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Inter- and Intra-Regional Stock Market Relations for the GCC Bloc

Salem Ziadat, Patrick Herbst and David G McMillan
Division of Accounting and Finance
University of Stirling

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Abstract
This paper examines the patterns of information transmission for equity markets in the seven Gulf Cooperation Council countries over the period from 2004 to 2019. Using weekly data, correlations and spillovers both within the region and from the US, the EU and Japan are modelled through the Dynamic Conditional Correlation-GARCH model and the Diebold-Yilmaz spillover index. While GCC markets exhibit increasing correlations with, primarily, the EU and, to a lesser extent, the US, they nonetheless remain relatively less interlinked globally. Our findings support significant return and volatility spillovers from the EU and the US to the GCC markets, with stronger spillovers from the EU. Intra-regionally, the UAE is the main transmitter and receiver of spillovers between the GCC and world markets. Furthermore, we see evidence of a decoupling pattern within the GCC countries, with notable segmentation in the markets of Bahrain and Kuwait.

Keywords: GCC, Stock Markets, Correlation, Spillovers
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Address for Correspondence: Professor David McMillan,
Accounting and Finance Division, University of Stirling, FK9 4LA
Telephone: +44(0)1786-467309
Fax: +44(0)1786-467308
E-mail: david.mcmillan@stir.ac.uk

1. Introduction.

This paper seeks to examine the linkages between the stock markets of major developed countries and those of the Gulf Cooperation Council (GCC; Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the UAE) bloc. The GCC countries play a pivotal role in the global economy, jointly accounting for 40% and 23% of proven oil and gas reserves respectively (Sedik and Williams, 2011). However, the behaviour of their stock markets is relatively under-researched (Balcilar et al., 2015). Moreover, the GCC economies are experiencing an economic liberalization process (Bley and Chen, 2006; Al-Khazali et al., 2006), which should result in greater integration into the world economy. Notwithstanding this, the economies are still regarded as emerging or frontier markets.[1]

Understanding the nature of the linkages between these markets with developed markets is important for investors who may be seeking to achieve cross-country diversification benefits. Historically, emerging markets exhibit a low correlation with developed markets. However, the rise of globalization and greater financial integration between developed and emerging markets has limited these benefits.[2] This leads investors to consider alternative markets. The GCC markets, given their frontier or newly emerging market status and unique economic structures, are likely to be least integrated with international stock markets and with lower levels of liquidity (Bley and Saad, 2012). Chen et al. (2014) state that frontier markets, which are in the early stages of economic development, generally demonstrate long-run growth potential and add that they are often compared to the emerging markets of the late 1990s. Despite the higher transaction costs that characterise frontier markets, this does not eliminate the diversification benefits investors receive from allocating capital to these markets (Marshall

[1] At the start of the sample period, all economies are listed as frontier markets, with Qatar and the UAE being ranked as emerging in 2014 and Saudi Arabia in 2019 (after our sample period).

[2] This research typically focusses on the markets of south-east Asia and dates back, for example, to Aggarwal and Rivoli (1989) as well as work cited below.

et al., 2015).

The literature on the interrelations among financial markets has evolved into two key strands relevant for this paper. First, stock market integration in the context of developed and emerging markets (see, for example, Bekaert and Harvey, 1995, 2000), and extended to include frontier markets (Pukthuanthong and Roll, 2009; Samarakoon, 2011). Second, the study of international financial market co-movements and spillovers that largely began with the work of Eun and Shin (1989), King and Wadhwani (1990) and Hamao et al. (1990).[3] Moreover, Kyle (1985) states that much of the value-relevant information is revealed in stock return volatility rather than the returns themselves. Thus, research began to focus on the examination of volatility spillovers, as in Li and Giles, (2015), Sedik and Williams (2011) and Baele (2005). Although some studies incorporate the GCC in their analysis, including Hammoudeh et al. (2009) and Khalifa et al. (2014), across both strands of research, an examination of the influences on the GCC market is largely limited to linkages with the US stock and oil markets. Thus, this study seeks a more extensive view of the GCC region, examining both inter- and intra-regional linkages.

Understanding the nature and extent of linkages between different financial markets is important for portfolio managers, investors and policy-makers. For example, Engle et al. (1990) establish the heat wave and meteor shower hypotheses and their attendant implications. The heat wave hypothesis is consistent with the idea that volatility shocks are country-specific. In contrast, the meteor shower hypothesis proposes that the volatility of a stock market is a function of past volatility from other markets. This implies that shocks generated in one market are transmitted to other markets, where potential linkages include trade and cross-country fund flows and has implications for international diversification (Ng 2000; Forbes and Chinn, 2004; Wei et al., 1995). Therefore, we examine both inter- and intra-regional patterns of

[3] For a comprehensive review on the topic of spillovers, see Gagnon and Karolyi (2006).

transmissions across GCC stock markets over the period from 2004 to 2019. We consider both correlation analysis using the DCC-GARCH approach introduced by Engle (2002) and the spillover index model of Diebold and Yilmaz (2009, 2012). These two methodologies allow us to consider both the contemporaneous and lead/lag linkages between the stock markets of the GCC with the major developed markets of the US, the EU and Japan.

We show that at the inter-regional level, the EU displays the highest level of comovement with the GCC. Moreover, the EU surpasses the US as a major originator of spillovers in most GCC nations, except for Saudi Arabia. At the intra-regional level, the UAE, represented by Dubai and Abu Dhabi, is the main recipient and sender of spillovers in the GCC region. This result illustrates the importance of financial market openness intra-regionally and geographical proximity as a determinant of the GCC market global linkages. From a dynamic point of view, events such monetary tightening polices of the US Federal Reserve, market crashes (2008, 2016 and 2018) and the Brexit vote amplify both correlations and volatility spillovers in the GCC.

The rest of the paper proceeds as follows: Section 2 reviews the relevant literature, Section 3 presents the methodology, Section 4 describes the data, Section 5 presents the empirical findings of the research and, finally, Section 6 concludes the study.

2. Literature Review.

Stock Market Connections

While early work on stock market interconnections began with Eun and Shin (1989), the main impetus to its development stemmed from Engle et al. (1990) and the competing heat wave and meteor shower hypotheses. They argue that the heat wave hypothesis is consistent with the view that the main source of volatility is country-specific, while the meteor shower hypothesis argues that shocks are transmitted across different markets. During the 1990s, research began to consider the importance of modelling the interactions in the second conditional moment, with the examination of volatility enhanced by the introduction of the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model (Engle, 1982; Bollerslev, 1986). Early examples include the work of Hamao et al. (1990), while Lin et al. (1994) use two univariate GARCH models to model volatility spillovers between the US and Japanese stock markets. However, a key criticism of the univariate approach is that it ignores the covariance between series.

A more effective way of estimating volatility interactions is through a multivariate GARCH model. Examples of this approach include the work of Theodossiou and Lee (1993) and Ng (2000). While multivariate GARCH models have become popular, a drawback is the large number of parameters required in estimation. This limits the number of series that can be tested within a system. Such a limitation helped motivate the Engle (2002) Dynamic Conditional Correlation (DCC)-GARCH model, which significantly reduces the number of parameters to be estimated.[4]

While the DCC-GARCH model improves the ability to model correlations between series compared to the multivatiate-GARCH approach, it does not capture spillover behaviour. Here, to avoid the over-parameterisation problem, Diebold and Yilmaz (2009) develop a spillover index based on forecast error variance decompositions from a VAR model. This methodology examines spillovers in equity returns and volatilities by determining the fraction of the forecast error variance of a country's stock market return or volatility, which is due to shocks in other countries' markets. This approach has the advantage of both simplicity in estimation and the ability to incorporate many variables. Diebold and Yilmaz (2012) further extend their model to incorporate a generalized VAR framework to overcome the drawback in

[4] This approach is further extended by Cappielo et al. (2006) through the Asymmetric Dynamic Conditional Correlation (ADCC-GARCH) model, which incorporates sign asymmetry whereby negative shocks impact volatility and correlations greater than equally-sized positive shocks.

which variance decompositions depend on the ordering of variables (Cholesky-factor identification). This revised methodology also allows for the identification of directional spillovers in addition to total spillovers.

Empirical Literature

Early research (e.g., Karolyi, 1995) focusses on correlations between developed markets. Berben and Jansen (2005) investigate shifts in correlation patterns among developed equity returns using a GARCH model with a smoothly time-varying correlation. Akin to the results in Arshanapalli and Doukas (1993), they show that correlations among most developed stock markets have increased during the period between 1980 and 2000, with Japan a notable exception. Baele (2005), Booth et al. (1997), Fratzscher (2002) and Tsai (2014) reach similar findings of increased linkages among developed markets.

Emerging financial markets became a subject of extensive research because of their rapidly growing economies and the diversification opportunities they provide to global investors. Bekaert and Harvey (1997) find that while stock market returns in emerging markets are high, they lack strong correlation with major markets. The authors state that as emerging markets mature, they are likely to become more sensitive to the volatility of stock markets elsewhere. Their increasing integration with world markets will weaken their ability to enhance and diversify international portfolios and will increase their vulnerability to external shocks. Bekaert and Harvey (1997) find that capital market liberalization often leads to a higher correlation between local and international markets. Ng (2000) argues that the relative importance of regional and world market factors is influenced by changes in foreign investment restrictions and the volume of trade. Yarovaya et al. (2016) examine intra- and inter-regional transmission of information across ten developed and eleven emerging markets. They state that markets are more prone to domestic and region-specific volatility shocks than to inter-regional contagion.

Yu and Hassan (2008) report evidence of segmentation of stock markets in the GCC bloc, using a GARCH model and data from 1999 to 2005. They also find negative correlations between GCC and developed markets, implying that investors in GCC stocks can benefit from international diversification. Sedik and Williams (2011) analyse the impact of global and regional spillovers on GCC equity markets. Using data from 2000 to 2010 and a trivariate GARCH model they identify the degree of spillovers and their transmission mechanisms. Their results indicate that regional volatility spillovers are highest in the UAE and Oman, and smallest in Kuwait. Meanwhile, US (global) spillovers are highest in the UAE, lowest in Saudi Arabia and insignificant in Bahrain. Sedik and Williams (2011) stress that GCC stock markets are vulnerable to financial shocks from global and regional sources, especially during the 2008 subprime crisis.

Alotaibi and Mishra (2015) examine spillover effects from the US (global) and Saudi markets on the remaining five GCC stock markets (Bahrain, Kuwait, Qatar, Oman, and the UAE).[5] Using three bivariate GARCH type models, they report significant intra-regional spillover effects from Saudi Arabia to each GCC market, with positive effects for Kuwait, Oman, Qatar and UAE, and negative effects for Bahrain. The US spillover effects are highly significant and positive for all GCC markets. Further, regional spillovers in Qatar and the UAE are greater in magnitude than global spillover effects.

Awartani et al. (2013) investigate return and volatility spillover effects from the US and Saudi Arabia to the GCC equities using the Diebold and Yilmaz spillover approach. Similar to Sedik and Williams (2011) and Alotaibi and Mishra (2015), they model the spillover transmission on the assumption of Saudi Arabia being the dominant regional player, and the

[5] Both Sedik and Williams (2011) and Alotaibi and Mishra (2015) use a UAE index instead of individual Abu Dhabi and Dubai indexes.

US as the global force. They find that the US influence on GCC equities is substantial and is a major factor in the spillover transmissions in the GCC. Further examples of studies investigating volatility spillovers to the GCC include Malik and Hammoudeh (2007) and Khalifa et al. (2014).

Considering the state of research on GCC market linkages, inter-regionally, the literature regarding global factors stresses US dominance as an exclusive originator of shocks and spillovers. This assumption is based on the view that the US is the most dominant market globally. Consequently, these studies ignore other developed markets as potential exporters of spillovers to the GCC region.

Analysing intra-regional interrelations, Assaf (2003) examines the dynamic relations among six GCC markets using VEC models with weekly data from January 1997 to April 2000. The results suggest that Bahrain's more open market plays a dominant role in influencing other GCC markets, while Saudi Arabia's segmented market is slow to receive shocks. Abraham and Seyyed (2006) investigate the volatility spillovers across two stock markets in the GCC region, the oil-based economy of Saudi Arabia and the trading-centred economy of Bahrain. Using daily data from 1998 to 2003 and a bivariate EGARCH model, they find an asymmetric flow of information from the smaller Bahraini market to the larger Saudi market. Alkulaib et al. (2009) argue that the UAE stock market leads all other markets in the region due to the significant growth of UAE's equity market, and its positioning as the main financial hub in the Middle East. Hammoudeh and Alesia (2004) find that the Saudi market has the highest linkages with other GCC countries, Bahrain and the UAE follow the Saudi lead, while Kuwait has the least causal linkages. Awartani et al. (2013) attribute the dominance of the Saudi market in the GCC bloc to higher market capitalisation and liquidity.

Intra-regionally, the literature documents the segmentation of Kuwait, however, there is some divergence in terms of which GCC market is the main driver. Considerable academic research proclaims Saudi Arabia as the driving force in the GCC. This assumption is based on the high-capitalisation and liquidity in the Saudi market (Awartani et al., 2013). Nonetheless, alternative studies suggest a leading role for Bahrain and the UAE. These differences might arise as the GCC bloc is young and highly sensitive to geopolitical factors. The aim of this study is to bring clarity to the issues of the main inter- and intra-regional relations by providing a more comprehensive and updated analysis.

3. Empirical Methodology.

This paper seeks to examine the nature of the linkages between the GCC markets and the major developed markets of the US, EU and Japan. We use separate approaches for the correlation and spillover analyses that both overcome the over-parameterisation problem of the multivariate-GARCH model.[6] Specifically, we use the Engle (2002) DCC-GARCH model to capture the time-varying correlations, which captures the contemporaneous linkages, and the Diebold and Yilmaz (2009, 2012) spillover index, which captures the lead/lag dynamics.

Dynamic Conditional Correlation (DCC-GARCH)

This study uses the DCC-GARCH model proposed by Engle (2002), which extends the constant conditional correlation (CCC) model of Bollerslev (1990) by allowing for time-variation in the conditional correlations. Such an approach is preferred to traditional correlation coefficient calculations as it accounts for heteroscedasticity. As noted by Forbes and Rigobon (2002), the presence of heteroscedasticity creates bias in correlations, notably, during high stress periods.

The DCC-GARCH model (Engle, 2002) models the time-varying correlation between

[6] The multivariate-GARCH approach is an obvious alternative to consider. It would allow for an examination of both correlations and spillovers within the same empirical approach. However, this approach suffers from the major drawback that it requires a large number of parameters to be estimated. For example, a fully specified bi- (tri-) variate GARCH model requires 21 (78) parameters, thus rendering the model impractical.

each market pair. The conditional covariance matrix is expressed in terms of the following decomposition:

$$\Omega_t = D_t \, \Gamma_t \, D_t \tag{1}$$

Where D_t refer to the diagonal matrix of the conditional standard deviations and Γ_t is the matrix of conditional correlations. To estimate the model, individual GARCH(1,1) processes are estimated for each series as such:

$$h_t^2 = \omega + \sum_{i=1}^{p} \alpha \varepsilon_{t-i}^2 + \beta h_{t-1}^2 \tag{2}$$

The standardised residuals (ξ_t) are then computed in the usual way:

$$\xi_t = D_t^{-1} \, \varepsilon_t \, . \tag{3}$$

With the correlations given by:

$$\Gamma = \frac{1}{T} \sum_{t=1}^{T} \xi_t \xi_t' \, . \tag{4}$$

The approach of Engle (2002) then allows the conditional correlation to exhibit time-variation in a manner similar to the GARCH(1,1) model. Specifically, conditional correlations fluctuate around their constant (unconditional) value as such:

$$Q_t = (1 - \alpha - \beta)\Gamma + \alpha \xi_{t-1} \xi_{t-1}' + \beta Q_{t-1} \tag{5}$$

where Q is the time-varying correlation matrix. The estimated correlations are standardised, $\rho_{ij,t} = \Gamma_{t,ij} = Q_{t,ij} / \sqrt{Q_{ii}} \sqrt{Q_{jj}}$, to ensure they lie between -1 and 1. This also ensures both a positive definite matrix as well as readily interpretable correlations.[7,8]

Spillover index

While the DCC-GARCH model provides information on the comovements of returns between

[7] We also consider asymmetric versions of the models i.e., a GJR-GARCH (Glosten et al., 1993) process and an asymmetric DCC (Cappiello et al., 2006). However, the results are qualitatively similar to those reported.
[8] The estimation of the parameters is carried out using the quasi-maximum likelihood estimation (QMLE) method that is robust to departures from normality of the return series (see, Bollerslev and Wooldridge, 1992).

markets, it does not capture how the innovations in one market affect another market, i.e., the transmission of information from one market to another in a subsequent period. Gebka and Serwa (2006) argue that in contrast with contemporaneous interdependence between financial markets measured by correlations coefficients, focusing on the time-varying structure of spillovers sheds new light on the assimilation of shocks and patterns of cross-country causality.

To capture spillovers, we use the framework introduced by Diebold and Yilmaz (2012), based on the forecast error variance decompositions from a vector autoregressive (VAR) model. The general *k*-variable and *p*-lagged VAR model is given by:

$$x_t = \sum_{i=1}^{p} \varphi_i \, x_{t-i} + \varepsilon_t \qquad (6)$$

Where x_t represents the vector of *k* endogeneous variables, while φ is a k x k matrix of parameters for each time lag, *p*, and $\varepsilon_t \sim (0,\Sigma)$ is a vector of disturbance terms that are assumed to be independently and identically distributed over time.

Assuming covariance stationarity, equation (6) can be rewritten as an infinite moving average model, as such:

$$x_t = \sum_{i=0}^{\infty} A_i \, \varepsilon_{t-i} + \varepsilon_t \qquad (7)$$

The parameter matrices, A_i, are recursively defined as follows: $A_1 = \varphi_1 A_{i-1} + \varphi_2 A_{i-2} + \ldots + \varphi_p A_{i-p}$ and with A_0 a k x k identity matrix. The variance decompositions allow the fraction of the *H*-step ahead error variance in forecasting x_i from shocks arising in x_j, where $i \neq j$, to be calculated.

The computation of variance decomposition requires orthogonal innovations. Some identification schemes, such as Cholesky factorization, orthogonalize innovations but the identified decompositions depend on the ordering of variables. As the direction of spillovers is important, a decomposition scheme that is invariant to ordering is preferred. Thus, the generalized VAR of Koop et al. (1996) and Pesaran and Shin (1998) is utilised. This generalized VAR procedure accounts for contemporaneous innovations by using the observed historical distribution of errors. Hence, this framework can identify variance decompositions that are invariant to the order of markets and robust to simultaneously correlated innovations.

The H-step-ahead forecast error variance decomposition is given by:

$$\theta_{ij}(H) = \frac{\sigma_{ii}^{-1} \sum_{h=0}^{H-1} (e'_j A_h \Sigma e_i)^2}{\sum_{h=0}^{H-1} (e'_j A_h \Sigma A'_h e_j)} \quad (8)$$

where Σ is the variance matrix of the error vector ε, σ_{ii} the standard deviation of the error term for variable i, and e_i is the selection vector with one as the *ith* element and zero otherwise.

Each element of the variance decomposition matrix is then normalised by the sum of the elements of each row of the decomposition as such:

$$\tilde{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{k} \theta_{ij}^{g}(H)} \quad (9)$$

This is to ensure that the own and cross-variable variance contribution sum to one under the generalised decomposition with $\sum_{j-1}^{k} \tilde{\theta}_{ij}^{g}(H) = 1$ and $\sum_{i,j-1}^{k} \tilde{\theta}_{ij}^{g}(H) = k$ by construction.

The total spillover index is then defined as:

$$TS^{g}(H) = \frac{\sum_{i,j=1,i\neq j}^{k} \tilde{\theta}_{ij}^{g}(H)}{\sum_{j=1}^{k} \tilde{\theta}_{ij}^{g}(H)} x100 \quad (10)$$

The directional spillover to variable i from all other variables j is given by:

$$DS_{j\rightarrow i}^{g}(H) = \frac{\sum_{j=1,i\neq j}^{k} \tilde{\theta}_{ij}^{g}(H)}{\sum_{j=1}^{k} \tilde{\theta}_{ij}^{g}(H)} x100 \quad (11)$$

With the reverse, i.e., from market i to all other markets j is given by:

$$DS_{i\rightarrow j}^{g}(H) = \frac{\sum_{j=1,i\neq j}^{k} \tilde{\theta}_{ji}^{g}(H)}{\sum_{j=1}^{k} \tilde{\theta}_{ji}^{g}(H)} x100 \quad (12)$$

From these last two measures we can then determine the net spillover from markets i to markets j as the difference between equation (12) and equation (11):

$$NS_i(H) = DS^g_{i\to j}(H) - DS^g_{j\to i} \quad (13)$$

The net spillover measure indicates whether a country is a net transmitter or a net receiver in the system. The total spillover index is applied to investigate the global and regional trends of spillover activity. Following the approach of Diebold and Yilmaz, we apply a two-lag VAR and 10-week forecast horizon.[9]

4. Data.

The first objective is to take a broad perspective on the linkages between GCC and developed markets. Thus, similar to Beirne et al. (2013), we take the US, EU and Japan as the developed markets and consider the GCC bloc as a whole. Following Balli et al. (2015), we use MSCI indices for the EU and GCC. All MSCI indices represent the performance of large and mid-cap equities and cover approximately 85% of the free float-adjusted market capitalization in each region. The MSCI GCC includes 82 constituents from the six member states. The S&P 500 and Nikkei 225 are used as the US and Japan indices. We also consider the individual GCC country markets and obtain the official all share indexes for Dubai, Saudi Arabia, Abu Dhabi, Qatar, Oman, Bahrain, and Kuwait. We also include the BRIC bloc as a point of comparison to the results for the GCC bloc, for which we use the MSCI BRIC Index. This index is designed to measure the equity market performance across the four emerging markets of Brazil, Russia, India and China. In conducting the correlation and spillover analysis, we include oil returns as an otherwise potential omitted variable that could influence the strength of the interrelations. To this end, we consider both Brent and WTI prices.[10] All the indices employed in this study are obtained from DataStream.

[9] Following Diebold and Yilmaz (2012), we experiment with a VAR lag length of between 2-6 and a H-step ahead of 4-10. As with their findings, our results remain robust across these alternatives. Full results are available upon request.

[10] The below results are obtained including the Brent return series but are quantitatively and qualitatively similar with WTI series.

Weekly data is used in order to maintain a high number of observations while avoiding the biases that can arise with daily data due to, for example, differences in trading hours and national holidays. Also, non-synchronous trading associated with daily data causes noise and consequently can result in spurious spillover effects. The sample ranges from 14/1/2004 to 17/1/2019 and return series are in US dollars to maintain comparability across countries. Return series are generated by applying the first-difference of the natural logarithm of the price index, with volatility calculated as the square of weekly returns.[11]

Table 1 presents the summary statistics for our data. As can be observed, all series demonstrate a positive mean return with the exception of Bahrain and Kuwait. As is common with financial asset returns data, the standard deviation dwarfs the mean value. Additionally, both the indices and oil prices display negative skewness and high kurtosis which is a departure from a normal distribution. Moreover, these traits note the prevalence of small gains and scattered but large losses. The Phillips-Perron (PP) unit root test shows that stationarity holds for all sampled markets.

5. Empirical Results.

5.1. Inter-Regional Linkages

Correlations

Based on the DCC-GARCH model,[12] Figure 1 depicts the time-varying correlation series of the US, EU and Japan with the GCC. Figure 1 shows that the EU-GCC correlation is the highest, for most of the sample period, with an average value of 0.27 and a maximum of 0.48. The US correlation stands in the middle, with an average value of 0.22 and a highest value of

[11] An alternative volatility proxy would include the range measure of Garman and Klass (1980), however, we lack the opening and closing market data for the GCC data. Following the suggestion of an anonymous referee we also estimate individual GARCH processes for each market and use these to examine the volatility spillovers. The results are similar to those reported below and are available upon request.

[12] As noted above, we include an oil return series in the modelling but do not report the results. These, together with full estimation results, are available upon request.

0.43, while the Japanese correlation trails with an average of 0.20, although has a high point of 0.51. There was a noticeable decline in the GCC domestic market in 2006 and we can observe this in a drop in the correlations at this time, particularly in the EU-GCC pair. Figure 1 also points to a sharp change in equity market comovements with a large increase in correlations in 2008 that appear linked to the onset of the financial crisis. A further increase in the correlations across all pairs arose from the 2009 Dubai Debt Standstill, where the Dubai request of debt deferment precipitated a fall in global markets. High US-GCC, EU-GCC, and Japan-GCC correlations were recorded in January 2016. This can be associated with multiple factors: first, the stock market selloff in January 2016; second, the oil price collapse to 25 dollars, which is notably damaging for the GCC economies; third, the US Federal Reserve increasing interest rates from 0.25 to 0.50 points in December 2015. While the Japan-GCC and US-GCC correlations declined shortly afterwards, the EU-GCC continue to rise and reached a peak of 0.48 following the Brexit vote in June 2016. The fall in correlations throughout 2017 coincides with the sluggish growth in the GCC markets as a result of oil price declines. Falling GCC stock markets at this time, contrast with US and EU markets that enjoyed stronger performance. Global market falls in February 2018 saw the correlations rebound back towards 0.4 in the EU-GCC and 0.3 in the US-GCC during March 2018.[13]

The results thus show that Europe has the highest correlations with the GCC bloc. Arguably, this is unexpected given the presumption that the US, as the world's largest economy, is likely to have the most influence on international stock markets. Moreover, GCC countries peg their currencies to the US dollar, forcing them to follow the US lead with respect to interest rate changes. Furthermore, oil, their main export commodity, is priced in US dollars. In order to explain the linkages among the EU and GCC equity markets, we follow the

[13] This is also linked to trade war concerns between the US and China with the Trump administration imposing tariffs on Chinese products (such as aerospace, information communication technology and machinery) on 22 March 2018.

argument of Ng (2000) regarding the importance of trade to stock market linkages. Data from the European Commission show that there is an increasing trend in trade between the GCC and the EU with a 54% growth between 2006 and 2016. Further, the EU bloc is the biggest importer of GCC goods and ranks 4th in terms of export value. With 16.6% of the overall global trading share, the EU is the main trading partner. Japan assumes 8.6% and the US trails with 7.9%. The geographical location of the EU alongside increasing US oil self-sufficiency are plausible explanatory factors to our results. Indeed, according to Forbes and Chinn (2004), trade is the most important determinant of cross-country linkages. Thus, the extent of trade can explain the high EU-GCC correlation.

Spillovers

The above correlation results may also imply the potential for significant spillovers from the EU to the GCC. As Karolyi and Stulz (2003) and Calvo and Reinhart (1996) note, since stock markets are correlated due to interdependence, it is plausible to expect shocks in one market to affect another. Given the above findings, it is pertinent to note that the previous literature overlooks the EU as a possible originator of spillovers to the GCC. Instead, the focus is on the US and oil as main sources of spillovers in the literature (see Malik and Hammoudeh, 2007; Sedik and Williams, 2011; Khalifa et al., 2014).

Table 2 presents the return and volatility spillovers using the Diebold and Yilmaz (2012) methodology. Examining the return spillovers in Panel A, the GCC is, predictably, a net recipient of spillovers from other markets, accounting for 29.3% of the movement in GCC returns, while the GCC contributes 16.9% to the other markets (and predominantly to oil). With 70.8% in the "To all" row, the EU is the highest net transmitter of return spillovers (a net value of 15.1%, compared to 8.3% for the US, -6.2% for Japan and -8.3% for oil). For the GCC, the EU spillovers rank first with a figure of 8.7%, while the US explains 6.3% and Japan only 4.0%

(and 7.0% from oil) of the variance decomposition of GCC returns. The results also demonstrate that the GCC receives the smallest amount of spillovers (26.0%) compared to the other markets within the system (i.e., the US receives 51.5%, the EU receives 55.7%, Japan receives 45.6% and oil receives 29.3% from the other markets). This supports the correlation results above, where the GCC appears relatively segmented from international stock markets.[14]

Panel B presents the volatility spillovers, with a total spillover index of 36.2%, this measure reveals moderate levels of connectedness among the US, EU, Japan and the GCC. In common with previous results, we can observe that there is a higher level of spillovers among developed markets (Morana and Beltratti, 2008; Baele, 2005; Booth et al., 1997; Fratzscher, 2002). Again, we can see that the GCC is relatively segmented with 29.3% contributions from other markets, which is the lowest in terms of exposure to volatility spillover from other indices (excluding the oil market). Similar to the above results, the EU is the main originator of volatility spillovers to the GCC region with 8.4% (although the value for the oil market is higher at 13.5%). Table 2 also illustrates that the US contributes marginally to GCC volatility, with a small figure of 1.9%, such that Japan (surprisingly) ranks second with spillovers to the GCC at 5.5%.

Figure 2 plots the time-varying return and volatility spillover indexes. Similar to previous results, return spillovers exhibit a propensity to increase over time, reflecting amplified connectedness among international equity markets. In the GCC context, similar results are documented by Awartani et al. (2013). Volatility spillovers tend to boom and bust with market turbulence and tranquillity. Notably, spikes in volatility spillovers that coincide with the subprime crisis and the Greek bailout from 2008 to 2010, the taper tantrum in 2013, the January 2016 market selloff and the Brexit vote in June 2016, can be observed. The stock

[14] To provide some statistical significance to these results, following the recommendation of an anonymous referee, we also conduct Granger causality tests. Using lag lengths determined alternatively by the AIC and BIC, the results reveal evidence of causality in both returns and volatility running from the EU and US to the GCC, while causality from Japan is in volatility only. A full set of results is available upon request.

market crash of February 2018 alongside fears of higher expected inflation also appear to contribute to higher spillovers.

Figure 3 shows the pairwise net return and volatility spillovers and thus provides greater information on the time-varying transmission of shocks between the markets. The subprime crisis ignited a change in the dynamics across all markets, with higher return and volatility spillovers. As noted above, the EU is the chief transmitter of return spillovers to the GCC. However, we can see this effect is diminished during the EU debt crisis of 2010/2011. Spillovers from the US and EU then recover their intensity until the taper tantrum, which caused them to deteriorate. After this period, the EU-GCC spillovers regain momentum and continue to be higher than the US spillovers to the GCC, which are more subdued. This is perhaps because, unlike the US Federal Reserve, the ECB continued its policy of monetary expansion. The results for the Japanese return spillovers show only a limited degree of spilloves, which are not consistent in their direction over the sample.

The volatility spillover to the GCC reflect episodes of turbulence in the originator country. For example, in 2006 we see volatility spillover uniquely from the US following the Federal Reserve increasing the Federal funds rates to 5.25%, its highest since January 2001. Further, we see the EU debt crisis instigate spillovers from the EU to the GCC. Global events such as the 2008 financial crisis and the taper tantrum in 2013 result in a spike in spillovers from the US and the EU to the GCC. Again, spillovers from Japan are generally low and exhibit no consistent direction. Of note, the EU-GCC volatility spillovers are higher on average than those from the US particularly in 2009 and 2010 during the aftermath of the financial crisis and EU debt crisis. In contrast, the US-GCC volatility spillovers were more intense but short-lived, notably following the collapse of Lehman Brothers in 2008, the 2013 taper tantrum, and the meltdown of February 2018.

Summarising the above set of results, we see that the EU-GCC correlations are the highest, while the EU is the main originator of both return and volatility spillovers to the GCC bloc. This overturns the presumption that the US dominates the nature of the interrelations. While US shocks appear to generate large shifts in correlations and spillovers, their effect tends to be short-lived, while the EU generates more consistent correlation and spillover behaviour over the full sample period.

5.2. Inter and Intra-Regional Linkages of Individual GCC Markets Correlation

The above analysis considers the GCC as a bloc, however, as noted in the Introduction, there is some evidence of segmentation within the GCC bloc. For example, both Qatar and UAE markets have been reclassified as emerging markets by MSCI in 2014, while the UAE has sought to become a regional financial hub. Thus, we briefly consider the correlations between the individual GCC markets and both the US and the EU, before examining the correlations between the GCC markets.[15] Figure 4 plots the correlations of the US with the individual GCC markets. Here, we can see that two broad camps appear to exist, Abu Dhabi, Dubai, Oman, Qatar and Saudi Arabia show signs of rising and volatile comovements with the US. In contrast, Kuwait and Bahrain tend to be segregated with correlation levels as low as 0.1. Figure 5 depicts the equivalent correlations between the EU and the individual GCC markets and reveal a similar distinction, although Kuwait now shows greater integration with the EU compared to the US.

In explaining the segregation of Bahrain and Kuwait, for Bahrain it is potentially associated with the social unrest that occurred in 2011. Bahrain also lost the role of regional financial hub to Dubai. The Kuwaiti segregation might be associated with the country's heavy dependence on oil and the sluggish GDP growth during recent years. Moreover, while Kuwaiti stock market capitalisation in 2010 was $128 Billion, a similar figure to the Qatari market

[15] Equivalent graphs are available for Japan but add little to the results obtained for the GCC bloc as a whole.

capitalisation, capitalisation dropped in Kuwait to reach $92 Billion in 2018. At the same time, the Qatari market capitalisation grew to reach $162 Billion. Further, both Bahrain and Kuwait have recently fallen in the Transparency corruption index,[16] which may lead to international investors shunning such markets.

Two further markets worthy of note are Qatar and Oman. As with the majority of the GCC markets they exhibit an increasing trend in the equity market correlations with the EU and the US, however, this propensity was interrupted in Qatar and Oman during 2017 and 2018. The impact of the Qatari blockade from May 2017 results in a steep drop in the EU-Qatar correlation, while the decline in the US-Qatar correlation resulted in a negative observation for the first time in nine years. The diplomatic crisis behind the Qatar blockade caused the Qatari stock market to drop by 18% during 2017. This decline was not the case in global markets which explains the lower correlations. However, the Qatari market shows recovery in 2018 and consequently, the correlations have risen. Oman, on the other hand, suffers a downmarket of -11.8% and -15.2% during 2017 and 2018 respectively. Therefore, the Omani integration that has occurred since the 2008 Crisis has now reverted to the level seen at the beginning of the millennium (and close to zero).

Figure 6 presents the correlations between the GCC markets. Across the full range of 21 correlations, we see that the correlations broadly fluctuate around a constant value. Moreover, we can observe that the correlation across the GCC markets typically fluctuate in a range below 0.5, suggesting that within the bloc, the degree of integration is relatively limited. In contrast, for example, the correlation between the US and the EU is 0.77 across the full sample. The exception to this is between Abu Dhabi and Dubai, both of which are part of the UAE. We can also observe some difference for the markets of Kuwait, Oman and Qatar, which do exhibit a trending pattern across some correlations. Notably, the correlations between these

[16] https://www.transparency.org/

three markets exhibit a tendency to decline, for Kuwait-Oman and Kuwait-Qatar, this occurs after 2010, while for Oman-Qatar, this occurs after 2015. The correlation between Qatar-Saudi Arabia also declines after 2015, while the correlation between Qatar and Abu Dhabi generally rises towards the end of the sample period.

Spillovers

Table 3 depicts the return and volatility spillover results for the individual GCC countries. Considering the return spillovers, in Panel A, we can observe the following points.[17] Again, considering the inter-regional effects, the EU remains the major transmitter of return spillovers. The EU surpasses the US as a major originator of spillovers in all GCC nations with the exception of Saudi Arabia and Bahrain. This finding contradicts those of Balli et al. (2015) who argue for the supremacy of the US influence across the GCC equity markets. That said, the return spillover from the US to Saudi Arabia has the highest intensity in the GCC region at 5.8%. This may explain the overestimation of Saudi Arabia's role intra-regionally in previous studies such as Awartani et al. (2013), where the US is the only global factor included. Japan has a relatively low influence on the GCC nations, nevertheless, 3.3% of the variance of the Qatari returns is due to Japanese innovations. This result is in accordance with Balli et al. (2015). The total spillover index of 53.1% remains close to previous findings.

In terms of volatility spillovers, Table 3 Panel B shows that the EU is an important originator of volatility in Kuwait with a relatively high figure of 6.1%. In addition, the EU is a notable source of volatility spillovers in the markets of Oman, Bahrain, and Qatar. In accordance with Balli et al. (2015), Yu and Hassan (2008) and Khalifa et al. (2014), the US is an equally substantial source of volatility spillovers in the GCC region and records 7.3%, 4.9%, and 1.7% in Abu Dhabi, Saudi Arabia and Dubai respectively. In contrast to return spillovers,

[17] The spillover graph equivalent to Figure 2 is available upon request.

Japan plays a more notable role in volatility spillovers for Dubai, Oman and Qatar. This illustrates that the more integrated markets in terms of return spillovers do not necessarily demonstrate equivalent vulnerability to volatility spillovers. This is evident in the case of Dubai and Qatar, perhaps mirroring the enhanced liquidity of these markets.

The above results consider the spillovers for the individual GCC markets and the developed economies. However, we can also consider intra-GCC spillovers. Examining the return spillovers in Table 3 panel A, we can see that the UAE indices of Dubai and Abu Dhabi exhibit the highest intra-regional integration. Notably, Dubai is the greatest recipient and originator of spillovers with figures of 61.2% and 77.2% respectively and thus, a net sender of spillovers. The spillovers from other markets to the Saudi market are 48.8%, while the level of spillovers from Saudi to the other markets is 41.3%, hence, Saudi Arabia is a net recipient of spillovers. Furthermore, looking at the "To all" row, the influence of the Saudi market in the system is noticeably lower than that of Dubai and Abu Dhabi and lower than Oman and Qatar. These results contrast with previous findings of transmission patterns in the GCC, such as Awartani et al. (2013) and Hammoudeh and Aleisa (2004) who argue that the Saudi market plays the leading role. The differences between their and our results could arise because the recent liberalisation efforts in the UAE and its subsequent inclusion in the MSCI emerging market index in 2014. Additionally, the inclusion of a fuller set of developed markets adds important transmissions, which were not captured by previous studies that exclusively focus on the US market.

Table 3 Panel B shows that Dubai is clearly the major instigator of volatility spillovers in the GCC region. Notably, Dubai exhibits larger spillovers in the "To" column towards all other GCC markets, with the exception of spillovers from Abu Dhabi to Saudi Arabia. Thus, Dubai contributes more volatility spillovers to other GCC markets than Saudi Arabia, which is commonly thought of as the dominant regional market. Moreover, the volatility spillovers from other GCC markets (Oman, Bahrain, Kuwait and Qatar) are greater than those of Saudi Arabia, again contrasting with the mainstream belief of Saudi Arabia's influence on the rest of the GCC. A final observation of interest within this table is that the volatility spillovers to the US, EU and Japan from the GCC markets is greatest from Abu Dhabi. This may reflect the small open nature of the Abu Dhabi market and simply reflects general international market movements.

To summarize, in line with Sedik and Williams (2011) and Alotaibi and Mishra (2015), we find that the UAE is the most integrated market inter-regionally. The GCC markets demonstrate more reflexivity towards region-specific innovations when compared with inter-regional ones. This result is not surprising and similar patterns are observed globally (Evans and McMillan, 2009; Yarovaya et al., 2016). The UAE, represented by Abu Dhabi and Dubai, is the main transmitter and receiver of spillovers in GCC; perhaps resulting from liberalisation policies and international capital flows, despite the higher market capitalisation and liquidity of Saudi Arabia, which (in 2016) accounts for over 48% of the GCC market capitalisation and for over 83% of the turnover in the region.

5.3. BRIC Comparison and Robustness

The above analysis examines the interrelations between the GCC and three major developed markets. This section reconsiders those linkages and additionally includes the BRIC bloc. The BRIC bloc represents an alternative group of emerging markets that typically received less investor attention than those of South-East Asia.[18] Thus, from the perspective of international linkages and investment, this group of countries shows some similarities with the GCC bloc. Therefore, we briefly examine the correlations and spillovers including the BRIC bloc.

[18] We do not consider the relations between the developed markets in our sample and the main emerging market bloc, the ASEAN, as Singapore, one of the constituents, is classified as a developed market.

Correlation

Figure 7 presents the correlations between the BRIC and developed markets. The EU-BRIC correlation is the highest with an average of 0.74 while the US-BRIC correlation revolves around 0.65. These values are approximately triple those for the EU-GCC (0.27) and the US-GCC (0.22). Japan has the lowest average correlation at 0.53 over the sample. The Japanese market is evidently less correlated with both the GCC and BRIC. This finding echoes the lower global integration of the Japanese markets as argued by Arshanapalli and Doukas (1993) and Morana and Beltratti (2008). These results demonstrate that the BRIC group is more globally interlinked throughout the period. This is perhaps because the BRIC markets are more mature than the GCC markets, with the MSCI classifying the BRICs as emerging markets while the majority of the GCC markets are classified as frontier. The lower correlations observed in the GCC block could also signal higher segmentation, a result in line with the findings of Yu and Hassan (2008). Further, the BRIC correlations also tend to be less erratic compared with the GCC. This may be due to their geographical dispersion across different continents.

Spillovers

We also consider the Diebold-Yilmaz index, when including the BRIC markets in the system, with the results presented in Table 4. Panel A presents the return spillovers. Here, the GCC remains the most segmented with 70.9% of the return variance explained by its own innovations. This compares with 38.1% in the BRIC bloc. Of note, while the EU continues to exhibit the highest spillover effect of the developed markets to the GCC, the BRIC markets contribute more (10.3%), although the reverse is not true from the GCC to BRIC. This perhaps again highlights the relative segmentation of the GCC from international markets. Calculated as the summation of the off-diagonal elements of the table divided by the sum of all elements of the table, the total spillover index effectively summarizes spillovers in a single measure and indicates that 41.5% of the variance in returns is due to spillovers excluding the BRIC markets which increases to 53.5% when the BRIC markets are included. The table illustrates that Japan has a lower impact on global markets than the BRIC bloc, where the BRIC influence in the system records 69.9% compared to 43.1% in Japan. This is in line with the 2016 IMF[19] world stability report, where it is argued that spillovers from emerging markets are increasing.

For the volatility spillovers in Panel B, again, the total spillover index is increased, from 37.6% to 50.7%. The GCC bloc remains relatively segmented, with own spillovers accounting for 71.7% of the variation, compared to 47.7% for the BRIC markets. The EU continues to be the main originator of shocks to the GCC bloc, while all developed markets exhibit greater spillovers towards the BRIC markets, with Japan the main contributor. Spillovers emanating from the BRIC bloc are also greater than the spillovers arising from the GCC. In total, the BRIC grouping of markets exhibit a greater integration into global markets than the GCC.

6. Summary and Conclusions.

This paper provides an extensive analysis of the inter- and intra-regional linkages between major international stock markets and the GCC region. The GCC bloc is a group of frontier and emerging markets that offer potential diversification opportunities for international portfolio managers. The study considers return correlations and return and volatility spillovers between the GCC and the US, EU and Japan. Using weekly data over the period from 2004 to 2019 and implementing the DCC-GARCH model for correlations as well as the Diebold and Yilmaz spillover index, we undercover the strength of correlations and the main sources of spillover effects.

The key findings reveal that the EU displays the highest degree of correlation with the

[19] https://www.imf.org/external/pubs/ft/gfsr/2016/01/pdf/text.pdf

GCC bloc and is the most important originator of return and volatility spillovers to the GCC region. This result runs counter to the literature, where the primary focus is on the US and oil as the major source of influence in the GCC market. Intra-regionally, contrary to the view of Saudi dominance, the UAE, represented by Dubai and Abu Dhabi, is the main transmitter of information in the GCC.

To demonstrate that the GCC exhibits a lower degree of integration with major financial markets, we also use the BRIC bloc as a point of comparison. Our results point towards higher diversification opportunities in the GCC bloc. Further, within the GCC bloc, there is evidence of disengagement between the different markets. Notably, Saudi Arabia, Qatar and UAE appear to be moving towards more integration while Bahrain and Kuwait (and Oman, to a lesser extent) demonstrate segmentation both regionally and globally. This decoupling pattern between the GCC countries caries essential information to global investors. Such heterogeneity across the markets within this region mean that international investors will not be able to treat each country as a single bloc. This characterisation of individual markets offers improvements in investment choices and market portfolios for global investors.

From a GCC domestic policy perspective, the results suggest that policy-makers must be cognisant of the EU as a major source of spillovers, in addition to the US. Equally, intra-regional spillovers play a prominent role, with the UAE acting as a gateway of spillovers from international developed markets, a role intensified after the 2014 inclusion of the UAE in the MSCI emerging market index. Additionally, policy-makers need to be aware of intra-regional spillovers arising from Qatar, Saudi Arabia and Oman. Moreover, notwithstanding the view that own-volatility innovations are considerably higher than volatility spillovers in the GCC markets, we observe episodes of noticeable volatility spillovers arising from major macroeconomic events such as Federal Reserve policy changes (e.g., interest rate increases in 2006 and 2016, and the 2013 taper tantrum).

Overall, the results here demonstrate the nature of the linkages between the GCC and major international stock markets. Notably, we observe a larger role for the EU in determining the strength of correlations and spillovers than previously recognised. Further, we report the UAE as the main gateway for spillovers into the bloc. These results are important for academics and investors in understanding the evolution of market linkages, for building portfolios and engaging in risk management and for policy-makers in recognising how movements in international markets can have domestic impacts.

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Table 1. Summary Statistics for Market Returns

	Abu Dhabi	Bahrain	BRIC	Dubai	EU	GCC	Japan
Mean	0.0013	-2.E-05	0.0011	0.0011	0.0003	0.0003	0.0008
Median	0.0020	0.0002	0.0045	0.0021	0.0027	0.0017	0.0021
Maximum	0.4024	0.0569	0.1332	0.1565	0.1142	0.1191	0.1410
Minimum	-0.3436	-0.0851	-0.2478	-0.2840	-0.1474	-0.2061	-0.1524
Std. Dev.	0.0342	0.0141	0.0347	0.0391	0.0278	0.0266	0.0252
Skewness	0.1885	-0.4724	-0.7377	-1.0127	-0.6468	-1.4151	-0.4492
Kurtosis	43.148	7.2331	7.3979	10.331	6.6360	13.915	6.7117
Jarque-Bera	52658	614.53	702.93	1889.7	486.52	4153.6	476.40
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PP test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

	Kuwait	Oman	Qatar	Saudi	US	Brent	WTI
Mean	-1.E-05	0.0005	0.0012	0.0008	0.0011	0.0008	0.0005
Median	2.E-05	0.0003	0.0014	0.0037	0.0029	0.0018	0.0025
Maximum	0.1081	0.1237	0.1501	0.1141	0.1653	0.2002	0.2512
Minimum	-0.1536	-0.1962	-0.2296	-0.2531	-0.2026	-0.1646	-0.1910
Std. Dev.	0.0200	0.0243	0.0346	0.0372	0.0234	0.0403	0.0415
Skewness	-1.4457	-1.5172	-0.5590	-1.7614	-1.5347	-0.1269	-0.1149
Kurtosis	15.557	16.067	9.2545	11.963	19.972	4.8737	6.2010
Jarque-Bera	5423.8	5878.8	1318.7	3029.8	9717.8	116.787	336.445
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PP test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 2. Return and Volatility Spillovers - US, EU, Japan and GCC

Return Spillovers						
	US	EU	Japan	GCC	Oil	From
US	48.5	29.5	14.6	3.4	4.0	51.5
EU	27.8	44.3	16.6	4.5	6.8	55.7
Japan	18.6	21.0	54.4	2.7	3.2	45.6
GCC	6.3	8.7	4.0	74.0	7.0	26.0
Oil	7.0	11.6	4.4	6.3	70.7	29.3
To all	59.8	70.8	39.5	21.0	21.0	208.0
All	108.3	115.1	94.0	90.9	91.7	41.6%
Volatility Spillovers						
	US	EU	Japan	GCC	Oil	From
US	50.9	24.5	11.1	8.5	5.1	49.1
EU	21.7	57.1	10.9	2.7	7.7	42.9
Japan	15.9	18.5	58.1	3.6	3.9	41.9
GCC	1.9	8.4	5.5	70.7	13.5	29.3
Oil	3.7	5.8	4.2	4.0	82.2	17.8
To all	43.3	57.3	31.7	18.8	30.1	181.1
All	94.1	114.4	89.7	89.4	112.3	36.2%

Note: The variance decomposition is based on a weekly VAR system with two lags. The spillover value is the assessed influence on the variance of the 10 step ahead stock return/volatility forecast error of country *i* coming from innovations to stock return/volatility of country *j*. The decomposition is based on the KPPS method, and therefore it is robust to variable ordering.

Table 3. Spillover among the US, the EU, Japan and the GCC markets.

Panel A: return spillovers

	US	EU	Japan	Saudi	Dubai	Abu Dhabi	Oman	Bahrain	Kuwait	Qatar	From
US	44.4	27.6	13.4	4.60	2.20	0.60	2.50	0.20	1.80	2.70	55.6
EU	27.0	42.2	15.6	2.70	3.50	0.30	2.60	0.50	2.20	3.40	57.8
Japan	17.4	19.5	51.2	2.70	2.30	0.70	2.00	0.40	1.00	2.70	48.8
Saudi	5.80	3.80	2.90	54.2	9.30	8.80	5.10	2.10	2.50	5.40	45.8
Dubai	2.80	3.70	1.70	7.30	38.8	17.3	10.1	4.30	5.10	8.90	61.2
Abu Dhabi	1.20	1.50	1.10	6.10	20.5	45.6	7.70	3.30	5.10	7.70	54.4
Oman	3.30	3.40	1.80	5.90	12.9	8.40	45.8	5.10	5.90	7.60	54.2
Bahrain	2.70	2.50	1.00	4.20	8.70	6.70	6.90	53.7	7.20	6.60	46.3
Kuwait	1.90	3.00	1.30	2.80	6.80	6.80	9.20	5.90	57.0	5.30	43.0
Qatar	3.50	5.10	3.30	5.00	10.9	8.70	7.60	3.90	5.70	46.2	53.8
To all	65.6	70.1	42.2	41.3	77.2	58.3	53.6	25.9	36.3	50.5	521
All	110.0	112.3	93.4	95.5	115.9	103.9	99.5	79.5	93.3	96.7	52.1%

Panel B: volatility spillovers

	US	EU	Japan	Saudi	Dubai	Abu Dhabi	Oman	Bahrain	Kuwait	Qatar	From
US	26.7	7.70	2.90	1.70	8.00	25.2	5.80	4.90	10.0	7.10	73.3
EU	9.30	49.3	5.50	0.40	2.80	18.7	3.20	2.30	4.50	3.90	50.7
Japan	4.60	8.20	50.3	1.40	3.90	17.9	3.20	2.70	2.30	5.40	49.7
Saudi	4.90	0.80	2.50	59.3	5.60	15.8	2.30	1.70	1.50	5.70	40.7
Dubai	1.70	0.70	2.00	3.40	37.2	7.00	14.1	9.40	9.60	15.1	62.8
Abu Dhabi	7.30	2.00	2.20	0.40	2.50	77.4	2.00	0.90	1.80	3.60	22.6
Oman	1.80	3.60	4.00	1.80	16.1	8.20	48.3	3.60	6.30	6.30	51.7
Bahrain	1.50	2.30	0.50	1.20	13.7	1.90	5.40	48.9	10.5	14.2	51.1
Kuwait	0.60	6.10	3.00	0.70	10.9	4.60	12.1	6.30	42.2	13.5	57.8
Qatar	0.70	2.20	2.40	3.40	16.0	5.90	7.30	9.60	11.9	40.7	59.3
To all	32.4	33.5	25.0	14.3	79.5	105	55.4	41.2	58.3	74.8	520
All	59.1	82.9	75.3	73.7	116.7	182.6	103.7	90.1	100.5	115.5	52.0%

Table 4. Return and Volatility Spillovers - US, EU, Japan, GCC and BRIC

Panel A; Return spillover US, EU, Japan, BRIC and GCC						
	US	EU	Japan	BRIC	GCC	From
US	40.5	24.9	12.1	19.5	3.00	59.5
EU	23.1	36.4	13.6	23.3	3.70	63.6
Japan	16.0	18.0	46.7	16.8	2.40	53.3
BRIC	19.3	24.4	13.5	38.1	4.60	61.9
GCC	6.50	8.50	3.90	10.3	70.9	29.1
To all	64.9	75.8	43.1	69.9	13.7	267
All	105	112	89.8	108	84.6	53.5%
Panel B: Volatility spillover US, EU, Japan, BRIC and GCC						
	US	EU	Japan	BRIC	GCC	From
US	39.8	20.7	22.2	9.30	8.10	60.2
EU	18.8	47.2	21.5	9.70	2.70	52.8
Japan	21.8	22.2	40.2	12.7	3.10	59.8
BRIC	14.0	16.5	18.6	47.7	3.10	52.3
GCC	2.10	11.6	8.20	6.40	71.7	28.3
To all	56.7	71.0	70.6	38.1	17.0	253
All	96.5	118	111	85.8	88.7	50.7%

Figure 1. Correlations among US, EU, Japan and GCC stock markets.

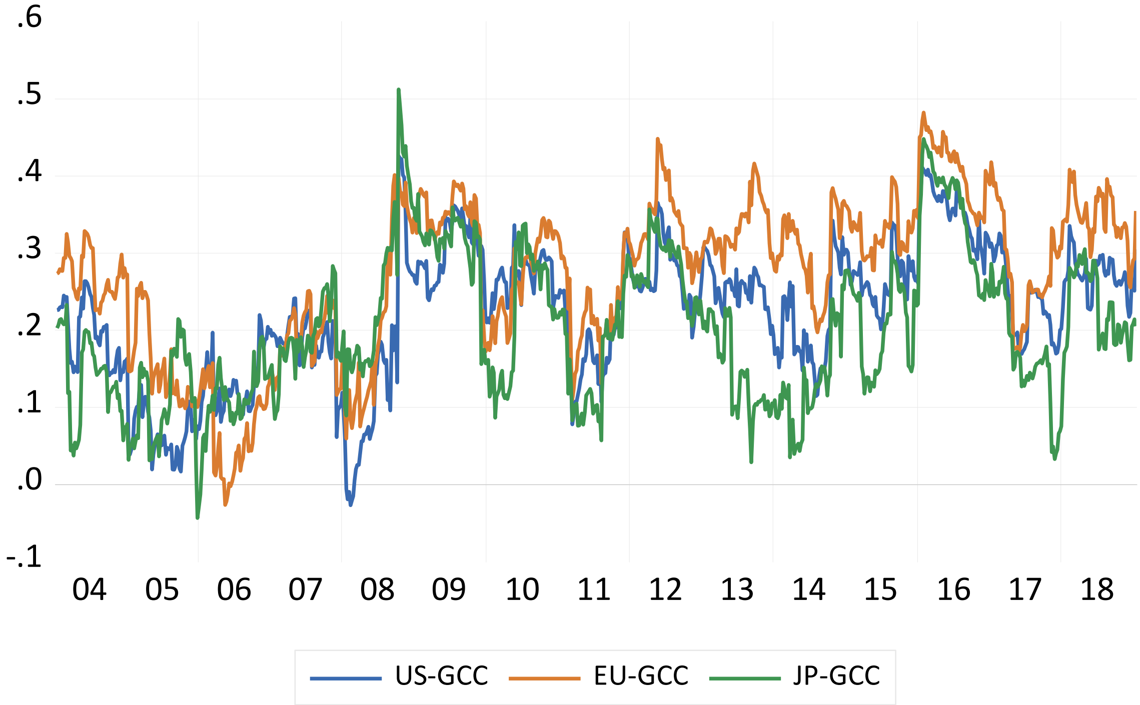
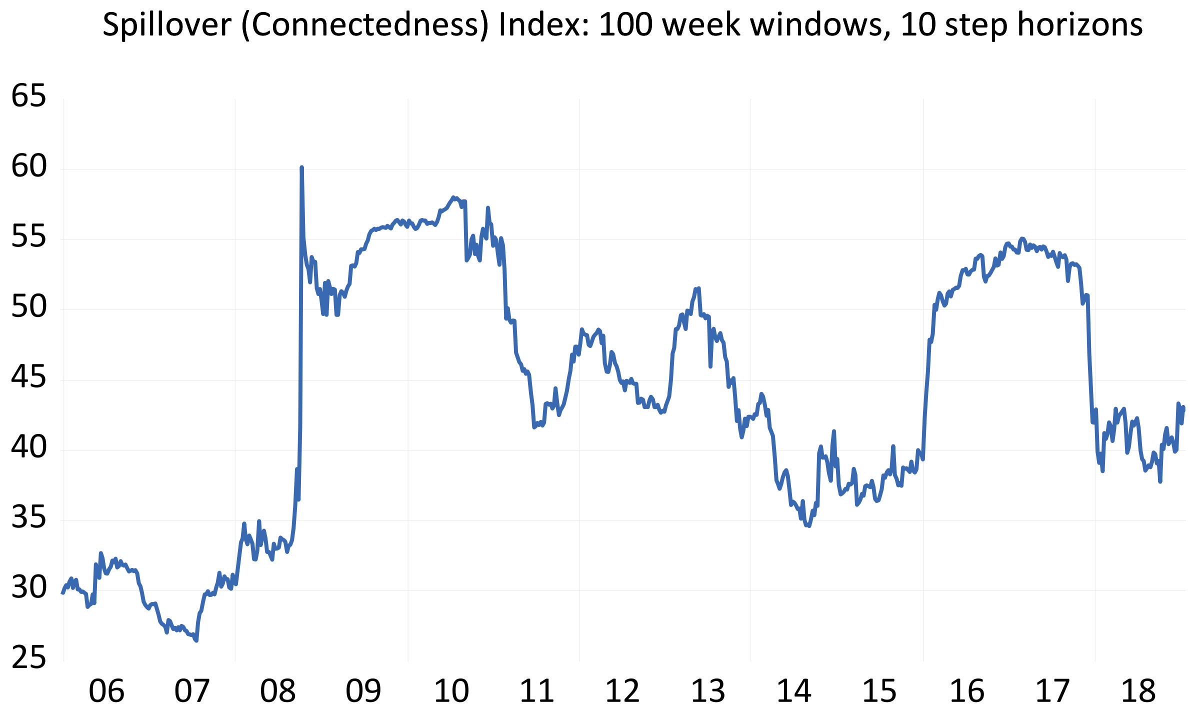
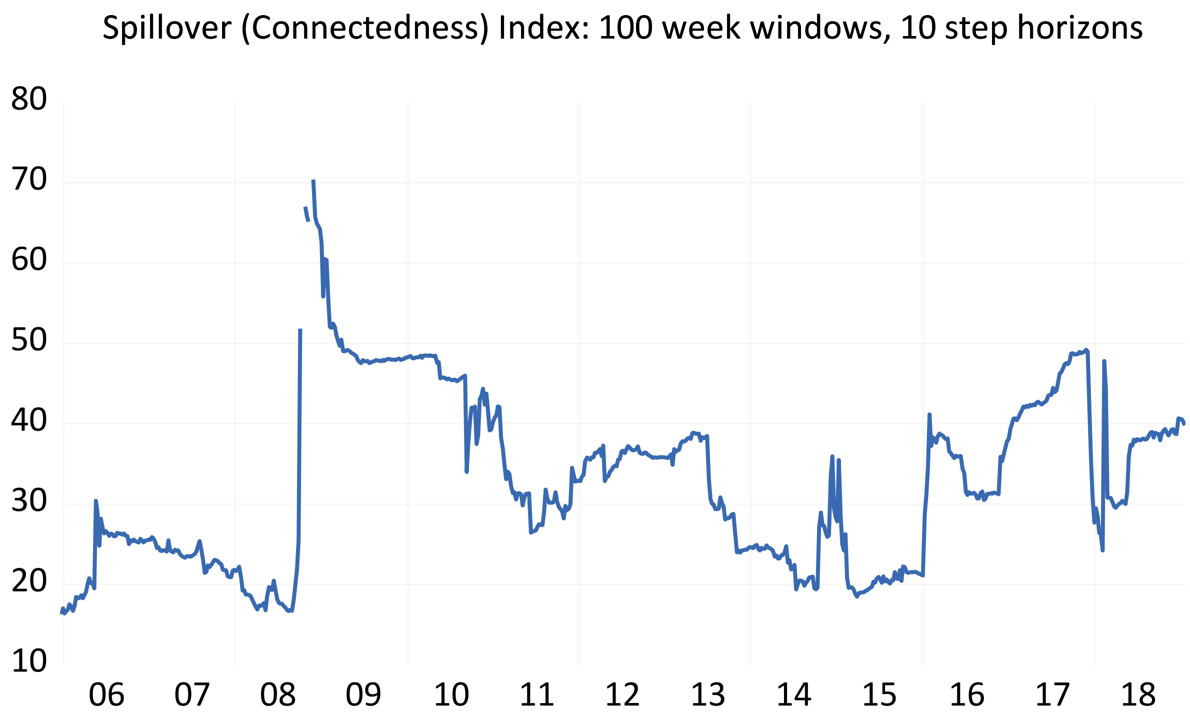


Figure 2. Dynamic Total Return and Volatility Spillover[20] Index:
US, EU, JP and GCC

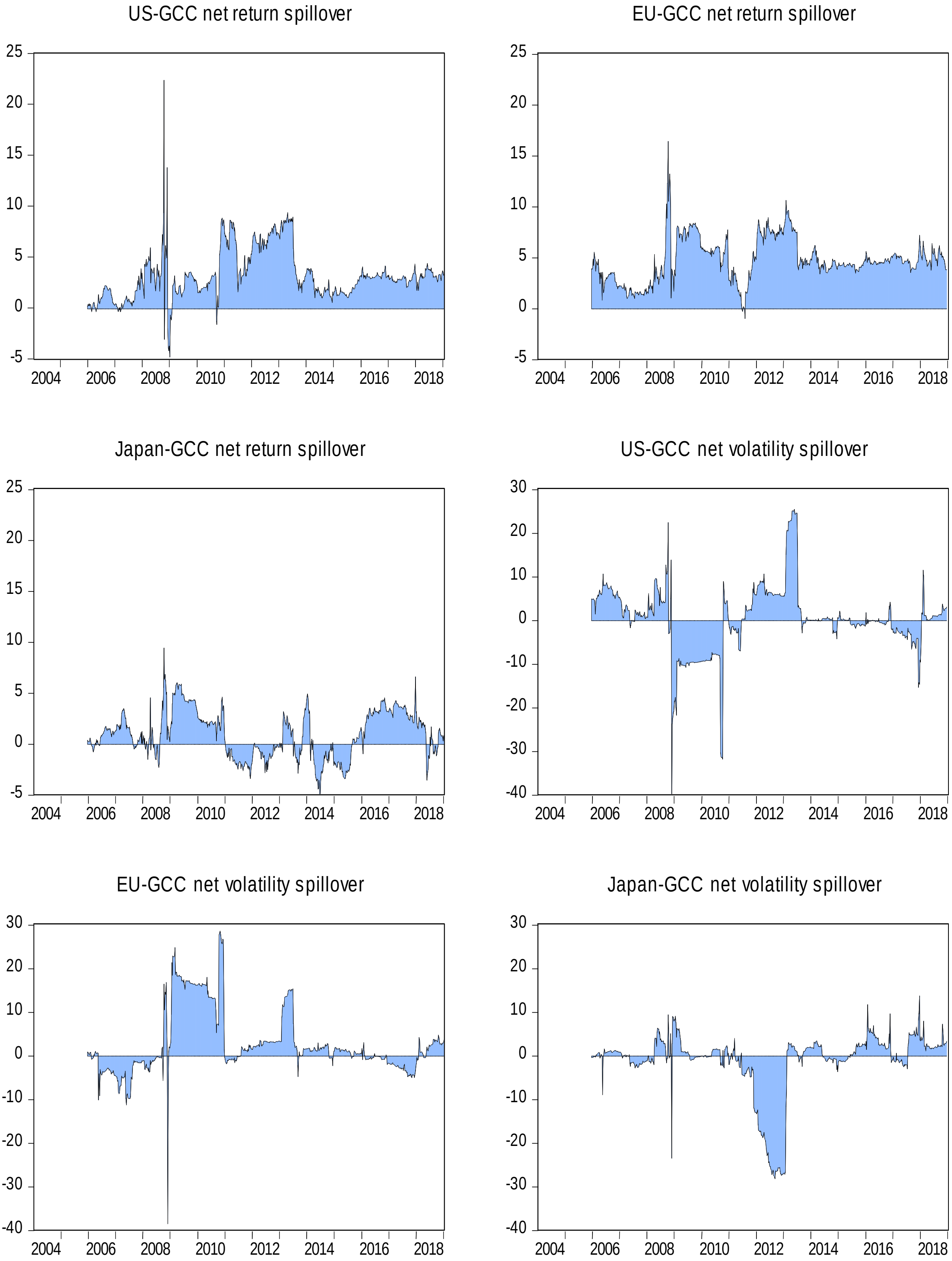




Note: Both figures are generated from a sample including the US, the EU, Japan and GCC based on a 100 week window and a 10-step horizons.

[20] The gap recorded in 2008 volatility series is due to the extreme changes related to the 2008 Crisis, similar gaps can be found in the calculations of Diebold and Yilmaz (2009).

Figure 3. Net pairwise return and volatility



Note: the figures above are generated by subtracting the spills to the GCC from its exported shocks.

Figure 4. Correlations among US and Individual GCC Markets

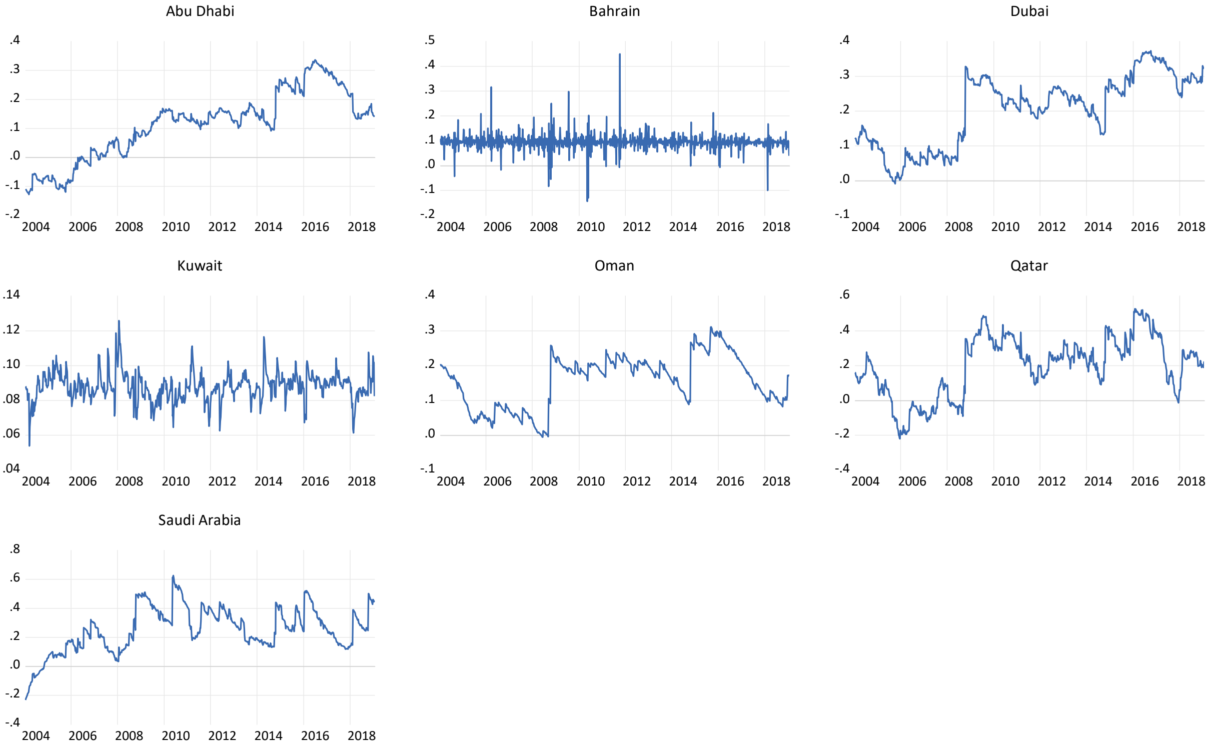


Figure 5 Correlations among the EU and Individual GCC Markets

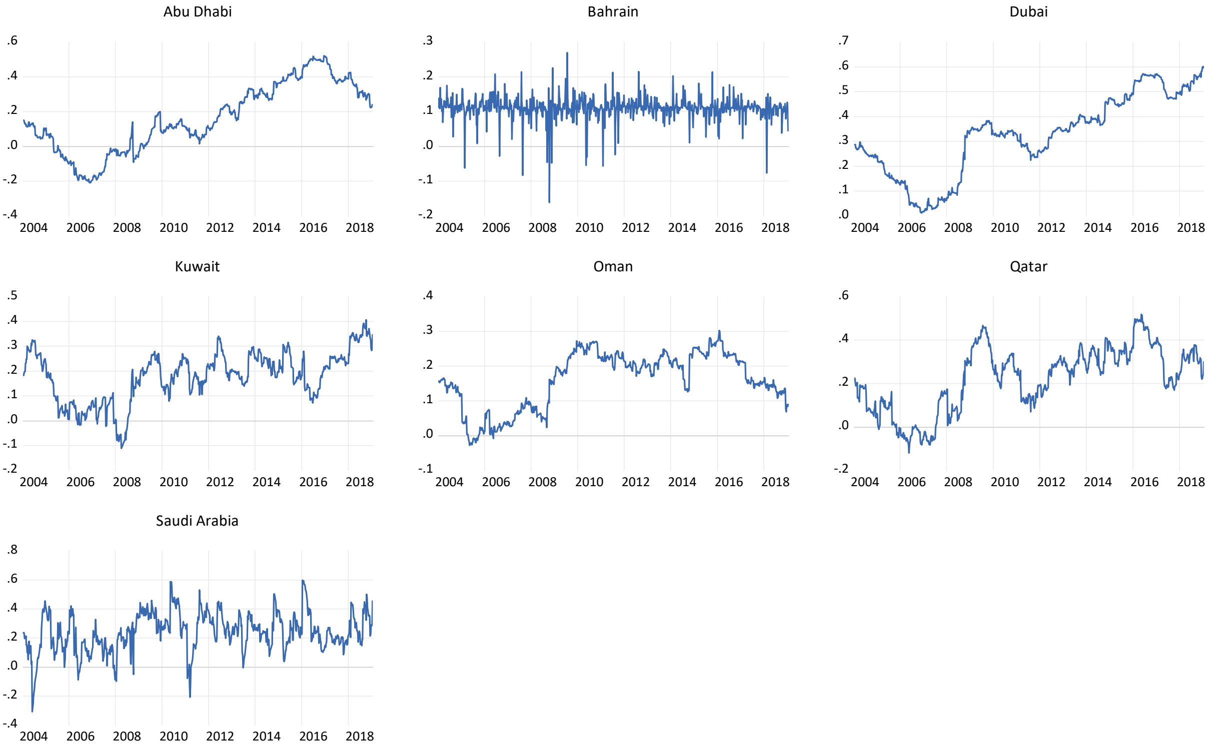


Figure 6. Correlation between GCC Markets

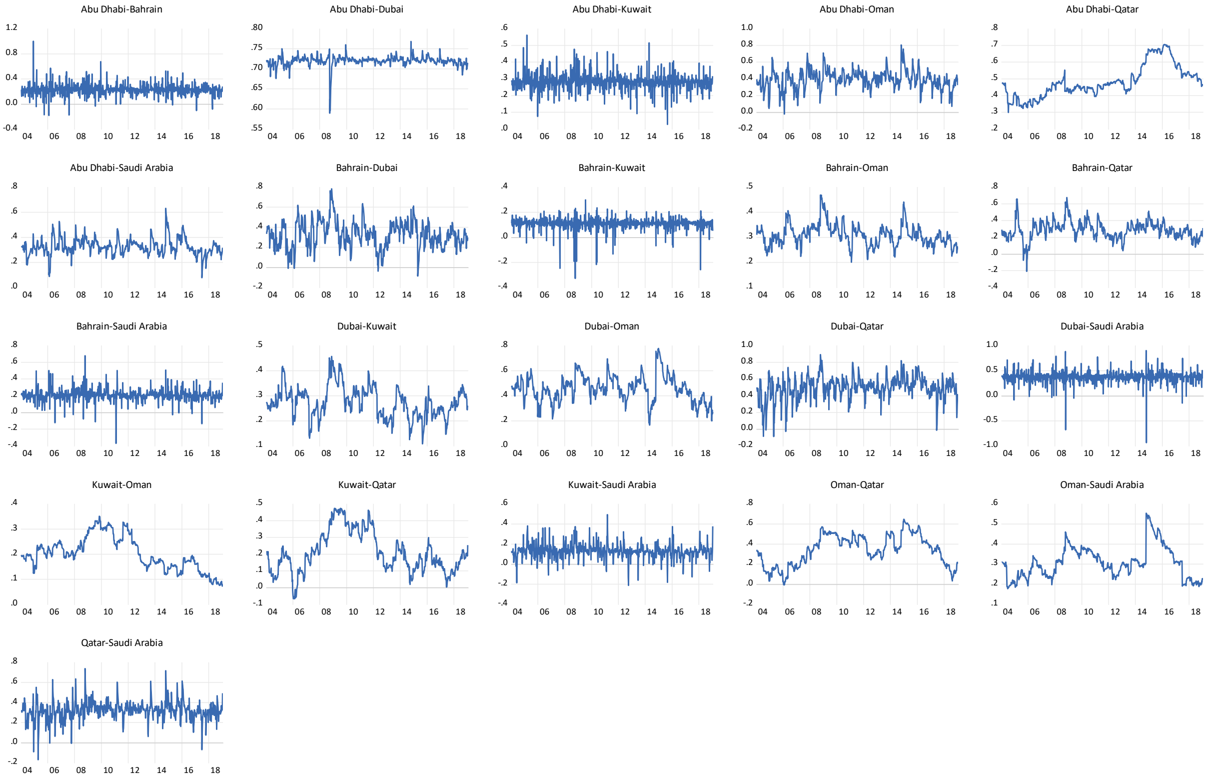


Figure 7. Correlations among US, EU, Japan and BRIC stock markets