

Article

Heterogeneous Dependence on Global Financial Conditions: Evidence from Emerging Equity Markets

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Abstract

This study investigates the transmission of global risk sentiment and U.S. monetary conditions across emerging equity markets. Using Multiple Wavelet Coherence (MWC) and Quantile-on-Quantile Regression (QQR) over January 2016–December 2025, the analysis examines time–frequency co-movements and asymmetric linkages between emerging market equity indices, the CBOE Volatility Index (VIX), and the U.S. Treasury yield spread (T10Y3M). The results reveal substantial heterogeneity across markets. China, Russia, Turkey, Mexico, Egypt, and South Africa exhibit stronger long-run synchronization with external financial conditions. Saudi Arabia and Nigeria display more episodic exposure to external shocks. India, Brazil, Indonesia, and the United Arab Emirates represent intermediate cases characterized by recurrent but less persistent linkages. The findings suggest that global risk sentiment and U.S. monetary conditions affect emerging markets differently across investment horizons and periods of financial stress. The robustness analysis indicates that synchronization patterns became fragmented following the tightening cycle and rising geopolitical tensions after 2022, with less uniform spillover transmission across regions. The analysis highlights the importance of nonlinear and time-varying mechanisms in shaping financial spillovers across emerging equity markets.

Keywords: emerging markets; global financial conditions; VIX; T10Y3M; MWC; QQR



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1. Introduction

Emerging markets have become integrated into global financial markets through rising capital mobility, cross-border investment flows, and exposure to international conditions. This integration has expanded financing opportunities and increased the attractiveness of emerging economies for global investors, but it has also increased exposure to financial shocks. Major episodes such as the 2008 global financial crisis, the 2013 “taper tantrum”, the COVID-19 pandemic, and recent geopolitical conflicts or trade disputes highlight the vulnerability of emerging asset markets to shifts in global risk sentiment and U.S. dollar liquidity conditions (Albulescu et al. 2019; Jana et al. 2022). Emerging markets do not respond uniformly to global financial conditions. Some exhibit persistent synchronization with global risk cycles, but others remain insulated outside periods of acute financial stress. Exposure to external liquidity conditions, particularly those originating in the U.S.,

generates heterogeneous patterns of vulnerability across emerging economies (Yan et al. 2016; Nguyen et al. 2024; Sharif et al. 2025).

Global financial shocks are transmitted to emerging markets through interconnected channels, including capital flows, investor behavior, and global liquidity dynamics. Periods of heightened global risk aversion often generate portfolio reallocations, capital outflows, and shifts toward safe-haven assets (Fratzscher 2012). At the same time, tighter U.S. monetary conditions can reduce global dollar liquidity and increase external financing pressures, particularly in financially open economies (Togonidze and Kočenda 2022; Obstfeld 2025). The intensity of global financial spillovers varies across countries depending on structural characteristics such as exchange-rate arrangements, commodity exposure, macroeconomic fundamentals, and financial openness (Mody et al. 2001; Dua and Verma 2024; Wang and Liu 2025).

The literature on global financial spillovers emphasizes the role of external risk factors in shaping synchronization across emerging markets. Disturbances originating in advanced economies often generate disproportionate spillovers to fragile emerging economies (González-Rozada and Levy Yeyati 2008; Gozgor 2014; Salisu et al. 2022). Other studies argue that imperfections in domestic and international financial markets amplify exposure to external shocks and increase sensitivity to changes in global liquidity conditions (Akinci and Queralto 2024). Recent research also highlights that spillover dynamics are nonlinear and time varying, particularly during periods of financial stress (Wang et al. 2022; Gaies and Bruna 2026). This growing focus on regime-dependent dynamics has encouraged the use of empirical approaches capable of capturing co-movements across time and frequency domains. Wavelet and other multi-scale techniques have proven particularly useful for identifying short-term fluctuations and persistent long-run dependence in noisy and nonstationary financial series (Afshan et al. 2024).

Important gaps remain in the literature on global financial spillovers to emerging markets. Existing research focuses predominantly on the VIX as the main proxy for global risk and uncertainty (Antonakakis et al. 2020; Badshah 2018). Far less attention has been devoted to the U.S. Treasury yield spread (T10Y3M), even though the yield curve has been widely associated with recession expectations, monetary policy shifts, and global liquidity conditions. Empirical studies also rely on conventional econometric approaches such as Vector Autoregression (VAR), Dynamic Conditional Correlation–Generalized Autoregressive Conditional Heteroskedasticity (DCC–GARCH) and spillover indices (Diebold and Yilmaz 2014; Zhang et al. 2023). Such methods provide valuable insights into financial interdependence but are less suited to capturing nonlinear and time-varying synchronization across different investment horizons. Existing comparative evidence also remains relatively narrow in geographical scope. Most studies focus primarily on BRICS (Gopal et al. 2025; Wang and You 2023), MINT (Aydoğan and Vardar 2021) or GCC (Naeem et al. 2025) groups, leaving cross-country heterogeneity in emerging market patterns insufficiently explored.

To address these gaps, the study investigates the role of global risk conditions and U.S. monetary expectations in shaping dependence across emerging equity markets. The analysis focuses on two central global financial indicators: the CBOE Volatility Index (VIX), widely used as a proxy for global risk sentiment (Altinkeski et al. 2024; Gubareva et al. 2025), and the T10Y3M, a widely recognized indicator of monetary and business cycle conditions (Estrella and Hardouvelis 1991; Gürkaynak et al. 2010). The empirical framework combines Multiple Wavelet Coherence (MWC) and Quantile-on-Quantile Regression (QQR). MWC captures the evolution of synchronization across different investment horizons and periods of financial stress. QQR complements the analysis by identifying asymmetric and quantile relationships across market states. The combined framework allows us to distinguish

between persistent long-run synchronization and more episodic forms across emerging equity markets.

The study contributes to the literature in several ways. First, it extends existing evidence beyond the narrow focus on BRICS or single regional groups by comparing a set of emerging equity markets characterized by different levels of financial openness and external vulnerability. Second, the analysis examines the roles of global risk sentiment and U.S. monetary expectations through the combined use of the VIX and T10Y3M. Third, the study identifies distinct profiles across emerging markets, ranging from persistent long-run synchronization with global financial conditions to more episodic forms of exposure to external shocks. Fourth, the robustness analysis indicates that dependence structures became increasingly fragmented during the 2022–2025 period, suggesting that the transmission of global financial shocks has become less uniform across emerging markets and regions.

The results reveal substantial differences in the exposure of emerging markets to global financial conditions. Structurally exposed markets such as Russia, Turkey, Mexico, Egypt, and South Africa exhibit stronger and more persistent long-run synchronization with global risk and liquidity cycles. Saudi Arabia and Nigeria display more episodic and crisis dependence patterns. India, Brazil, Indonesia, and the United Arab Emirates occupy an intermediate position characterized by recurrent external sensitivity combined with varying degrees of domestic macroeconomic influence. The findings indicate that exposure to global financial shocks differs across countries, investment horizons, and market conditions.

The remainder of the paper is organized as follows. Section 2 reviews the literature on global financial spillovers and emerging market dependence structures. Section 3 describes the data and reports the descriptive statistics. Section 4 presents the methodology. Section 5 presents the empirical results. Section 6 discusses the findings and their policy implications, and Section 7 concludes.

2. Literature Review

The transmission of global financial shocks to emerging markets has intensified alongside the growing integration of emerging economies into the global financial cycle. Financial disturbances originating in advanced economies can spread across borders through capital flows, shifts in investor sentiment, and changes in global liquidity conditions. Episodes such as the COVID-19 pandemic, the Russia–Ukraine war, and rising U.S.–China trade and geopolitical tensions have been associated with heightened volatility across emerging equity markets, abrupt price adjustments, and destabilizing capital movements (Yuan et al. 2023; Hong et al. 2024). Existing evidence suggests that spillover dynamics are nonlinear and unstable across different market conditions, particularly during periods of financial stress (Wang et al. 2022; Soltani and Boujelbène Abbas 2025). Dependence on external financial conditions intensifies during global stress, although the persistence and magnitude of spillovers differ considerably across emerging markets and crisis episodes.

Among global risk indicators, the VIX has become one of the most widely used proxies for investor sentiment and financial uncertainty. Existing evidence identifies the VIX as a major source of spillovers to emerging markets, particularly during periods of heightened market stress. Rising U.S. market uncertainty is associated with declining equity returns, higher sovereign risk, and tighter financial conditions across BRICS and other emerging economies (Sarwar and Khan 2017; Bouri et al. 2018). More recent research shows that both the VIX and U.S. dollar liquidity conditions continue to shape emerging market dynamics, with effects that intensify during adverse market conditions and elevated volatility (Feng et al. 2026; Valadkhani and O'Mahony 2025). Changes in global risk sentiment also influence capital flows and exchange rate movements, increasing the sensitivity of emerging

markets to external shocks (Ma and Wang 2025). VIX shocks affect emerging markets differently across countries and market conditions, reflecting heterogeneous levels of financial integration and exposure to global risk conditions (Soltani and Boujelbène Abbes 2025; Wang et al. 2022).

The U.S. Treasury yield curve, particularly the spread between the 3-month and 10-year maturities, has attracted attention as an indicator of external financial conditions. Estrella and Hardouvelis (1991) first documented its predictive power for U.S. recessions, and subsequent research highlighted its role in shaping inflation expectations and monetary policy outlooks (Gürkaynak et al. 2010). More recent evidence indicates that U.S. monetary policy uncertainty weakens macroeconomic stability and financial conditions in inflation-targeting emerging economies (Azad and Serletis 2022). Changes in the slope of the yield curve also influence capital flows and investment dynamics across BRICS markets (Bayaa and Qadan 2024). Yield curve inversions frequently precede periods of global financial stress and strengthen the interdependence between emerging and developed equity markets (Gao et al. 2024). The U.S. yield curve reflects not only domestic monetary expectations, but also shifts in global liquidity conditions and external financial pressures affecting emerging markets.

Methodological approaches to financial spillovers have gradually moved beyond traditional econometric frameworks such as VAR and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models, which are less effective in capturing nonlinear and time-varying dependence during periods of financial stress (Lütkepohl 2005). Growing interest in crises and multi-scale dynamics has encouraged the use of wavelet approaches capable of examining co-movements across both time and frequency domains. Torrence and Compo (1998) introduced wavelet analysis for nonstationary time series. Aguiar-Conraria and Soares (2014) later extended the framework to multivariate settings. Subsequent applications suggest that global shocks generate heterogeneous short- and long-run effects across commodity and equity markets (Li et al. 2021). Different evidence indicates that spillover dynamics vary substantially across crises and market conditions. Nguyen et al. (2022), for example, find that U.S. spillovers dominated during the Global Financial Crisis, but dependence during the COVID-19 pandemic was moderate and strongly associated with Japan and China.

MWC extends the wavelet framework beyond standard bivariate analysis by capturing the influence of multiple global factors and reducing the risk of spurious associations (Hu and Si 2016). The approach is particularly useful for examining how dependence evolves across different investment horizons and periods of financial stress. QQR complements the analysis by identifying asymmetric relationships across market conditions (Sim and Zhou 2015), allowing the effects of shocks to vary across different states of the market distribution. The combined use of MWC and QQR provides a comprehensive framework for examining the spillovers across emerging markets.

Another strand of research emphasizes the heterogeneous responses of emerging markets to global shocks. Vulnerability to external disturbances reflects not only global risk conditions, but also domestic macroeconomic and financial characteristics. Stronger fiscal and monetary fundamentals can partially attenuate the transmission of global volatility and reduce exposure to external stress (Li et al. 2024). Ahmed (2023) similarly shows that spillover intensity is shaped by both global risk sentiment and domestic policy space, with changes in U.S. monetary conditions either mitigating or amplifying flight-to-safety dynamics. Tighter U.S. monetary policy and rising uncertainty weaken monetary policy transmission in emerging economies, particularly in financially open countries with stronger integration into global markets (Renzhi and Beirne 2025). Periods of monetary tightening are associated with persistent output losses across emerging markets, although

the intensity and persistence of the effects differ substantially across countries (Lastauskas and Nguyen 2024). Such differences reflect varying levels of domestic resilience, financial openness, and exposure to global risk conditions across emerging economies.

Recent research highlights the heterogeneous and fragmented nature of financial integration in emerging markets. Exposure to global financial conditions differs substantially between countries and sources of external risk. Sayed and Charteris (2024), for example, show that BRICS linkages are far from homogeneous, with India and Russia exhibiting stronger integration patterns than China and Brazil. Other studies emphasize the growing importance of investor sentiment and geopolitical uncertainty in shaping transmission mechanisms. Soni (2025) finds that spillovers associated with fear in the U.S. exert stronger effects than those associated with Brazil, India, and South Africa. Zhang and Hamori (2022) document strong interactions between BRICS geopolitical risks and U.S. macroeconomic conditions, pointing to the simultaneous role of financial and political transmission channels. The literature also indicates substantial differences in the intensity, persistence, and asymmetry of exposure to global financial conditions across emerging economies. At the same time, much of the existing evidence remains concentrated on relatively narrow regional blocs such as BRICS, MINT, or GCC economies, leaving differences in exposure across emerging economies insufficiently explored.

Building on the existing literature, the study develops the following research hypotheses regarding the transmission of global financial shocks to emerging equity markets:

H1. *Emerging equity markets exhibit more persistent long-run dependence on global risk conditions and U.S. monetary shocks.*

H2. *Dependence between emerging equity markets and global financial risk factors intensifies during periods of financial stress.*

H3. *The effects of global risk sentiment and U.S. monetary expectations vary across investment horizons and market states.*

3. Data and Descriptive Statistics

3.1. Data

The empirical analysis relies on daily data from 1 January 2016 to 31 December 2025, a period marked by major episodes of financial volatility, geopolitical uncertainty, and shifts in global monetary conditions. The dataset includes three groups of variables: (i) emerging market equity indices, (ii) the VIX, which captures global risk sentiment and market uncertainty, and (iii) the T10Y3M, defined as the spread between the 10-year Treasury bond yield and the 3-month Treasury bill rate, commonly used as an indicator of business cycle conditions and monetary policy expectations.

Data on emerging market equity indices are obtained from Bloomberg (2025). The VIX is collected from the Chicago Board Options Exchange (CBOE 2025), and T10Y3M is retrieved from the Federal Reserve Economic Data database (FRED 2025). The daily frequency facilitates the identification of structural breaks, regime shifts, and volatility clustering, features that are particularly relevant for the wavelet framework employed in our study.

The sample consists of major emerging and transition economies that are widely represented in the emerging markets literature. Most countries are classified as emerging markets according to the MSCI Market Classification Framework (MSCI 2025). Nigeria is generally classified as a frontier market, and Russia was reclassified following the market disruptions of 2022. Both countries were retained because of economic significance,

regional representativeness, and frequent use in studies examining the transmission of global financial shocks.

For each country, the most widely followed benchmark equity index was selected on the basis of market coverage, liquidity, and data availability. Some indices cover a wide segment of the domestic market, and others track leading listed companies. The indices differ in construction and coverage, but all serve as standard indicators of national equity market performance and are widely used in academic research and investment analysis.

Figure 1 presents the price and return dynamics of the emerging market indices, grouped into BRICS, Africa and Middle East, and MINT economies. Most indices display a positive long-run trajectory interrupted by sharp declines during episodes of global and regional stress, particularly the COVID-19 pandemic, the Russia–Ukraine conflict, and the trade tensions between the U.S. and China. Return series also exhibit recurrent volatility clustering and large fluctuations, especially in Russia, Turkey, Egypt, and Nigeria, indicating stronger sensitivity to external disturbances. India, Brazil, and Saudi Arabia present more stable long-run trajectories, although temporary periods of elevated volatility remain visible. The descriptive patterns point to substantial heterogeneity in the response of emerging equity markets to external financial conditions.

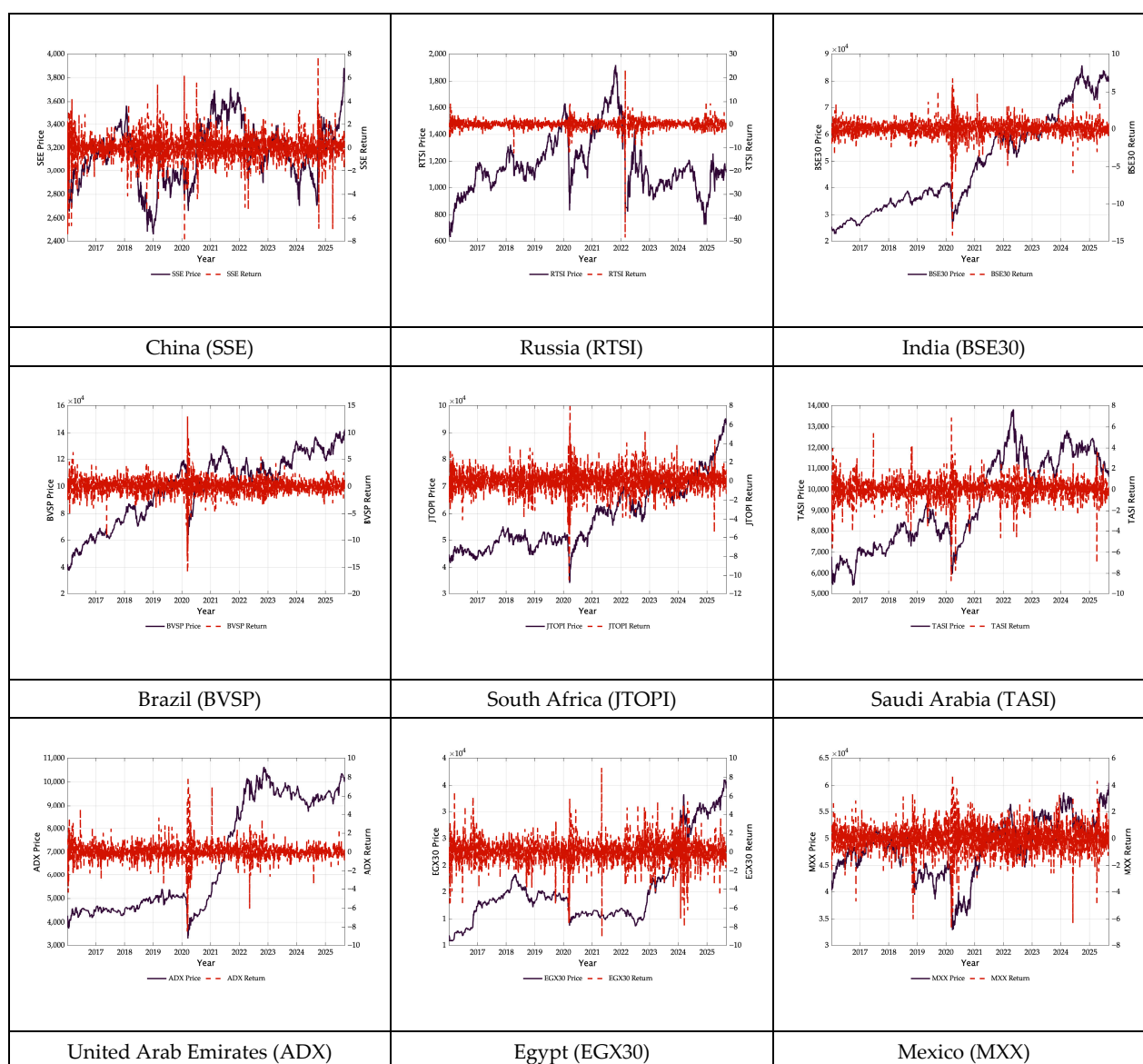


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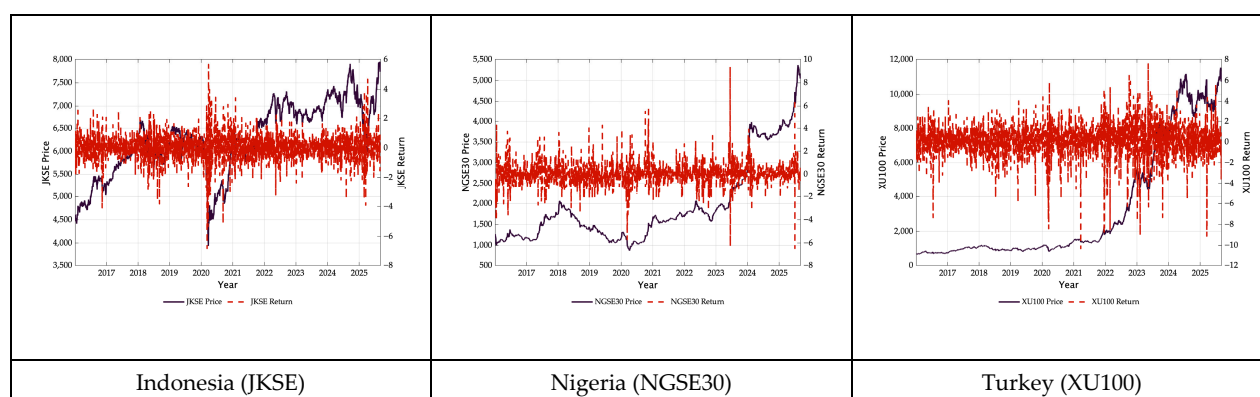


Figure 1. Price indices and return series of selected emerging equity markets (2016–2025). Note: The left axis reports the price index (black line), and the right axis shows the corresponding return series (red dashed line).

3.2. Descriptive Statistics

Table 1 reports the descriptive statistics for the daily return series of the emerging market indices and the two global risk factors. Most equity indices display positive average returns over the sample period, although the magnitude of returns differs substantially across countries. Turkey, Egypt, Nigeria, Brazil, and India record higher average returns; China and Russia exhibit lower mean values. Return volatility remains elevated across all markets, with particularly high dispersion observed in Russia, Turkey, Brazil, and Egypt, indicating stronger sensitivity to external shocks and changing market conditions. The extreme RTSI observations reflect exceptional market conditions associated with the Russia–Ukraine conflict and disruptions in the Russian stock market.

Table 1. Descriptive statistics of daily returns and risk factors.

Index	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	JB	Prob.
SSE	0.006	0.042	7.755	−7.994	1.062	−0.604	11.383	7463.229	0.000
RTSI	0.016	0.098	229.612	−228.439	6.796	0.089	1035.202	1,110,000.0	0.000
BSE30	0.046	0.051	6.747	−14.102	1.010	−1.586	26.494	58,475.910	0.000
BVSP	0.049	0.065	13.023	−15.994	1.457	−1.186	21.858	37,586.400	0.000
JTOPI	0.030	0.045	7.907	−10.450	1.143	−0.514	10.388	5789.122	0.000
TASI	0.017	0.056	6.831	−8.685	0.970	−1.151	14.030	13,208.980	0.000
ADX	0.034	0.021	8.076	−8.406	0.896	−0.336	22.464	39,464.340	0.000
EGX30	0.063	0.077	8.939	−9.042	1.318	−0.369	9.120	3953.308	0.000
MXV	0.014	0.024	4.744	−6.638	0.980	−0.479	7.242	1967.663	0.000
JKSE	0.022	0.059	5.663	−6.805	0.904	−0.455	9.055	3900.902	0.000
NGSE30	0.055	0.008	9.360	−6.464	0.942	0.529	13.216	10,974.140	0.000
XU100	0.108	0.141	7.572	−10.307	1.554	−0.835	8.341	3258.632	0.000
T10Y3M	0.454	0.580	2.270	−1.890	1.034	−0.511	2.161	181.814	0.000
VIX	18.505	16.690	82.690	9.140	7.401	2.522	15.137	17,973.720	0.000

Note: Daily stock market returns are expressed in percentage terms. T10Y3M is measured in percentage points, and VIX is reported in index points.

The VIX exhibits substantial variability over the sample period, reflecting periods of heightened uncertainty and financial stress, particularly during the COVID-19 pandemic and the Russia–Ukraine conflict. The T10Y3M spread also fluctuates considerably, capturing shifts in U.S. monetary conditions and expectations about future economic activity.

Distributional properties indicate strong departures from normality. Most return series exhibit negative skewness, although Russia's RTSI and the VIX remain positively skewed. Kurtosis values are well above the Gaussian benchmark, suggesting fat tails and the presence of extreme market movements. The Jarque–Bera test rejects the null hypothesis of normality for all variables at the 1% significance level.

3.3. Unit Root Tests

The stationarity properties of the variables were examined using the Augmented Dickey–Fuller (ADF) test (Dickey and Fuller 1979), the Phillips–Perron (PP) test (Phillips and Perron 1988), and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test (Kwiatkowski et al. 1992). The corresponding results are reported in Appendix A.

4. Empirical Framework

This study employs the MWC framework to examine the dynamic dependence between emerging market equity indices and two global financial risk factors, the VIX and the T10Y3M. MWC allows the analysis of dependence simultaneously across time and frequency domains, making it possible to distinguish short-term co-movements from more persistent long-run relationships (Hu and Si 2016). Compared with conventional econometric approaches such as VAR and GARCH models, wavelet methods are better suited for financial time series characterized by nonlinearity, structural breaks, and regime shifts (Torrence and Compo 1998). The nature of the wavelet framework also allows dependence patterns to evolve across different market conditions and investment horizons, providing a more detailed representation of changing interdependencies across emerging markets.

4.1. Wavelet Transform and Coherence

The empirical analysis relies on the continuous wavelet transform (CWT), a technique that decomposes a time series simultaneously across time and frequency domains. For a signal $x(t)$, the CWT using the Morlet wavelet is defined as:

$$W_x(a, b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} x(t) \Psi^* \left(\frac{t-b}{a} \right) dt, \quad (1)$$

where $W_x(a, b)$ denotes the wavelet coefficient of $x(t)$, $\psi(t)$ represents the wavelet, a is the scale parameter, and b corresponds to the time location. The Morlet wavelet is widely used in financial applications because it provides a suitable balance between time and frequency localization (Aguilar-Conraria and Soares 2014).

$$R_{xy}^2(a, b) = \frac{|S(W_x(a, b))(W_y^*(a, b))|^2}{S(|W_x(a, b)|^2) S(|W_y(a, b)|^2)}, \quad (2)$$

where $S(\cdot)$ denotes a smoothing operator and $*$ represents the complex conjugate. The wavelet coherence coefficient $R_{xy}^2(a, b)$ ranges from 0 (no association) to 1 (perfect coherence), allowing the identification of both the intensity and timing of co-movements across frequencies.

4.2. Multiple Wavelet Coherence

Bivariate wavelet coherence captures the dependence between two series but cannot account for the simultaneous influence of multiple variables. To address this limitation, we employ MWC, which extends the framework to a multivariate setting. Following Aloui et al. (2018) and Wu et al. (2020), the MWC statistic measures the proportion of variance in

the dependent variable associated with two or more explanatory variables across time and frequency domains. Formally, the statistic is defined as:

$$R_{y|x_1, x_2}^2(a, b) = \frac{|S(W_y(a, b)W_{x_1}^*(a, b), W_y(a, b)W_{x_2}^*(a, b))|^2}{S(|W_y(a, b)|^2)S(|W_{x_1}(a, b)|^2, |W_{x_2}(a, b)|^2)}, \quad (3)$$

where W_y , W_{x_1} , and W_{x_2} denote the continuous wavelet transforms of the respective time series. The statistic ranges from 0 to 1, with values closer to 1 indicating stronger joint dependence between the variables at a given time–frequency point.

Statistical significance is evaluated using Monte Carlo simulations under the null hypothesis of no coherence, reducing the likelihood of spurious associations during periods of elevated market volatility. Statistical significance is evaluated using 500 Monte Carlo simulations under the null hypothesis of no coherence. Statistical significance is assessed at the 5% level, reducing the likelihood of spurious associations during periods of pronounced market volatility.

4.3. Quantile-on-Quantile Regression

To complement the multiple wavelet analysis, the study employs the QQR approach proposed by [Sim and Zhou \(2015\)](#). Unlike conventional mean-based regressions or standard quantile regressions ([Koenker and Bassett 1978](#)), QQR examines how specific quantiles of the explanatory variable are associated with particular quantiles of the dependent variable. The approach is particularly suitable for financial applications, where the relationship between global risk factors and emerging market returns may vary across market conditions and tail events.

Formally, the specification for a dependent variable y_t and an explanatory variable x_t is written as:

$$Q_{y_t}(\theta|x_t) = \alpha(\theta, \tau) + \beta(\theta, \tau)(x_t - q_x(\tau)) + \varepsilon_t, \quad (4)$$

where $Q_{y_t}(\theta|x_t)$ denotes the conditional quantile θ of y_t , $q_x(\tau)$ represents the τ -th quantile of x_t , $\alpha(\theta, \tau)$ and $\beta(\theta, \tau)$ are unknown functions to be estimated, and ε_t is the error term. By expanding y_t around $q_x(\tau)$, the QQR framework links quantiles of y_t with quantiles of x_t , allowing nonlinearities and asymmetric dependence patterns to be captured more effectively than conventional approaches. Estimation is conducted using nonparametric kernel methods, which provide greater flexibility and avoid restrictive functional form assumptions. The estimated surfaces of $\beta(\theta, \tau)$ illustrate how different states of global risk factors are associated with emerging market returns under bearish, normal, and bullish market conditions.

5. Empirical Results and Robustness Tests

5.1. MWC Results

The MWC results reported in [Figure 2](#) reveal substantial heterogeneity in the relationship between BRICS equity markets and the two global financial risk factors. Co-movement patterns differ not only across countries, but also across investment horizons and periods of market stress. China's SSE exhibits fragmented coherence concentrated at medium and long horizons, suggesting an episodic connection with external financial conditions. This pattern may reflect the partial insulation provided by capital controls and the stronger role of domestic policy intervention in Chinese financial markets. Russia's RTSI displays persistent coherence across medium- and long-run frequencies, indicating stronger synchronization with global risk conditions over the sample period. The strong dependence of the Russian market is consistent with its sensitivity to commodity price fluctuations, external financing conditions, and geopolitical risk ([Gopal et al. 2025](#)).

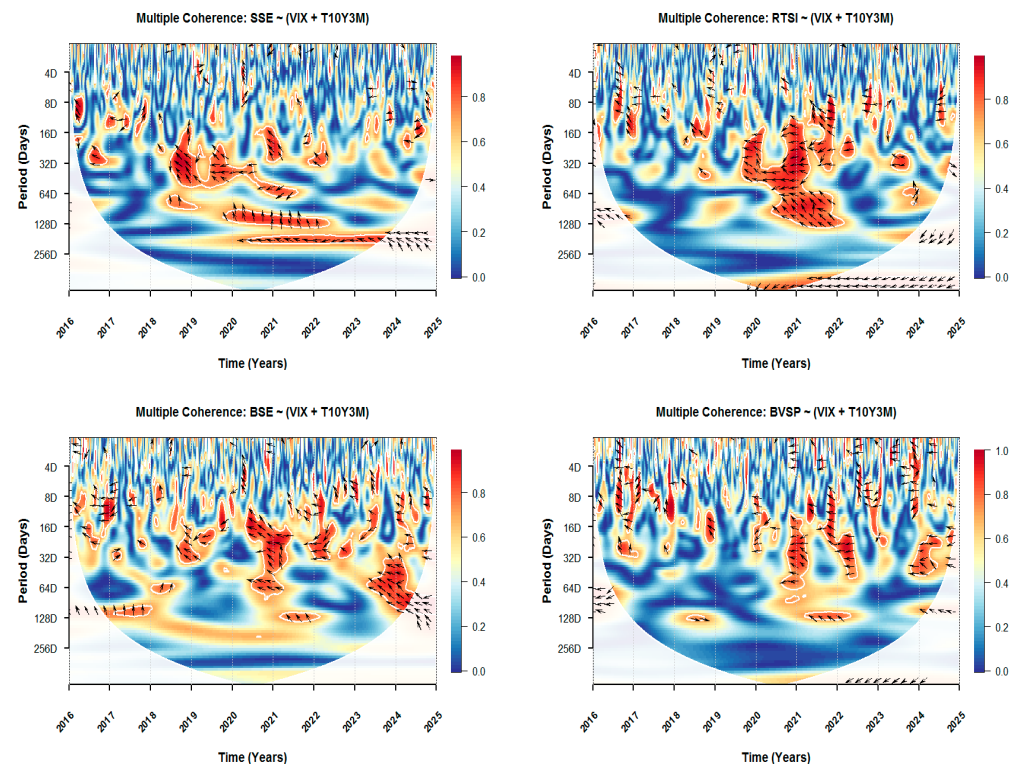


Figure 2. MWC plots for BRICS countries with VIX and T10Y3M. Note: The horizontal axis represents daily observations from January 2016 to December 2025, and the vertical axis represents wavelet periods (investment horizons) expressed in trading days. Arrows indicate phase differences and lead–lag relationships. The shaded area outside the cone of influence (COI) denotes regions subject to edge effects.

India's BSE shows intermediate dynamics characterized by recurrent medium-horizon linkages and comparatively weaker long-run coherence. This pattern suggests that domestic macroeconomic conditions continue to play an important role alongside external financial influences. BVSP exhibits several episodes of medium- and long-horizon coherence, suggesting a meaningful but less persistent association with external financial conditions than that observed for RTSI. The stronger dependence observed in Brazil may reflect the importance of commodity exports (Adeosun et al. 2023) and the sensitivity of the Brazilian market to global financial spillovers and changing external financial conditions associated with shifts in global liquidity (Giraldo et al. 2024). The results suggest that BRICS equity markets react differently to changes in global risk sentiment and U.S. monetary conditions, with stronger co-movements emerging during episodes of elevated financial stress. The evidence also points to substantial heterogeneity in the exposure of BRICS markets to global financial spillovers.

The MWC results for the African and Middle Eastern markets presented in Figure 3 highlight substantial cross-country differences in the response of emerging equity markets to global financial conditions. South Africa and Egypt display comparatively stronger and more persistent coherence with the global risk indicators, particularly at medium- and long-run investment horizons. In both cases, co-movements intensify during periods of global uncertainty. The stronger dependence observed in South Africa may reflect its high degree of financial openness and integration into global commodity and portfolio investment markets (Enya et al. 2026). Egypt's persistent coherence is also aligned with its reliance on external financing and exposure to liquidity constraints arising from external debt pressures (Barbary and Mohamed 2025).

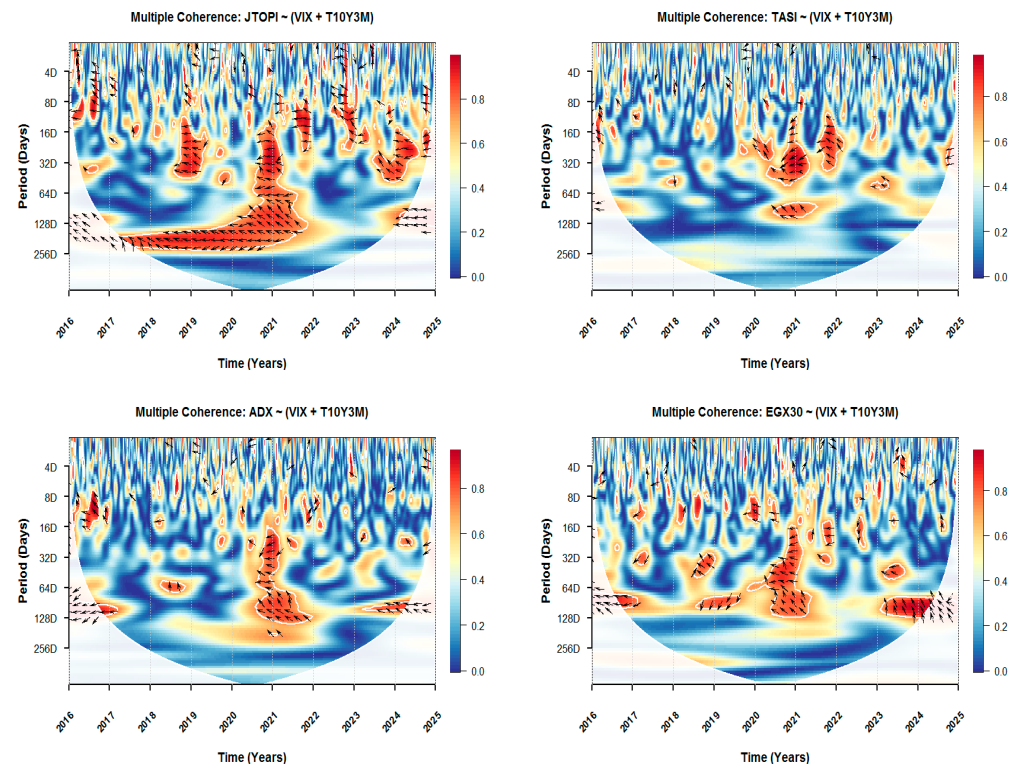


Figure 3. MWC plots for African and Middle Eastern equity indices with VIX and T10Y3M. Note: The horizontal axis represents daily observations from January 2016 to December 2025, and the vertical axis represents wavelet periods (investment horizons) expressed in trading days. Arrows indicate phase differences and lead–lag relationships. The shaded area outside the cone of influence (COI) denotes regions subject to edge effects.

Saudi Arabia exhibits a fragmented and intermittent coherence structure, with linkages concentrated primarily at medium investment horizons and little evidence of persistent long-run association. This pattern may reflect the stabilizing role of fiscal buffers and oil revenues, which partially mitigate the transmission of external financial shocks. The Abu Dhabi market presents an intermediate profile characterized mainly by medium- and long-horizon coherence, particularly during periods of heightened global uncertainty, with only limited evidence of short-run synchronization. The findings suggest simultaneous exposure to global financial conditions and regional risk factors. The results point to substantial variation in the persistence and intensity of exposure to global risk sentiment and U.S. monetary conditions across African and Middle Eastern equity markets. Structural integration and episodic vulnerability appear to coexist across markets, although with different degrees of persistence across countries and investment horizons.

The MWC results for the MINT economies reported in Figure 4 illustrate the heterogeneous nature of dependence across emerging markets. Nigeria exhibits weak and intermittent coherence with the global risk indicators. This pattern is consistent with the comparatively lower integration of Nigerian financial markets into global capital flows and portfolio investment networks. Indonesia displays more recurrent dependence patterns concentrated around periods of market turbulence, indicating that external shocks generate temporary increases in synchronization with global financial conditions.

Turkey and Mexico exhibit comparatively stronger coherence structures across medium- and long-run investment horizons. In Turkey, coherence becomes particularly pronounced during 2020–2022, especially at medium and long horizons, indicating periods of heightened synchronization with global financial conditions. Mexico displays the strongest and most persistent coherence patterns in the sample, particularly at longer

investment horizons, consistent with its close financial and trade integration with the U.S., although short-run dependence varies across sub-periods. The results point to substantial differences in the persistence, intensity, and stability of exposure to global risk sentiment and U.S. monetary conditions across MINT economies.

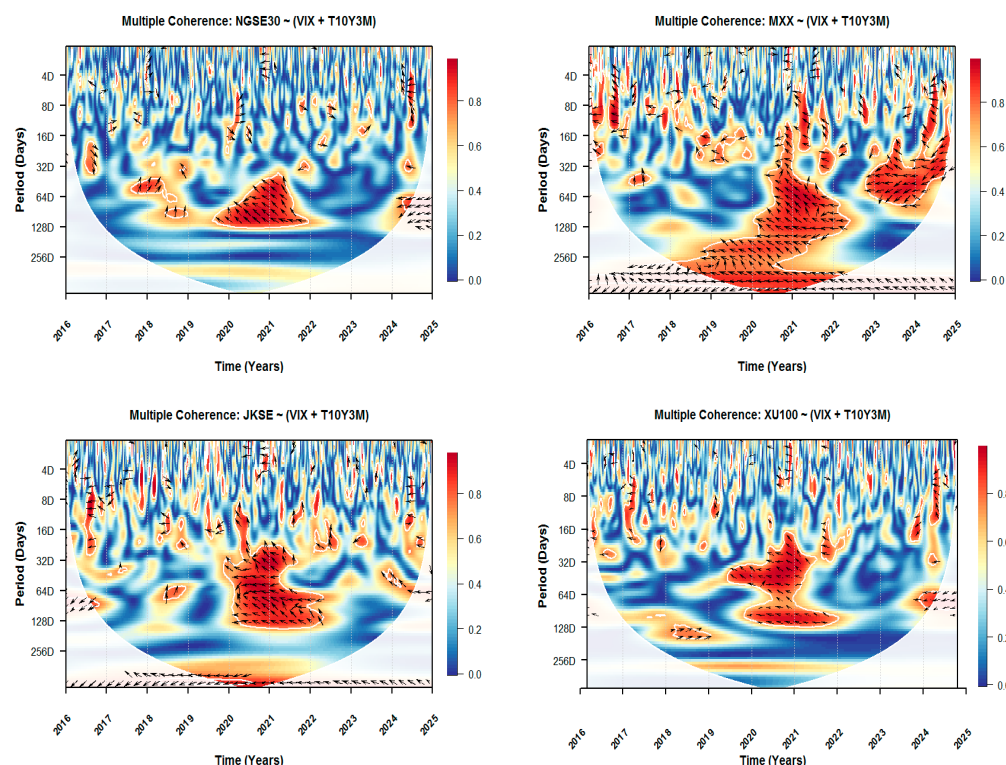


Figure 4. MWC plots for returns of MINT Countries with VIX and T10Y3M. Note: The horizontal axis represents daily observations from January 2016 to December 2025, and the vertical axis represents wavelet periods (investment horizons) expressed in trading days. Arrows indicate phase differences and lead–lag relationships. The shaded area outside the cone of influence (COI) denotes regions subject to edge effects.

The results reveal substantial variation in the way emerging markets respond to global financial conditions. Nigeria represents a relatively weakly integrated case, where coherence with the global risk indicators remains limited and concentrated mainly during periods of market stress. India, Indonesia, and Saudi Arabia display more recurrent but less persistent linkages, suggesting conditional forms of integration that strengthen during episodes of elevated uncertainty. By contrast, Russia, Brazil, South Africa, Turkey, Mexico, and Egypt exhibit stronger and more persistent coherence across investment horizons, indicating sustained exposure to external financial conditions and closer synchronization with global risk cycles.

5.2. QQR Results

The QQR results for BRICS equity markets presented in Figure 5 reveal important differences in the sensitivity of emerging markets to global financial risk factors. China's SSE displays asymmetric exposure, with lower return quantiles responding more strongly to volatility shocks, suggesting that periods of market decline are associated with stronger reactions to global uncertainty. By contrast, the influence of T10Y3M remains more persistent across the return distribution, suggesting that U.S. monetary conditions and external liquidity dynamics exert a different influence on the Chinese market.

Russia's RTSI exhibits pronounced dependence on both VIX and T10Y3M across most quantiles, reflecting sustained exposure to commodity price fluctuations, geopolitical tensions, and changing global liquidity conditions. India's BSE30 shows comparatively weaker linkages with the VIX but stronger sensitivity to T10Y3M, particularly during bullish market conditions, highlighting the importance of capital flows and monetary spillovers in supporting market expansions. Brazil's BVSP displays more limited responsiveness to volatility shocks but pronounced asymmetry in relation to the yield curve, with stronger effects concentrated in upper quantiles. This pattern suggests that favourable global liquidity conditions and expectations regarding U.S. monetary policy play a stronger role during periods of market growth. The findings point to substantial variation in both the intensity and transmission channels of exposure to global financial conditions across BRICS equity markets.

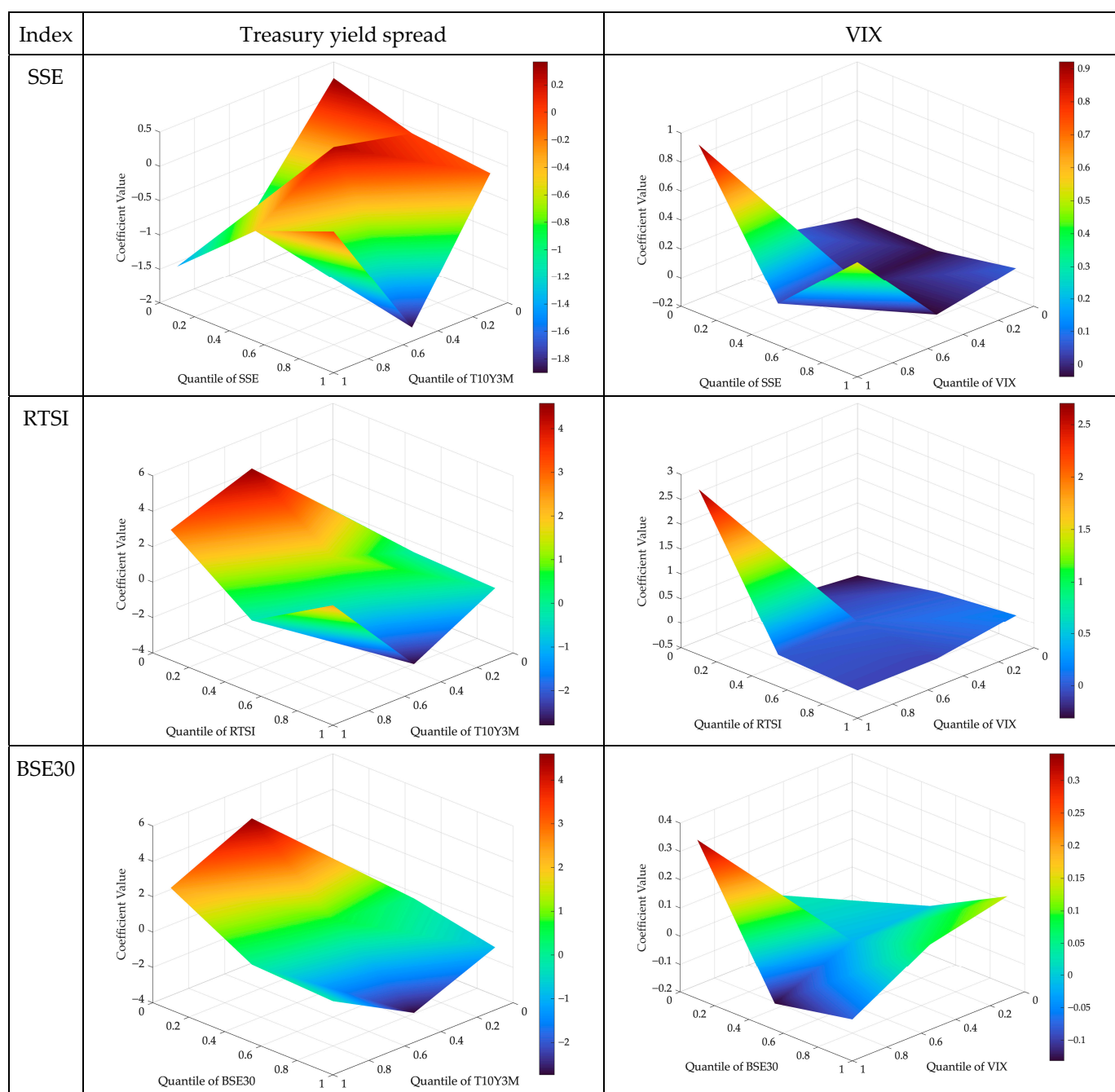


Figure 5. Cont.

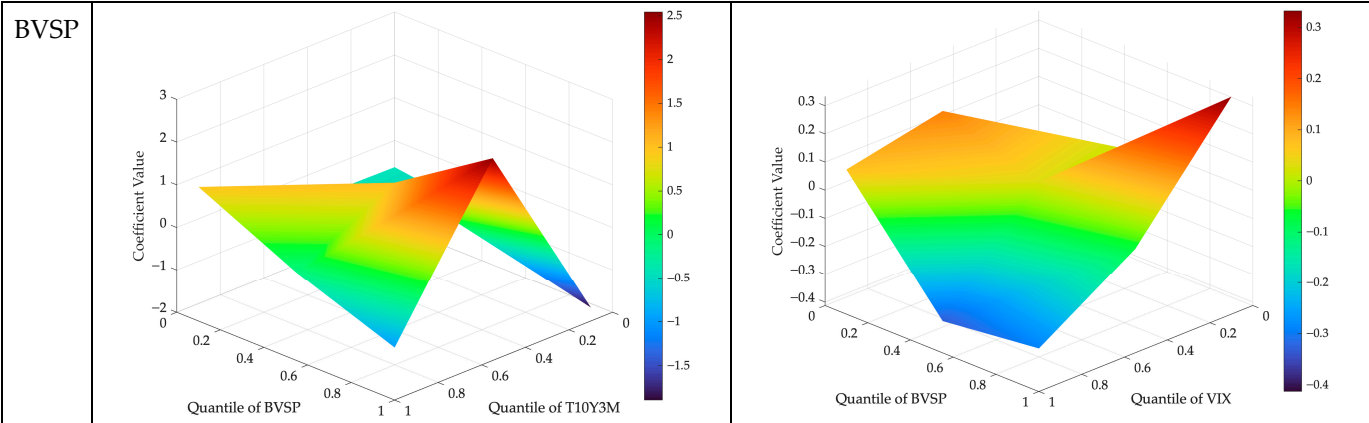


Figure 5. QQR plots for BRICS equity returns with VIX and T10Y3M. Note: The vertical axis shows the coefficient values, with warmer colours indicating stronger positive dependence and cooler colours reflecting weaker or negative linkages.

The QQR results for African and Middle Eastern markets presented in Figure 6 reveal heterogeneous dependence patterns with global financial risk factors. South Africa’s JTOPI exhibits weak but asymmetric dependence, with global uncertainty affecting primarily the tails of the return distribution. Saudi Arabia’s TASI appears comparatively less sensitive to volatility shocks but more responsive to T10Y3M during bullish market conditions.

The UAE (ADX) displays more extensive dependence across the return distribution, with volatility shocks exerting stronger effects during downturns and the yield curve influencing most quantiles. Egypt’s EGX30 exhibits the strongest and most pronounced dependence on both VIX and T10Y3M, particularly in the lower and upper quantiles, indicating elevated sensitivity to international liquidity conditions and shifts in investor sentiment. The results suggest that Gulf markets remain comparatively less exposed to external volatility shocks, where South Africa and especially Egypt display stronger synchronization with global financial conditions.

The QQR analysis for MINT economies presented in Figure 7 reveals heterogeneous dependence patterns with global financial risk factors. Mexico’s MXX displays strong sensitivity to T10Y3M, particularly during downturns, and the effects of VIX remain more selective and concentrated in bullish market conditions. This pattern suggests that U.S. monetary conditions and external liquidity pressures play a more important role during periods of market weakness.

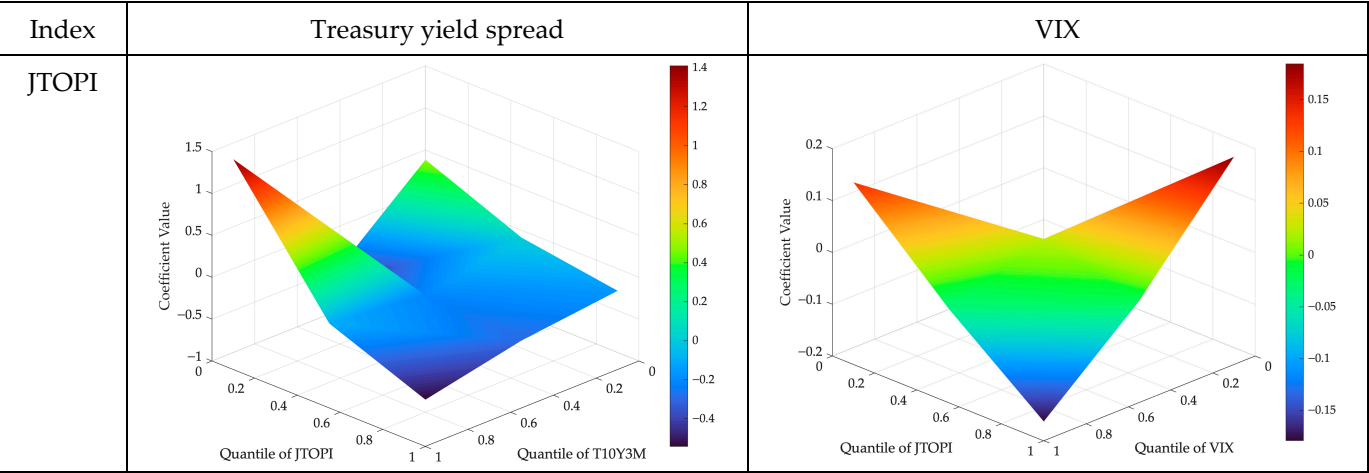


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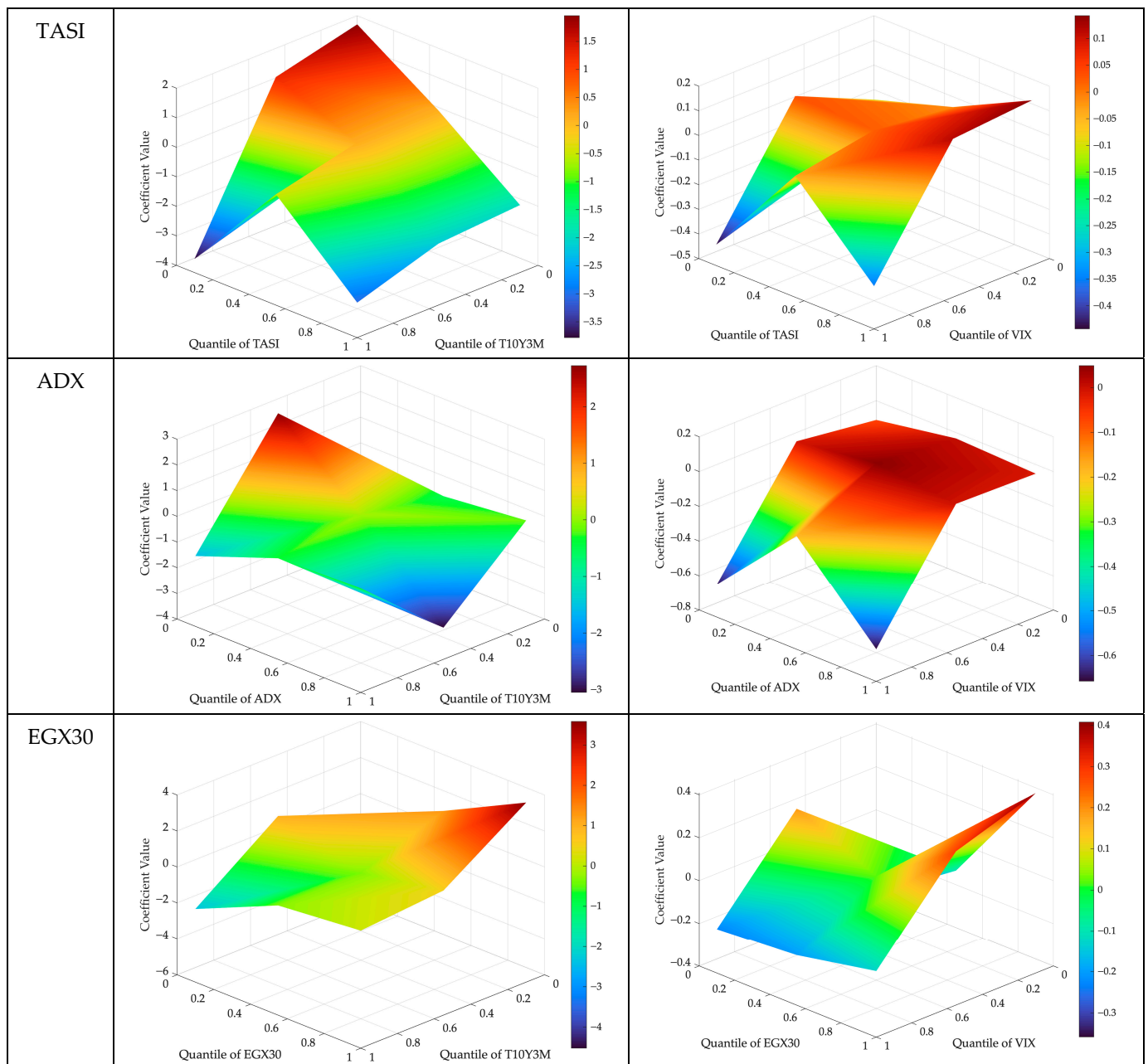


Figure 6. QQR plots for African and Middle Eastern equity indices with VIX and T10Y3M. The vertical axis shows the coefficient values, with warmer colours indicating stronger positive dependence and cooler colours reflecting weaker or negative linkages.

Indonesia's JKSE exhibits a U-shaped response to the term spread, with both lower and upper quantiles influenced by changes in U.S. monetary conditions. By contrast, volatility shocks remain relatively modest and concentrated in the tails of the distribution. Nigeria's NGSE30 shows weak and intermittent dependence on both global factors, consistent with its comparatively lower integration into international financial markets and stronger reliance on domestic liquidity conditions.

In contrast, Turkey's XU100 exhibits strong and pervasive dependence on both VIX and T10Y3M across most quantiles of the return distribution, indicating pronounced sensitivity to global financial conditions, external financing pressures, and changes in investor sentiment. The results point to substantial differences in the transmission of global financial shocks across MINT economies.

The results highlight substantial heterogeneity in the transmission of global financial shocks across emerging markets. Markets characterized by stronger integration with global financial conditions exhibit more persistent long-run linkages with global risk factors, particularly during periods of elevated financial stress. Both the MWC and QQR analyses also reveal important asymmetries across investment horizons and market conditions, indicating that the effects of global risk sentiment and U.S. monetary conditions vary considerably across frequencies and quantiles.

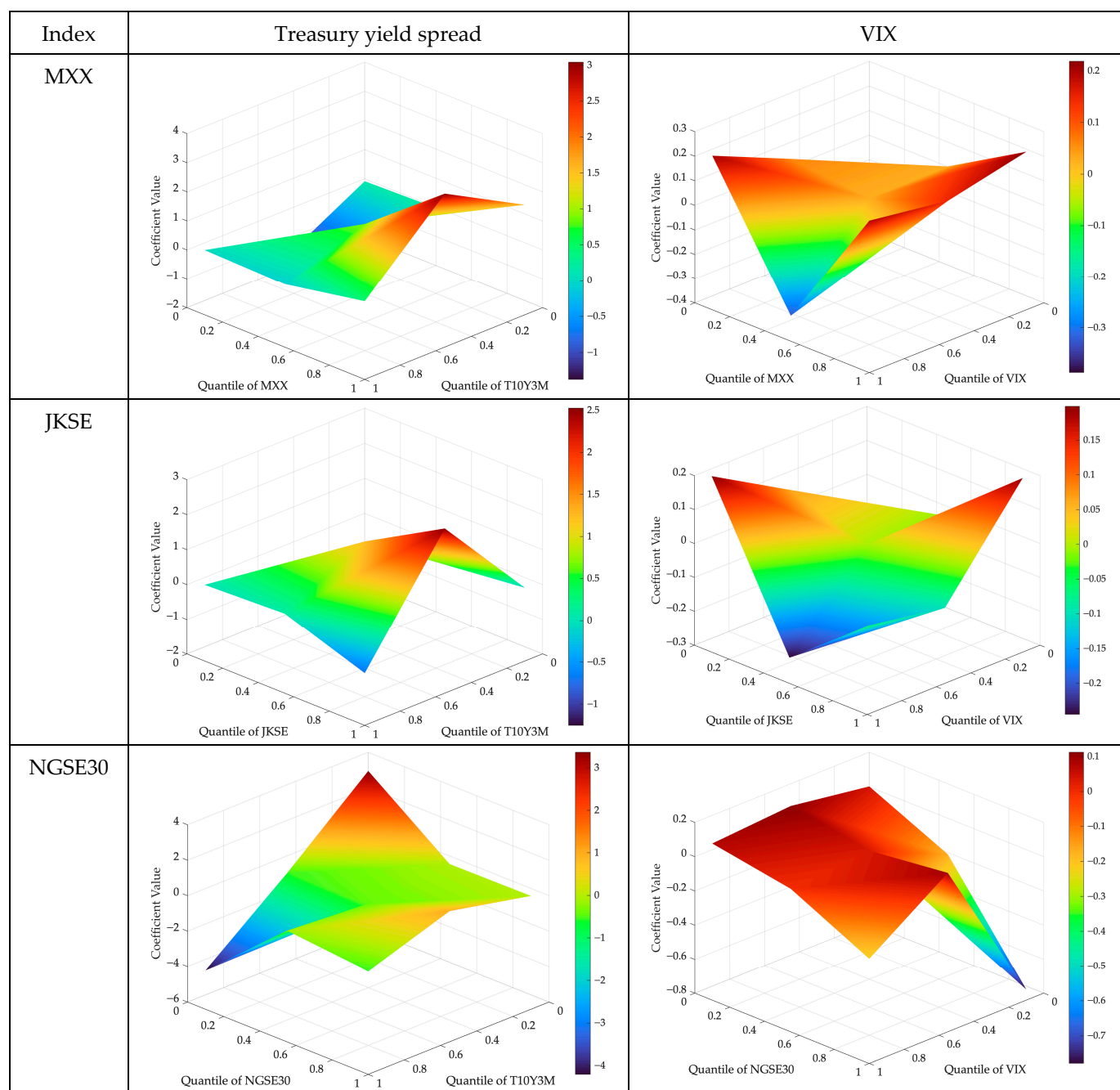


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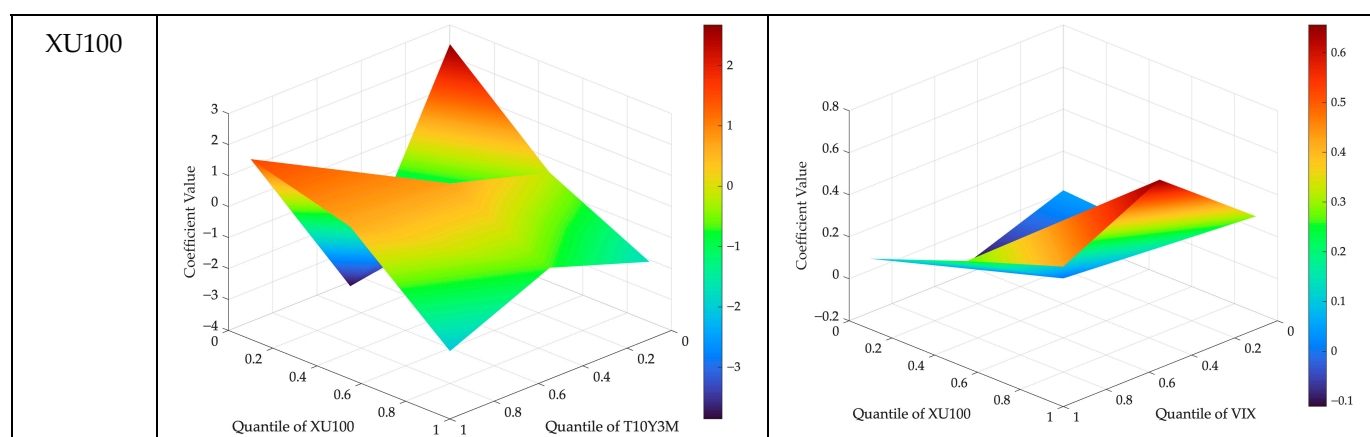


Figure 7. QQR plots for MINT Countries equity indices with VIX and T10Y3M. The vertical axis shows the coefficient values, with warmer colours indicating stronger positive dependence and cooler colours reflecting weaker or negative linkages.

Table 2 provides a concise summary of the main MWC and QQR findings and highlights the heterogeneous dependence profiles observed across emerging equity markets.

Table 2. Summary of dependence patterns across emerging markets.

Country/Index	Dominant MWC Horizon	Main QQR Pattern	Dependence Profile
China/SSE	Medium and long horizon coherence	Stronger response in lower quantiles	Episodic
Russia/RTSI	Persistent medium and long horizon coherence	Strong dependence across quantiles	Structural
India/BSE30	Recurrent medium horizon coherence	Greater sensitivity to T10Y3M	Episodic
Brazil/BVSP	Persistent long horizon coherence	Asymmetric dependence on T10Y3M	Structural
South Africa/JTOPI	Persistent medium and long horizon coherence	Tail dependence	Structural
Saudi Arabia/TASI	Fragmented coherence	Limited VIX sensitivity	Episodic
UAE/ADX	Long horizon and short episodes	Different quantile dependence	Intermediate
Egypt/EGX30	Persistent coherence	Strong dependence on VIX and T10Y3M	Structural
Mexico/MXX	Persistent long horizon coherence	Strong sensitivity to T10Y3M	Structural
Indonesia/JKSE	Crisis-related coherence	U-shaped response	Episodic
Nigeria/NGSE30	Weak coherence	Weak dependence	Episodic
Turkey/XU100	Strong coherence across horizons	Strong dependence across quantiles	Structural

5.3. Subperiod Robustness Analysis

To capture structural changes across different economic and geopolitical environments, the sample is divided into three subperiods: the pre-pandemic period (January 2016–December 2019), the COVID-19 and global disruption period (January 2020–December 2021), and the monetary tightening and geopolitical fragmentation period (January 2022–December 2025). During the COVID-19 period, the QQR surfaces became more uniform

and predominantly positive across most markets, indicating stronger synchronization and more pervasive spillover effects during episodes of global financial stress. Detailed QQR surfaces for the three subperiods are reported in Appendix B.

By contrast, the 2022–2025 period, characterized by monetary tightening and increasing geopolitical fragmentation, displays more heterogeneous dependence structures. Cross-market relationships become less uniform across regions and market states, suggesting that the transmission of global financial shocks changed considerably following the pandemic period.

The results also indicate that the VIX exerts stronger and more nonlinear effects than T10Y3M across most emerging markets, particularly in the tails of the return distribution. This finding suggests that global risk sentiment and financial uncertainty remain more important drivers of dependence during periods of market stress than changes in U.S. monetary expectations alone.

Important differences also emerge across country groups. MINT economies appear comparatively more vulnerable to global shocks. BRICS and MENA markets display more heterogeneous dependence structures across regimes. The findings also suggest that the mechanisms through which global financial shocks are transmitted to emerging markets changed substantially across the three economic and geopolitical regimes considered in the analysis.

6. Discussions

The results reveal substantial differences in the transmission of global financial shocks across emerging markets. The combined influence of the VIX and T10Y3M shows that global risk sentiment and U.S. monetary conditions play an important role in shaping dependence across emerging equity markets. Relationships between global and domestic financial conditions also differ across investment horizons and market states. This pattern highlights the nonlinear and time-varying nature of financial spillovers across emerging markets.

For the BRICS economies, China's SSE exhibits relatively weak coherence at short investment horizons. Stronger medium- and long-run dependence emerges during periods of prolonged global stress. The result is consistent with [Zhou et al. \(2025\)](#), who document time-varying effects of geopolitical tensions on China's financial system, particularly through capital and currency markets. The weaker short-run response may reflect the influence of domestic financial regulations and policy intervention. Stronger medium- and long-run coherence indicates that the influence of global financial and liquidity conditions becomes more pronounced over longer investment horizons.

Russia's RTSI exhibits strong and sustained coherence, particularly across medium- and long-run investment horizons, indicating close synchronization with global financial conditions. The result aligns with earlier evidence showing that commodity-exporting economies are particularly sensitive to global risk-off episodes and tightening dollar liquidity conditions ([Wang and You 2023](#)). India's BSE30 displays more episodic linkages concentrated around periods of financial stress, particularly during the COVID-19 pandemic. [Balli et al. \(2021\)](#) report similar evidence for India, showing that exposure to external financial shocks intensifies during adverse market conditions, especially in the lower quantiles of the return distribution.

Brazil's BVSP exhibits relatively strong long-run coherence with global financial conditions, reflecting the importance of commodity markets and external financing conditions for the Brazilian economy. This result aligns with [Adeosun et al. \(2023\)](#) and [Mensi et al. \(2022\)](#), who emphasize the role of energy shocks, investor sentiment, and macroeconomic fundamentals in shaping financial spillovers across BRICS economies. The results also show that Brazil's sensitivity to the U.S. yield spread becomes stronger during bullish

market conditions. The pattern suggests that global monetary conditions influence market dependence not only during crises, but also during expansionary periods characterized by stronger capital inflows and investor optimism.

Among the African and Middle Eastern markets, the strongest and most persistent coherence patterns are observed for South Africa. This result is consistent with the country's high degree of financial openness and dependence on commodity exports, supporting the findings of [Smolo et al. \(2022\)](#), who identify South Africa as strongly connected to global risk dynamics. Dependence becomes more pronounced during periods of heightened global uncertainty, particularly when global risk sentiment deteriorates, and external financing conditions tighten.

A more episodic pattern of dependence is observed for Saudi Arabia, where coherence is concentrated primarily at medium investment horizons, indicating comparatively lower sensitivity to external volatility shocks. Periods of heightened uncertainty generate temporary increases in synchronization with global financial conditions, despite the presence of substantial fiscal and financial buffers. An intermediate profile emerges in Abu Dhabi, characterized mainly by medium- and long-run coherence, with only limited evidence of short-run synchronization. The patterns suggest that exposure to global financial conditions remains important across Gulf markets, although the persistence and intensity of transmission differ considerably across countries and investment horizons.

Egypt's EGX30 exhibits strong and persistent dependence across medium- and long-run horizons, consistent with its reliance on external financing and portfolio inflows. This result supports earlier evidence showing that shifts in U.S. monetary conditions and flight-to-safety episodes generate substantial spillovers to emerging markets ([Ahmed 2023](#)). The findings also indicate that Egypt remains highly sensitive to changes in global financial conditions across different market states and investment horizons.

The MINT economies illustrate the heterogeneous nature of dependence across emerging markets. Comparatively weak and episodic coherence is observed in Nigeria, suggesting intermittent exposure to external shocks, with dependence becoming more pronounced during periods of elevated global uncertainty and volatility ([Zheng et al. 2025](#)). A more recurrent, although short-lived, dependence pattern emerges in Indonesia, indicating temporary increases in synchronization during episodes of external stress. Longer-run market dynamics nevertheless appear to remain influenced primarily by domestic fundamentals.

Among the MINT economies, the strongest coherence patterns are observed in Turkey, particularly during periods of heightened global uncertainty and at medium- and long-run investment horizons. This finding is consistent with [Adebayo et al. \(2022\)](#), who identify Turkey as particularly sensitive to reinforcing interactions between financial and macroeconomic risks. Mexico displays persistent long-run dependence combined with comparatively weaker short-run linkages, reflecting its close trade and financial integration with the U.S. These results also align with [Rakshit and Neog \(2022\)](#), who demonstrate that periods of heightened global uncertainty and exchange rate volatility generate significant spillovers across major emerging markets.

Three dependence profiles emerge from the analysis. Structurally dependent markets, including Russia, Brazil, South Africa, Turkey, Mexico, and Egypt, display persistent medium- and long-run coherence with global financial conditions, indicating sustained sensitivity to external shocks across investment horizons. Episodically exposed markets, such as India, Indonesia, China, Saudi Arabia, and Nigeria, exhibit more intermittent dependence concentrated around periods of global stress, suggesting that domestic fundamentals partially mitigate exposure during more stable market conditions. An intermediate profile is observed in Abu Dhabi, where medium- and long-run dependence remains visible over extended periods, accompanied by only limited episodes of short-run synchronization.

This pattern may reflect the combined influence of regional geopolitical developments and global financial shocks.

The findings also suggest that emerging markets should not be treated as a homogeneous asset class from an investment perspective. Cui et al. (2024) similarly show that global crises amplify nonlinear and tail-risk dependence across financial markets, consistent with the stronger synchronization observed in some emerging markets during periods of global stress.

From a policy perspective, markets characterized by persistent long-run dependence may require macroprudential frameworks aimed at improving domestic financial resilience through deeper capital markets, stronger local investor participation, and more effective liquidity management. Markets with more episodic exposure may benefit from flexible short-term measures, including reserve management and targeted capital flow interventions during periods of elevated volatility.

The more heterogeneous coherence patterns observed after 2022 suggest that emerging market exposure has become increasingly differentiated across regions. This development may enhance the potential benefits of regional diversification and selective portfolio allocation by reducing the degree of synchronization across markets.

The findings also carry important implications for international portfolio diversification. Persistent long-run synchronization with global financial conditions may reduce the diversification benefits offered by some emerging equity markets, particularly during periods of global stress when cross-market dependence strengthens. By contrast, more episodic and fragmented dependence structures suggest that certain markets may preserve diversification potential outside periods of elevated financial uncertainty.

7. Conclusions

The analysis reveals substantial differences in the way emerging equity markets respond to global financial conditions. Global risk sentiment and U.S. monetary conditions influence emerging markets differently, with exposure varying across investment horizons, market states, and country groups. Dependence also becomes more asymmetric during periods of financial stress, indicating that the transmission of global shocks differs across segments of the return distribution.

China, Russia, Turkey, Mexico, Egypt, and South Africa exhibit stronger and more persistent medium- and long-run coherence with global financial conditions. This pattern indicates sustained sensitivity to U.S. monetary conditions, global liquidity cycles, and shifts in investor sentiment, particularly during periods of heightened uncertainty. Greater synchronization at longer investment horizons may also reduce diversification benefits during episodes of global stress. From a policy perspective, the findings highlight the importance of macroprudential frameworks aimed at strengthening financial resilience, improving liquidity management, and enhancing the capacity of domestic financial systems to absorb external shocks.

Saudi Arabia and, to a lesser extent, Nigeria exhibit more episodic and short-lived exposure to global financial conditions. In both markets, sensitivity to external shocks becomes more pronounced during periods of market stress than under normal financial conditions. Despite substantial fiscal and financial buffers, Saudi Arabia remains influenced by global financial conditions through its exposure to oil market dynamics. Nigeria displays weaker but more volatile linkages with global financial markets, reflecting lower financial integration alongside heightened vulnerability during episodes of elevated uncertainty.

India, Brazil, Indonesia, and the UAE represent intermediate cases in which domestic fundamentals coexist with recurrent exposure to external shocks. Long-run market dynamics remain partly shaped by domestic macroeconomic conditions. At the same

time, capital flow reversals, commodity price fluctuations, and U.S. monetary tightening generate temporary increases in synchronization with global financial conditions. Strengthening domestic financial resilience and countercyclical policy capacity may help reduce the destabilizing effects of external financial shocks.

The findings carry several important implications. First, global financial conditions remain a major driver of equity market dynamics across emerging economies. Second, domestic policy autonomy remains partially constrained during prolonged periods of global risk aversion and liquidity tightening. Third, the results highlight the need for differentiated policy responses across emerging markets. Economies characterized by stronger long-run integration with global financial conditions may require resilience frameworks, while episodically exposed markets may benefit more from flexible stabilization measures during periods of elevated volatility.

Several limitations should be acknowledged. Methodologically, MWC identifies time-frequency dependence but does not establish causality. Alternative approaches, including time-varying VARs, spillover models, network methods, and non-parametric dependence measures based on Kendall's tau, may provide insights into financial transmission mechanisms during periods of extreme market stress. The analysis also focuses exclusively on equity markets and does not consider other transmission channels such as sovereign bonds, exchange rates, or banking linkages. Future research could extend the analysis toward sectoral and firm-level dynamics and assess the robustness of the reported dependence structures using alternative non-parametric estimators.

The findings show that the synchronization of emerging equity markets with global financial cycles is neither uniform nor constant. Some markets exhibit persistent long-run integration with external financial conditions, while others remain more episodically exposed during periods of global stress. This heterogeneity has important implications for investors and policymakers, particularly in reassessing diversification opportunities and strengthening resilience to external financial shocks.

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Abbreviations

The following abbreviations are used in this manuscript:

MWC	Multiple Wavelet Coherence
QQR	Quantile-on-Quantile Regression
VIX	CBOE Volatility Index
T10Y3M	U.S. Treasury yield spread
U.S.	United States
VAR	Vector Autoregression
DCC-GARCH	Dynamic Conditional Correlation—Generalized Autoregressive Conditional Heteroskedasticity
BRICS	Brazil, Russia, India, China and South Africa

MINT	Mexico, Indonesia, Nigeria and Turkey
GCC	Gulf Cooperation Council
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
SSE	Shanghai Stock Exchange Composite Index
RTSI	Russian Trading System Index
BSE30	Bombay Stock Exchange Sensitive Index 30
BVSP	Bovespa Index
JTOPI	FTSE/JSE Top 40 Index
TASI	Tadawul All Share Index
ADX	Abu Dhabi Securities Exchange General Index
EGX30	Egyptian Exchange 30 Index
MXX	Mexican Stock Exchange IPC Index
JKSE	Jakarta Composite Index
NGSE30	Nigerian Exchange 30 Index
XU100	Borsa Istanbul 100 Index
ADF	Augmented Dickey–Fuller test
PP	Phillips–Perron test
KPSS	Kwiatkowski–Phillips–Schmidt–Shin test
CWT	Continuous wavelet transform

Appendix A

Table A1. Stationarity tests.

Index	ADF		PP		KPSS	
	t-Statistic	t-Statistic	Adj. t-Stat	Adj. t-Stat	LM-Stat.	LM-Stat.
	Level	1st Diff	Level	1st Diff	Level	1st Diff
SSE	−52.28 (0.000)	−19.47 (0.000)	−52.23 (0.000)	−998.97 (0.000)	0.076	0.053
RTSI	−35.72 (0.000)	−20.66 (0.000)	−127.70 (0.000)	−1951.55 (1.000)	0.094	0.096
BSE30	−21.51 (0.000)	−21.82 (0.000)	−51.15 (0.000)	−1833.17 (1.000)	0.028	0.031
BVSP	−35.24 (0.000)	−21.57 (0.000)	−55.32 (0.000)	−1044.53 (1.000)	0.134	0.034
JTOPI	−49.25 (0.000)	−19.37 (0.000)	−49.42 (0.000)	−880.50 (0.000)	0.075	0.040
TASI	−19.02 (0.000)	−20.69 (0.000)	−44.23 (0.000)	−900.27 (0.000)	0.072	0.102
ADX	−15.08 (0.000)	−22.94 (0.000)	−46.76 (0.000)	−464.62 (0.000)	0.119	0.031
EGX30	−42.86 (0.000)	−23.16 (0.000)	−43.16 (0.000)	−416.11 (0.000)	0.187	0.016
MXX	−48.06 (0.000)	−20.94 (0.000)	−48.03 (0.000)	−943.19 (0.000)	0.060	0.087
JKSE	−48.14 (0.000)	−22.32 (0.000)	−48.25 (0.000)	−770.19 (0.000)	0.051	0.143
NGSE30	−29.00 (0.000)	−19.92 (0.000)	−42.12 (0.000)	−1132.53 (1.000)	0.349	0.068
XU100	−48.73 (0.000)	−21.49 (0.000)	−48.79 (0.000)	−882.28 (0.000)	0.354	0.072

Note: ADF, PP, and KPSS denote the Augmented Dickey–Fuller, Phillips–Perron, and Kwiatkowski–Phillips–Schmidt–Shin tests, respectively. Values in parentheses represent the corresponding *p*-values.

Appendix B

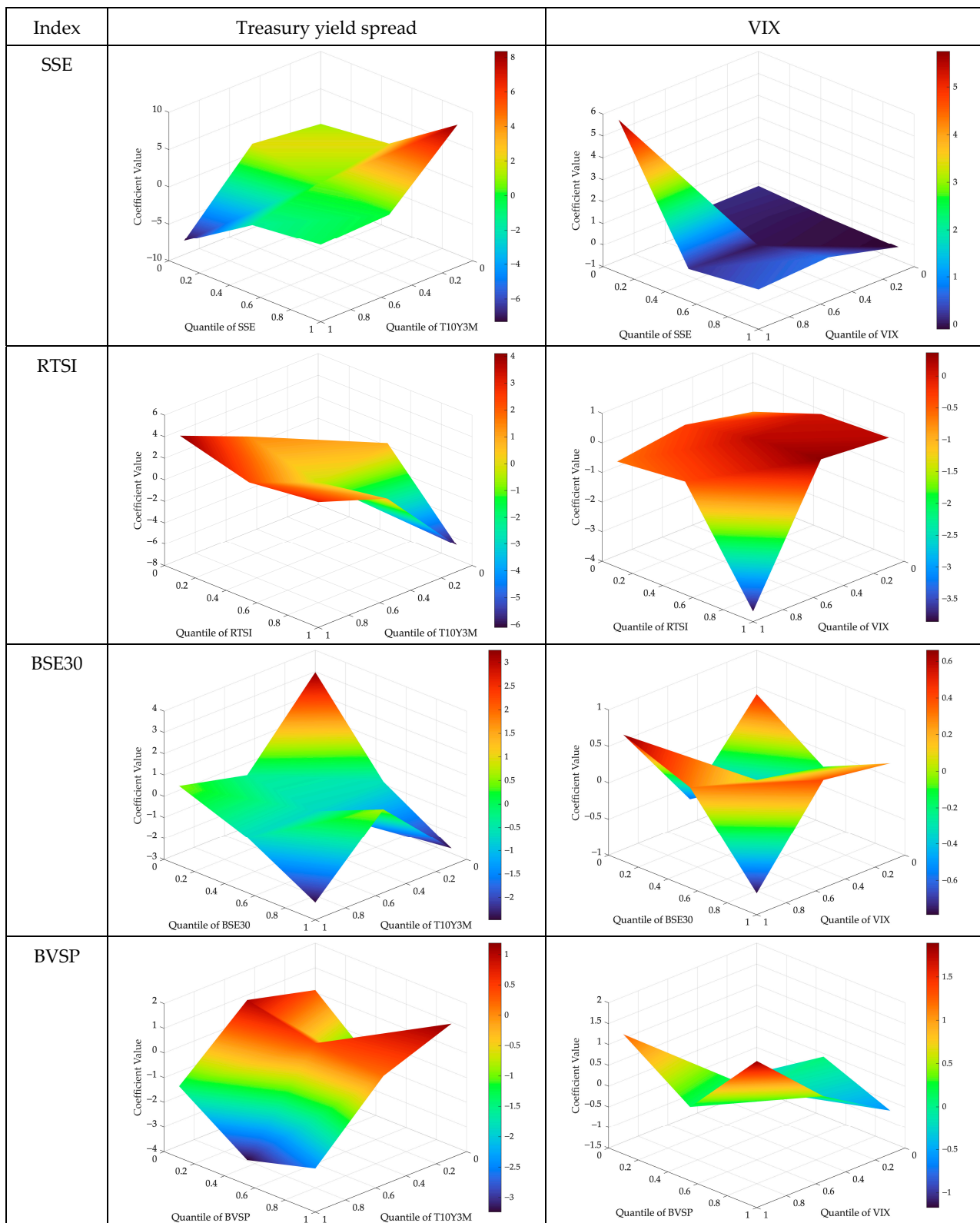


Figure A1. QQR plots for BRICS equity returns with VIX and T10Y3M during the period January 2016–December 2019.

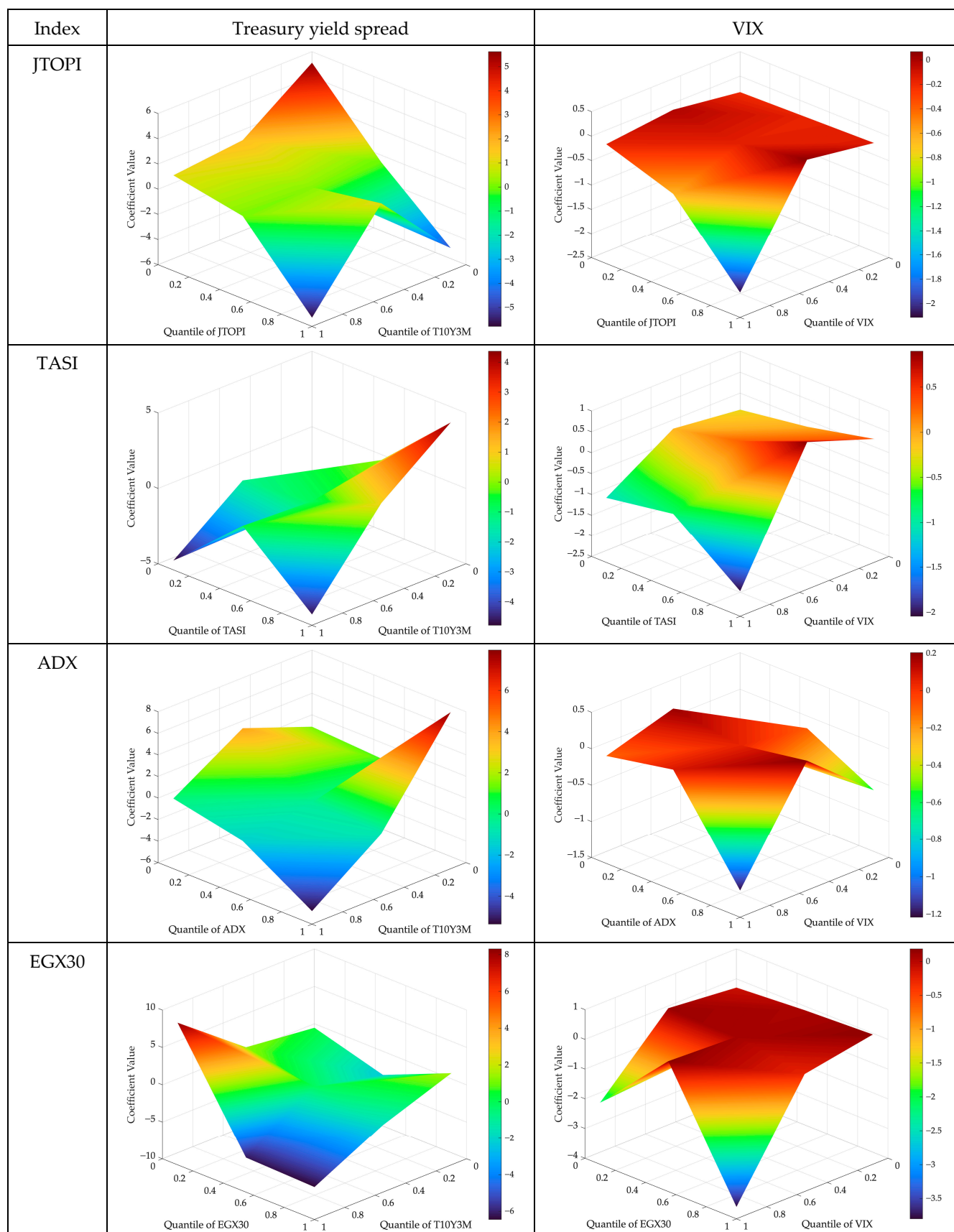


Figure A2. QQR plots for African and Middle Eastern equity indices with VIX and T10Y3M during the period January 2016–December 2019.

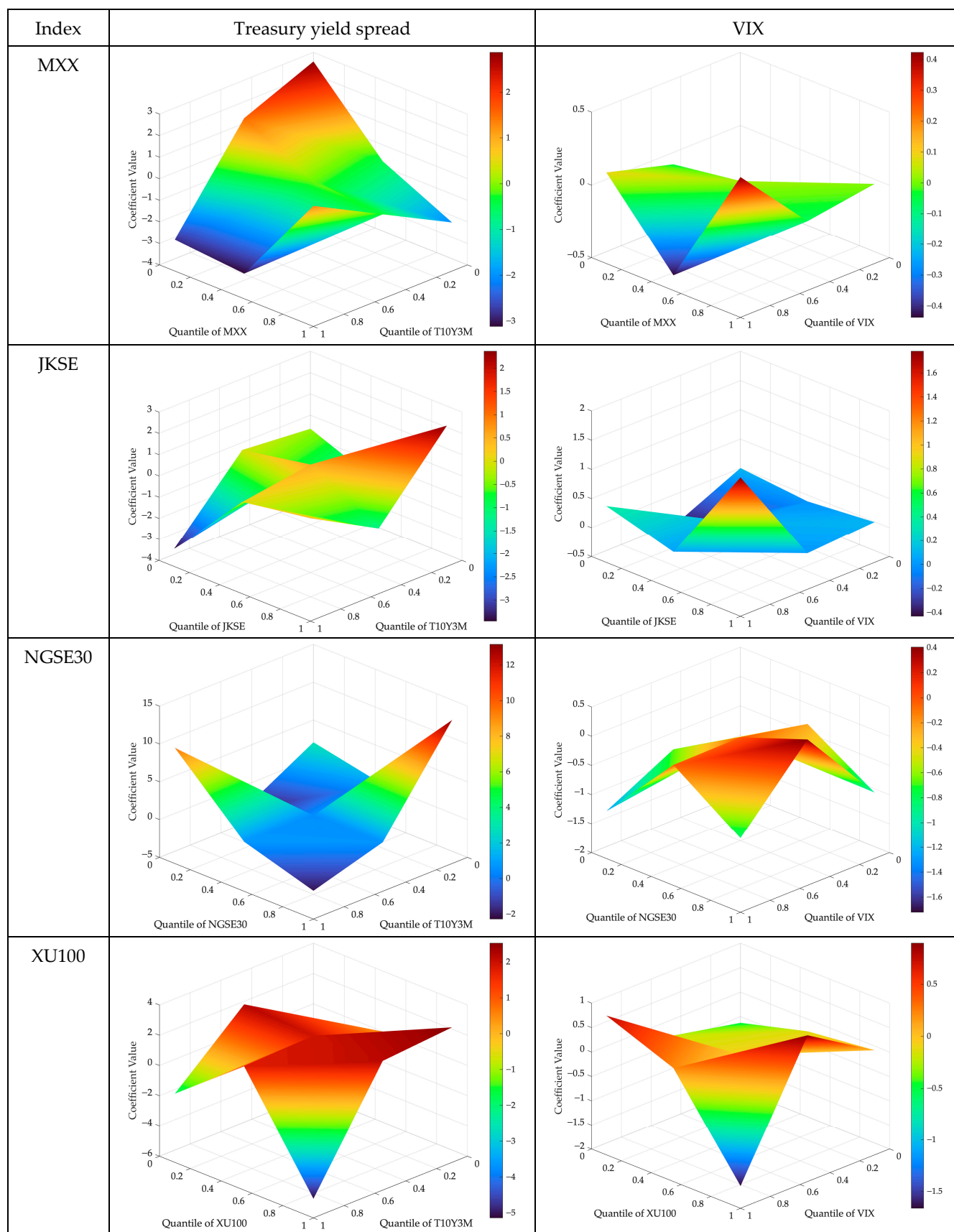


Figure A3. QQR plots for MINT Countries equity indices with VIX and T10Y3M during the period January 2016–December 2019.

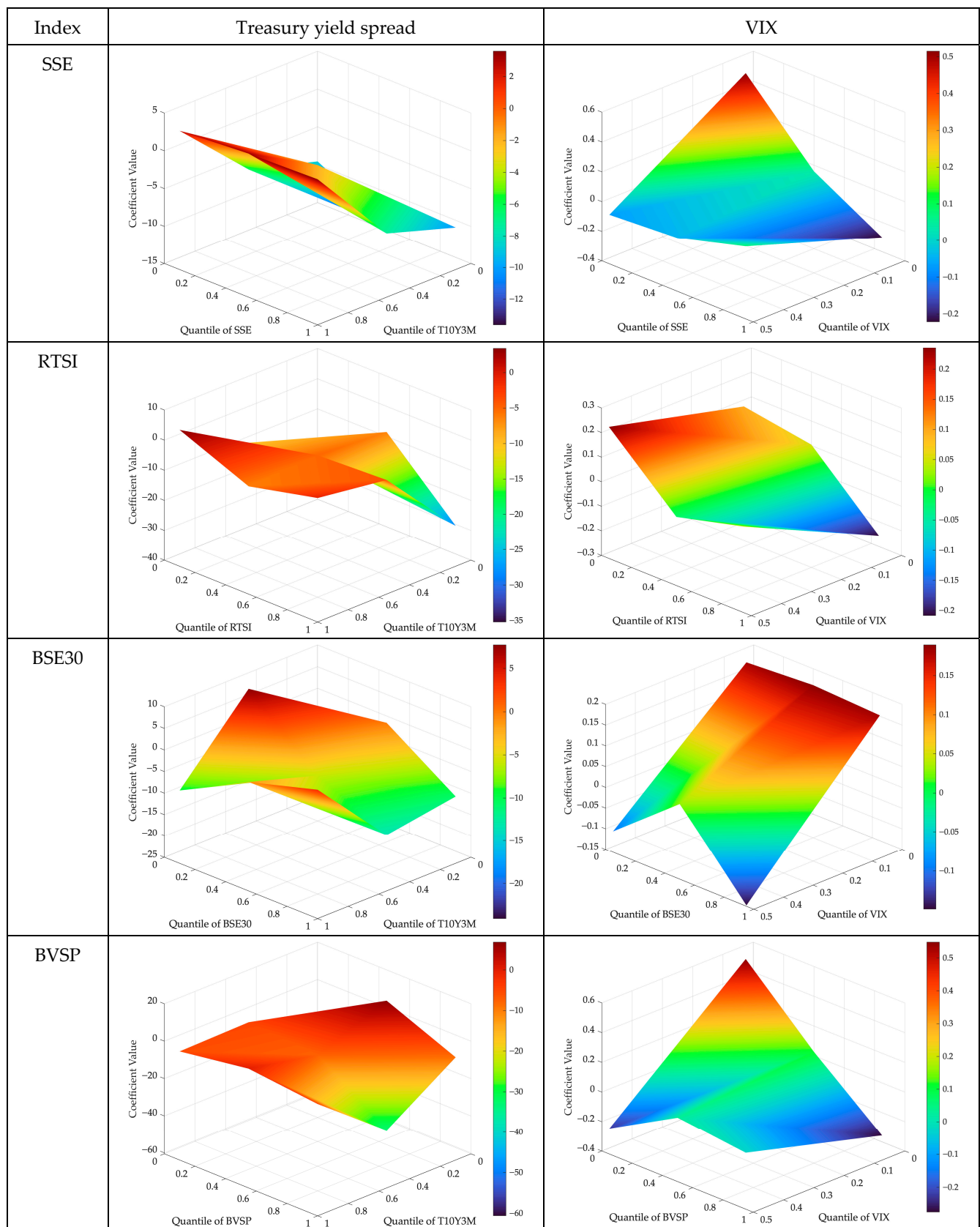


Figure A4. QQR plots for BRICS equity returns with VIX and T10Y3M during the period January 2020–December 2021.

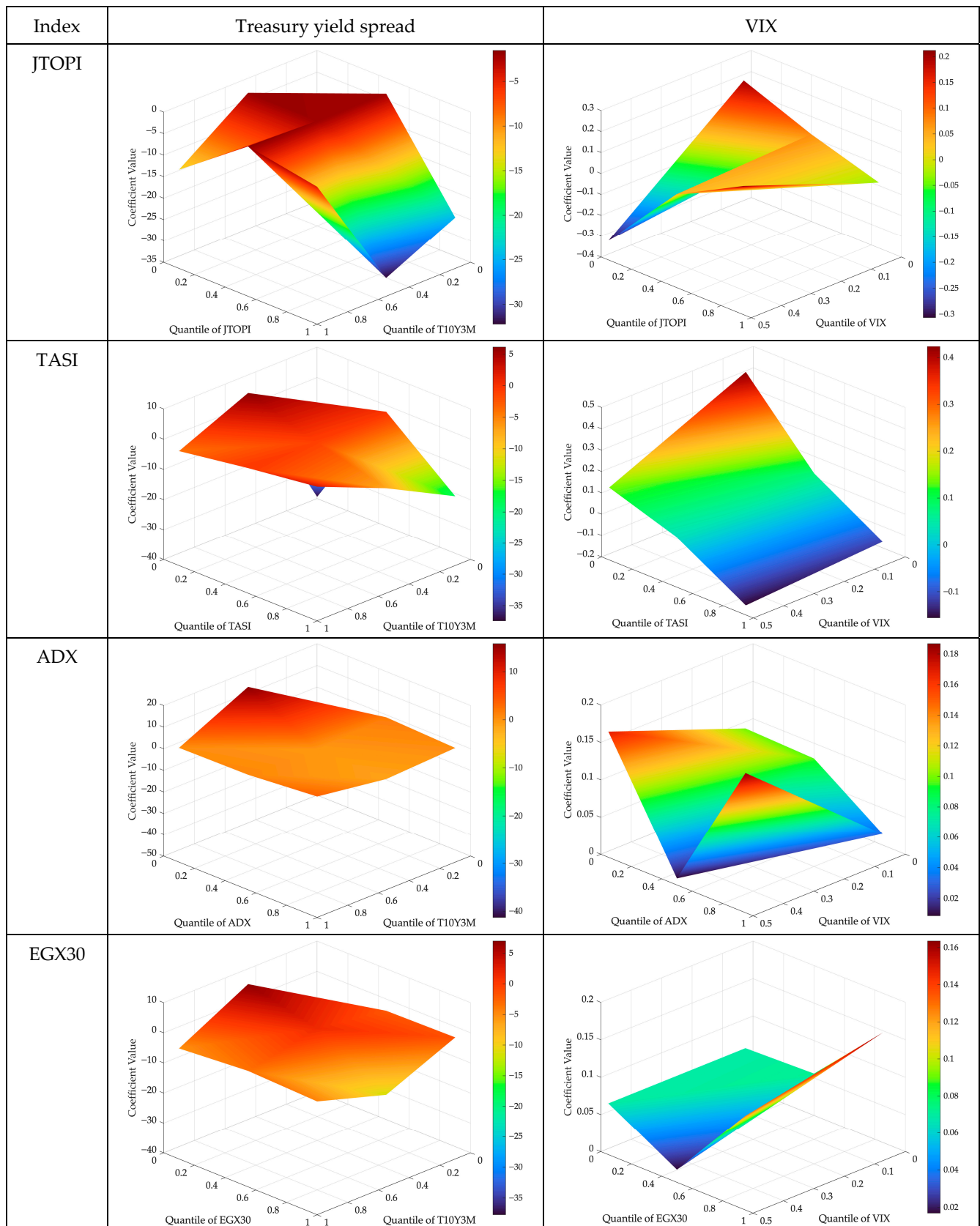


Figure A5. QQR plots for African and Middle Eastern equity indices with VIX and T10Y3M during the period January 2020–December 2021.

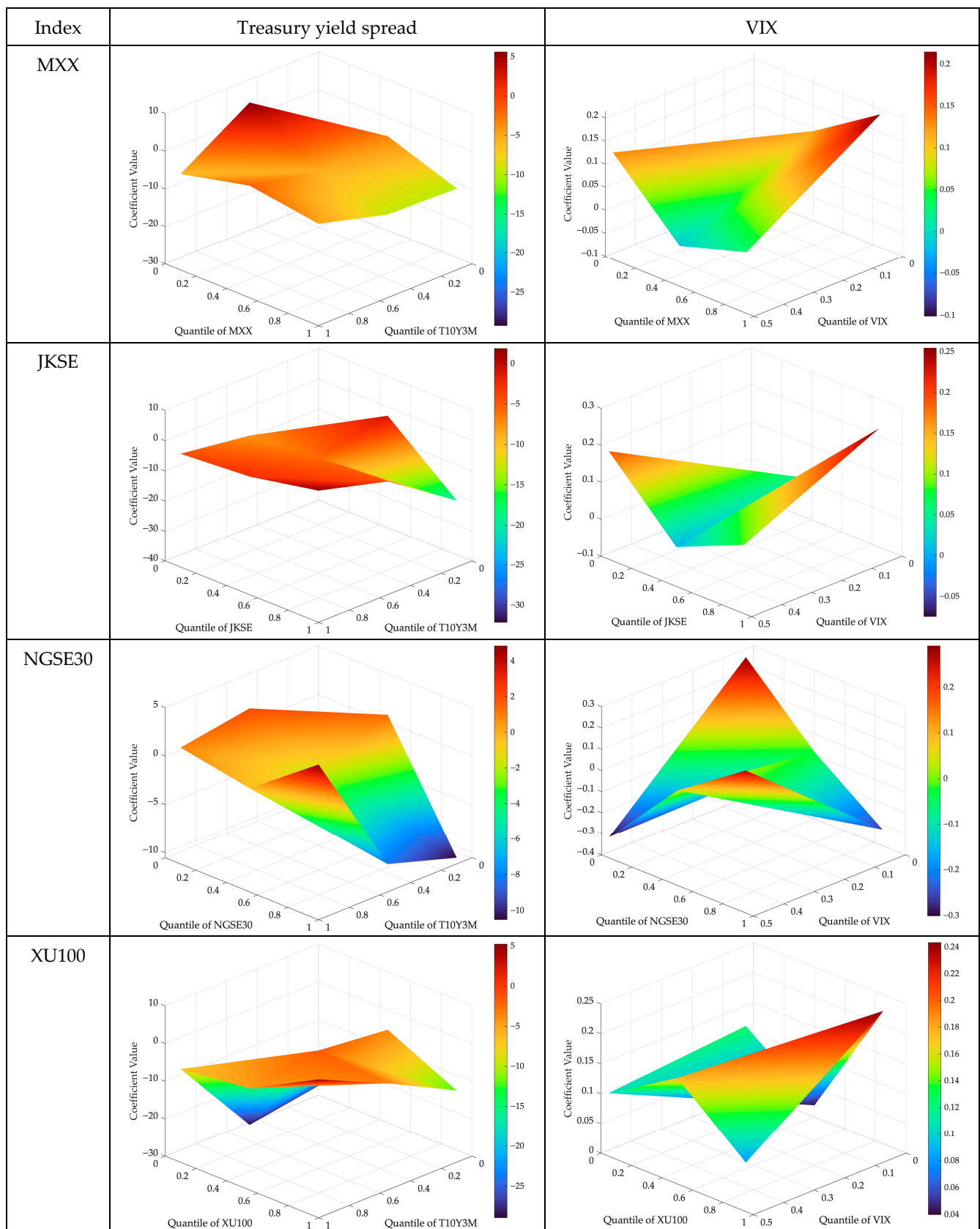


Figure A6. QQR plots for MINT Countries equity indices with VIX and T10Y3M during the period January 2020–December 2021.

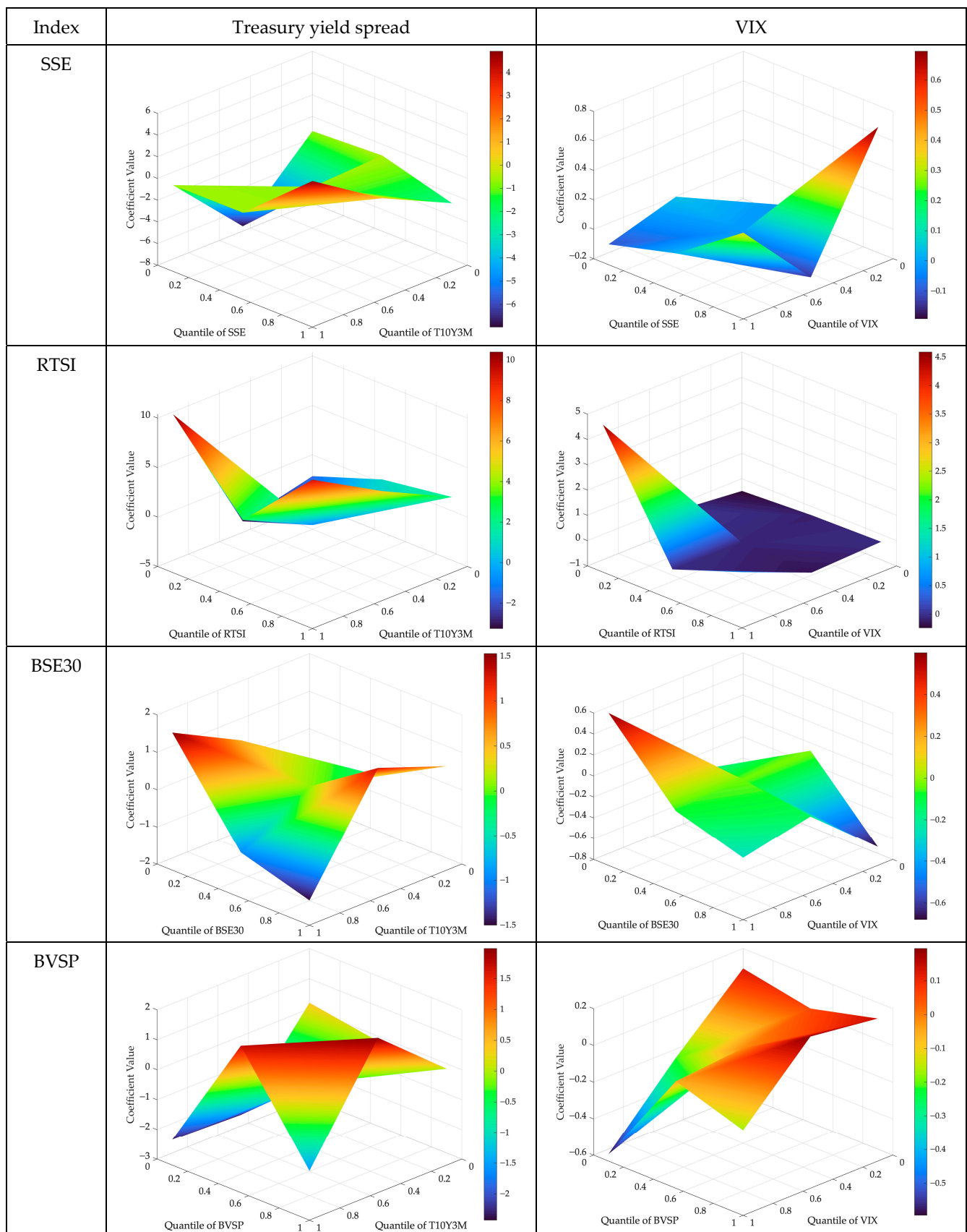


Figure A7. QQR plots for BRICS equity returns with VIX and T10Y3M during the period January 2022–December 2025.

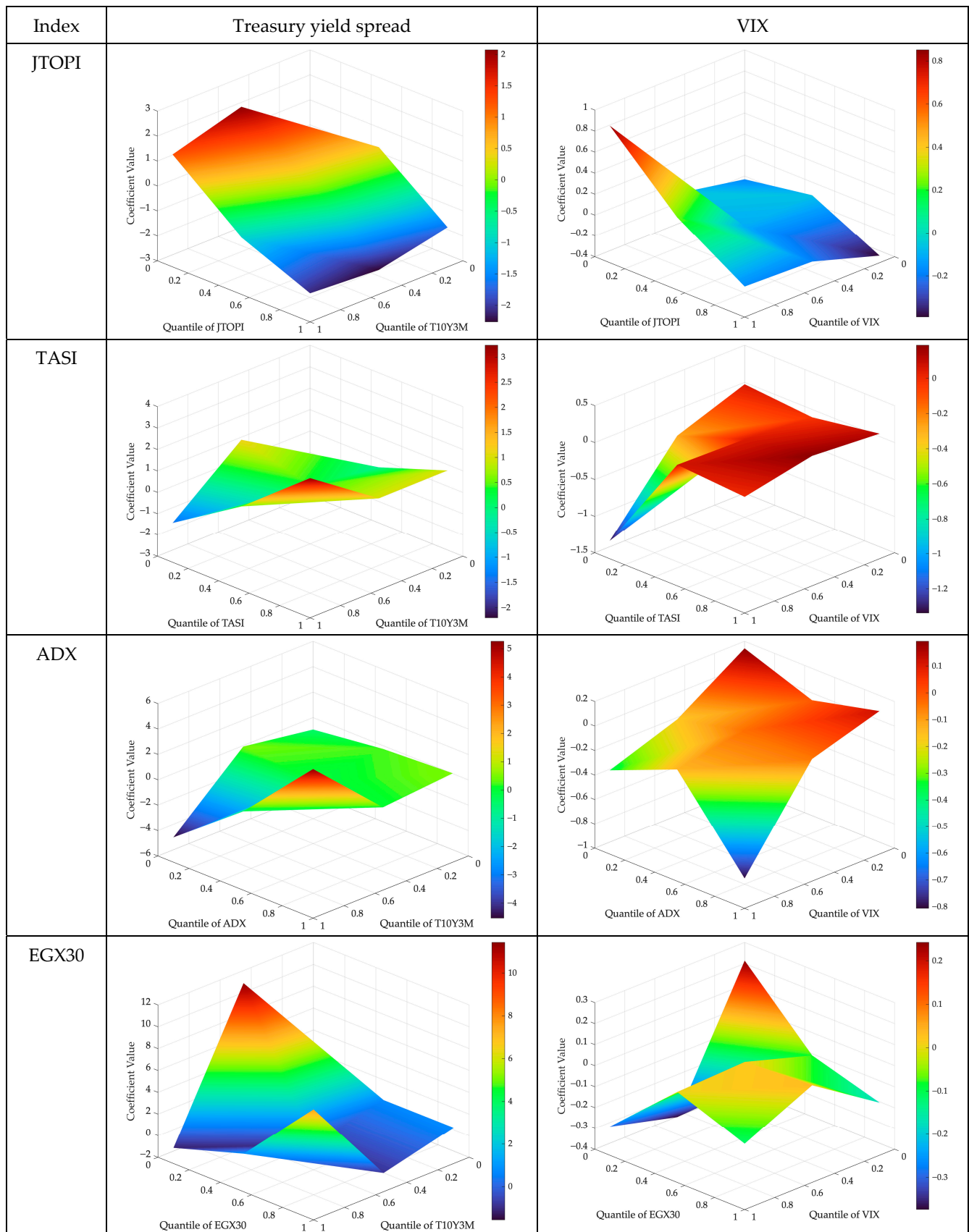


Figure A8. QQR plots for African and Middle Eastern equity indices with VIX and T10Y3M during the period January 2022–December 2025.

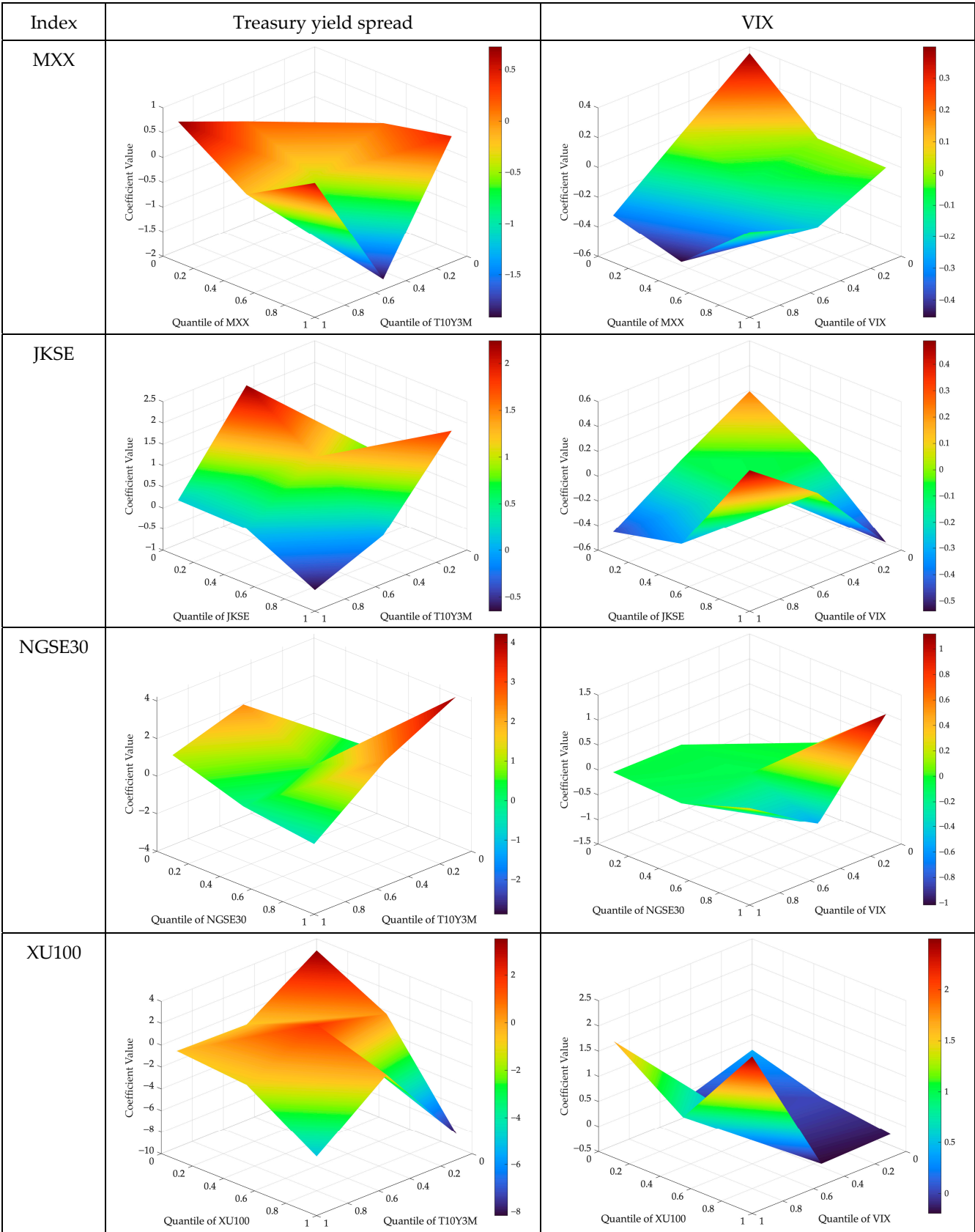


Figure A9. QQR plots for MINT Countries equity indices with VIX and T10Y3M during the period January 2022–December 2025.

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