Exploring Stability of Systematic Risk: Sectoral Portfolio Analysis

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Abstract

Results in this paper support evidence of time-varying systematic risk (beta coefficients) for five sectors, their securities are traded in Kuwait Stock Market. The paper indicates banks, and real estate sectors exhibit relatively wider range of systematic risk variation compared to the other sectors. As higher volatility in risk factor imply additional difficulty in managing and controlling risk, then wider range of systematic risk imply more exposure to risk. This new interpretation of risk evaluation adds a new element to risk assessment tools, since the standard CAPM approach views risk as high or low depending on whether it is greater or lower than the market beta, which is a unit.

قياس المخاطر المنتظمة في سوق الأسهم الكويتي : دراسة قطاعية

ملخص

تهتم الورقة بنمذجة المخاطر المنتظمة المتغيرة عبر الزمن لخمس قطاعات يتم تداول أوراقهم المالية في سوق الأسهم الكويتي، وتضم هذه القطاعات البنوك، الخدمات، العقار، الأغذية، الصناعة. توضح نتائج الدراسة بأن أسهم قطاع البنوك والعقار بجانب ارتفاع مخاطرهما فوق مخاطر السوق، يتسمان بمعدل تذبذب أعلى نسبياً مقارنة ببقية القطاعات الأخرى، الأمر الذي يرجح صعوبة إدارة وتقييم مخاطر أسهم هذين القطاعين. تقترح نتائج البحث بأن يصبح مستوى تذبذب المخاطر المنتظمة ضمن معايير قياس المخاطر للأوراق المالية المتداولة في أسواق الأسهم إذ لا يكفي في رأينا الاعتماد على الطريقة المتبعة في أدبيات الإدارة المالية وهي مقارنة حجم المخاطر المنتظمة إذا كانت أكبر أو أقل من الواحد الصحيح.

1. Introduction

How should a rational investor measure the risk of stock market investments? The search for an answer to this question became the major task in financial economics and that led to the development of the Capital Asset Pricing Model (CAPM) which became the centre piece in modern finance textbooks. The CAPM decomposes risk valuation into risk size (risk premium) and risk price (beta[(1)]). According to CAPM the required rate of return on a company's stock (or the cost of equity capital) depends on three components among which the stock's equity beta which measures the risk of company's stock relative to the market risk; or putting it differently, the risk each dollar invested in equity i contributes to the market portfolio. CAPM predicts that low beta stocks should offer low stock returns and higher beta stocks should offer higher stock returns. This implies that stocks with higher risks should yield higher returns to compensate for the additional risk borne.

Since the empirical findings of Fama and French (1992, 1993, 1995, 1996, and 1997) the traditional application of CAPM that assume constant beta has been invalidated, and since then research efforts were directed towards time-varying beta estimates. In theory beta estimates should reflect investors' uncertainty about future cash flows to equity, which in turn requires time-varying and thus forward looking beta estimates.

In pursuit for obtaining better beta estimates research focused on the use of time varying volatility models. Recent such work supporting time-varying beta include Mckenzie et al (2000) for U.S. banks; Lie, Brooks and Faff (2000) for the Australian financial sector; Faff, Hillier, and Hillier (2000) for U.K. industry portfolio; Yu (2002) for New Zealand, Moonis and Shah (2002) for the Indian Market, and Kanwer (2006) for the Karachi Market. The empirical implication of all these studies is that portfolio managers need constantly update and re-estimate the relationship between risk factors and returns, contrary to traditional application of CAPM that assumes constant beta coefficient.

An appropriate specification of time-varying volatility depends on what empirical regularities the model should capture. An important phenomena that characterizes volatility of asset returns is the so-called "leverage effect" which refers to the different response of volatility to bad news as compared to good news. To account for asymmetric effect of news on traded asset returns' volatility in this paper we adopt the Glosten, Jagannathan, and Runkle (1993) specification of GARCH model. GJR-GARCH specification separates the effect of negative news on volatility from that of positive news[(2)].

While there is a considerable amount of research in this area for industries in developed and in some emerging stock markets, similar work on GCC and less developed stock markets is lacking. Constrained by the lack of suitable time series data availability for other GCC stock markets, investigation in this paper has been

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[(1)] Beta also called systematic risk, which is the risk that cannot be reduced via a diversification strategy.

[(2)] Engle and Ng (1993) report evidences that, of many GARCH specifications the GJR asymmetric GARCH model provides the best forecast of volatility.

limited to the Kuwait stock market using data on six key sectors in Kuwait economy. This paper contributes to the existing literature by taking into account leverage effect, and skewed-fat-tailed aspects of volatility when estimating beta coefficients.

The reminder of the paper is structured as follows. The next section includes summary statistics. Section three outlines beta and volatility modeling approach. Section four includes estimation results. The final section concludes the study.

2. Data and Summary Statistics

Data employed in this study are daily stock price indices related to five sectors in Kuwait stock market, beside the aggregate stock index. The sample period covers from July-1-2002 to Feb-30-2008, including 1410 observations. The sectors included in this study are, banks; food; industrial; real estate; and the service sectors. Results in table (1) indicate that all sectors yield positive mean returns. The high values of kurtosis statistics indicate the stock price returns distribution is characterized by high peakness (fat tailedness) . The negative skewness results indicate that Kuwait portfolio investments exhibit high probability of negative returns, which is similar to the case in some developed and emerging markets as indicated by Harvey and Siddique (1999).

Table (1): Summary Statistics of Log Differenced Stock Returns

	Banks Sector	Food Sector	Industrial Sector	Real Estate Sector	Service Sector	Market Index
Mean	0.1E-2	0.7E-3	0.9E-3	0.9E-3	0.1E-2	0.1E-2
Skewness	-15.2	-13.1	-15.3	-14.6	-15.1	-15.1
Excess kurtosis	704	594	705	673	687	694
JB test p-value	**3856 (0.00)**	**2485 (0.00)**	**4348 (0.00)**	**3363 (0.00)**	**4400 (0.00)**	**5527 (0.00)**
Q(5) p-value	**356 (0.00)**	**319 (0.00)**	**353 (0.00)**	**338 (0.00)**	**346 (0.00)**	**351 (0.00)**
$Q^2(5)$ p-value	**355 (0.00)**	**354 (0.00)**	**352 (0.00)**	**354 (0.00)**	**355 (0.00)**	**355 (0.00)**
LM ARCH(1) p-vlue	**141 (0.00)**	1.50 (0.47)	**226 (0.00)**	**8.77 (0.01)**	**32.3 (0.00)**	**27.3 (0.00)**
LM ARCH(5) p-value	**208 (0.00)**	**567 (0.00)**	**579 (0,00)**	**567 (0.00)**	**539 (0.00)**	**568 (0.00)**

Note: Highlighted values are significant at 5% significance level.

The Jarque-Bera (JB) test statistic provides clear evidence to reject the null-hypothesis of normality for the unconditional distribution of the daily stock price changes for all sectors. The sample autocorrelation statistic indicated by Ljung-Box , Q statistic, show the Q(5) test statistic reject the null hypothesis of uncorrelated price changes up to five lags for all sectors. The high values for $Q^2(5)$ test statistic suggest that conditional homoskedasticity can be rejected for all sectors. To test the presence of hetroskidasticity more formally the LM test is employed. Results of LM statistics for ARCH(1) and ARCH(5) error terms confirm the significance of ARCH effects in the data.

3. Methodology
3.1Beta and Volatility modeling

Although the simple GARCH specification is widely used in the empirical research of finance, there is substantial evidence to show that volatility of asset returns is characterized by time varying asymmetry (Glosten, Jagannathan and Runkle (1993). As a result, to avoid misspecification of the conditional variance equation, a leverage term in the GARCH specification is included. The GARCH-type specification introduced by Glosten, et al, (1993) allows a quadratic response of volatility to news with different coefficients for good and bad news, but maintains the assertion that the minimum volatility will result when there is no news[(3)].
Given the capital market model**,**

$$R_{it} = \eta_i + \beta_i R_{mt} + e_{it} \qquad (1)$$

$$where \quad e_t = \sigma_t z$$

$$z_t \overset{i.id}{\sim} f(\omega;0,1)$$

$$and \quad \sigma^2{}_t = \alpha_0 + \sum_{q=1}^{Q} \alpha_q e^2{}_{t-q} + \sum_{p=1}^{P} \delta_p \sigma^2{}_{t-p} + \varepsilon_t$$

where R_{mt} is the return on market portfolio, R_{it} is the return on sector i, and η_i and β_i are the associated portfolio mean, and beta respectively. f(.) is the density function of the standardized residuals, z_t, where $E(z_t) = 0$, $v(z_t) = 1$, and ω is a vector of the parameters reflecting skewness and kurtosis parameters.

Beta coefficient in (1) reflects the sensitivity of industry return to change in market return. Thus, a portfolio with beta greater than one is considered more sensitive to market conditions[(4)]. In GARCH-type models the variance-covariance matrix of the different portfolios and the market index returns are not constant over time. In this case Beta is defined as:

$$\beta_{it}^{GARCH} = \frac{\text{cov}(R_{it}, R_{mt})}{\text{var}(R_{mt})} \qquad (2)$$

so that equation (1) becomes,

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(3) Any selection of an appropriate ARCH/GARCH model requires having a good idea of what empirical regularities the model should capture. Among documented other regularities in the literature are thick tails that characterize asset returns, and volatility clustering, which refers to the phenomena that large changes in volatility tend to be followed by large changes of either sign, and small changes to be followed by small changes.

(4) An important implication of Market Model represented by (1) is that the average beta for all sectors is equal to one. To see this note that the average market index is given as:

$$\overline{R}_{mt} = (1/N)\sum_{i=1}^{N} R_{it} = \sum_{i=1}^{N} (1/N)(\overline{\eta}_i + \beta_i R_{mt} + e_{it})$$

$$= \overline{\eta} + \overline{\beta}\, \overline{R}_{mt} + \overline{e}$$

$$\rightarrow \overline{\eta} = 0, \overline{\beta} = 1$$

$$R_{it} = \eta_i + \beta_{it}^{GARCH} R_{mt} + e_{it} \qquad (3)$$

One approach to estimating β_{it}^{GARCH} is to estimate conditional covariance, $cov(R_{it}R_{mt})$ and conditional market variance $v(R_{mt})$. Adopting asymmetric GARCH-type model the problem can be reduced to estimating the following specifications of variance and covariance equations:

$$\text{var}(R_{it}) \equiv \sigma^2{}_{it} = \omega + \sum_j [\alpha_j{}^+ I(e_{i,t-j} > 0) \,|\, e_{i,t-j} \,|^{\lambda} + \alpha_j{}^- (I-1)(e_{i,t-j} \le 0) \,|\, e_{i,t-j} \,|^{\lambda}]$$

$$+ \sum_{j=1} \delta_j \sigma^2{}_{i,t-j} \qquad (4)$$

where I denotes an indicator function taking on the values of 1 when $e_{t-i} > 0$, and 0 otherwise. The threshold ARCH (TARCH) model of Zakoian (1993) corresponds to equation (4) with $\lambda = 1$, whereas GJR–GARCH –type specification treats equation (4) with $\lambda = 2$, to allow for quadratic response of volatility to news with different coefficients for good and bad news, while maintaining the possibility that minimum volatility occurs when there is no news. Similarly, the variance of market portfolio from equation (4) holds with the change of the subscript from i to m.

The situation that $\alpha^+ > 0$, captures the asymmetric relationship between news (e_t) and volatility. For example, when $e_{it-j} > 0$, then I=1 and the conditional variance becomes,

$$\sigma^2{}_{it} = \omega + \sum_{j,q} \alpha_i{}^+ e^2{}_{i,t-j} + \sum_{j,p} \delta_j \sigma^2{}_{i,t-j}$$

and when $e_{it-j} < 0$, then I=0 and the conditional variance becomes

$$\sigma^2{}_{it} = \omega + \sum_{j,q} \alpha_i{}^- e^2{}_{i,t-j} + \sum_{j,p} \delta_j \sigma^2{}_{i,t-j}$$

Therefore, the negative news result in a variance level different from that associated with positive news.

Since it can be verified from (4), that $E(R_i - E(R_i))^2 = E(e_i{}^2)$ then $v(R_i) = v(e_i), v(R_m) = v(e_m)$. Then the conditional covariance of individual sectors and market portfolio can be computed by:

$$\text{cov}(R_{it}, R_{mt}) = \rho_{im} \sqrt{\sigma^2{}_{it} \sigma^2{}_{mt}} \qquad (5)$$

where ρ_{im} is the correlation coefficient between R_{it} and R_{mt}.

3.2 Skewed Distribution

It is well documented that even asymmetric GARCH models fail to fully account for skewness and leptkurtosis of high frequency financial time series when they are assumed to follow normal or symmetric Student's t-distributions. This has led to the use of asymmetric non-normal distributions to better specify conditional higher moments. An important candidate in this respect is Hansen's (1994) skewed t-distribution. Despite the fact that there are other distributions that allow for skewness and excess kurtosis we choose Hansen's distribution due to its relative simplicity and its superiority in empirical performance (Patton, 2004).

Given the standardized errors $\frac{\varepsilon_t}{\sqrt{\sigma^2{}_t}} = z_t$, with mean zero and variance one, then Hansen's (1994) autoregressive conditional density model with skewed error terms is specified as:

$$skt(z \setminus \phi, \theta) = \begin{cases} bc\left(1 + \frac{1}{\theta - 2}\left(\frac{bz + a}{1 - \phi}\right)^2\right)^{-(\theta+1)/2} & if \ \ z < -a/b \\ bc\left(1 + \frac{1}{\theta - 2}\left(\frac{bz + a}{1 + \phi}\right)^2\right)^{-(\theta+1)/2} & if \ \ z \geq -a/b \end{cases} \qquad (6)$$

where

$$a = 4\phi c \frac{\theta - 2}{\theta - 1}, \quad b = 1 + 3\phi^2 - a^2 \ , \quad c = \frac{\Gamma(\theta + 1)/2}{\sqrt{\pi(\theta - 2)}\Gamma(\theta/2)} \qquad (7)$$

and Γ denotes gamma function.

Specification of conditional distribution of the standardized residuals, $z_{t,}$ in equation (6) is determined by two parameters, Kurtosis (θ) and the skewness parameter (ϕ).The two parameters are restricted to $\theta > 2,$ and $-1 < \phi < 1$. When $\phi = 0,$ the skewed t-distribution tends to a symmetric t-distribution, and when $\theta \to \infty$, it tends to standardized normal distribution.

Hansen's skewed t-distribution is fat tailed, and skewed to the left (right) when ϕ is less (greater) than zero. Similar to the case of Student's t-distribution, when $\theta > 2,$ Hansen's skewed t-distribution is well defined and its second moment exists, while skewness exists if $\phi \neq 0,$ and kurtosis is defined if $\theta > 4,$. The formulas for the third and fourth moments of Hansen's skewed distribution are given as:

$$E(Z^3) = (m_3 - 3am_2 + 2a^3)/b^3$$
$$E(Z^4) = (m_4 - 4am_3 + 6a^2m_3 + 6a^2m_2 - 3a^4)/b^4$$

where

$$m_2 = 1 + 3\phi^2$$
$$m_3 = 16c\phi(1 + \phi^2)\frac{(\theta - 2)^2}{(\theta - 1)(\theta - 3)} \qquad if \ \ \theta > 3$$
$$m_4 = 3\frac{\theta - 2}{\theta - 4}(1 + 10\phi^2 + 5\phi^4) \qquad if \ \ \theta > 4$$

(for proof see Hansen, 1994, and also Jondeau, and Rockinger 2000).
The log-likelihood function of the GJR-skt is defined as:

$$L(\Omega;\Psi_{t-1}) = \sum_{t=2}^{T} \ln[SKt(z \setminus \theta, \phi; \Psi_{t-1})]$$

The maximum likelihood estimator for Ω is the solution of maximizing the log likelihood function stated above.

3.3 Performance Evaluation

In the following the predictive power of volatility forecast is utilized to evaluate the performance of the two models, the Normal distribution and skew-t distribution. To compute s-step ahead forecast for the conditional variance in equations (1) - (4), we need first to simplify equation (4) by assuming:

$$E(I(e_t > 0) = p(e_t > 0) = 0.5$$

$$E(I-1)(e_t \le 0) = p(e_t \le 0) = 0.5$$

and

$$E(e^2 \setminus \Omega_t) = \sigma^2{}_t$$

Since $e^2{}_t$ and the indicator function $I_t(e_t)$ are uncorrelated, then s-step ahead forecast can be stated as:

$$\hat{\sigma}^2{}_{t+s\setminus t} = w + [(0.5\alpha^+ + 0.5\alpha^-) + \delta]\sigma^2{}_{t+s-1\setminus t} \qquad (8)$$

The parameters of the two models are estimated using the sample data up to three days before the end of the sample date (Feb/27/2008). And then a forecast of one day ahead (Feb-28 observation) is computed. Using the estimated parameters and the one day-ahead forecast value of volatility a new forecast for volatility of Feb-29, is computed from equation (8) to obtain two days ahead forecast vaue. This procedure is repeated until we exhaust the actual realized values.

To test the predictive power of the two competing models (GJR-N, and GJR-skt) the Root Mean Squared Error (RMSE) is employed, which is computed by comparing the forecast values F_{t+j} with the actually realized values, A_{t+j}, or

$$RMSE(k) = \sqrt{\sum_{j=0}^{N_k-1} \frac{[F_{t+j+k} - A_{t+j+k}]^2}{N_k}}$$

Where k=1,2,3 denotes the forecast step, N_k, is total number of k-steps ahead forecasts.

Diebold and Mariano (1995) (DM) test has been employed to compare the accuracy of forecasts. When comparing forecasts from two competing models; model A, and model B, it is important to verify that prediction of model A is significantly more accurate, in terms of a loss function, DM(d), than the prediction of model B. The Diebold and Mariano test aims to test the null hypothesis of equality of forecast accuracy against the alternative of different forecasts across models. The null hypothesis of the test can be written as:

$$d_t = E(h(e_t{}^A) - h(e_t{}^B)) = 0 \qquad (9)$$

where $h(e_t^{\,i})$ refers to the forecast error of model i =A, B, when performing k-steps ahead forecast. The Diebold and Mariano test uses the autocorrelation-corrected sample mean of d_t in order to test significance of equation (9). If N observations are available, the test statistic is:

$$DM = [\hat{w}(\bar{d})]^{-1/2}\,\bar{d}$$

$$where \quad \hat{w}(\bar{d}) = \frac{1}{N}\{\hat{\rho}_0 + 2\sum_{h=1}^{K-1}\hat{\rho}_h\}$$

and

$$\hat{\rho}_h = \frac{1}{N}\sum_{t=h+1}^{N}(d_t - \bar{d})(d_{t-h} - \bar{d})$$

Under the null hypothesis of equal forecast accuracy, DM is asymptotically normally distributed.

4. Estimation Results

Estimation of beta coefficient based on conditional volatility of stock returns, assuming asymmetric GARCH specification under Normal distribution (GJR-N); and Skewed t-distribution (GJR-skt) of error terms is reported in table (2). Table (A1) in the appendix includes estimation results of the parameters of equations (4), (6), and (7). The significance of the asymmetry coefficient (α^+) for the Normal distribution for all sectors indicates positive shocks (or good news) have more significant effect on volatility than the effect of bad news. This result indicates that since investors in stock markets seek short term profit gains they attempt to benefit from positive news they seize often, but adjusting portfolios to negative shocks depends on the size of the shock, because portfolio adjustment to adverse shocks requires hedging aspects that entails additional cost.

Results of the skewed t-distribution also indicate the significance of the Kurtosis coefficient (θ) for all sectors, which suggest fat-tailed student t-density is needed to fully model the distribution of return. The log-likelihood values strongly suggest that the skewed-t distribution model outperform the Normal distribution model. Moreover, Root Mean Square Error (RMSE) and Diebold-Mariano (1995) test results in table (3), indicate the skewed-t distribution model yields the lowest values of the RMSE loss functions for all sectors compared to the Normal distribution specification. Thus, DM test statistic confirms that the predictive power of the two models are significantly different for all sectors; implying that skewed-t distribution model yields superior forecast performance for forward-looking beta values.

It is apparent from the range of beta values that both models support evidence of time-varying beta values for all sectors. Based on the skewed-t distribution model results, Beta values for Banks, and real estate sectors exhibit wider range compared to the remaining other sectors. The high values of the correlation coefficient values confirm strong association between volatilities of the sectors and the market volatility.

Table (2): Estimate of Beta Coefficients

Sectors	GJR-GARCH Normal dist.	GJR-GARCH Sk-t dist.
Banks **(low/high)** **Range** ρ	1.51 (0.68/25.1) 24.4 0.75	3.89 (0.46/4.27) 3.8 0.69
Food **(low/high)** **Range** ρ	0.17 (0.01/7.3) 7.3 0.78	2.38 (0.7/2.97) 2.3 0.88
Industry **(low/high)** **Range** ρ	1.69 (0.71/1.72) 1.01 0.79	3.5 (0.22/3.8) 3.6 0.62
Real Estate **(low/high)** **Range** ρ	0.64 (0.16/0.74) 0.6 0.89	3.17 (1.27/6.18) 4.9 0.95
Service **(low/high)** **Range** ρ	0.76 (0.30/9.1) 8.8 0.78	2.54 (0.23/2.77) 2.5 0.66

Note: The first row entries are mean values of Betas. Range statistics refer to the difference between high and low values. ρ denotes correlation coefficient between volatilities of market index and sector portfolio.

Table (3): RMSE Loss Functions and Diebold & Mariano Test

	RMSE Loss Functions GJR-N	 GJR-sk(t)	D&M statistic
Banks **p-value**	1.36	0.15	7.99* (0.00)
Food **p-value**	0.93	0.016	79.9* (0.00)
Industry **p-value**	0.95	0.196	69.7* (0.00)
Real estate **p-value**	0.94	1.60	5.54* (0.00)
Service **p-value**	1.37	0.126	9.12* (0.00)

Note: The loss functions are based on three days ahead forecast errors.
* significant at 5% significance level.

5. Concluding remarks

Taking into account empirical regularities that characterize asset returns in emerging markets in this paper time-varying beta coefficients for the major sectors in Kuwait economy are estimated. Among the regularities that characterize asset markets are the “leverage effect” which refers to the different response of volatility to bad news as compared to good news, and skewness and fat-tailedness of stock returns distribution. To account for the asymmetric effect of news on asset returns' volatility in this paper Glosten, Jagannathan, and Runkle (1993) specification is adopted under two alternative assumptions about stock returns distribution, the Normal distribution and skewed t-distribution specification.

Results of predictive power performance and log-likelihood values support overwhelmingly, evidence of GJR-skewed-t distribution model superiority over GJR-Normal distribution specification when modeling volatility in Kuwait stock market.

The findings in the paper also support evidence of time-varying beta values for all sectors included in the study. However, banks, and real estate sectors exhibit relatively wider range of beta coefficients compared to the beta values of the other sectors in the study. The implication of relatively wider range of beta variation for banks and real estate sectors includes not only higher risk for the securities of these two sectors, as their average betas exceed the market beta, which is equal to one, but also reflect the difficulty of controlling and managing risk associated with securities of these two sectors.

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Appendix

Table (A1):Estimation of Parameter*

	Banks GARCH(1,1)		Food ARCH(1)		Industry ARCH(1)	
	GJR-t skew	GJR-Normal	GJR-t skew	GJR-Normal	GJR-t skew	GJR-Normal
ω (p-value)	**0.11 (0.00)**	**0.09 (0.00)**	**0.03 (0.00)**	**0.02 (0.00)**	**0.11 (0.00)**	**0.09 (0.00)**
δ (p-value)	**0.36 (0.00)**	**0.42 (0.00)**	**0.29 (0.02)**	**0.41 (0.00)**	**0.42 (0.00)**	**0.49 (0.00)**
α^+ (p-value)	0.00 (0.64)	**0.26 (0.00)**	0.26 (0.30)	**0.06 (0.00)**	0.00 (0.60)	**0.06 (0.00)**
α^- (p-value)	0.47 (0.85)	-0.00 (0.99)	-2.5 (0.59)	0.01 (0.11)	**0.20 (0.00)**	-0.00 (0.99)
ϕ (p-value)	0.46 (0.15)	--	0.99 (0.16)	--	0.99 (0.16)	--
θ (p-value)	**2.96 (0.00)**	**--**	**3.91 (0.00)**	**--**	**3.91 (0.00)**	--
LnL	3909	3619	10145	8806	8474	2749

Note: All values rounded to two decimals.
*The lag parameters (p,q) determined based on stationarity restrictions. An examination of the coefficients in GARCH specification in the table reveals that h_{it} for Food and Industry , follow stationary ARCH(1), whereas for Banks follow GARCH(1,1). The highlighted values are significant at 5% significance level.

Table (A2): Estimation of Parameter*

	Real estate ARCH(1)		Service GARCH(1,1)	
	GJR-t skew	GJR-Normal	GJR-t skew	GJR-Normal
ω (p-value)	**0.04 (0.00)**	**0.03 (0.00)**	**0.00 (0.00)**	**0.04 (0.00)**
δ (p-value)	**0.31 (0.00)**	**0.49 (0.00)**	**0.33 (0.00)**	**0.50 (0.00)**
α^+ (p-value)	0.52 (0.30)	**0.13 (0.00)**	0.51 (0.60)	**0.20 (0.00)**
α^- (p-value)	**0.20 (0.00)**	-0.00 (0.99)	**1.1 (0.00)**	-0.00 (0.99)
ϕ (p-value)	0.99 (0.15)	--	0.99 (0.16)	--
θ (p-value)	**3.9 (0.00)**	**--**	**3.91 (0.00)**	--
LnL	9671	3828	4674	2832

Note: All values rounded to two decimals.
The lag parameters (p,q) determined based on stationarity restrictions. An examination of the coefficients in GARCH specification in the table reveals that h_{it} for Real Estate sector follow stationary ARCH(1), whereas Service sector follows GARCH(1,1). The highlighted values are significant at 5% significance level.

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