Sectoral equity returns and portfolio diversification opportunities across the GCC region

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Abstract

We examine the spillover effects of local and global shocks on Gulf Cooperation Council (GCC)-wide sector equity returns. We find the GCC-wide sector returns have asynchronous responses to global and regional shocks. Although the effects of these shocks differ in magnitude across individual GCC-wide sector returns, there is evidence that the GCC-wide sector equity markets are mostly driven by their own volatilities. For the basic materials, telecom and utility sectors, the effects of regional and global shocks are lower in magnitude in comparison to the rest of the GCC-wide sector indices. Applying a time-varying spillover model, we also indicate that the effect of global shocks on the volatility of GCC sector returns has been decreasing, whereas regional shocks have been affecting the sector indices with a positive and significant trend. We also document that portfolios diversified across GCC-wide sectors perform better than portfolios diversified across GCC national equity markets. To some extent, portfolios diversified with a mix of GCC-wide sector and national equities produce higher returns than portfolios made up of pure GCC national equity indices or GCC-wide sector indices.

JEL classification: G12, G15.

Keywords: GCC stock markets; Portfolio diversification; Sectoral equity indices.

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1 Introduction

Modern portfolio theory postulates that both investors and consumers hold cross-border assets in their portfolios to minimize risk in the hope of securing a given level of expected return. Under the assumption that economic agents are rational and markets are efficient, it is understood that a choice of the right combination of assets can deliver lower overall risk than individual assets in the portfolio. The ability to achieve this goal is further enhanced when market participants possess a good understanding of the origins and drivers of local markets volatility and cross-market correlations. In this respect, previous research has documented a strong positive relationship between the sensitivity of local market returns to common shocks and the degree of financial integration. Such studies group the works of Bekaert and Harvey (1997), Hardouvelis *et al.* (2006) and Stulz and Karolyi (2001) on the effect of global risk factors on asset prices across countries; and Adjaoute and Danthine (2003), Baele *et al.* (2004), Baele (2005) and Bekaert *et al.* (2005) on the cross-correlations of equity markets.

Empirical research on the volatility of stock market returns can be gathered into two strands. The first strand investigates whether the volatility of stock markets' returns is tributary to the dynamics of key macroeconomic variables. For example, Schwert (1989) used vector autoregression models (VAR) comprising the growth rate of producer price index and the monetary base to explain the volatility of stock market returns, whereas King *et al.* (1994) estimated multivariate models using data on interest rates, industrial production and oil prices, and unobservable factors that are not reflected in published stock market data to uncover the linkages between stock returns and observable factors for a number of developed and emerging markets. The second strand of the literature looks into the linkages among equity markets to explain the sources of disturbances in specific markets. In this vein, early empirical research on stock market integration has focused on the concept of conditional volatility implied by ARCH/GARCH models introduced by Engle (1982) and Bollerslev (1986), and the spillover analysis subsequently developed by Engle *et al.* (1990). Since Lin *et al.* (1994) first used this framework to investigate the volatility spillover effects between the United States (US) and the Japanese stock markets, integration of equity markets and the effects of return and volatility spillovers on markets have been studied intensely, using national stock price indices. For example, Fratzscher (2002) and Baele (2005) investigated the volatility and return spillovers for the European stock markets. Bekaert and Harvey (1997) carried out similar work for emerging stock markets to investigate the volatility spillovers from regional and global shocks. Ng (2000) provided evidence of volatility spillover effects in various Pacific Basin stock markets from Japan (local effects) and from the US (global effects). Fedorova and Saleem (2010) looked into the linkages between emerging Eastern European equity markets and Russia from the perspective of volatility spillovers; more recently, Yilmaz (2010) documented strong return spillover effects in the East Asian markets.

Stock markets in the Middle East, though fairly new on average, were growing at a fast pace prior to the recent financial crisis. With oil prices at their highest levels in the past two decades and interest rates as low as 3–4%, foreign investors have enjoyed staggering profits over the years; around $150 billion in 2003 and over $170 billion in 2004, with the bulk generated from the Gulf Cooperation Council (GCC) markets (Bley and Chen, 2006). Despite the growing importance and the increasing attraction of these markets to foreign investors, the number of studies on the dynamics of the GCC equity markets is relatively small. For example, Bley and Chen (2006) analyzed the impact of increased stock market activity in the GCC and the GCC's path towards economic integration on the return behavior and the dynamic relationships among the individual GCC stock markets. Their results show that although GCC stock markets are not homogeneous, they are increasingly integrated, but this integration does not line up with developed stock markets such as the US and the United Kingdom (UK), thereby providing investors with clear portfolio diversification opportunities. Al-Khazali *et al.* (2006) conducted similar research on the effect of capital market liberalization on intra-regional integration of GCC stock markets and found clear evidence of a common stochastic trend between the equity markets of Saudi Arabia, Kuwait, Bahrain and Oman. Further tests on the underlying factors of the common trend led them to conclude that measures taken since 1997 to liberalize the capital markets in the Gulf region have been at least partly responsible for the integration of the Gulf markets.

Studies on the volatility of stock market returns across GCC markets can also be classified according to the two strands of the literature mentioned above. Hammoudeh and Aleisa (2004) used cointegration tests to examine the relationship between fluctuations in oil prices and that volatility of stock market returns in GCC countries. Their results show that the Saudi market is the only one of the group that can be forecasted using oil future prices. Using VAR analysis to study the effect of oil price changes on GCC stock markets, Bashar (2006) found almost similar results: apart from Saudi and Omani stock markets, oil price disturbances cannot be used as a strong predictor of stock market returns for the rest of the GCC. By contrast, in their study on the volatility and shock transmission among the US equity market, the global crude oil market, and the equity markets of Saudi Arabia, Kuwait and Bahrain, Malik and Hammoudeh (2007) discovered that all three GCC equity markets are influenced by volatility from the oil market, but Saudi Arabia is the only market to exert significant volatility spillover back to the oil market. The work of Onour (2007) on the short- and long-term determinants of GCC stock markets' volatility concurred with earlier findings that the effect of oil price changes on GCC stock markets indeed materializes in the long term. Unobservable speculative factors, however, drive short-term market returns, as changes in oil prices pass through observable factors in GCC economies. Hammoudeh and Choi (2007) found that all GCC stock market returns move in the same direction irrespective of whether one considers total returns or differentiates between the permanent component of returns that arise due to fundamental economic shocks, and the transitory component that stems from speculative attacks or fads. They also find the correlations of the stock returns and their components with each other and with the oil price return to be weak, which, in their view, suggests that country particularities above and beyond oil price volatility are important contributors to stock component returns.

The literature has thus far shown that different techniques have been used empirically in an attempt to gauge the linkages in GCC stock markets by investigating the similarity (or lack thereof) of underlying determinants of markets return and volatility to shed light on diversification opportunities for portfolio holders. To that end, the dynamics of the GCC markets are often compared with those of the developed world. However, had it not been for the contributions of Hammoudeh *et al.* (2009) and Benjoullin (2009), the literature would have been silent on the possibility of sectoral diversification opportunities across GCC markets for investors. Hammoudeh *et al.* (2009) used a multivariate VAR(1)-GARCH(1,1) to examine the dynamic volatility and volatility transmission for the service, banking and industrial/insurance sectors of Kuwait, Qatar, Saudi Arabia and the United Arab Emirates (UAE). Their results suggest that past idiosyncratic (own) volatilities matter more than past shocks and that there are moderate volatility spillovers between the sectors within the individual countries, with the exception of Qatar. They also found that the optimal portfolio weights favor the banking/financial sector for Qatar, Saudi Arabia and the UAE, and the industrial sector for Kuwait. These results, however, are in contrast with those of Benjoullin (2009) who failed to find good opportunities for portfolio risk diversification across the Qatar and UAE sectors.

In this paper, we look at the GCC sector equity markets in a broader sense. First, we investigate the return and volatility spillover effects for the GCC-wide sector indices using data collected by Thomson Reuters. Thomson Reuters has been publishing equity indices for eight main economic sectors and more than 40 industry sectors since 2005 under their rubric of GCC economic sectors. Empirically, we model the GCC-wide sectoral equity returns with a GARCH model and show that in majority of the cases, GCC-wide sectoral returns are highly dependent on their own volatilities rather than on local or global shocks. Additionally, we find the magnitudes of the responses to past own volatilities, and local and global shocks to be very different across sectors, indicating that GCC sector indices are mostly heterogeneous. Applying a time-varying spillover model, we also find that the both return and volatility spillover effects of global shocks have been diminishing over time and that conversely, the spillover effects of regional shocks have been increasingly affecting for GCC-wide sector equity indices. Second, we show that portfolios diversified across GCC-wide sectors perform better than portfolios diversified across GCC national equity markets. Portfolio performance is much better when diversification takes place across the GCC-wide sectors that are less dependent on global or local shocks. Portfolios diversified with a mix of GCC-wide sector and national equities produce better results than portfolios made up of pure GCC national equity indices or GCC-wide sector indices, to some extent. Overall, this paper sheds light on the importance of portfolio diversification across the GCC-wide sectors and contributes to the debate on whether sectoral diversification is superior to national diversification when it comes to the GCC stock markets.

The discussion to follow is organized as follows. Section 2 describes the data and presents some descriptive analysis. Section 3 outlines the econometric methodologies behind the return and volatility spillovers, while Section 4 reports the empirical analysis of the spillover effects. Section 5 provides an analysis of the mean–variance frontiers of portfolios in the GCC market, while Section 6 offers additional statistical results associated with the portfolios. Section 7 concludes the paper.

2 Data and descriptive statistics

We use weekly data on GCC-wide sector equity indices from Thomson Reuters Sector Indices, which are based on the Thomson Reuters Business Classification (TRBC) system, an industry classification of global companies. TRBC covers over 70,000 public companies from 130 countries and provides over 10 years of classification history. It consists of four levels of hierarchical structure. Each company is allocated to an industry, which falls under an industry group, which, in turn, belongs to a business sector that is part of an overall economic sector. TRBC comprises 10 economic sectors, 25 business sectors, 52 industry groups and 124 industries. In this paper, we use eight of the economic sectors with financial sub-sectors for the GCC, namely finance, basic materials, industrial goods and services, energy, basic materials, telecom and utilities.[1] Among these economic sectors, the finance sector is the largest in terms of trading volume across the GCC. Additionally, we differentiate between three industries under the finance sector: banking, insurance and real estate. To capture the full extent of the spillovers, we also extract data on the aggregate GCC-wide index and the aggregate world index. The former comes from the Morgan Stanley Capital International (MSCI) equity database, whereas the latter is a broad market benchmark originating from the Dow Jones STOXX database that covers 47 countries and represents 95% of the market capitalization of emerging markets, 95% of the market capitalization of Europe and 95% of the market capitalization of all other developed markets on a country-by-country basis. The overall data for this study spans the period 2005–2012.[2]

In Table 1, we present the summary statistics for the equity returns. It shows that the average of the weekly returns based on the GCC-wide sector equity indices range from -0.12% (energy) to 0.12% (telecom), whereas the variability (or standard deviation) is more dispersed, ranging from 2.45% (insurance) to 6.02% (real estate). Generally, the sectoral equity return tends to be more variable as the average stock return increases in value. We also observe that the statistical distributions of the returns are skewed to the left and they all show excess kurtosis. Accordingly, the unreported Jarque and Bera (1980) test rejects normality for all the series. The last four columns of Table 1 report the Ljung and Box (1978) portmanteau test statistics Q and $Q^\dagger$ (for the squared data) for first- and second-moment dependencies in the distribution of the sector equity indices. For most of the sector equity indices, the Q statistic is significant (Q(1) and Q(4)), suggesting that sector equity indices are serially correlated. The $Q^\dagger$ statistic is significant for all sectors, providing evidence of strong second-moment dependencies (conditional heteroskedasticity) in the distribution of the sector equity indices.

[1] Cyclical and non-cyclical goods and services sectors are excluded due to the discontinuity in the time series data.

[2] The last time series observation of the series corresponds to October 31, 2012.

3 The spillover models

We follow Bekaert and Harvey (1997), Ng (2000) and Bekaert *et al.* (2005) in building the spillover models for the GCC-wide sector equity indices. We consider both the return and the volatility spillover effects of the aggregate world and the aggregate GCC equity markets to formulate their respective univariate AR-GARCH models. The conditional return based on the aggregate GCC equity index (R_{GCC}) and the aggregate world equity index (R_{w}) are assumed to follow an AR(1) process

$$R_{\mathrm{GCC},t} = a_{\mathrm{GCC}} + b_{\mathrm{GCC}} R_{\mathrm{GCC},t-1} + \epsilon_{\mathrm{GCC},t} \tag{1}$$

$$R_{\mathrm{w},t} = a_{\mathrm{w}} + b_{\mathrm{w}} R_{\mathrm{w},t-1} + \epsilon_{\mathrm{w},t} \tag{2}$$

The idiosyncratic shocks $\epsilon_{\mathrm{GCC},t}$ and $\epsilon_{\mathrm{w},t}$ are assumed to be independently and identically distributed. We model the conditional returns of the GCC individual sector equity (R_{s}) as a linear combination of its own history and the return spillovers from both the aggregate GCC and the world equity markets. Accordingly

$$R_{\mathrm{s},t} = a_{\mathrm{s}} + b_{\mathrm{s}} R_{\mathrm{s},t-1} + \eta_{\mathrm{GCC},t-1} R_{\mathrm{GCC},t-1} + \eta_{\mathrm{w},t-1} R_{\mathrm{w},t-1} + \epsilon_{\mathrm{s},t} \tag{3}$$

where a_{s} is the intercept, b_{s} is the sensitivity to a sector's own past performance; $\eta_{\mathrm{GCC},t-1}$ and $\eta_{\mathrm{w},t-1}$ are, respectively, the return spillover from the GCC-wide area and worldwide equity markets; and $\epsilon_{\mathrm{s},t}$ is the error term. The error term is made up from the sector indices' own shocks and global and regional equity market shocks. Accordingly, $\epsilon_{\mathrm{s},t} = \phi_{\mathrm{GCC}} \varepsilon_{\mathrm{GCC},t} + \phi_{\mathrm{w}} \varepsilon_{\mathrm{w},t} + \varepsilon_{\mathrm{s},t}$.

Since it is possible for both the GCC and the world markets to be driven by common news, following the footsteps of Ng (2000), we use Choleski decomposition to separate shocks that are specific to the GCC from those that are specific to the rest of the world. We orthogonalized the innovations so that each market is driven by its own idiosyncratic shocks. The orthogonalized innovations, $\varepsilon_{\mathrm{GCC},t}$ and $\varepsilon_{\mathrm{w},t}$, are approximated by $\epsilon_{\mathrm{GCC},t}=\varepsilon_{\mathrm{GCC},t}+ K_{t-1} \times \varepsilon_{\mathrm{w},t}$ and $\epsilon_{\mathrm{w},t} = \varepsilon_{\mathrm{w},t}$ where K_{t-1} is computed by Cholesky decomposition such that $H_t=K_{t-1}\ \Sigma_t\ K'_{t-1}$ and $\Sigma_t = \begin{pmatrix} \sigma^2_{\mathrm{GCC},t} & 0 \\ 0 & \sigma^2_{\mathrm{w},t} \end{pmatrix}$. Under this specification, the aggregate GCC shock, $\varepsilon_{\mathrm{GCC},t}$, represents a shock that is unrelated to world shocks. The corresponding volatility spillover effects are introduced by the variables $\varepsilon_{\mathrm{GCC},t}$ and $\varepsilon_{\mathrm{w},t}$. Hence, we measure the volatility spillover effects of the GCC market and world market by the coefficients ϕ_{GCC} and $\phi_{\mathrm{w},}$ respectively.

To arrive at the volatility spillover effects, we assume that the idiosyncratic shock in Equation (3), $\varepsilon_{\mathrm{s},t}$, follows a normal distribution with a zero mean and conditional variance, and evolves according to a GARCH(1,1) process

$$\sigma^2_{\mathrm{s},t} = \omega_{\mathrm{s}} + \alpha_{\mathrm{s}}\varepsilon^2_{\mathrm{s},t-1} + \beta_{\mathrm{s}}\sigma^2_{\mathrm{s},t-1} \tag{4}$$

Stability conditions require ω_{s}, α_{s} and β_{s} all be positive and $\alpha_{\mathrm{s}}+\beta_{\mathrm{s}}$ to be strictly less than 1. Since the idiosyncratic shock of Equation (1) follows a distribution similar to Equation (3), we model the conditional variance of the unexpected return from each GCC sector equity market based on information available at time $t-1$ (I_{t-1}) as

$$h_{\mathrm{s},t} = E(\epsilon^2_{\mathrm{s},t}|I_{t-1}) = \phi^2_{\mathrm{GCC},t-1}\sigma^2_{\mathrm{GCC},t} + \phi^2_{\mathrm{w},t-1}\sigma^2_{\mathrm{w},t} + \sigma^2_{\mathrm{s},t} \tag{5}$$

Literally, Equation (5) states that the conditional variance of the unexpected return of each sector equity market depends on the variance of the contemporary aggregate GCC stock market, the aggregate world equity market and its own idiosyncratic shocks. The coefficient estimates (ϕ) are the corresponding return volatility spillovers from the GCC and the world. Accordingly, the sign and significance of the parameters $\phi_{\mathrm{GCC},t-1}$ and $\phi_{\mathrm{w},t-1}$ determine whether the volatility spillover effects from the aggregate GCC and the aggregate world equity markets, respectively, are powerful in explaining the conditional variance of the sector equity returns.

3.1 Constant spillover model

In this paper, we have two approaches for modeling spillovers. First, we model the spillover parameters X(η_{GCC}, η_{w}, ϕ_{GCC}, ϕ_{w}) as being constant throughout the entire sample period, i.e. $X_{a,t} = X_a$ for $t = 1, 2, ..., n$ for any spillover parameter X_a. This specification is well known in the literature as the constant spillover model. However, it is quite possible that the spillover parameters are governed by a set of underlying exogenous factors that are different from the ones contemplated here, or that these parameters may vary with time, which would call for different representations of the volatility spillover models.

3.2 Time-varying spillovers

Once we relax the assumption of constant parameters, we estimate the time-varying spillover model to determine which of the parameters have changed through time by incorporating trends into the analysis. We measure the integration of the sector indices with the global and regional indices by allowing the spillover parameters to undergo a gradual transition, taking on a different value for every six months throughout the sample.[3]

$$\phi_t^{\mathrm{w}} = \phi^{\mathrm{w}_0} + \phi^{\mathrm{w}_1} \times \textsc{trend} \tag{6}$$

$$\phi_t^{\mathrm{GCC}} = \phi^{\mathrm{GCC}_0} + \phi^{\mathrm{GCC}_1} \times \textsc{trend} \tag{7}$$

$$\eta_t^{\mathrm{w}} = \eta^{\mathrm{w}_0} + \eta^{\mathrm{w}_1} \times \textsc{trend} \tag{8}$$

$$\eta_t^{\mathrm{GCC}} = \eta^{\mathrm{GCC}_0} + \eta^{\mathrm{GCC}_1} \times \textsc{trend} \tag{9}$$

TREND is a variable that takes 1 for the year 2006 and increases by 1 for each six months until the end of the sample. Accordingly

$$\begin{aligned} R_t^{\mathrm{s}} &= a_{\mathrm{s}} + b_{\mathrm{s}} R_{t-1}^{\mathrm{s}} + \rho_{t-1}^{\mathrm{GCC}_0} R_{t-1}^{\mathrm{GCC}} + \rho_{t-1}^{\mathrm{GCC}_1} R_{t-1}^{\mathrm{GCC}} \times \textsc{trend} + \rho_{t-1}^{\mathrm{w}_0} R_{t-1}^{\mathrm{w}} \\ &+ \rho_{t-1}^{\mathrm{w}_1} R_{t-1}^{\mathrm{w}} \times \textsc{trend} + \psi_{t-1}^{\mathrm{GCC}_0} \varepsilon_t^{\mathrm{GCC}} + \psi_{t-1}^{\mathrm{GCC}_1} \varepsilon_t^{\mathrm{GCC}} \times \textsc{trend} + \psi_{t-1}^{\mathrm{w}_0} \varepsilon_{\mathrm{w},t} \\ &+ \psi_{t-1}^{\mathrm{w}_1} \varepsilon_t^{\mathrm{w}} \times \textsc{trend} + \varepsilon_t^{\mathrm{s}} \end{aligned} \tag{10}$$

3.3 Variance ratios

To measure the magnitude of the global and regional shocks on the volatility of the unexpected return of each sector equity market, we computed the following variance ratios. For the constant spillover model

$$VR_{\mathrm{s},t}^{\mathrm{w},} = \frac{\phi^2_{\mathrm{w},t-1} \varepsilon^2_{\mathrm{w},t}}{h_{\mathrm{s},t}} \tag{11}$$

$$VR_{\mathrm{s},t}^{\mathrm{GCC}} = \frac{\phi^2_{\mathrm{GCC},t-1} \varepsilon^2_{\mathrm{GCC},t}}{h_{\mathrm{s},t}} \tag{12}$$

[3] Since we have a shorter time period, we intend to have the trend variable changing in every six months instead of every year.

For the time varying spillover model

$$VR^{\mathrm{w}}_{\mathrm{s},t} = \frac{(\phi^{\mathrm{w}_0} + \phi^{\mathrm{w}_1} * \text{TREND})^2 \times \varepsilon^2_{\mathrm{w}}}{h_{s,t}} \tag{13}$$

$$VR^{\mathrm{GCC}}_{\mathrm{s},t} = \frac{(\phi^{\mathrm{GCC}_0} + \phi^{\mathrm{GCC}_1} * \text{TREND})^2 \times \varepsilon^2_{\mathrm{GCC}}}{h_{s,t}} \tag{14}$$

$VR^{\mathrm{w}}_{\mathrm{s},t}$ measures the effect of global shocks (the aggregate world equity index), whereas $VR^{\mathrm{GCC}}_{\mathrm{s},t}$ measures the effect of local shocks on the GCC sector equity indices at time t. The variance ratios are helpful in explaining how powerful the spillover effects are in influencing the unexpected return of each sector equity market. By comparing the simple averages of the variance ratios, we assess the relative magnitude of the local and global shocks on the volatility of the sector.

4 Empirical analysis

4.1 Constant spillover model

Using the numerical optimization algorithm of Berndt *et al.* (1974), we estimate the spillover model using the quasi-maximum likelihood (QML) method with (univariate) Gaussian likelihood functions, and present the results in Table 2. Except for energy and utilities, we find the AR(1) parameter estimates, b_{s}, are positive for each of the sectoral equity markets, but these are statistically significant for only the finance (including banking) and the telecom sectors. Table 2 therefore documents a weak first-order autocorrelation that is, by and large, consistent with the summary statistics reported in Table 1. We find evidence of return spillovers from the local shocks (η_{GCC}) to sectors such as real estate, insurance, construction materials, energy, and utilities. Surprisingly, the telecommunication sector returns contract as growth takes place in overall GCC stock market returns. Only two sectors significantly benefit from return spillover effects from the global shocks (η_{w}): insurance and energy sectors. Table 2 also shows that the volatility spillovers from the local shocks (ϕ_{GCC}) are significant at the 1% level across the board for all sectors, whereas those from the world (ϕ_{w}) are only significant for the finance, real estate, insurance sectors. The volatility process is highly persistent and stationary, as the sum of α_s and β_s is greater than 0.9 but less than 1. In Table 3, we provide robust Wald tests for testing four different joint hypotheses related to the spillover effects of both regional and global factors.[4] Evidently, we cannot reject Hypothesis 1 for the banking, industrial and utilities sectors; nor can we reject Hypothesis 4 for the banking, industrial, energy and telecom sectors. However, there is overwhelming support for rejecting Hypotheses 2 and 3 for all sectors. As could be expected, these results reflect what has happened to the GCC, notably in Dubai in the UAE, where the real estate sector plummeted to alarming levels due to the recent financial crisis.

Thus far, we have documented the linkages between sectoral equity markets in the GCC as a whole, and the regional GCC and global equity markets by focusing on the sign and significance of the spillover parameters. However, these and the magnitudes of the parameters are not particularly useful in quantitatively evaluating the relative importance of local and global shocks on the sectoral equity markets. To address this issue, we computed the variance ratios $VR_{s,t}^{\text{GCC}}$ and $VR_{s,t}^{\text{w}}$, and report the results for both the mean and standard deviations (Table 4). We find evidence of clear dominance of local over global shocks for all sectors. Except the insurance sector, local shocks tend to be more volatile. The combined effects of the two shocks do not exceed 50% in any of the sectors, indicating that idiosyncratic (own) shocks contribute the bulk of the variation in GCC sectoral return volatility, as measured by $(1 - VR_{s,t}^{\text{GCC}} - VR_{s,t}^{\text{w}})$. The values range from a minimum of 46% for the insurance sector to a maximum of 76% for the basic materials sector. These findings suggest that investors might be better off if they diversify their portfolios across sectors in the GCC because of the sheer size of risk associated with idiosyncratic shocks.

4.2 Time-varying spillover model

The trend spillover model allows the spillover parameters to increase or decrease with a constant value. Thus, the spillover parameters may change gradually during the sample period. Table 5 shows the results arising from estimating the trend spillover models for the GCC-wide sector equity indices. Table 5 is structured in a way similar to Table 3, except that we model the spillovers to vary across time. Since the estimated time-varying models produce results that are similar in nature to Table 3, we will not repeat the explanations provided earlier, but focus on interpreting the return and volatility spillovers.

We find the initial level of the return spillover effect of local shocks (η^{GCC_0}) for the time-

[4]The hypotheses are: Hypothesis 1: $H_o : \eta_{\text{GCC}} = \eta_{\text{w}} = 0$ (no return spillover effects); Hypothesis 2: $H_o : \phi_{\text{GCC}} = \phi_{\text{w}} = 0$ (no volatility spillover effects); Hypothesis 3: $H_o : \eta_{\text{GCC}} = \phi_{\text{GCC}} = 0$ (no local spillover effects); and Hypothesis 4: $H_o : \eta_{\text{w}} = \phi_{\text{w}} = 0$ (no global spillover effects).

varying models to be significant for almost all the GCC-wide sector indices, save for, financial institutions and banking. The trend coefficient of the local shocks (η^{GCC_1}) is mostly insignificant or negative for the return spillovers. The return spillovers of world shocks (η^{w_0}) are significant for only the finance sectors (financial institutions, banking and real estate) and the energy sector, whereas the effect of global shocks on return spillovers has been decreasing, as the trend coefficient (η^{w_1}) of global shocks is negative and significant. Strong volatility spillover effects are at play for both the local and global shocks for the GCC-wide sector indices. We find that the initial level of the volatility spillovers of local shocks (ψ^{GCC_0}) is significant for nearly all sectors, as in Table 3, and for all sectors (except for insurance and construction materials, utilities and industrial goods) and we can observe a positive and significant trend for local volatility spillovers. Empirically, we find that (ψ^{GCC_1}) is positive and highly significant, indicating an increase in the effect of local volatility spillovers on GCC sector indices. Even for some sectors, particularly for insurance, the initial level of local volatility spillovers negative, and the increase in the local volatility spillovers throughout the period is 4% and significant, which makes the local volatility spillovers positive at the end of the period. Applying the time-varying spillover models to the GCC sector indices, the initial level of the volatility spillovers of world shocks (ψ^{w_0}) is significant and positive for all sector indices (except basic materials and industrial goods). However, there is a significant decrease of this world shocks on volatility spillovers throughout time. The trend coefficient (ψ^{w_1}) is negative and significant except for the financial sectors, indicating the decrease of global shock spillover on the volatility of GCC-wide sector indices

5 Mean–variance frontiers

The spillover analysis has shown that investors' decisions to diversify their portfolios across sectors is mostly driven by the relative importance of idiosyncratic shocks across GCC-wide sectors. We complement this analysis by investigating the mean–variance frontiers of portfolios created with all GCC-wide sectoral equities, selected samples of GCC-wide sectoral stocks, and pure GCC national equities to arrive at the optimal investment portfolio, using the well-known optimization method proposed by Markowitz (1952).[5,6]

[5]See Markowitz (1952) and Moerman (2008) for further details.

[6]The mean-variance portfolio approach proposed by Markowitz (1952) assumes normality, whereas most financial series have non-Gaussian distributions and rarely follow (if at all) symmetric distributions. Normality assumption of the mean variance approach has been challenged by behavioral economists such as Campbell *et*

Figure 1a illustrates the mean–variance frontiers for the three investment opportunity sets over the period 2005–2008. The selected GCC sector equity indices include: basic materials, telecom and utilities. These sectors are selected because they have the lowest variance ratios from local and regional shocks and are mostly driven by own past volatilities. By comparing the efficiency frontiers of the portfolios created using the sector equity indices with those of the GCC national equity indices, we are able to determine whether investing in sectoral equity markets provides more diversification opportunities than investing in stocks across the national borders. The dotted line is the efficiency frontier for the portfolio composed of selected GCC sector indices only, the short-dashed line is for the GCC-wide sector indices portfolio and the long-dashed line is for the national indices portfolio. Figure 1a shows that the portfolio created with the selected GCC-wide sector indices has a higher efficiency frontier than the portfolio built with all GCC-wide sector indices as well as the national indices and is confirmed by the tangency portfolio as shown by the intersection of the capital market line (the solid line) and the efficient frontier. The tangency portfolio measures the maximum return to risk that can be obtained by forming portfolios of the assets generating the efficient frontier.[7] Comparing sectoral and national indices, the pure GCC-wide sector equity portfolio has a better portfolio than the pure nation portfolio in most of the cases.

Figure 1b presents the mean–variance frontiers for the same three investment opportunities for the period 2008–2012. At first glance, we observe that all efficiency frontiers in Figure 1b are at lower levels compared to Figure 1a, which is likely due to the spillover effects of the 2008–2009 financial crisis on the GCC markets. The efficiency frontier of the selected sector equity indices is above those of the national and the GCC sectoral equity indices. This finding suggests that investors are better off diversifying their investments across different sectors as opposed to across national markets. Fairly enough, portfolio diversification within the selected GCC equity sectors creates better opportunities than a portfolio diversified across all the GCC sector equity markets. Since the selected indices (basic materials, telecom and utilities) are the least affected by regional and global shocks, we are not quite sure how much of an effect this may have on the results.

To compare the performance of the portfolios, we calculate the Sharpe ratios[8] and present

al. (2001). We thank the anonymous reviewer for bringing this point to our attention.

[7]In selecting the optimal point (i.e., the tangent point reflecting the capital market line and the efficient portfolio) we considered both US 10-year Treasury bond rate and US 3-month Treasury bill rate available on the last day of the sample period, which is equal to 1.27% and 0.10%, respectively, in October 2012. In all cases, the more suitable risk-free rate required to find the optimal point was represented by the 3-month Treasury bill rate.

[8]The Sharpe ratio is a measure of the excess return (or risk premium) per unit of deviation in an investment

the results in Table 6. The upper panel of Table 6 reports the average monthly return, the standard deviation and the Sharpe ratios for the full period (2008–2012). Higher Sharpe ratios are preferred to lower ones for investment purposes.[9] We find the Sharpe ratios are 0.24, 4.83 and 7.34 respectively for the portfolios constructed with purely national equities, all GCC-wide sector equities and selected GCC-wide sector equities. These confirm our results depicted in Figures 1a and 1b that investors are better off with a portfolio made up of GCC-wide sector indices, in particular with basic materials, telecom, and utilities than a portfolio built with GCC national indices.

The bottom panel of Table 6 reports the Jobson and Korkie (1981) z-statistics matrix, which is used to test whether the Sharpe ratios are indeed different across portfolios.[10] The null hypothesis is that the Sharpe ratios for any two portfolios are the same, with the alternative that they are different. In all three cases, considering at the p-values in the parentheses, we reject the null hypothesis at the 5% critical level, confirming that (i) the selected few GCC-wide sectors portfolio investment brings highest return to investors per unit of risk, and (ii) diversifying the portfolio across GCC-wide sector indices bring a better mean–variance outcome than diversifying the portfolio across national sector indices.

6 Spanning and intersection tests

To further assess the differences in efficiency frontiers that emerge from the three portfolios created, we empirically estimate the mean–variance spanning and interception tests introduced by Huberman and Kandel (1987). The basic idea underlying this test is that if an investor holds an efficient portfolio with a number of assets, X, it is incumbent upon him/her to determine whether the efficiency frontier improves when a number of assets, say Y, are added to that portfolio before making such investment. Accordingly, the added assets only add diversification opportunities to the portfolio if they are not a linear combination of X (i.e. not "spanned").

asset or a trading strategy, typically referred to as risk (and is a deviation risk measure). The higher the risk premium per unit of risk for an asset/portfolio the more it is preferred to other assets/portfolios. It is defined as: $S = E[R - R_f]/\sigma$, where R is the asset return, R_f is the return on a benchmark asset (such as the risk free rate of return), $E[R - R_f]$ is the expected value of the excess of the asset return over the benchmark return and σ is the standard deviation of the excess of the asset return. Sharp ratios are widely used to rank the performance of portfolio or mutual fund by investment professionals.

[9] It should be mentioned that the statistical distribution of the traditional Sharp ratio test is only valid asymptotically, but not valid for small samples. Recent studies such as Bai *et al.* (2005) offer new testing procedures that are robust to small samples.

[10] For comparison purposes, we used the performance testing with the Sharpe ratio introduced by Memmel (2003). Although the estimated values have been affected, the rankings have remained unchanged.

The mean–variance spanning test is a regression-based test. Since we have two sets of indices, six dimensional national indices (six GCC national indices) and eight dimensional vectors of GCC-wide sector indices, we use these as portfolios and ask: whether adding other sector indices improves the portfolio. Accordingly, we run the following regression

$$R_{s,t} = \alpha + \beta R_{i,t} + \varepsilon_t \tag{15}$$

where $R_{s,t}$ is a $N \times 1$ vector of sector index returns for time t, $R_{i,t}$ is a $K \times 1$ vector of national index returns for time t, α is a $N * 1$ vector of intercepts, β represents the regression coefficients($N \times K$) and ε_t is the error term by $N \times 1$. The null hypothesis for mean–variance spanning is therefore

$$H_o : \alpha = 0, \quad \beta I_k - I_n = 0 \tag{16}$$

which is evaluated by using a joint Wald test. The Wald test statistic follows a χ^2 distribution with $2 \times N$ degrees of freedom. A rejection of the null hypothesis signifies that investors can improve their portfolio by including additional assets, $R_{s,t}$. The relation of this to the mean–variance frontiers is relatively straightforward. Under the null hypothesis, the efficiency frontiers are equal to each other. If they are not equal, the mean–variance spanning test can be used to investigate whether they are significantly different from each other. A slightly less restrictive version of the spanning test is the intersection test, which examines whether the expansion of the investment opportunities by adding extra indices is important for one specific investor, whereas the spanning test investigates whether the addition is important for all investors. The restriction imposed as per the null hypothesis of intersection test is

$$\alpha - I_n - \kappa I_k = 0 \tag{17}$$

where κ is the (gross) risk-free interest rate, which is directly related to the risk aversion of the marginal investor. This test consists of N restrictions and the joint Wald test is χ^2 distributed with N degrees of freedom. We are particularly interested in determining whether investors are better off by investing in specific industry assets, national assets or both.

The statistical results for both the spanning and the intersection tests are reported in Table 7. As shown in the upper panel of Table 7, we reject the null hypothesis at the 1% significance level for both tests irrespective of the sample period considered when the GCC-wide sector indices are added to the portfolio, which implies that addition of GCC-wide sector assets improves investors' portfolios. However, when national indices are added instead, the null hypothesis is accepted for the spanning test but is rejected for the intersection test at the 10% level, indicating that investors are not better off with this expansion of their portfolios, though these are valid for a specific risk-free rate or risk aversion parameter.[11]

Looking at Figures 2a and 2b, we observe similar findings in graphical form. In Figure 2a, the efficiency frontier of the portfolio composed of GCC national and sectoral indices (the dotted line) is better than the efficiency frontier of the pure national index portfolio (the long-dashed line) for the period 2005–2008. However, it is not clear whether the portfolio made up of both sectoral and national indices is better than the portfolio built with sectoral indices (the short-dashed line) only. The efficiency frontier for the portfolio comprising GCC sectoral indices is the best at times when the standard deviation of the mean (risk) is very high and exceeds 3.60%. These times can be characterized by very volatile oil prices and/or very high geopolitical risk.

In Figure 2b, the efficiency frontier of the portfolio created with sectoral and national indices is much better than the portfolio with pure national indices for the period 2008–2012, indicating that investors holding portfolios of GCC national stocks benefit from adding GCC-wide sectoral assets to their portfolios as well. To complement this result, we investigated whether having a national and sector portfolio performs better under different constraints. In particular, we tested for the extreme short- and long positions, but the superior performance of national plus sectoral indices seems to dominate. As in Figure 2a, we cannot unambiguously rank the portfolios built with GCC sectoral and national indices and the portfolio made up of GCC sectoral indices only. Overall, we conclude from the spanning tests and efficiency frontiers that the portfolio diversification across GCC national indices is not optimal, and adding GCC sectoral indices brings better opportunities. However, it is somewhat ambiguous whether adding national indices to portfolio created with purely GCC sectoral indices makes the investors better off.

[11] The reported results in Table 7 are based on a risk-free interest rate of 4%. A risk-free rate of 2% is also considered as a check of the robustness of our results. Although this affects the test statistics, but the overall conclusions remain the same.

7 Conclusions

Our objective in this paper was to determine the extent of regional and global equity markets, return and volatility spillover effects on the GCC equity markets by focusing on the GCC-wide sectors. We also investigated whether portfolios diversified across the GCC region provide better opportunities for investors and whether returns are enhanced when portfolios expand to incorporate other assets. Our results show that GCC-wide sector equity markets are mainly driven by idiosyncratic shocks. Local and global factors account for less than 50% of the total variation in sectoral equity return volatility, irrespective of the sector taken into consideration. For sectors such as basic materials, telecom and utilities, the return volatility is less dependent on both local and global factors. Additionally, we show that the spillover effects of global shocks on GCC-wide sector equity returns has been decreasing throughout the period; conversely, the spillover effect of regional shocks had a positive and increasing effect on the volatility of GCC sector equity indices. We also find that diversifying a portfolio across GCC sectors yields a better portfolio than diversifying a portfolio across national GCC equity markets. Portfolios with selected GCC-wide sector equities are an even better option. This paper offers clear insights for investors seeking to invest or diversify their portfolio in the GCC equity markets as the GCC clears away hurdles towards achieving full monetary union, which could eventually mean full capital market integration.

This paper remains silent on the possibility of including commodities as important elements for portfolio diversification. In recent years, global trading of major precious metals (e.g., gold, silver and platinum) have risen significantly and are now being considered by investors in designing prudent risk management and portfolio strategies – see Hammoudeh *et al.* (2012) for a recent analysis. Since the economic function of commodities, and hence commodity futures, are strikingly different from stocks, bonds and other conventional assets (see Gorton and Rouwenhorst, 2006), the diversification benefits of commodity futures may work well when they are needed most. In particular, over a long period, as demonestrated by Gorton and Rouwenhorst (2006), commodity futures returns match equities but with a negative correlation, indicating that they are an attractive asset class to diversify traditional portfolios of stocks and bonds. We hope future research will investigate this issue further.

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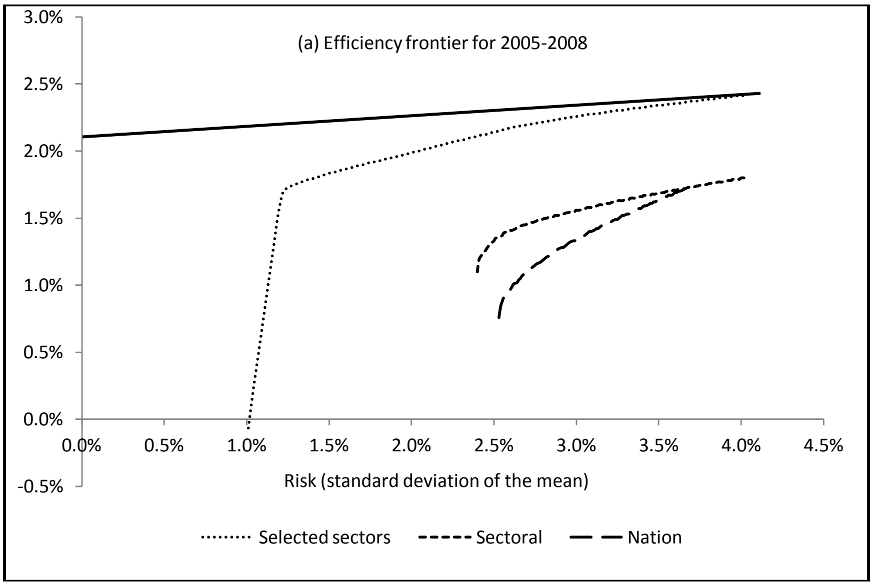
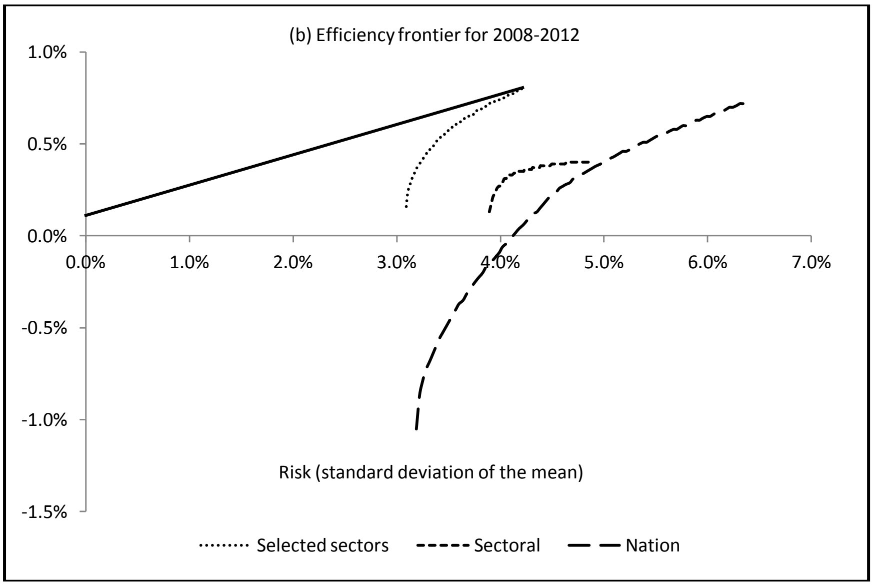
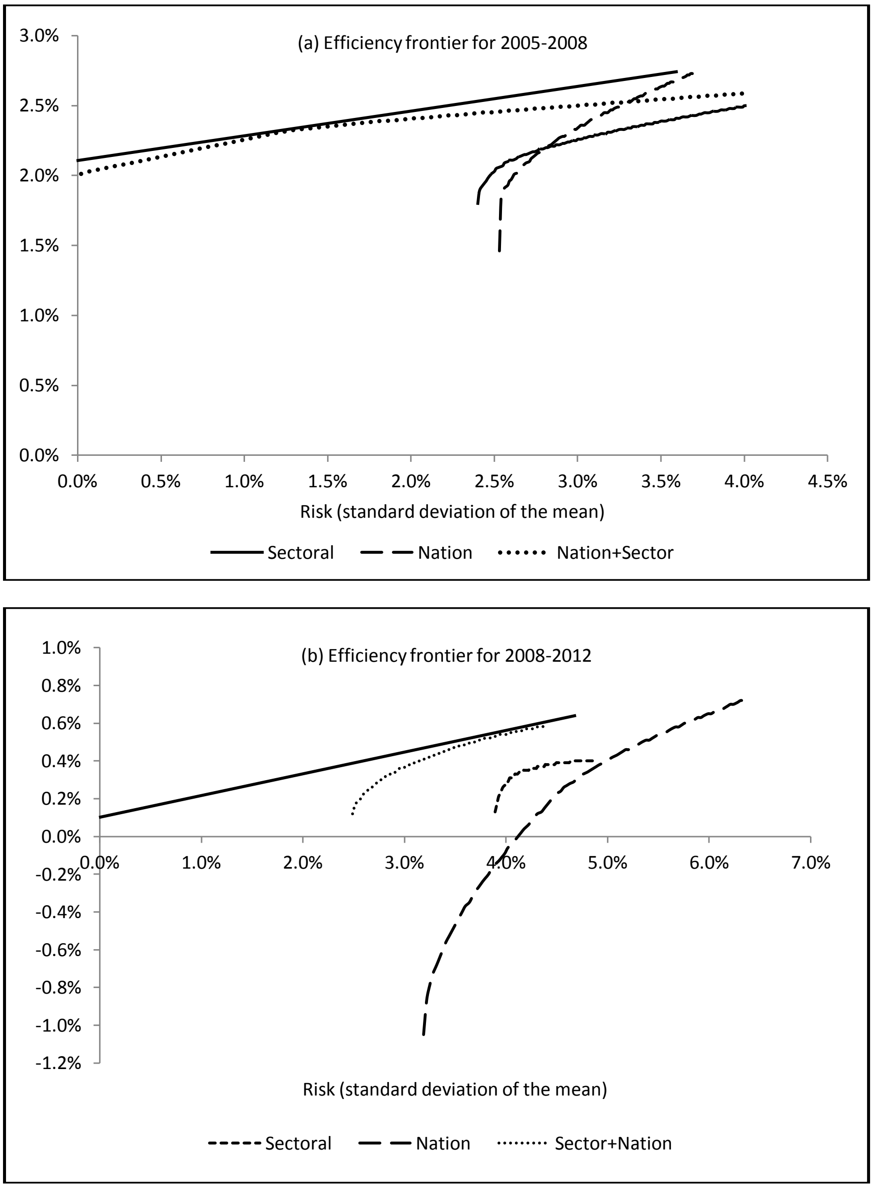
Figure 1: Mean–variance frontiers





Note: The dotted line represents investment possibilities including selected GCC-wide sector equity indices. The short-dashed line represents all investment possibilities including only GCC-wide sectoral equity indices only. The long-dashed line represents investment possibilities including GCC national equity indices only. The solid line denotes the capital market line and the tangency point with the efficiency frontier is obtained using the 3-month US Treasury bill rate.

Figure 2: Mean–variance frontiers with portfolio expansion



Note: The short-dashed line represents all investment possibilities including GCC-wide sectoral equity indices only. The long-dashed line represents investment possibilities including GCC national equity indices only. The dotted line represents investment possibilities including GCC national and sectoral equity indices. The solid line denotes the capital market line and the tangency point with the efficiency frontier is obtained using the 3-month US Treasury bill rate.

Table 1: Descriptive statistics

	Mean	STD	Skew	Kurt	Q(1)	Q(4)	$Q^{\dagger}(1)$	$Q^{\dagger}(4)$
FIN	0.10	6.48	–0.87	2.37	0.19***	0.11***	0.12**	0.14***
BNK	-0.01	2.12	–1.45	10.23	0.14***	0.11**	0.21***	0.13***
INSR	-0.02	2.45	0.12	2.43	0.09***	0.14***	0.14***	0.21***
REST	-0.02	6.02	–0.32	7.21	0.21***	−0.05	0.13***	0.05**
BSMT	0.05	5.21	–2.21	5.44	0.03*	0.12**	0.18***	0.23***
IDS	0.06	3.56	–1.01	4.59	0.17***	0.01***	0.12***	0.04***
CNS	–0.02	3.91	–0.48	4.91	0.11**	−0.03	0.20**	0.15***
ENERGY	–0.12	4.11	–0.45	2.81	0.12	0.01	0.21***	0.12***
TEL	0.05	3.04	–0.15	3.51	−0.11*	0.03	0.15***	0.15***
UTI	0.03	4.44	–1.04	4.99	−0.05	−0.04	0.16***	0.11***
GCC	–0.04	4.01	–0.96	4.41	0.06***	−0.05	0.17***	0.13***
WORLD	0.02	3.05	–1.21	15.31	−0.11**	0.13***	0.16***	0.09***

Notations: FIN: Finance, INSR: Insurance, REST: Real Estate, BNK: Banking, BSMT: Basic Material, CNS: Construction Materials, IDS: Industrial, ENERGY: Energy, TEL: Telecom and UTI: Utilities. The three sub-sectors of the finance sectors include banking, insurance and real estate.

The table reports the summary statistics for the weekly returns (in %) of the GCC-wide sector, aggregate GCC and aggregate world equity indices. The following statistics are reported: mean, standard deviation (STD), skewness (Skew), kurtosis (Kurt), autocorrelations of order 1 and 4 (Q(1) and Q(4)) and autocorrelations of the squared time series of order 1 and 4 ($Q^{\dagger}(1)$ and $Q^{\dagger}(4)$). *, ** and *** indicate that the Ljung and Box (1978) test statistic is significant at the 10%, 5% and 1% levels, respectively.

Table 2: Constant spillover model for GCC-wide sectoral equity indices

	b_{s}	η_{GCC}	η_{w}	ϕ_{GCC}	ϕ_{w}	α_s	β_s
FIN	0.13**	0.00	0.02	0.47***	0.16**	0.10**	0.69***
BNK	0.17***	0.02	0.00	0.45***	0.03	0.18***	0.73***
INSR	0.03	0.21***	0.12***	0.37***	0.09***	0.33***	0.60***
REST	0.02	0.21***	0.05	0.65***	0.07***	0.15***	0.78**
BSMT	−0.01	−0.03	0.04	0.79***	0.04	0.11**	0.88***
IDS	0.03	0.11	0.05	0.71**	0.05	0.21***	0.68***
CNS	0.03	0.12***	0.04	0.40***	0.09**	0.11**	0.86***
ENERGY	−0.01	0.20***	0.12**	0.49***	0.11	0.21***	0.70***
TEL	0.24**	−0.08**	−0.05	0.62***	0.05	0.11***	0.88***
UTI	0.00	0.11***	0.01	0.43***	0.05*	0.32***	0.59**

Notations: FIN: Finance, INSR: Insurance, REST: Real Estate, BNK: Banking, BSMT: Basic Material, CNS: Construction Materials, IDS: Industrial, ENERGY: Energy, TEL: Telecom and UTI: Utilities. The three sub-sectors of the finance sectors include banking, insurance and real estate.

The spillover model for GCC-wide sector equity indices is defined as follows:

$$R_{\text{s},t} = a_{\text{s}} + b_{\text{s}}\, R_{\text{s},t-1} + \eta_{\text{GCC},t-1} R_{\text{GCC},t-1} + \eta_{\text{w},t-1} * R_{\text{w},t-1} + \epsilon_{\text{s},t}$$

where $\epsilon_{\text{s},t} = \phi_{\text{GCC},t-1}\varepsilon_{\text{GCC},t} + \phi_{\text{w},t-1}\varepsilon_{\text{w},t} + \varepsilon_{\text{s},t}$. $R_{\text{s},t}$ is the weekly return of each GCC-wide sector equity index. η_{GCC} and η_{w} are the return spillover effects of the returns of the aggregate GCC equity index and the aggregate world index respectively. ϕ_{GCC} and ϕ_{w} are the volatility spillover effects of the returns of the aggregate GCC equity index, and the aggregate world index, respectively. The constants of each variance equation and mean equation are not reported for the sake of brevity. *, ** and *** indicate that the relevant coefficient is significant at the 10%, 5% and 1% levels, respectively.

Table 3: Tests for constant spillover effects

	$Wald_1$	$Wald_2$	$Wald_3$	$Wald_4$
FIN	6.23*	145.45***	201.12***	21.70***
BNK	1.24	214.13***	304.34***	3.23
INSR	14.44***	101.34***	121.97***	21.21***
REST	6.51***	342.23***	127.76***	10.32***
BSMT	10.12***	113.12***	124.12***	111.61***
IDS	0.86	302.12***	214.23***	1.61
CNS	6.04*	66.34***	534.23***	8.43*
ENERGY	5.23*	231.34***	321.33***	0.71
TEL	4.41*	500.52***	178.90***	1.23
UTI	1.43	156.34***	623.34***	78.12***

Notations: FIN: Finance, INSR: Insurance, REST: Real Estate, BNK: Banking, BSMT: Basic Material, CNS: Construction Materials, IDS: Industrial, ENERGY: Energy, TEL: Telecom and UTI: Utilities. The three sub-sectors of the finance sectors include banking, insurance and real estate.

The table reports the joint robust Wald test statistics for the following null hypotheses regarding the spillover effects in the constant spillover model:

$Wald_1 : H_o : \eta_{\text{GCC}} = \eta_{\text{w}} = 0$ (no return spillover effects)

$Wald_2 : H_o : \phi_{\text{GCC}} = \phi_{\text{w}} = 0$ (no volatility spillover effects)

$Wald_3 : H_o : \eta_{\text{GCC}} = \phi_{\text{GCC}} = 0$ (no local spillover effects)

$Wald_4 : H_o : \eta_{\text{w}} = \phi_{\text{w}} = 0$ (no global spillover effects)

*, ** and *** indicate that the relevant coefficient is significant at the 10%, 5% and 1% levels, respectively.

Table 4: Variance ratios: local and global shocks

	Local	STD	*Global*	STD
FIN	0.38	0.08	0.12	0.04
BNK	0.34	0.04	0.10	0.03
INSR	0.30	0.11	0.25	0.04
REST	0.38	0.10	0.16	0.08
BSMT	0.22	0.06	0.02	0.04
IDS	0.36	0.08	0.06	0.04
CNS	0.26	0.08	0.16	0.06
ENERGY	0.33	0.05	0.17	0.04
TEL	0.20	0.13	0.6	0.03
UTI	0.17	0.09	0.09	0.06

Notations: FIN: Finance, INSR: Insurance, REST: Real Estate, BNK: Banking, BSMT: Basic Material, CNS: Construction Materials, IDS: Industrial, ENERGY: Energy, TEL: Telecom and UTI: Utilities. The three sub-sectors of the finance sectors include banking, insurance and real estate.

The table reports the mean and the standard deviation (STD) of the sector equity indices' variance ratios. The variance ratio of the spillover effect of both local aggregate GCC equity index and the sector equity indices is formulated as:
$VR^{\text{GCC}}_{\text{s},t} = \frac{\phi^2_{\text{GCC},t-1}\varepsilon^2_{\text{GCC},t}}{h_{\text{s},t}}$ and $VR^{\text{w}}_{\text{s},t} = \frac{\phi^2_{\text{w},t-1}\varepsilon^2_{\text{w},t}}{h_{\text{s},t}}$, where $h_{\text{s},t} = \sigma^2_{\text{s},t} + \phi^2_{\text{GCC},t-1}\sigma^2_{\text{GCC},t} + \phi^2_{\text{w},t-1}\sigma^2_{\text{w},t}$.

*, ** and *** indicate that the relevant coefficient is significant at the 10%, 5% and 1% levels, respectively.

Table 5: Time-varying spillover model for GCC-wide sectoral equity indices

	b_s	η_{GCC_0}	η_{GCC_1}	η_{w_0}	η_{w_1}	ϕ_{GCC_0}	ϕ_{GCC_1}	ϕ_{w_0}	ϕ_{w_1}	α_s	β_s
FIN	0.16***	0.04	0.01	0.20**	0.01	0.15***	0.06***	0.21*	0.02	0.23***	0.74***
BNK	0.15***	−0.02	0.00	0.32**	−0.06**	0.08**	0.04**	0.10**	0.01**	0.08***	0.81***
INSR	0.01	0.24**	−0.04**	0.01	−0.01	0.03	0.10***	0.45***	0.05**	0.11***	0.87***
REST	0.01	0.25***	−0.04**	0.44***	−0.05***	0.21***	0.16***	0.78***	0.03	0.14***	0.80***
BSMT	0.12**	0.05*	0.21**	0.20	−0.09**	0.11**	0.02	−0.01	−0.05**	0.10***	0.86***
IDS	0.14**	0.21*	0.04**	0.01	0.02	0.05	0.14**	0.03	0.03	0.05***	0.90***
CNS	0.01	0.35**	−0.03	0.01	0.01	−0.32	0.15***	0.35**	−0.05**	0.06***	0.71***
ENERGY	−0.03**	0.21***	0.01	0.20***	−0.04***	0.35***	0.06**	0.21**	−0.04**	0.05***	0.78***
TEL	0.02	0.19***	−0.06***	−0.06	0.04	0.03	0.08**	0.47***	−0.08**	0.20***	0.75***
UTI	−0.04	0.30**	−0.04**	0.06	0.01	0.38***	0.01	0.43**	−0.06**	0.12***	0.59***

Notations: FIN: Finance, INSR: Insurance, REST: Real Estate, BNK: Banking, BSMT: Basic Material, CNS: Construction Materials, IDS: Industrial, ENERGY: Energy, TEL: Telecom and UTI: Utilities. The three sub-sectors of the finance sectors include banking, insurance and real estate.

The time-varying spillover model for GCC-wide sector equity indices is defined as follows:

$$
\begin{aligned}
R_t^{s} &= a_s + b_s R_{t-1}^{s} + \rho_{t-1}^{GCC_0} R_{t-1}^{GCC} + \rho_{t-1}^{GCC_1} R_{t-1}^{GCC} * \text{TREND} + \rho_{t-1}^{w_0} R_{t-1}^{w} + \rho_{t-1}^{w_1} R_{t-1}^{w} * \text{TREND} \\
&+ \psi_{t-1}^{GCC_0} \varepsilon_t^{GCC} + \psi_{t-1}^{GCC_1} \varepsilon_t^{GCC} * \text{TREND} + \psi_{t-1}^{w_0} \varepsilon_{w,t} + \psi_{t-1}^{w_1} \varepsilon_t^{w} * \text{TREND} + \varepsilon_t^{s},
\end{aligned}
$$

where $R_{s,t}$ is the weekly return of each GCC-wide sector equity index. η_{GCC} and η_w are the return spillover effects of the returns of the aggregate GCC equity index, and the aggregate world index respectively. ϕ_{GCC} and ϕ_w are the volatility spillover effects of the returns of the aggregate GCC equity index, and the aggregate world index, respectively. TREND is a time trend variable. The constants of each variance equation and mean equation are not reported for the sake of brevity. *, ** and *** indicate that the relevant coefficient is significant at the 10%, 5% and 1% levels, respectively.

Table 6: Performance tests and Z-statistics

	A. Performance Tests		
	Mean	STD	Sharpe Ratio(%)
Nation	0.02	8.12	0.24
Sector	0.30	6.21	4.83
Selected Sector	0.36	4.90	7.34

	B. Z-statistics		
	Nation	Sector	Selected Sector
Nation	–		
Sector	2.99	–	
	(0.0011)	–	
Selected Sector	3.34	2.20	–
	(0.0003)	(0.016)	–

The mean and standard deviation (STD) of monthly returns and Sharpe ratios are all in percentages. The Nation (Sector) row represents the mean and standard deviation of the monthly return and Sharpe ratio for when the portfolio is diversified across GCC national (sectoral) indices only. Selected Sector equity indices are made up from selected sector equity indices. Jobson-Korkie z-statistics are reported in the lower panel via a matrix. For example, 2.99 is the Jobson-Korkie z-statistic when we test if the Sharpe ratio of the portfolio, made up from GCC national equity indices (Nation) and the Sharpe ratio of the portfolio, made up from GCC sectoral equity indices (Sector) are different from each other (H_0 : $\text{SHARPE}_{Nation} = \text{SHARPE}_{Sector}$). p-values are in parentheses.

Table 7: Spanning and intersection tests

	A. Adding GCC-wide Sector Indices		
	2005–2008	2008–2011	2005–2011
Spanning	0.000	0.001	0.000
Intersection	0.000	0.010	0.001
	B. Adding National Indices		
Spanning	0.141	0.171	0.92
Intersection	0.062	0.081	0.094

This table presents the p-values of the mean–variance spanning and intersection tests, as described in the text. The null hypothesis of the spanning test is that there is no investor who can significantly improve his/her portfolio by including the added indices. The intersection test tests the null hypothesis that one specific investor (measured by his/her risk aversion parameter or the risk-free rate) cannot significantly improve his/her portfolio by including the added assets. We used an interest rate of 4% per annum for this test, but unreported results show that the results are robust to this assumption.