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Financial Interconnectedness in the GCC Region: New Empirical Evidence

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Financial Interconnectedness in the GCC Region: New Empirical Evidence

Abstract

The purpose of this study is to examine the equity market interconnectedness in the Gulf Cooperation Council (GCC) region during the influential international and regional events-filled period 2003-2022. In order to accomplish this, we apply the Diebold-Yilmaz approach to emphasize not only the overall interconnectedness among markets, but also the most influential and leading market in the region through analyzing directional spillovers.

The findings indicate that interconnections between markets are dynamic and relatively high. A specific period of intensified interconnectedness emerges during the global financial crisis and its aftermath, spanning from October 2008 to September 2013. The analysis reveals disparities in the degrees of market interconnectedness among the individual markets, with the Emirati market being the most interconnected and the Bahraini market being the most segmented. These results carry meaningful implications for policymakers and investors, offering valuable insights for decision-making.

Keywords: Financial interconnectedness, Time-varying spillovers, Generalized VAR model, GCC region

JEL Classification: C32, C58, F36

Financial Interconnectedness in the GCC Region: New Empirical Evidence

1. Introduction

The increasing interconnectedness of financial markets across economies and regions has been a primary focus of academics and policymakers' research for the past three decades. This is due in part to the pervasive liberalization of financial markets[1] that many countries have implemented in an effort to boost market efficiency and economic growth. Nonetheless, the crises and disruptions that have occurred during this time have also raised concerns about the potential costs and benefits of financial integration, particularly during times of economic turmoil.

Increased cross-market comovements can lead to greater welfare because they can provide more opportunities for risk sharing (see Yu, 2015; and Billio et al., 2017), allow domestic and foreign investors to diversify their portfolios, and assist economies in absorbing disruptions. On the other hand, increased cross-market integration can undercut specific policy objectives (see Blanchard et al., 2010), diminish the potential benefits of international portfolio diversification (see Donadelli and Paradiso, 2014; and Billio et al., 2017), and heighten the risk of financial contagion.

In this study, we examine the equity market links between six GCC countries, namely Bahrain, Kuwait, Qatar, Oman, Saudi Arabia, and

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[1] Market-opening policies increase financial efficiency by removing inefficient markets, enhancing infrastructure, and formulating legal procedures.

the United Arab Emirates (UAE)[2] from 2003 to 2022. Since the establishment of the Gulf Cooperation Council in 1981 to accomplish economic and financial integration and joint cooperation, the GCC countries have negotiated multilateral agreements and adopted common regulations and legislations, but due to economic similarity, this has not led to significant economic and financial ties. In this vein, our aim is to illuminate the extent to which the endeavors in economic collaboration, the policies of liberalizing capital markets, and the reforms implemented within the GCC region have truly influenced the process of equity market integration among the economies being examined. Additionally, we seek to investigate whether the significant global financial crises have played a substantial role in shaping these dynamics. Through our analysis, we seek to shed light on the interplay between economic cooperation, capital market liberalization, and financial crises, as well as their combined effect on financial integration within the economies under consideration.

Spanning from 2003 to 2022, the research timeframe encompasses significant global occurrences, notably including the COVID-19 recession-induced stock market crash in 2020 and the international developments in 2022 and their impact on oil and commodity prices. This expansive purview enables us to compare the effects of these

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[2] Diversification of portfolios in heterogeneous financial markets provides profitable investment opportunities.

events on the interconnections between stock markets to those of other significant crises that transpired during the study period, such as the notable global financial crisis of 2008-2009. Unquestionably, the variation in the degree of financial integration during crises has a direct impact on the portfolio diversification benefits, contingent upon the magnitude of changes in cross-market links. Furthermore, these fluctuations can furnish investors with pertinent insights prior to making investment decisions, as well as valuable indicators for financial authorities to manage contagion risks and develop effective market policies.

Adopting the innovative methodology developed by Diebold and Yilmaz (2012, 2014), our analysis takes a captivating approach to investigating the evolutionary process of financial interconnectedness among the economies under consideration. This novel strategy investigates the extensive interrelationships that exist between stock markets, considering the directional connections between markets. It employs both a static analysis of the entire dataset and a dynamic framework using a rolling-window method. Notably, this methodology possesses a remarkable characteristic that enables the identification of the most interconnected and segmented equity markets.

The findings presented in this study contribute to the existing body of literature concerning equity market integration within the GCC region. Notably, the results provide evidence of a relatively high level

of intermarket connections. The interconnections between markets exhibit temporal variability, with a notable intensification observed during the period spanning from October 2008 to September 2013. This emphasizes the significant impact of influential global events, which led to a sharp increase in cross-market linkages and, as a result, a reduction in the potential benefits of portfolio diversification. Moreover, the results shed light on the varying levels of financial linkages among individual stock markets, highlighting the Emirati equity market's prominent position in the region. These findings hold pertinent implications for both investors and policymakers, offering valuable insights into decision-making in the financial landscape.

The structure of the paper is as follows. In Section 2, we present a summary of the pertinent literature in the field. Section 3 introduces the econometric approach applied to address the empirical problem. Section 4 then describes the utilized data and provides an initial analysis. Section 5 delves into the empirical findings regarding the observed interdependence of the investigated equity markets. Finally, Section 6 concludes with our final remarks and a discussion of the study's policy recommendations.

2. Literature review

Before delving into an examination of the dynamics of financial integration within the GCC region, we provide a brief summary of recent empirical research on the integration of stock markets.

Financial Interconnectedness in the GCC Region: New Empirical Evidence

Throughout the past three decades, a great deal of research has been conducted on the topic of financial integration and the observed interconnectedness of stock markets. Contributing to a comprehensive understanding of this subject matter, these studies have utilized diverse empirical methodologies and analyzed data collected at varying frequencies.

Yu et al. (2010) provide an extensive examination of different high-frequency measures, shedding light on the dynamics of financial integration in Asia. Their findings indicate a significant divergence in the integration process between emerging and mature stock markets. Similarly, Patel et al. (2022) conduct an exhaustive meta-literature review on financial market integration in a related context. They identify important research groups and propose thought-provoking questions for future investigation in this field. According to them, the outcomes of their review are of significant relevance to both academics and policymakers who have a keen interest in understanding and navigating the complexities of financial market integration.

Using a conditional variant of the ICAPM model, Abid et al. (2014) examine the dynamic aspects of financial integration in five prominent South Asian nations. The findings suggest that variations in regional cross-market linkages are predominantly attributable to fluctuations in the US term premium and the level of market openness. In addition, the study indicates that interconnectedness is

subject to change over time. Based on the asymmetric dynamic covariance method, Guidi et al. (2016) investigate the dynamic interconnections between the stock markets of the Greater China region (Hong Kong, Mainland China, and Taiwan), the United Kingdom, and the United States. The findings uncover moderately positive conditional correlations between markets, indicating potential opportunities for diversifying stock portfolios and generating earnings.

Billio et al. (2017) evaluate the effectiveness of stock market integration measures in terms of international portfolio diversification across three market groups: developed economies, emerging economies, and a mixture of both. The study analyses data from two time periods, 1973 to 2016 and 1990 to 2016, for a total of 27 economies. All measures reveal an astonishingly similar pattern of long-term financial integration. Intriguingly, the conventional correlation approach is more effective than computationally intensive methods in explaining the variations in the diversification benefits of international portfolios. Chowdhury et al. (2019) examine the dynamic landscape of regional financial integration within Asian stock markets spanning from 1995 to 2016 by focusing on the dynamic patterns preceding and following the turbulent events of the 1997–1998 Asian financial crisis and the 2008–2009 global stock market collapse. During the examined period, the results shed light on the existence of profound linkages between Asian markets and the rest of the globe. Notably, the study demonstrates an increase in

financial integration during times of turmoil, while the number of connections experiences a decline in the aftermath of crises.

Using a nested analytical approach, Cagliesi and Guidi (2021) examine the fluctuating patterns of integration between emergent and frontier equity markets and the US stock market from 2002 to 2014. During the global stock market collapse, the results reveal an increase in integration between frontier markets and the US market. However, the crisis only has a short-term effect on the integration between emerging markets and the US market. Despite the temporary impact of the crisis, the integration between emerging markets and the U.S. stock market remains substantially stronger than that between frontier markets and the U.S. market. Qin et al. (2022) conduct a study examining the integration of stock markets across 53 markets. Using a counterfactual analysis, they discover that the variations in cross-market linkages can be attributed to the presence of heteroscedasticity and contagion during periods of turmoil. These factors wield significant explanatory power in understanding the dynamics of financial integration.

In the relevant literature, research on financial integration for the GCC region has been conducted. In this context, Arouri and Nguyen (2010) delve into the dynamic characteristics of cross-market linkages in selected GCC economies by employing a multivariate dynamic conditional correlation GARCH model. The findings reveal that the conditional correlations among the markets exhibit time-

varying patterns, are influenced by past conditions, and are susceptible to structural changes. However, despite these variations, the overall co-movements within the GCC region remain limited, and there is a lack of significance in the correlations between GCC markets and the global market. Graham et al. (2013) investigate the interrelation among selected MENA equity markets and between them and the US market from 2002 to 2010 by analyzing wavelet squared coherency with simulated confidence bounds. The findings show moderate linkages between the US stock market and MENA markets at higher frequencies, indicating greater short-term diversification benefits. In addition, there is evidence of a relatively high degree of financial integration among MENA economies at lower frequencies throughout the entire study period.

Aloui and Hkiri (2014) use the wavelet squared coherence to investigate the short- and long-term co-movements between equity markets in the GCC region from 2005 to 2010. The outcomes display frequent variations in the dependence pattern, particularly after 2007, at relatively higher frequencies. During the global financial crisis, there is a growing degree of interdependence between the markets, indicating that investors will experience greater short-term portfolio gains than long-term gains. Jouini (2015) explores financial market integration between Saudi Arabia and international economies using the Asymmetric Generalized Dynamic Conditional Correlation GARCH methodology and finds that co-movements are weak and dependent on the specific subsample being analyzed regardless of

data frequency. Using the AR-DCC-FIGARCH methodology, Jouini (2020) investigates whether cross-market integration experiences significant changes during periods of high volatility. The findings indicate that the process of financial integration in the GCC region still faces challenges. Despite the authorities' significant efforts to promote economic cooperation and integration, stock market ties remain relatively feeble. During turbulent times, the analysis of structural changes reveals varying degrees of equity market integration among GCC economies. This indicates that the effectiveness of regional stock portfolio diversification depends on the prevailing regime.

In light of the aforementioned contradictory results, our study revisits the financial interconnectedness between GCC countries over a more recent time period that incorporates the most recent influential international events and is based on a more sophisticated empirical methodology than those used in previous research related to the region.

3. Econometric approach

We employ the methodology proposed by Diebold and Yilmaz (2012, 2014), which relies on the VAR model and the generalized forecast error variance decomposition (GFEVD) technique. This methodology enables us to assess the mutual influence between variables within the generalized VAR framework, thereby addressing

the challenge of variable ordering sensitivity in variance decomposition. Using this method, we can precisely determine the degree to which one variable influences the variability of another variable.

Practically, let us examine the following N-variable VAR(p) model:

$$Y_t = \sum_{i=1}^{p} \Psi_i Y_{t-i} + u_t \tag{1}$$

where Y_t is a column vector of N stationary variables, u_t is a column vector of N *i.i.d.* disturbance terms, Ψ_i is a coefficients square matrix of order N, and p is the model's order. The variance decomposition technique quantifies the proportions of the error variances, H periods ahead, in predicting the variable Y_i, attributed to shocks originating from the variable Y_j for $i, j = 1, 2, \dots, N$ and $i \neq j$. The analytical expression for the H-step-ahead GFEVD is as follows:

$$\varphi_{ij}^H = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' C_h \Sigma_u e_j \right)^2}{\sum_{h=0}^{H-1} \left(e_i' C_h \Sigma_u C_h' e_i \right)}, \qquad for\ H = 1, 2, \dots \tag{2}$$

where $\sum_{j=1}^{N} \varphi_{ij}^H \neq 1$, Σ_u is the covariance matrix of u_t, σ_{jj} is the standard deviation of the error term of the jth equation, e_i is the selection vector where the ith element is equal to one and the others are equal to zero, and C_h is a coefficients square matrix of order N such as $C_h = \Psi_1 C_{h-1} + \Psi_2 C_{h-2} + \cdots + \Psi_p C_{h-p}$ with C_0 an identity matrix of order N and $C_h = 0$ for $h < 0$. For the purpose of

generating the spillover index using the variance decomposition matrix, each entry is normalized as follows:

$$\tilde{\varphi}_{ij}^H = \frac{\varphi_{ij}^H}{\sum_{j=1}^N \varphi_{ij}^H} \tag{3}$$

with $\sum_{j=1}^N \tilde{\varphi}_{ij}^H = 1$ and $\sum_{i,j=1}^N \tilde{\varphi}_{ij}^H = N$.

The total spillover index can be derived as follows:

$$TS^H = \frac{1}{N}\sum_{i,j=1}^N \tilde{\varphi}_{ij}^H, \qquad for\ i \neq j \tag{4}$$

This index, which measures the interdependence of the entire system, varies from zero to one, indicating that the variables are either all mutually disassociated or all fully interrelated.

Additionally, we measure the directional volatility spillovers received by variable i from all other variables j in the following manner:

$$DS_{i\cdot}^H = \frac{\sum_{\substack{j=1 \\ j \neq i}}^N \tilde{\varphi}_{ij}^H}{\sum_{j=1}^N \tilde{\varphi}_{ij}^H} \tag{5}$$

Similarly, the directional volatility spillovers from variable i to all other variables j can be defined as follows:

$$DS_{\cdot i}^H = \frac{\sum_{\substack{j=1 \\ j \neq i}}^N \tilde{\varphi}_{ji}^H}{\sum_{j=1}^N \tilde{\varphi}_{ji}^H} \tag{6}$$

The directional volatility spillovers can be used to calculate the net volatility spillover from variable i to all other variables j as follows:

$$DS_i^H = S_{\cdot i}^H - S_{i \cdot}^H \tag{7}$$

A positive net directional spillover implies that variable i contributes more to all other variables j than it receives from. In this regard, the top net contributor has the greatest net contribution to the other variables, indicating that it is the strongest influencer in terms of explaining the future swings of all the other variables, and can be used to expect the behavior of the markets.

The net pairwise volatility spillover between variables i and j, whose positive value indicates that variable i contributes more to variable j than it receives from, is computed as follows:

$$DS_{ij}^H = \frac{\widetilde{\varphi}_{ij}^H}{\sum_{k=1}^N \widetilde{\varphi}_{ik}^H} - \frac{\widetilde{\varphi}_{ji}^H}{\sum_{k=1}^N \widetilde{\varphi}_{jk}^H} \tag{8}$$

We apply a rolling-window analysis, which entails estimating VAR models using overlapping subsets of data, in accordance with Diebold and Yilmaz (2009, 2012, 2014), to explore the fluctuations over time in the aforementioned spillover indicators provided in Eqs. (4)-(8) and emphasize the impact of significant global events on the interrelationships among the variables. By employing this time-evolving perspective on the spillover indicators, we can determine whether financial crises and shocks possess the ability to shape the level of interconnectedness among stock markets.

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In the literature, Diebold-Yilmaz's approach has been applied to analyze the interconnectedness of markets. In this context, Jouini (2015) provides evidence of Saudi Arabia's and international economies' weak intermarket relationships. According to Zhang (2017), oil price shocks contribute considerably to six of the world's largest equity markets. The level of volatility spillovers is more important than the level of returns spillovers between the carbon and energy markets, according to Ji et al. (2018). Zhang et al. (2018) find out that the relationship among oil prices, market fundamentals, and gas prices in Japan, the US, and Germany varies by country and over time. Wu et al. (2019) reveal time-varying spillovers across Chinese stock sectors and that the industrial sector plays a significant impact on the Chinese equity market. Zhang and Fan (2019) provide evidence that China's urban housing prices have become increasingly interconnected. Wu (2020) provides evidence of East and Southeast Asia's highly integrated equity markets. Zhang and Broadstock (2020) identify major shifts in the correlations among international commodity prices after the 2008 global financial crisis.[3]

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[3] Readers are also referred to Yilmaz (2010) for the interrelationships among East Asian stock markets, Zhou et al. (2012) for the interactions between the Chinese equity market and international markets, and Narayan et al. (2014) for the relationships between equity markets and mutual fund flows in India.

4. Data analysis

We examine the monthly stock prices for Bahrain (Bahrain All Share), Kuwait (Premier Market PR), Oman (MSM 30), Qatar (QE General), Saudi Arabia (Tadawul All Share), and the UAE (FTSE ADX General) from February 2003 to July 2022. Data is collected from the Arab Federation of Capital Markets database and expressed in US dollars to ensure consistency across different markets.

Figure 1. Evolution of the GCC stock market returns
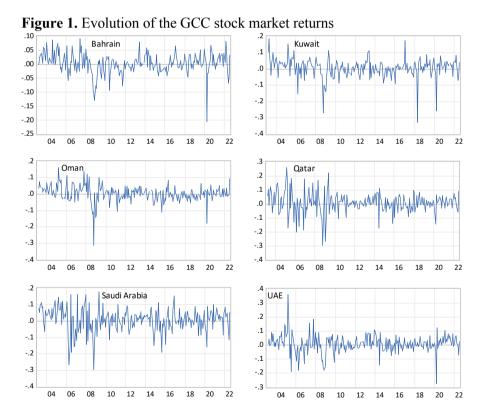

Figure 1 depicts the evolution of GCC index returns. The plots illustrate the fluctuating pattern of stock market returns during

periods of disruptions, reflecting the sensitivity of stock markets to global crises. Notably, the most turbulent period in equity markets occurred during the 2008-2009 global financial crisis, when stock market returns fluctuated significantly. In addition, calmer equity market conditions were observed during the 2020 stock market collapse caused by the COVID-19 recession and the 2022 international developments than during the global financial crisis.

Table 1 presents the statistical summary of the equity index returns for the six GCC economies, obtained by calculating the logarithmic difference between consecutive stock market prices. In terms of average returns, all markets exhibit positive values, with the UAE market experiencing the highest average return, followed by the Qatari and Saudi markets, which share the same value. Conversely, Bahrain has the lowest mean return, followed by Oman and Kuwait, respectively. Turning to market volatility, the findings indicate that the Qatari and Saudi stock markets display higher levels of volatility compared to the other markets during the time period, as evidenced by their standard deviations. On the other hand, Bahrain exhibits the lowest standard deviation, followed by Oman and Kuwait, indicating that these markets are relatively less volatile. Apart from the UAE, the remaining stock markets exhibit negative skewness, suggesting a likelihood of extreme negative index returns rather than extreme positive ones. Additionally, all markets have kurtosis coefficients exceeding three, indicating that return distributions have heavier tails. These outcomes emphasize that the stock market returns do not

follow a normal distribution, which aligns with the results of the Jarque-Bera test.

Table 1. Descriptive statistics for the GCC stock market returns

	Mean	Max.	Min.	Std. Dev.	Skew.	Kurt.	JB
BAH	0.003	0.092	-0.207	0.036	-1.067	8.201	306.876[***]
KUW	0.005	0.184	-0.328	0.059	-1.508	10.610	650.602[***]
OMA	0.004	0.162	-0.313	0.049	-1.258	10.965	677.442[***]
QAT	0.007	0.260	-0.296	0.074	-0.436	5.450	65.647[***]
SA	0.007	0.179	-0.298	0.073	-0.839	4.816	59.342[***]
UAE	0.008	0.359	-0.272	0.065	0.062	8.486	292.386[***]

Notes: Max.: Maximum; Min.: Minimum; Std. Dev.: Standard deviation; Skew.: Skewness; Kurt.: Kurtosis; and JB: Jarque-Bera normality test. [***] stands for non-normality at the 1% level.

Table 2. Correlations among the GCC stock market returns

	BAH	KUW	OMA	QAT	SA	UAE
BAH	1					
KUW	0.661[***]	1				
OMA	0.500[***]	0.540[***]	1			
QAT	0.448[***]	0.412[***]	0.465[***]	1		
SA	0.422[***]	0.451[***]	0.471[***]	0.485[***]	1	
UAE	0.545[***]	0.516[***]	0.525[***]	0.507[***]	0.500[***]	1

Note: [***] stands for statistical significance at the 1% level.

The correlation analysis presented in Table 2 reveals that the correlation coefficients between index returns are uniformly positive and hover around 0.5, indicating a relatively high level of correlation among the GCC markets. Notably, the strongest correlation is observed between Bahrain and Kuwait (0.661). Conversely, the Kuwait-Qatar pair exhibits the weakest correlation (0.412), suggesting potential opportunities for further portfolio diversification advantages compared to the other pairs of markets. The average correlation across all returns (cross-market average correlation)

stands at 0.497, indicating that the six markets are interconnected to a relatively high degree. This initial correlation analysis will be supplemented by a comprehensive study employing the aforementioned econometric techniques to derive reliable conclusions regarding cross-market dependencies.

5. Empirical analysis

To gain insights into spillover dynamics, we estimate VAR models.[4] Initially, we utilize the GFEVD method[5] to estimate the spillover matrix and construct a connectedness graph based on pairwise relationships. Subsequently, we conduct a rolling-window analysis[6] to capture the time-varying nature of spillover effects. This involves plotting various measures, such as total spillovers, directional spillovers (from and to), net directional spillovers, and net pairwise spillovers. By employing these techniques, we aim to quantify and visualize the changing patterns of spillover dynamics over time.

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[4] The optimal lag length, p, for the VAR model is determined to be one based on the Schwarz information criterion.

[5] In accordance with Diebold and Yilmaz (2009) and Zhang (2017), we adopt a 10-month time horizon H in our analysis.

[6] In the absence of a consensus regarding the optimal window length, we have decided to set the window size at 60 months, in accordance with Billio et al. (2017), who suggest that a window length approximating a full business cycle can provide meaningful insights.

5.1. Full-sample analysis

In Table 3, we present the connectedness matrix, which displays the spillover indices computed using Eqs. (3)-(7). The analysis reveals that the total spillover index, indicating overall interconnectedness, amounts to 55.99% throughout the full-sample analysis, implying that, on average, 55.99% of the forecast error variance in the system is caused by spillover effects, highlighting the relatively high level of cross-market interconnectedness in the GCC region. Hence, investors might not experience advantages in terms of equity portfolio diversification within these markets.

Table 3. Spillover matrix for the GCC stock market returns (%)

	BAH	KUW	OMA	QAT	SA	UAE	**From others**
BAH	39.32	17.85	10.19	10.81	8.44	13.39	60.68
KUW	16.96	41.33	12.21	9.43	9.22	10.85	58.67
OMA	9.95	12.03	43.86	10.75	9.92	13.49	56.14
QAT	9.72	7.81	10.84	48.23	11.22	12.18	51.77
SA	8.30	9.29	10.73	11.01	48.92	11.75	51.08
UAE	11.82	10.97	10.79	12.37	11.66	42.39	57.61
To others	56.75	57.95	54.76	54.37	50.46	61.66	335.95
Net	-3.93	-0.72	-1.38	2.60	-0.62	4.05	**Total: 55.99**

Notes: "From others": All other markets' directional spillovers received by market i; "To others": Directional spillovers from market i to all other markets; "Net" ("To others" minus "From others"): Net spillover from market i to all other markets; and "Total": Total spillover index (sum of all non-diagonal values divided by the number of markets, 335.95/6).

One possible explanation for the relatively high level of financial interconnectedness in the GCC region is that the economies of these countries are highly dependent on energy, so changes in oil prices can have synchronized effects on their economic fundamentals. As

economic conditions throughout the region are affected simultaneously, this shared economic dependence can foster a higher degree of linkages between the stock markets.

The range of directional volatility spillovers received by each stock market from all other markets ("From others" column) is between 51.08% and 60.68%, indicating that each stock market receives a considerable amount of information from the remaining equity markets. The three primary receivers of spillover effects are Bahrain, Kuwait, and the UAE, with Bahrain's stock market receiving the highest gross directional spillovers from other markets (60.68%). Following closely is the Kuwaiti equity market, with gross directional spillovers from other markets reaching 58.67%. Similarly, the Emirati stock market receives 57.61% of its value from other markets. We observe slight disparities in the magnitude of directional volatility spillovers from each stock market to all other equity markets ("To others" raw), ranging from 50.46% to 61.66%. Individually, the top three receivers contribute over 55% to the other markets, suggesting their prominent role as leading contributors. As a result, Bahrain, Kuwait, and the UAE have a significant influence on the interconnected stock markets, while also exhibiting greater susceptibility to shocks and information spillovers from the other stock markets.

By evaluating the net directional spillovers (computed as the difference between "To others" and "From others"), we gain insight

into the net contribution of each market to the broader system. It becomes evident that the UAE and Qatar play a role as net contributors, surpassing the amount they receive. Within this framework, the UAE stands out as the leading net contributor, with the greatest net directional spillover to others (4.05%), closely followed by Qatar with a value of 2.60%. In contrast, Bahrain, Kuwait, Oman, and Saudi Arabia act as net receivers within the system, receiving more than they contribute. Notably, Bahrain emerges as the leading net receiver, experiencing the highest net directional spillover from others (-3.93%), followed by Oman (-1.38%), Kuwait (-0.72%), and Saudi Arabia (-0.62%). These findings highlight the importance of the Emirati stock market as the most interconnected over the observed time period, aligning with the UAE's pivotal role in regional financial integration due to its open market. Conversely, Bahrain stands out as the most segmented market among the examined counterparts.

5.2. Rolling-sample analysis

While the comprehensive analysis of the entire dataset provides valuable insights into the average level of spillovers among the stock markets, it may overlook potential fluctuations in interrelationships due to the impact of influential crises, as well as legal and institutional procedures within the GCC region, on the equity markets and their interactions during the study period. To address this, we estimate time series of spillover indices by performing a 60-

month rolling analysis to evaluate the evolving patterns of financial linkages within the GCC region.

Figure 2. Rolling-window total spillover index among the GCC stock market returns

Figure 2 depicts the rolling-window version of the overall spillover index (as defined in Eq. (4)) across the six equity markets with the aim of tracking and assessing the evolution of financial interconnectedness within the GCC region. The rolling-window implementation of the total spillover index yields an average value of 55.70%, which corresponds closely to the magnitude observed in the full-sample analysis (55.99%). This consistency confirms the existence of a relatively high level of financial market linkages among the economies under consideration, thereby affecting equity portfolio diversification earnings.

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At first glance, the total spillover index representation reflects a time-varying pattern of cross-market linkages, with the period between October 2008 and September 2013 exhibiting the highest levels of financial interconnectedness, which range from a minimum of 59% to a maximum of 70%.[7] This highlights the effects of the global financial crisis and its subsequent repercussions, as well as the heightened uncertainty and disruptions in the global economy from 2011 to 2013 on the cross-market interconnections.[8] After that, cross-market linkages experience a downward trend until February 2020, where the spillover index fluctuates over the range of 32%-58%. The final episode, starting from the equity market crash in March 2020 triggered by the COVID-19 pandemic and continuing until the end of the study period characterized by international events, exhibits upward trends in the spillover index ranging from 53% to 60%.

Figure 3 illustrates the evolution of oil prices over the same time period as the rolling-window total spillover index to clarify the relationship between the two series. Throughout many years of the

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[7] This indicates that the benefits of portfolio diversification vary depending on the market regime, emphasizing the importance for investors to exercise caution when considering investments in these markets during volatile times.

[8] According to Wu (2020), the correlation between nine stock markets in East and Southeast Asia experiences a substantial increase, reaching approximately 79% between the beginning of 2009 and the middle of 2013. This finding provides compelling evidence of how the crises that took place during this time period affected the interconnectedness of equity markets.

sample period, oil prices and the total spillover index exhibit similar patterns, as depicted by the graphs. This may be explained by the fact that oil prices can influence the degree of stock market linkages between GCC nations by affecting investor behavior, economic conditions, government policies, and foreign investment. In fact, when oil prices are high, there tends to be a larger sense of economic well-being and investor appeal, which can foster closer interconnection between the stock markets of GCC nations. In contrast, economic performance and investment attractiveness may diverge more during periods of low oil prices, thereby decreasing the level of interconnectedness.
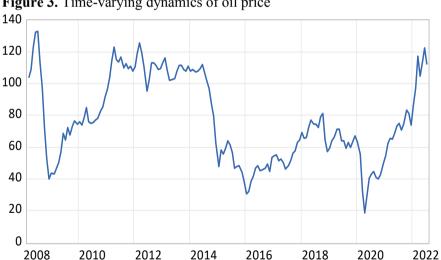
Figure 3. Time-varying dynamics of oil price

To illustrate the connection between oil prices and stock market linkages in the GCC region, we regressed the total spillover index on oil prices and a constant term. The results exhibit a statistically

significant and positive slope (0.132), indicating a positive relationship between financial linkages and oil prices in the GCC region despite the relatively low impact.

Figure 4. Rolling-window directional spillovers, from all the other GCC markets

Figure 4 shows that the time-varying patterns of the directional spillovers that each equity market has received from all other markets closely match those of the total spillover index (see Figure 2), with peak levels of approximately 65% occurring during the period of intense interconnectedness between October 2008 and September

2013. Similar to the directional spillovers originating from all other markets, the dynamic contributions of individual stock markets to the other markets, as depicted in Figure 5, fluctuate over time and vary between economies. Notably, throughout the examined time period, the Emirati equity market consistently outperforms other markets in terms of its influence on market interdependence.

Figure 5. Rolling-window directional spillovers, to all the other GCC markets
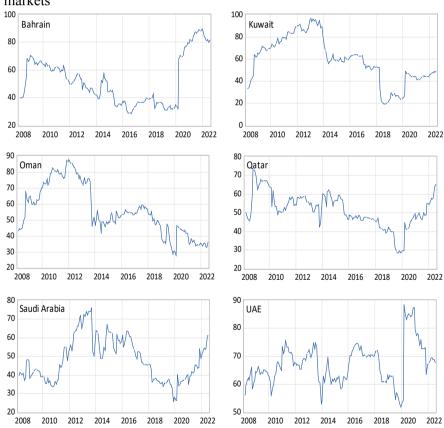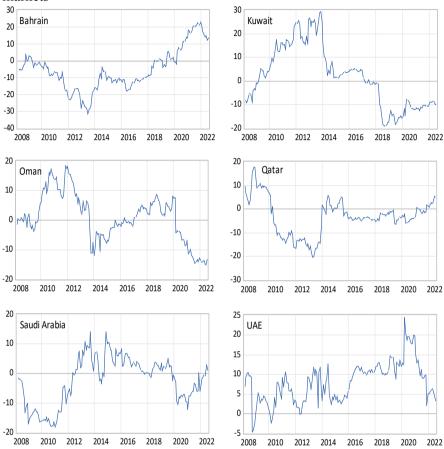
Figure 6. Rolling-window net directional spillovers, all the other GCC markets

The net flow of directional spillovers (as denoted by Eq. (7) and depicted in Figure 6), which measures each stock market's net contribution to the other markets, exhibits substantial time-varying variability and differing magnitudes across markets and time periods. Notably, in the case of the Emirati equity market, positive net spillovers prevail for the majority of years, implying that this market

contributes more to other markets than it receives in return.[9] On the other hand, as the top net receiver among all markets, Bahrain receives more than it transmits, as the net spillovers are negative for most of the sample years.

Figure 7. Rolling-window net pairwise directional spillovers among the GCC stock market returns

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[9] The UAE is a net receiver for a few months from October 2008 to January 2009, from February 2010 to April 2010, and from May 2012 to June 2012, but its net spillover is positive for the remaining time periods.

Through the examination of net pairwise spillovers (as defined in Eq. (8) and depicted in Figure 7), we observe instances of diverse net spillovers, including both positive and negative interactions between pairs of stock markets. Notably, the UAE stands out by transmitting more to other markets than it receives, as evidenced by predominantly positive net pairwise spillovers for the majority of the studied period. This highlights the UAE's significant influence among the markets under study. In contrast, Bahrain exhibits a tendency to receive more from other markets than it contributes, as it predominantly experiences negative net spillovers during the majority of time periods.

6. Conclusion and policy recommendations

This paper investigates the issue of financial interconnectedness among the six GCC economies (Bahrain, Kuwait, Qatar, Oman, Saudi Arabia, and the UAE) from 2003 to 2022, considering the volatile impact of the COVID-19 pandemic and global events. To capture the dynamic character of equity market connection patterns, the analysis employs the Diebold-Yilmaz's technique, which allows us to evaluate the mutual influence among variables within the generalized VAR framework. While previous research focuses on analyzing the interconnectedness of GCC equity markets, our study advances the relevant literature by identifying the region's most interconnected and segmented stock market.

Financial Interconnectedness in the GCC Region: New Empirical Evidence

This study provides valuable insights into the interdependence of different markets. It reveals that stock market interconnectedness among the examined GCC markets is relatively strong, particularly during and after the global financial crisis. This finding implies that the benefits of diversifying equity portfolios diminish when these markets are simultaneously disrupted by global events. Furthermore, the study highlights that the UAE emerges as the most interconnected market within the GCC region, while the Bahrain stock market appears to be the most segmented. Overall, this research presents a novel and exhaustive method for analyzing the levels and trends of financial linkages among the six GCC economies.

The results of this study carry significant implications for policymakers and investors alike. For policymakers, our findings indicate that achieving greater financial interdependence or complete integration within the GCC region remains challenging. Therefore, it is crucial for all countries involved to align their objectives and intensify their collaborative efforts on multiple fronts. Various measures, such as harmonizing market practices, developing multilateral arrangements to promote intra-GCC stock trading, and developing a regional framework for the clearance and settlement of stocks can help achieve this goal. These actions are crucial for stimulating capital flows and enhancing regional capital market integration and should be the focus of attention. In terms of portfolio diversification, the findings provide investors, who are interested in

expanding their stock portfolios within the GCC region, with valuable insights and informative guidance.

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