0 and variance 1. Therefore, tests can be conducted to show dependency at short lags in the stock prices, as well as the presence of long-memory in the stock prices.

Empirical analysis:

Before we present our statistical findings, table 2 was constructed. This table presents a descriptive statistics of DSM stock prices during the whole period.

In investigating the behavior the DSM, we applied weekly individual prices over the time span from January 2002 to October 2004, and the variance ratio is calculated for each stock for the cases k = 2 and 3. The results are presented in Table 3.

Table (2) : Descriptive statistics of DSM stock prices

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Stock	N	Min	Max	Range	Mean	Std. Dev	Skewness	Kurtosis
AAHS	147	14.2	72.0	57.80	35.91	14.49015	.363	-.720
ABQK	142	24.0	153	129.20	66.37	33.50273	.596	-.698
AKHI	84	34.0	188	154.00	97.18	51.71385	.382	-1.613
CBQK	152	51.0	239	188.40	110.5	51.11233	.848	-.487
DHBK	148	45.0	225	179.60	112.6	45.83375	.387	-.925
DOHI	151	14.6	64.7	50.10	34.15	13.39155	.303	-1.255
GWCS	29	19.6	32.3	12.70	26.85	2.89786	-.424	.292
IQCD	67	48.6	74.1	25.54	57.98	5.75983	.709	-.197
NLCS	61	27.1	48.5	21.40	34.80	5.32676	.370	-.674
QATI	142	60.6	207	146.70	109.4	43.11258	1.115	-.194
QCFS	126	22.8	88.0	65.20	43.00	15.63708	1.232	.641
QEWS	153	20.9	66.0	45.10	39.83	11.56730	.080	-1.196
QFLS	103	26.5	52.0	25.50	39.52	6.99324	-.441	-.801
QFMD	122	22.1	34.5	12.40	28.59	2.22695	.247	.059
QGMD	145	12.5	47.0	34.50	27.71	8.55844	.086	-1.066
QGRI	51	54.0	209	155.00	122.6	45.44579	.327	-1.558
QIBK	152	34.0	215	180.70	85.14	50.23920	.889	-.453
QIIK	151	34.1	186	151.80	92.84	48.30832	.544	-1.152
QIMD	153	15.2	54.7	39.50	36.53	10.49863	-.608	-.657
QISI	120	23.5	201	177.00	97.57	57.39647	.266	-1.460
QLTS	38	5.70	8.90	3.20	6.7105	.76150	1.213	.847
QMLS	40	17.2	27.8	10.60	23.17	3.24750	-.350	-1.366
QNBK	151	52.1	180	128.20	106.7	35.83417	.540	-.850
QNCD	148	80.0	249	168.80	154.6	43.19703	.239	-.749
QNNS	151	58.5	209	150.10	111.3	29.35080	.628	.602
QRES	153	17.0	102	84.80	44.53	24.55255	1.197	.197
QSHS	152	20.5	177	156.30	63.73	43.00359	.892	-.210
QTEL	152	82.5	206	123.20	135.5	30.55891	.313	-.701
QTIS	76	68.2	99.7	31.50	83.95	7.38047	-.110	-.744
SIIS	142	.60	15.4	14.80	10.07	3.64029	-1.643	2.264
UDCD	74	16.5	50.3	33.80	32.33	7.45859	.606	-.011
Total	3676	.60	249	248.20	71.19	51.10531	.997	.111

Table 3: Empirical results of the variance ratio and long-range dependence tests for weekly Doha Stock Market series.

Stock	VR(2)	$Z_1(2)$	$Z_2(2)$	VR(3)	$Z_1(3)$	$Z_2(3)$	λ_1	λ_2
1. AAHS	0.952339	-0.57786	-0.09321	0.857736	-2.57127	-0.41475	-1.11633	-0.88246
2. ABQH	1.028219	0.336268	0.059158	1.039561	0.702758	0.123585	-0.71861	-0.69352
3. AKHI	0.292791	2.683474	0.478671	1.559606	7.645678	1.363815	0.007705	0.006313
4. CBQK	0.888958	-1.36902	-0.28696	0.850379	-2.74984	-0.57637	0.519306	0.568607
5. DHBK	0.823392	-2.14853	-0.32014	0.714665	-5.17463	-0.77104	-1.02903	-0.93194
6. DOHI	0.903436	-1.17476	-0.20883	0.912475	-1.58729	-0.28216	-0.24491	-0.22905
7. GWCS	0.708046	-1.57222	-0.19733	0.722409	-2.22843	-0.2797	0.36934	0.422493
8. IQCD	0.828306	-1.40538	-0.36329	0.66155	-4.12977	-1.06754	-1.08325	-1.21538
9. NLCS	0.78281	-1.69631	-0.20348	0.717394	-3.29034	-0.3947	0.211676	0.272542
10. QATI	1.066278	0.789799	0.186862	0.967642	-0.57481	-0.13593	-1.7073	-1.20444
11. QCFS	0.972059	-0.31364	-0.06674	0.937699	-1.0425	-0.22174	-0.85277	-0.86086
12. QEWS	0.871733	-1.58658	-0.27619	0.804472	-3.60535	-0.62751	-1.05065	-0.9366
13. QFLS	0.763107	-2.4042	-0.44554	0.736311	-3.98937	-0.7393	0.576475	0.491623
14. QFMD	0.99804	-0.02165	-0.00494	0.921414	-1.29396	-0.29418	-1.98779	-1.83964
15. QGMD	0.887447	-1.35532	-0.22004	0.818821	-3.25226	-0.528	0.02198	0.020825
16. QGRI	1.159447	1.138681	0.167745	1.155364	1.65398	0.243657	-1.0372	-1.27567
17. QIBK	1.032113	0.395921	0.076431	1.13876	2.550235	0.492325	0.048398	0.049311
18. QIIK	0.772728	-2.79277	-0.55833	0.672654	-5.99639	-1.19883	-0.56166	-0.61461
19. QIMD	0.870173	-1.60587	-0.31151	0.920101	-1.47327	-0.28578	0.200027	0.210675
20. QISI	1.190384	2.085555	0.349956	1.343572	5.610509	0.941501	-0.85396	-0.89909
21. QLTS	1.200678	1.237063	0.209733	1.13999	1.28642	0.216703	-1.13686	-1.43388
22. QMLS	0.811516	-1.19208	-0.15988	0.763296	-2.23166	-0.29929	-0.20982	-0.29781
23. QNBK	0.964286	-0.43886	-0.11402	0.834126	-3.03851	-0.78941	-1.46271	-1.41987
24. QNCD	0.903544	-1.17343	-0.29119	0.853741	-2.65245	-0.65816	-0.83164	-0.77659
25. QNNS	0.862111	-1.69441	-0.33738	0.877734	-2.2397	-0.44595	0.030744	0.030856
26. QRES	0.99201	-0.09883	-0.01962	1.143098	2.638599	0.523722	1.451083	1.01997
27. QSHS	0.941348	-0.72311	-0.10539	0.977881	-0.40652	-0.05924	1.238508	1.328531
28. QTEL	1.007102	0.087564	0.033109	0.96647	-0.61625	-0.2329	-1.0735	-1.08361
29. QTIS	0.737961	-2.2844	-0.4764	0.730955	-3.49644	-0.72913	0.224352	0.243143
30. SIIS	1.01249	0.148839	0.064369	1.032143	0.570987	0.024694	-0.12186	-0.46569
31. UDCD	0.897952	-0.87785	-0.09886	0.840303	-2.04789	-0.23058	-0.51457	-0.62616

From Table 3, we can conclude the following ;

Firstly, it can be seen that for the majority of individual stocks in the sample, the variance ratios are not significantly different from unity.

Secondly, as stated earlier, under the corresponding relevant null hypotheses, namely H_1 and H_2 respectively, $Z_1(k)$ and $Z_2(k)$ both have a standard normal distribution. Therefore, any sample values of these statistics falling in the tailends of the standard normal distribution is then an indicative of a non-random walk behavior. From Table 3, and under the homoscedasticity hypothesis, we found that only 5 stocks have produced significant statistics for 2 weeks returns, 2 point towards mean aversion over 2 weeks.

Thirdly, when the effect of heteroscedasticity is taken into account, however, no stock appeared to violate the null hypotheses.

Fourthly, evidence of mean dependence under H_2, over a longer horizon (3 periods), is found for 20 return series. When interpreted jointly with the results over a 2 weeks period, we conclude that the majority of these series pointed to mean reversion, with only 2 suggesting mean aversion.

Fifthly, the dependence documented by the variance ratio tests appeared to be of the long-range type for no stocks, implying that the dependency is of short-range type for all stocks.

Sixthly, for exactly 60% of them, the Lagrange Multiplier test suggested that this dependence may be, under the homoscedastic null hypotheses, negative. When heteroscedasticity is taken into account, the evidence of fractional differencing can not be found for any stocks also, suggesting short-run mean reversion.

Concluding Remarks and Policy Implications:

This paper has been concerned with the dynamic behavior of prices in the DSM. We attempted to establish the nature of documented departures by focusing on the behavior of autocorrelation in the process. Specifically, we applied Robinson's semi-parametric Lagrange Multiplier tests in search of evidence patterns consistent with long-memory in stock prices.

Taking an overall view of the results in Table 3, the random walk hypothesis cannot be supported, and would seem to lend support for weak-form efficiency in the DSM. Since these results provide additional empirical support for the efficiency of the DSM, public policy makers are thus furnished with the economic and marketing basis upon which to implement appropriate regulatory measures to improve market performance as well as to enhance the informational efficiency of the market more generally.

Finally, the policy implication to be derived from such analysis is as follows:

. These statistical results derived for Qatar, could be applicable to other countries in the Gulf Cooperation Council, due to the similarities in economic and financial structures.

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