APPENDIX 1

Figure A1 Time-variations in GCC stock market indexes

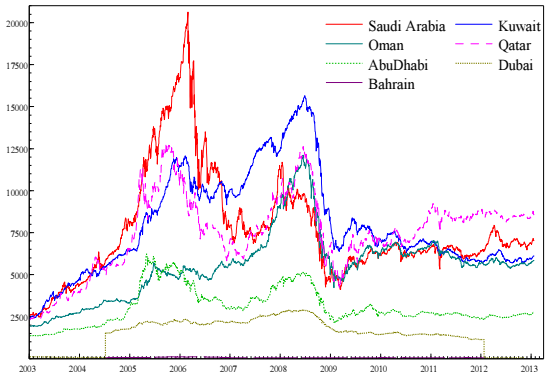
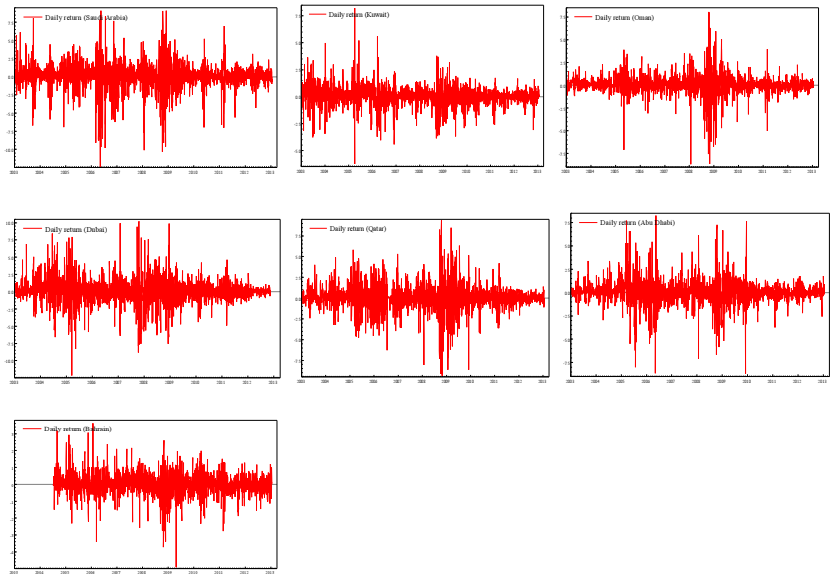


Figure A2 Time-variations in GCC stock market returns



APPENDIX 2

Table A1 Descriptive statistics and unit root tests

	S. Arabia	Kuwait	Oman	Bahrain	Dubai	Abu Dhabi	Qatar
Panel A Descriptive statistics							
Mean	0.038801	0.036102	0.042428	-0.015611	0.023724	0.027037	0.049757
Max.	9.1146	8.2072	8.0388	6.8076	10.22	8.25	9.422
Min.	-12.428	-6.2417	-8.699	-4.92	-12.157	-8.6793	-9.3592
S.D.	1.7282	0.86271	1.0602	0.62469	1.7537	1.227	1.4854
Skewness	-0.9868***	-0.1819***	-0.9710***	-0.4129***	-0.1316***	-0.0707***	-0.350***
Ex. Kurtosis	7.1773***	9.906 ***	13.531***	6.0374***	5.3861***	7.7766***	5.4223***
J-B test	4543.6** [0.0000]	8058.1** [0.0000]	1532.3** [0.0000]	3044.9** [0.0000]	2384.5** [0.0000]	4960.7** [0.0000]	2451.2** [0.0000]
ARCH(10)	52.111** [0.0000]	27.580** [0.0000]	83.77** [0.0000]	10.64** [0.0000]	51.79** [0.0000]	30.25** [0.0000]	50.41** [0.0000]
$Q^2(10)$	382.52** [0.00000]	495.57** [0.0000]	165.31** [0.0000]	115.71** [0.0000]	437.96** [0.00895]	115.96** [0.0000]	233.05** [0.0000]
Number of Obs.	2,620	2,620	2,620	2,620	2,620	2,620	2,620
Panel B Unit root tests							
ADF	-16.88***	-15.04***	-13.22***	-16.09***	-17.72***	-16.50***	-16.44***
Schimdt & Philips test	-542.16***	-519.73***	-523.44***	-699.21***	-834.5***	-415.72***	-714.08***
Zivot-Andrews	-26.75***	-34.56***	-31.22***	-55.62***	-24.02***	-47.09***	-61.25***

Notes: This table reports the main descriptive statistics and the results of several statistical tests applied to both returns and squared returns. S.D. is the standard deviation. For all the time series, the descriptive statistics for daily returns are expressed in percentage. J-B test is the Jarque-Bera normality test statistic. $Q^2(10)$ is the Ljung-Box Q-statistic of order 10 on the squared returns. ARCH(10) refers to Engle (1982)'s test for conditional heteroscedasticity. ADF is the Augmented Dickey-Fuller test. The Zivot and Andrews (1992) unit root test examines the null of unit root hypothesis against the break-stationary alternative. Numbers between brackets are the p-values. Asterisks (***), and (**), denotes the significance at 1% and 5% levels respectively.

APPENDIX 3

Long memory tests[1]

A- Geweke and Porter-Hudak (GPH) (1983)

Geweke and Porter-Hudak (1983), suggested a semi-parametric procedure to obtain an estimate of the fractional difference parameter based on the periodogram of a time series $z_t(t = 1, \dots T)$ defined as: $I(\lambda_j) = \frac{1}{2\pi T}\left|\sum_{t=1}^{T} z_t e^{-i\lambda t}\right|^2$, where $\lambda_j = \frac{2\pi j}{T}, j = 1, \dots, m$ (m is a positive integer). The long memory parameter $\hat{d}_{GPH}$ is the OLS estimator in a regression of the log-periodogram $log(I(\lambda_j))$ of the process on a constant and a variable X_j. $X_j = log\{4sin^2(\lambda_j/2)\}$. Formally, the long memory parameter is given by: $\hat{d}_{GPH} = -\frac{\sum_{j=1}^{m}(X_j - \bar{X})log\{I(\lambda_j)\}}{2\sum_{j=1}^{m}(X_j - \bar{X})}$. The theoretical asymptotic variance of the spectral regression error term is known to be $\pi^2/6$. For non-stationary fractional integrated process, Kim and Phillips (2006) demonstrated that this estimator is consistent in the range $0.5 < d \leq 1$.

B- The Gaussian Semi-parametric Estimator (GSP)

The spectrum of a stationary process with long memory parameter (d) can be approximated in the neighborhood of the zero frequency $f(\lambda) \sim C\lambda^{-2d}$ as $\lambda \to 0^+$, $C > 0$. The GSP estimator is derived from the approximation, $\lim_{\lambda_{i \to 0^+}} f(\lambda_i) = C\lambda_i^{-2d}$ of a long memory process in the Whittle approximate maximum likelihood estimator $L_W(\theta)$. For $m^* = \left[\frac{T}{2}\right]$, an approximation to the Gaussian likelihood, Beran (1994) is given as: $L_W(\theta) = -\frac{1}{2\pi}\sum_{j=1}^{m^*} log f_\theta(\lambda_j) + \frac{I_T(\lambda_j)}{f_\theta(\lambda_j)}$. for a given parametric spectral density $f_\theta(\lambda)$, d is estimated by solving the minimization of: $\arg min L(C, d) = \frac{1}{m}\sum_{j=1}^{m}\left\{\log\left(C\lambda_j^{-2d}\right) + \frac{I(\lambda_j)}{C\lambda_j^{-2d}}\right\}$ where $I(\lambda_i)$ is the periodogram evaluated for a degenerated range of (m) harmonic frequencies $\lambda_j = \frac{2\pi j}{T}$, $(j = 1, \dots m \ll < \left[\frac{T}{2}\right])$. [.] denotes the integer part operator, bounded by the bandwidth parameter (m), which increases with the sample size T but more slowly. According to Härdle (2008), the bandwidth (m) must satisfay $\frac{1}{m} + \frac{m}{T} \to 0$ as $T \to \infty$. For $m = \left[\frac{T}{2}\right]$, this estimator is Gaussian for the parametric model $f(\lambda) = C\lambda^{-2d}$. The Gaussian semi-parametric estimator $\hat{d}_{GSP}$ is given by: $\hat{d}_{GSP} = \text{argmin}_d \left\{log\left(\frac{1}{m}\sum_{j=1}^{m}\frac{I(\lambda_j)}{C\lambda_j^{-2d}}\right) - \frac{2d}{m}\sum_{j=1}^{m}\log(\lambda_j)\right\}$. Robinson (1995) proves that $\sqrt{m}(\hat{d}_{GSP} - d) \xrightarrow[d]{} N\left(0, \frac{1}{4}\right)$.

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[1] The presentation of the long memory tests is largely inspired from Hardle and J. Mungo (2008). Value-at-risk and expected shortfall when there is long-range dependence. SFB 649 Discussion Paper 2008-006, University of Berlin.

APPENDIX 4

Table A2 Long-memory test results

	S. Arabia	Kuwait	Oman	Bahrain	A. Dhabi	Dubai	Qatar
Panel A GPH (1983) test							
• *Stock returns* (r_t)							
$m = T^{0.5}$	0.73 [0.02]	0.55 [0.33]	0.46 [0.18]	0.46 [0.01]	0.71 [0.16]	0.54 [0.11]	0.42 [0.22]
$m = T^{0.6}$	0.69 [0.01]	0.43 [0.28]	0.44 [0.37]	0.57 [0.02]	0.63 [0.18]	0.52 [0.26]	0.42 [0.33]
• *Squared return* (r_t^2)							
$m = T^{0.5}$	0.74 [0.00]	0.53 [0.00]	0.51 [0.01]	0.55 [0.00]	0.69 [0.00]	0.49 [0.00]	0.51 [0.00]
$m = T^{0.6}$	0.73 [0.00]	0.49 [0.00]	0.48 [0.00]	0.51 [0.00]	0.70 [0.00]	0.44 [0.00]	0.38 [0.00]
Panel B Robinson (1995) test							
• *Stock returns* (r_t)							
$m = T/4$	0.67 [0.16]	0.62 [0.00]	0.44 [0.23]	0.62 [0.01]	0.63 [0.13]	0.62 [0.15]	0.44 [0.21]
$m = T/8$	0.65 [0.22]	0.58 [0.00]	0.41 [0.28]	0.71 [0.02]	0.62 [0.19]	0.58 [0.10]	0.43 [0.25]
• *Squared return* (r_t^2)							
$m = T^{0.5}$	0.74 [0.00]	0.57 [0.00]	0.45 [0.00]	0.57 [0.00]	0.73 [0.00]	0.54 [0.00]	0.42 [0.00]
$m = T^{0.6}$	0.71 [0.00]	0.56 [0.00]	0.47 [0.00]	0.54 [0.00]	0.70 [0.00]	0.55 [0.00]	0.43 [0.00]

Notes: (*m*)refers to the bandwidth for the Geweke and Porter-Hudak's (1983) and the GSP Robinson (1995) tests. T is the total number of observations. The associated *p*-values are displayed between brackets

APPENDIX 5

Table A3a Estimation results of GARCH-class models

	Saudi Arabia						Kuwait					
	GARCH	**EGARCH**	**ARFIMA-FIAPARCH**		**ARFIMA-FIGARCH**		**AR-GARCH**	**AR-EGARCH**	**AR-FIGARCH**		**AR-FIAPARCH**	
Panel A Estimation results												
	Normal	Normal	Student	skewed St.	Student	skewed St	Normal	Normal	Student	skewed St.	Student-t	skewed St.
$d-arfima$			0.2628*** (3.02)	**0.2737***** (3.08)	0.2190*** (5.38)	0.2168*** (4.21)						
$AR(1)$	0.235*** (3.26)	0.235*** (4.01)					0.0512*** (3.13)	0.0548*** (4.07)	0.0586** (2.03)	0.0535** (2.01)	0.0534 (1.06)	0.0548*** (2.99)
$d-figarch$			0.3412*** (5.56)	**0.3429***** (4.08)	0.5248*** (6.41)	0.5201*** (6.33)			0.5685*** (4.31)	0.4259*** (5.02)	0.3488 ** (4.09)	0.3515** (2.00)
$ARCH$	0.0362*** (2.09)_	0.053*** (3.11)	0.1564*** (4.06)	0.1521*** (3.22)	0.1141 (1.09)	0.5237** (2.11)	0.0385*** (2.96)	0.0341*** (3.02)	0.2805*** (5.21)	0.5449 (3.09)	0.6301 *** (7.02)	0.2264** (2.13)
$GARCH$	0.9562*** (4.01)	0.924*** [3.06]	0.7931*** (6.02)	0.7209*** (3.01)	0.8632** (2.00)	0.4481* (2.01)	0.9451*** (5.11)	0.9384*** (3.66)	0.7026*** (4.03)	0.3533 (3.99)	0.2295*** (3.96)	0.7249*** (5.55)
$EGARCH(\delta)$		-0.042*** [6.65]						-0.056*** (8.32)				
$Student-df$			3.1517*** (2.86)	3.2107** (2.00)	3.1318*** (3.08)	3.1534*** (4.01)			4.8074*** (7.06)	5.0891*** (4.22)	4.8576*** (5.63)	4.6466*** (6.08)
$asymmetry$			-	-0.0561** (2.01)		-0.0484* (1.99)				-0.1096*** (3.99)	-0.1004*** (4.01)	-
$APARCH(\gamma)$			0.7555*** (4.22)	0.7570*** (5.65)							0.4391*** (3.99)	0.4497*** (5.39)
$APARCH(\delta)$			1.5829*** (11.08)	1.5806*** (9.68)							1.7165*** (10.22)	1.7198*** (13.09)
Panel B Diagnostic tests												
$Ln(L)$	-1558.6	-1557.7	-1557.5	-1556.2	-1572.5	-1571.6	-1028.77	-1029.36	-1030.11	-1026.39	-1027.77	**-1020.9**
AIC	3.6654	3.6655	3.6776	3.5775	3.5776	3.5792	3.4501	3.4523	3.4533	3.4532	3.4464	**3.4452**
$SHIC$	3.5709	3.5704	3.5776	3.5774	3.5772	3.5789	3.4499	3.4519	3.4531	3.4521	3.4432	**3.4429**
$Q^2(10)$	22.08 [0.0046]	22.13 [0.0044]	22.55 [0.0041]	22.44 [0.0039]	22.24 [0.0044]	25.71 [0.0011]	60.25 [0.0000]	62.38 [0.0010]	61.22 [0.0000]	66.43 [0.0000]	56.70 [0.0000]	24.08 [0.0022]
J-B	112 [0.00000]	113.5 [0.0000]	125 [0.0000]	121 [0.0000]	231 [0.0000]	233.5 [0.0000]	266 [0.0000]	301 [0.0000]	356.8 [0.0000]	308 [0.0000]	365 [0.0000]	302 [0.0000]

Notes: The table reports the estimation results of GARCH-class models for GCC markets. $\mathrm{Ln(L)}$ is the value of the maximized log-likelihood. $Q^2(10)$ is the Box-Pierce statistics for remaining serial correlation for the squared standardized residuals. AIC and SHIC represents the is the Akaike Information and Shibata and Hanan-Quinn information criteria, respectively. Student-t values are reported in parentheses. The *p*-values associated to the statistical tests are presented in brackets. Sk.-t refers to the skewed Student-t distribution. J-B refers to the Jarque-Bera normality test of residuals. ***, **, and * represent the significance of 1%, 5% and 10% levels, respectively.

Table A3b Estimation results of GARCH-class models

	Oman						Qatar					
	GARCH	**EGARCH**	**AR-FIGARCH**		**AR-FIAPARCH**		**GARCH**	**EGARCH**	**AR-FIGARCH**		**AR-FIAPARCH**	
Panel A Estimation results												
	Normal	Normal	Student	Skewed St.	Student	Skewed St.	Normal	Normal	Student	Skewed St.	Student	Skewed St.
$AR(1)$	0.2469*** (3.01)	0.2462*** (5.02)	0.2466*** (4.10)	0.2504*** (7.63)	0.2465*** (7.83)	0.2509 (8.04)	0.1071*** (4.11)	0.1066*** (4.32)	0.1079*** (3.19)	0.1025*** (3.01)	0.1031*** (3.14)	0.1031 (3.14)
$d-figarch$			0.5509*** (8.08)	0.5601*** (8.50)	0.5805*** (4.67)	0.5852*** (4.52)			0.6153*** (5.40)	0.6180*** (5.44)	0.5981*** (5.59)	0.6064*** (5.76)
$ARCH$	0.8611*** (5.02)	0.8512*** (6.12)	0.82516*** (4.01)	0.7521*** (2.96)	0.7628*** (3.06)	0.8032 (4.09)	0.8426*** (3.13)	0.8356*** (4.010	0.4252*** (4.50)	0.4245*** (4.54)	0.3964*** (4.17)	0.3897*** (4.17)
$GARCH$	0.1125*** (5.62)	0.1054*** (3.320	0.1762*** (6.09)	0.1628** (2.00)	0.1595** (2.02)	0.1125*** (3.98)	0.1232*** (5.39)	0.1366** (2.01)	0.7661*** (8.59)	0.7710*** (9.02)	0.7457*** (9.37)	0.7528*** (9.95)
$EGARCH(\delta)$		-0.055*** (-4.06)						-0.1352** (2.00)				
$Student-df$			4.0742*** (10.08)	4.0987*** (9.84)	3.9887*** (8.13)	4.0203*** (8.03)			4.1799*** (9.97)	4.1834*** (10.0)	4.0814*** (8.51)	4.0656*** (8.64)
$asymmetry$				-0.0390*** (-2.11)	-	-0.0404*** (2.15)				-0.0770*** (-2.23)		-0.0792** (-2.22)
$APARCH(\gamma)$			-	-	0.1687*** (2.16)	0.1703*** (2.19)					0.2342*** (2.55)	0.2346 (2.53)
$APARCH(\delta)$			-	-	1.9960*** (7.127)	1.9888*** (7.040)					1.9329*** (9.990)	1.9533*** (9.848)
Panel B Diagnostic tests												
lln	-1129.35	-1126.95	-1125.00	-1132.43	-1121.931	**-1121.23**	-1503.66	-1501.32	-1500.97	-1498.77	-1496.75	-1494.49
AIC	5.0165	5.03213	5.012206	5.012549	5.004451	5.006630	2.316221	2.326247	2.326362	2.324816	2.324062	2.322686
$SHIC$	5.0166	5.00621	5.012186	5.012529	5.004299	5.006698	2.326258	2.326254	2.326342	2.324790	2.324030	2.322648
$Q^2(10)$	31.08 [0.6625]	31.32 [0.5211]	32.8060 [0.5661]	32.4537 [0.4453]	25.0172 [0.5454]	4.04459 [0.7714]	3.66255 [0.644]	3.77898 [0.6214]	3.80033 [0.8746]	3.71446 [0.8819]	4.38511 [0.8208]	4.28180 [0.83089]
J-B	822 [.0000]	826 [0.0000]	811 [0.0000]	810 [0.0000]	841 [0.0000]	822 [0.0000]	112 [0.0000]	113 [0.0000]	115 [0.0000]	113 [0.0000]	118 [0.0000]	

Notes: The table reports the estimation results of GARCH-class models for GCC markets. $\mathrm{Ln(L)}$ is the value of the maximized log-likelihood. $Q^2(10)$ is the Box-Pierce statistics for remaining serial correlation for the squared standardized residuals. AIC and SHIC represents the Akaike Information and Shibata and Hanan-Quinn information criteria, respectively. Student-t values are reported in parentheses. The *p*-values associated to the statistical tests are presented in brackets. Sk.-t refers to the skewed Student-t distribution. J-B refers to the Jarque-Bera normality test of residuals. ***, **, and * represent the significance of 1%, 5% and 10% levels, respectively.

Table A3c Estimation results of GARCH-class models

	Dubai						Abu Dhabi					
	AR-GARCH	**AR-EGARCH**	**AR-FIGARCH**		**AR-FIAPARCH**		**AR-GARCH**	**AR-EGARCH**	**AR-FIGARCH**		**AR-FIAPARCH**	
Panel A Estimation results												
	Normal	Normal	Student	Skewed St.	Student	Skewed St.	Normal	Normal	Student	Skewed St.	Student	Skewed St.
$AR(1)$	-0.01668** (-2.00)	-0.01599*** (-2.66)	-0.0161*** (-2.45)	-0.0159*** (-3.33)	-0.0160*** (-3.56)	-0.0161*** (-3.47)	0.2162*** (5.02)	0.2161*** (4.06)	0.2108*** (6.53)	0.2070*** (6.40)	0.2116*** (6.54)	0.2097*** (6.05)
$d-figarch$			0.4996*** (6.81)	0.4177*** (3.83)	0.3970*** (2.81)	0.3961*** (2.67)			0.5724*** (4.63)	0.574*** (4.71)	0.5155*** (3.75)	0.5201*** (3.87)
$ARCH$	0.7302*** (3.11)	0.7299*** (4.14)	0.1935** (2.15)	0.1585 (1.29)	0.1271 (0.98)	0.1259 (0.90)	0.7121*** (4.00)	0.7702*** (6.66)	0.32*** (2.41)	0.3087** (2.33)	0.3354*** (2.32)	0.3246*** (2.27)
$GARCH$	0.1355** (2.01)	0.1432** (2.09)	0.6707*** (5.66)	0.5365*** (2.89)	0.4757** (1.97)	0.6613** (2.73)	0.2501** (2.01)	0.2099*** (3.19)	0.6526*** (5.24)	0.6467*** (5.167)	0.6051*** (3.69)	0.6028*** (3.78)
$EGARCH(\delta)$		-0.034*** (10.25)						-0.021*** (-3.66)				
$Student-df$			5.0815*** (8.59)	5.0912*** (6.23)	4.7670*** (5.68)	0.0244 (0.32)			4.2750*** (9.81)	4.2631*** (9.93)	4.3346*** (8.08)	4.3325*** (8.20)
$asymmetry$			-	0.0393 (0.89)	-	0.0429 (0.95)			-	-0.0431*** (-1.09)		-0.0416*** (-2.06)
$Aparch(\gamma)$			-		0.020691 (0.2827)	0.024423 (0.3289)			-	-	0.1344 (1.325)	0.1307** (2.297)
$Aparch(\delta)$			-	-	2.2096*** (8.798)	2.2196*** (8.932)			-	-	1.8746*** (10.41)	1.8715*** (10.32)
Panel B Diagnostic tests												
lln	-1,421.66	-1,423.55	-1,422.6	-1,353.7	-1,353.8	-1,353.3	-1,235.9	-1.235.9	-1,236.6	-1236.02	-1,235.4	-1,234.8
AIC	4.0133	4.0156	4.0133	4.0425	4.0083	4.0057	2.3195	2.3230	2.3233	2.3280	2.4367	2.3435
$SHIC$	4.6652	4.7520	4.7688	4.0145	4.0083	4.0088	2.3569	2.3700	2.3766	2.3339	2.3338	2.3477
$Q^2(10)$	33.06 [0.62]	34.21 [0.51]	34.98 [0.56]	34.42 [0.43]	24.04 [0.34]	4.043 [0.77]	4.06 [0.61]	4.29 [0.62]	3.83 [0.86]	3.33 [0.77]	4.32 [0.64]	4.32 [0.84]
J-B	212 [0.0000]	245 [0.0000]	231 [0.0000]	264 [0.0000]	201 [0.0000]	199.3 [0.0000]	199 [0.0000]	201 [0.0000]	206 [0.0000]	212 [0.0000]	232.5 [0.0000	236 [0.0000]

Notes: The table reports the estimation results of GARCH-class models for GCC markets. $\mathrm{Ln(L)}$ is the value of the maximized log-likelihood. $Q^2(10)$ is the Box-Pierce statistics for remaining serial correlation for the squared standardized residuals. AIC and SHIC represents the Akaike Information and Shibata and Hanan-Quinn information criteria, respectively. Student-t values are reported in parentheses. The *p*-values associated to the statistical tests are presented in brackets. Sk.-t refers to the skewed Student-t distribution. J-B refers to the Jarque-Bera normality test of residuals. ***, **, and * represent the significance of 1%, 5% and 10% levels, respectively.

Table A3d Estimation results of GARCH-class models

Bahrain						
	AR-GARCH	**AR-EGARCH**	**ARFIMA-FIGARCH**		**ARFIMA-FIAPARCH**	
Panel A Estimation results						
	Normal	**Normal**	**Student**	**Skewed St.**	**Student**	**Skewed St.**
$d-arfima$	0.1402*** (3.03)	0.1402*** (3.00)	0.1403*** (3.68)	0.1459** (2.49)	0.1460** (2.78)	0.1448** (2.59)
$d-figarch$			0.3963*** (5.35)	0.392860*** (5.14)	0.3849*** (3.50)	0.3794*** (3.22)
$ARCH$	0.6632*** (4.06)	0.6602*** (5.93)	0.6458* (1.96)	0.2214*** (2.84)	0.3827 (1.01)	0.5737** (2.79)
$GARCH$	0.2036*** (5.96)	0.2136*** (4.99)	0.1882** (2.31)	0.6768*** (3.26)	0.235** (2.51)	0.2409** (2.42)
$EGARCH(\delta)$		-0.0625*** (-11.03)				
$Student-df$			3.6393*** (9.89)	3.6756*** (9.67)	3.3477*** (8.15)	3.4032*** (8.05)
$asymmetry$			-	-0.0564** (-1.93)	-	-0.0559* (-1.89)
$Aparch(\gamma)$			-		0.0828*** (2.91)	0.0883*** (2.96)
$Aparch(\delta)$			-		2.3173*** (5.81)	2.2824*** (5.71)
Panel B Diagnostic tests						
lln	-846.99	-847.0	-847.26	-845.84	-845.89	-844.53
AIC	4.0142	4.0142	4.0144	5.0125	4.0083	4.0089
$SHIC$	4.0141	4.0142	4.0143	5.0125	4.0082	4.0088
$Q^2(10)$	42.06 [0.62]	41.26 [0.55]	42.46 [0.65]	42.45 [0.44]	35.01 [0.65]	4.044 [0.78]
J-B	122.6 [0.0000]	162 [0.0000]	141 [0.0000]	165 [0.0000]	146 [0.0000]	106 [0.0000]

Notes: The table reports the estimation results of GARCH-class models for GCC markets. $\mathrm{Ln(L)}$ is the value of the maximized log-likelihood. $Q^2(10)$ is the Box-Pierce statistics for remaining serial correlation for the squared standardized residuals. AIC and SHIC represents the Akaike Information and Shibata and Hanan-Quinn information criteria, respectively. Student-t values are reported in parentheses. The *p*-values associated to the statistical tests are presented in brackets. Sk.-t refers to the skewed Student-t distribution. J-B refers to the Jarque-Bera normality test of residuals. ***, **, and * represent the significance of 1%, 5% and 10% levels, respectively.

APPENDIX 6

Table A4 The in-sample VaR and ES estimates

Quantile	Engle and Manganelli (2004) test	Kupiec test	ES	Quantile	Engle and Manganelli (2004) test	Kupiec test	ES
Panel A Short trading position				**Panel B Long trading position**			
Saudi Arabia: estimated model ARFIMA-FIAPARCH with skew. Student distribution							
0.95	**14.88***** (0.01)	0.638 (0.42)	3.28	0.05	1.82 (0.93)	1.538 (0.21)	-4.34
0.975	2.65 (0.85)	0.161 (0.68)	3.83	0.025	2.05 (0.91)	1.365 (0.24)	-5.36
0.99	2.00 (0.91)	0.041 (0.83)	4.26	0.01	4.55 (0.60)	0.847 (0.35)	-6.41
0.995	2.05 (0.90)	0.154 (0.69)	4.54	0.005	8.56 (0.19)	0.421 (0.51)	-7.02
0.9975	7.21 (0.30)	0.000 (0.98)	5.38	0.0025	0.27 (0.99)	0.210 (0.64)	-7.51
Oman: estimated model AR-FIAPARCH with skew. Student distribution							
0.95	2.66 (0.85)	1.538 (0.21)	3.34	0.05	7.23 (0.31)	0.123 (0.72)	-2.25
0.975	2.93 (0.81)	1.365 (0.24)	5.30	0.025	2.062 (0.89)	0.310 (0.57)	-3.02
0.99	2.66 (0.82)	0.847 (0.35)	6.00	0.01	4.552 (0.82)	0.041 (0.83)	-3.42
0.995	0.26 (0.99)	0.421 (0.51)	7.01	0.005	**18.99***** (0.00)	0.099 (0.75)	-4.37
0.9975	0.27 (0.99)	0.210 (0.64)	4.50	0.0025	0.742 (0.88)	0.823 (0.36)	-4.68
Abu Dhabi: estimated model AR-FIAPARCH with skew. Student distribution							
0.95	**14.236***** (0.01)	**6.39***** (0.01)	2.49	0.05	**12.96***** (0.01)	**3.57*** (0.05)	-2.53
0.975	6.32 (0.33)	**4.83**** (0.02)	2.93	0.025	4.02 (0.56)	0.03 (3.64)	-2.87
0.99	4.99 (0.51)	2.56 (0.10)	3.24	0.01	5.36 (0.48)	0.01 (2.56)	-3.87
0.995	0.67 (0.99)	0.42 (0.51)	3.89	0.005	0.20 (0.99)	**0.00***** (0.00)	-5.07
0.9975	2.17 (0.89)	**3.01*** (0.08)	3.98	0.0025	0.05 (0.96)	**0.00***** (0.00)	-5.587
Dubai: estimated model AR-FIAPARCH with skew. Student distribution							
0.95	**14.03***** (0.02)	0.352 (0.55)	4.15	0.05	8.56 (0.22)	0.666 (0.41)	-4.05
0.975	**15.96***** (0.01)	0.7697 (0.38)	4.39	0.025	2.112 (0.86)	0.171 (0.67)	-4.64
0.99	4.233 (0.62)	1.922 (0.16)	4.99	0.01	1.00 (0.99)	0.044 (0.83)	-5.76
0.995	0.210 (0.98)	0.000 (0.97)	6.48	0.005	0.702 (0.98)	0.428 (0.51)	-6.71
0.9975	0.26 (0.98)	0.213 (0.64)	6.53	0.0025	0.715 (0.98)	0.831 (0.36)	-6.00
Bahrain: estimated model ARFIMA-FIAPARCH with skew. Student distribution							
0.95	**12.63**** (0.02)	0.000 (0.97)	1.46	0.05	**19.63***** (0.01)	0.408 (0.52)	-1.38
0.975	**21.63***** (0.01)	0.452 (0.50)	1.87	0.025	5.63 (0.44)	0.392 (0.53)	-1.80
0.99	0.652 (0.98)	0.131 (0.71)	2.48	0.01	6.05 (0.33)	0.113 (0.73)	-2.37
0.995	0.156 (0.87)	0.002 (0.96)	2.68	0.005	0.78 (0.86)	0.664 (0.41)	-2.60
0.9975	0.5662 (0.41)	0.419 (0.51)	3.39	0.0025	0.44 (0.99)	0.350 (0.55)	-2.82

continued

Quantile	Engle and Manganelli (2004) test	Kupiec test	ES	Quantile	Engle and Manganelli (2004) test	Kupiec test	ES
Panel A Short trading position				**Panel B Long trading position**			
Kuwait: estimated model AR-FIAPARCH with skew. Student distribution							
0.95	**51.23***** (0.00)	0.071 (0.78)	1.70	0.05	6.96 (0.23)	**4.033*** (0.04)	-1.71
0.975	**49.63***** (0.00)	0.725 (0.78)	2.20	0.025	1.56 (0.92)	0.461 (0.49)	-2.22
0.99	**48.33***** (0.00)	0.718 (0.73)	2.78	0.01	3.65 (0.53)	**2.701*** (0.10)	-2.71
0.9950	**31.02***** (0.00)	0.712 (0.78)	3.16	0.005	0.432 (0.98)	0.060 (0.80)	-3.45
0.9975	0.512 (0.99)	0.400 (0.52)	3.61	0.0025	0.810 (0.99)	0.821 (0.36)	-3.63
Qatar: estimated model AR-FIAPARCH with skew. Student distribution							
0.95	7.96 (0.19)	**3.17*** (0.07)	2.71	0.05	5.22 (0.51)	**3.57*** (0.05)	-3.05
0.975	8.39 (0.12)	**5.48***** (0.01)	3.03	0.025	6.23 (0.48)	**3.64*** (0.05)	-3.53
0.99	3.06 (0.32)	0.84 (0.35)	3.16	0.01	5.33 (0.49)	**3.32**** (0.06)	-4.05
0.995	1.06 (0.88)	1.37 (0.24)	4.32	0.005	10.56 (0.12)	2.52 (0.11)	-4.78
0.9975	2.01 (0.95)	1.27 (0.28)	2.71	0.0025	2.32 (0.91)	**3.01*** (0.08)	-4.40

Notes: This table reports the empirical statistics of the Kupiec test, DQT test of Engle and Manganelli (2004). The bold face numbers indicate the rejection of the null hypothesis at the 1% level (***), 5% (**) and 10% (*). The best model is one with the least rejections. The *p*-values relative to the accuracy tests are displayed in parentheses. ES refers to the expected shortfall.

APPENDIX 7

Table A5 The out-of-sample VaR and ES forecasts

Panel A Short trading position					Panel B Long trading position				
Quantile	Engle and Manganelli (2004) test	Kupiec test	$\hat{L}_{\alpha,m}$	ES	Quantile	Engle and Manganelli (2004) test	Kupiec test	$\hat{L}_{\alpha,m}$	ES
Saudi Arabia: estimated model ARFIMA-FIAPARCH with skew. Student distribution									
0.95	2.65 (0.85)	0.206 (0.64)	0.016	2.17	0.05	5.22 (0.52)	0.751 (0.38)	0.016	-2.54
0.975	8.76 (0.15)	0.015 (0.90)	0.018	2.53	0.025	4.00 (0.61)	0.788 (0.37)	0.021	-3.31
0.99	6.25 (0.39)	**3.662**** (0.05)	0.042	3.25	0.01	0.62 (0.98)	0.019 (0.89)	0.048	-4.46
0.995	5.41 (0.49)	**2.680*** (0.10)	0.076	4.08	0.005	2.93 (0.81)	0.095 (0.75)	0.078	-5.53
0.9975	2.69 (0.78)	1.337 (0.24)	0.088	3.03	0.0025	2.28 (0.97)	1.676 (0.19)	0.098	-5.24
Oman: estimated model AR-FIAPARCH with skew. Student distribution									
0.95	2.55 (0.84)	0.283 (0.59)	0.035	1.45	0.05	0.26 (0.98)	1.074 (0.29)	0.032	-1.45
0.975	3.77 (0.56)	0.280 (0.59)	0.042	1.55	0.025	4.06 (0.52)	0.836 (0.36)	0.045	-1.87
0.99	**19.63***** (0.00)	1.095 (0.29)	0.053	2.47	0.01	7.25 (0.28)	0.073 (0.78)	0.053	-2.18
0.995	0.11 (0.98)	0.000 (0.97)	0.078	1.07	0.005	0.32 (0.98)	0.163 (0.68)	0.078	-2.76
0.9975	**7.65***** (0.00)	0.134 (0.87)	0.086	3.24	0.0025	0.27 (0.99)	0.1210 (0.72)	0.086	-3.13
Abu Dhabi: estimated model AR-FIAPARCH with skew. Student distribution									
0.95	**9.86***** (0.00)	0.806 (0.36)	0.036	1.60	0.05	8.08 (0.15)	1.279 (0.25)	0.036	-1.84
0.975	2.36 (0.91)	0.072 (0.78)	0.048	1.91	0.025	2.01 (0.81)	0.004 (0.94)	0.050	-2.34
0.99	5.89 (0.39)	0.329 (0.56)	0.086	1.83	0.01	1.66 (0.91)	1.095 (0.29)	0.086	-3.57
0.995	7.02 (0.32)	0.000 (0.97)	0.091	2.07	0.005	0.11 (0.99)	0.000 (0.97)	0.090	-4.15
0.9975	0.27 (0.99)	0.000 (0.97)	0.098	2.49	0.0025	1.23 (0.93)	1.8733 (0.17)	0.098	-4.15
Qatar: estimated model AR-FIAPARCH with skew. Student distribution									
0.95	3.43 (0.73)	0.575 (0.44)	0.015	2.16	0.05	5.69 (0.29)	0.283 (0.59)	0.014	-2.41
0.975	3.11 (0.78)	0.836 (0.36)	0.035	2.60	0.025	4.96 (0.53)	0.072 (0.78)	0.034	-2.62
0.99	2.05 (0.92)	0.001 (0.96)	0.055	3.45	0.01	0.44 (0.98)	0.132 (0.71)	0.056	-3.70
0.995	0.11 (0.99)	0.000 (0.97)	0.078	3.80	0.005	0.32 (0.99)	0.163 (0.68)	0.078	-4.00
0.9975	0.27 (0.99)	0.121 (0.72)	0.086	5.99	0.0025	0.27 (0.99)	0.081 (0.77)	0.085	-4.94
Dubai: estimated model AR-FIAPARCH with skew. Student distribution									
0.95	**16.22***** (0.00)	0.938 (0.33)	0.022	2.06	0.05	5.02 (0.48)	0.467 (0.49)	0.020	-1.82
0.975	4.23 (0.56)	0.141 (0.70)	0.055	2.43	0.025	2.73 (0.82)	0.202 (0.65)	0.049	-2.25
0.99	6.99 (0.35)	0.141 (0.70)	0.053	2.37	0.01	0.47 (0.99)	0.046 (0.82)	0.053	-2.39
0.995	0.22 (0.99)	0.152 (0.69)	0.014	2.21	0.005	0.12 (0.99)	0.005 (0.93)	0.014	-3.51
0.9975	**0.56e**$^{+035}$*** (0.00)	0.152 (0.69)	0.066	2.54	0.0025	0.16 (0.99)	0.131 (0.71)	0.066	-4.30

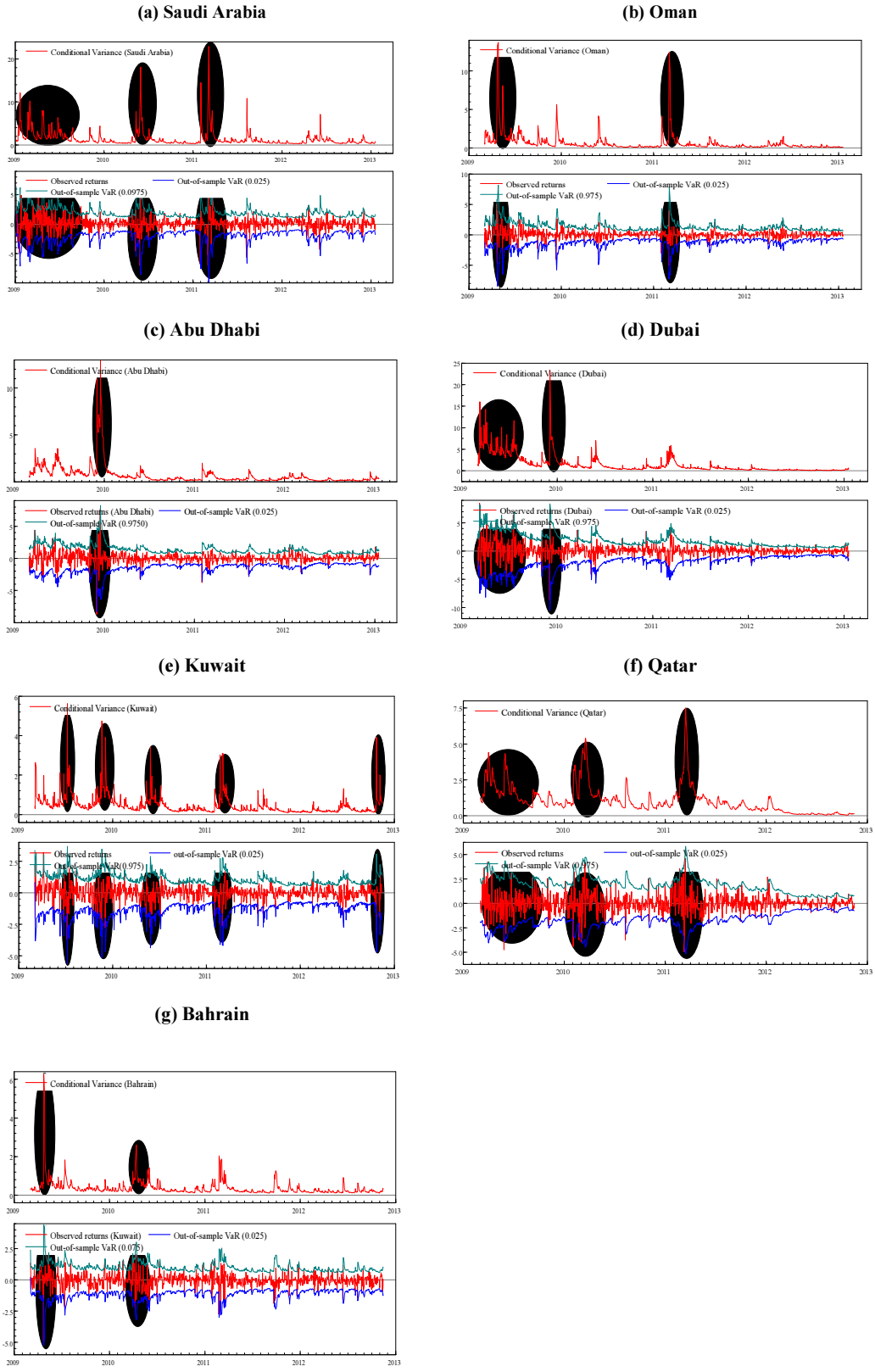
continued

Panel A Short trading position					Panel B Long trading position				
Quantile	**Engle and Manganelli (2004) test**	**Kupiec test**	$\hat{L}_{\alpha,m}$	**ES**	**Quantile**	**Engle and Manganelli (2004) test**	**Kupiec test**	$\hat{L}_{\alpha,m}$	**ES**
Kuwait: estimated model AR-FIAPARCH with skew. Student distribution									
0.95	4.22 (0.49)	0.062 (0.80)	0.021	1.07	0.05	5.09 (0.48)	0.683 (0.40)	0.021	-1.49
0.975	8.12 (0.13)	1.759 (0.18)	0.054	1.36	0.025	3.05 (0.71)	0.332 (0.56)	0.054	-1.86
0.99	0.60 (0.98)	0.306 (0.582)	0.066	1.63	0.01	0.46 (0.99)	0.011 (0.91)	0.062	-2.27
0.995	1.02 (0.96)	0.806 (0.36)	0.078	2.20	0.005	0.37 (0.95)	0.264 (0.60)	0.077	-2.30
0.9975	1.98 (0.90)	1.068 (0.34)	0.095	3.20	0.0025	0.10 (0.99)	0.075 (0.78)	0.094	-2.58
Bahrain: estimated model ARFIMA-FIAPARCH with skew. Student distribution									
0.95	3.02 (0.76)	1.231 (0.26)	0.017	0.97	0.05	4.02 (0.61)	3.256 (0.07)	0.017	-1.25
0.975	**13.96**** (0.02)	0.599 (0.43)	0.022	1.12	0.025	3.82 (0.78)	0.332 (0.56)	0.021	-1.57
0.99	3.06 (0.78)	1.619 (0.20)	0.035	1.59	0.01	0.61 (0.98)	0.306 (0.58)	0.034	-2.03
0.995	3.99 (0.46)	**4.525**** (0.03)	0.055	1.54	0.005	0.20 (0.00)	0.152 (0.69)	0.054	-2.67
0.9975	1.23 (0.53)	**1.546**$^{+035}$ (0.00)	0.078	1.79	0.0025	0.09 (0.99)	0.075 (0.78)	0.077	-3.84

Notes: This table reports the empirical statistics of the Kupiec test, DQT of Engle and Manganelli (2004). The bold face numbers indicate the rejection of the null hypothesis at the 1% level (***), 5% (**) and 10% (*). The best model is one with the least rejections. The *p*-values relative to the accuracy tests are displayed in parentheses. ES refers to the expected shortfall. $\hat{L}_{\alpha,m}$ refers to the expected loss statistic of VaR forecasts suggested by Giacomini and Kamunjer (2005).

APPENDIX 8

Figure A3 Conditional variance and the out-of-sample VaR forecasts



APPENDIX 9

Table A6 The VaR and ES for a GCC multi-country portfolio

Quantile	DQT	Kupiec test		ES	Quantile	DQT	Kupiec test		ES
Panel A The in-sample VaR and ES estimates									
Panel A1 Short trading position						**Panel A2 Long trading position**			
0.95	4.48 (0.52)	1.01	(0.31)	2.0	0.05	8.86 (0.32)	**11.16*** (0.08)		-2.34
0.975	4.43 (0.61)	1.13	(0.28)	2.46	0.025	**5.52***** (0.01)	8.87	(0.18)	-1.66
0.99	4.20 (0.64)	2.77	(0.09)	2.67	0.01	0.46 (0.49)	4.12	(0.66)	-2.32
0.995	5.03 (0.39)	10.04	(0.31)	2.24	0.005	0.08 (0.74)	0.350 (0.99)		-3.42
0.9975	**15.79***** (0.00)	**13.4***** (0.00)		3.43	0.0025	1.06 (0.29)	2.116 (0.90)		-3.22
Panel B The out-of sample VaR and ES forecasts									
Panel B1 Short trading position						**Panel B2 Long trading position**			
0.95	0.85 (0.99)	0.277	(0.60)	1.15	0.05	8.52 (0.26)	7.77*** (0.00))		-1.34
0.975	6.01 (0.41)	**3.72****	(0.05)	1.78	0.025	6.00 (0.33)	1.254 (0.26)		-1.85
0.99	**20.06***** (0.00)	1.03	(0.31)	2.15	0.01	**12.33***** (0.00)	0.000 (0.98)		-2.91
0.995	**1.44***** (0.56)	4.16	(0.28)	3.78	0.005	0.39 (0.99)	0.262 (0.60)		-3.86
0.9975	**1.93***** (0.55)	**2.33***	(0.09)	3.14	0.0025	0.73 (0.99)	0.602 (0.43)		-3.30

Notes: This table reports the empirical statistics of the Kupiec test, DQT of Engle and Maganelli (2004). The bold face numbers indicate the rejection of the null hypothesis at the 1% level (***), 5% (**) and 10% (*). The best model is one with the least rejections. The *p*-values relative to the accuracy tests are displayed in parentheses. ES refers to the expected shortfall.

APPENDIX 10

Figure A4a The in-sample conditional variance and VaR for the GCC multi-country portfolio

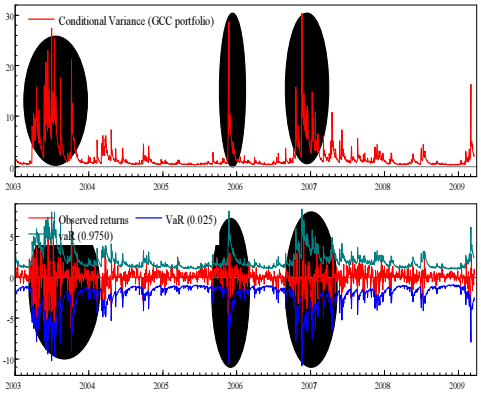


Figure A4b The ARFIMA-FIAPARCH conditional variance and VaR for the GCC multi-country portfolio (out-of-sample)