

Asymmetric Spillovers and Nonlinear Linkages between Oil Prices and MENA Equity Markets: Evidence from the Crisis and Post-Crisis Periods

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ABSTRACT

This paper considers the asymmetric and nonlinear spillover dynamics among oil price shocks and MENA stock markets during the major crisis and post-crisis sub-periods of 2005–2024. By applying Time-Varying Parameter Vector Autoregressive (TVP-VAR) and Nonlinear Autoregressive Distributed Lag (NARDL) models, the study finds considerable heterogeneity in the transmission of oil shocks across countries and market regimes. The results indicate that increases in oil prices have stronger and more persistent effects on equity returns and volatility than decreases, especially during crises such as the Global Financial Crisis (2008–2009), the COVID-19 pandemic, and the Russia–Ukraine war. Moreover, spillover intensity and direction are time-varying and conditional on each country's oil dependence, market depth, and economic diversification. These findings underscore the overriding importance of energy risk management, financial diversification, and policy coordination in stabilizing MENA markets amid mounting global uncertainty.

Keywords: Asymmetric spillovers, Crisis regimes, Financial contagion, MENA equity markets, NARDL, Nonlinear linkages, Oil price shocks, TVP-VAR.

JEL Classification: Q43, G15, C32, Q02, E44.

INTRODUCTION

The nexus between oil price volatility and financial market performance represents a pillar of international finance with very significant implications for global economic stability. The link between oil price movements and financial market performance is vital in the Middle East and North Africa (MENA) region, given its geographical and economic diversity, which includes large oil-exporting countries alongside energy-importing economies. The regional finance markets have gone through a significant overhaul prompted by a succession of economic reforms due to their liberalization and integration into the global economy (Naceur et al., 2007; Assefa and Mollick 2017), given that the markets offer favorable prospects for portfolio diversification even in the face of measurement and depth issues in the markets (Allen et al., 2011). Empirical research indicates that interconnections across regional markets are more robust in their volatility patterns than in the comovement of returns (Asongu, 2014) and are significantly influenced by trends in the global financial markets (Assefa and Mollick, 2017).

The acute volatility in global oil prices over the past two decades has created a complex and opaque environment for policymakers and investors alike. The year witnessed a staggering jump from around \$60 per barrel in 2007 to a historical high of well over \$140 in 2008, before crashing precipitously through the financial crisis of the world, then resuming another spiral of decline through the oil price crisis (2014-2016) before recording record lows during the COVID-19 pandemic (Zhang et al., 2021).

These price changes are passed on to the world economy through multiple channels (Salgado et al., 2017), two primary mechanisms being: the first is the cash flow channel, as these directly affect corporate incomes and input prices through oil prices, which are carried over into profit and dividend expectations, and the second is the discount rate channel, as oil price shocks can affect inflationary expectations and monetary policy, which subsequently alters the interest rates utilized to discount future cash flows when applying equity valuation models (Arouri et al., 2011a).

The interaction of these effects makes a proper understanding of the relationship between oil and the stock market an essential requirement for portfolio investment, risk management, and the formulation of effective monetary and energy policies (Mensi et al., 2022).

Despite this importance, the academic literature covering the MENA region is plagued by apparent gaps, the most critical of which is the geographical one in which the vast majority of previous studies aim at the developed economies or the GCC nations (Arouri et al., 2011b; Malik and Ewing, 2009) and therefore the more diverse equity markets of the broader MENA region, such as these key importers of Jordan, Tunisia, and Morocco, remain under researched.

There also appears to be a significant methodological gap, as linear models dominate the research and ignore the inherent nonlinearity, structural breaks, and asymmetric behavior in financial data, leading to model misspecification and spurious empirical results (Ewing and Malik, 2016).

To bridge the gaps, this study aims to accomplish several objectives: the first one is to examine the direction and form of the dynamic correlation between regional stock markets and oil prices during the period from 2007 to 2023, which facilitates over one such severe crisis; the second one is to estimate the level of asymmetric volatility spillovers and test whether negative sign shocks spread faster or strengthened faster compared to positive shocks; the third one is to examine the existence of nonlinear relationships and tail dependence among the assets based on novel econometric techniques.

The research also aims to enhance model robustness by formally identifying and using structural breaks caused by major crises, and, finally, deriving practical implications for investors from the calculation of optimal portfolio weights and dynamic hedging ratios.

The following is based on a set of main hypotheses to be tested. It assumes asymmetric effects in the transmission of oil price volatility to regional stock markets. It anticipates that the nature and intensity of this relationship will differ between oil-exporting and oil-importing countries. It also predicts the presence of tail dependence and nonlinear dynamics in the interdependence among these markets, and that omitting structural breaks in the model leads to an overestimation of the degree of volatility persistence and market interdependence. Finally, it predicts that oil assets can be best used to build investment portfolios and reduce the risk in the region's market portfolios.

Methodologically, the book will commence with an overview of the theoretical and empirical research on oil prices and financial market relationships, specifically drawing on studies from the MENA region and on nonlinear methodologies. This would be followed by a characterization of the research approach, data, and source type for the period 2007-2023, and the econometric models used. The paper will then present a preliminary statistical analysis of the data and results, followed by a discussion of the chief empirical results, namely the results of hypothesis testing and calculations of hedge ratios and portfolio weights. It will finish by presenting the chief conclusions, the most important implications for policymakers and investors, and proposals for possible future research.

This exhaustively methodological design represents a tangible contribution to the literature in the form of the provision of an exhaustive and up-to-date analysis of the nonlinear and dynamic relationship between one of the world's most valuable commodities and the stock markets of a dynamic and opportunity-rich region and challenges region, thereby providing decision-makers and investors with findings based on state-of-the-art methodologies that are capable of capturing the complex and asymmetric character of these relationships.

The research has been organized into six main sections. Section One introduces the research problem, objectives, and hypotheses. Section Two discusses the theoretical framework and available literature on the interaction between oil prices and financial markets, with a specific focus on nonlinear modeling techniques. Section Three explains the research design and tabulates the asymmetric models and data sources for 2007-2023. Section Four presents the preliminary statistical results and descriptive outcomes of the data. Section Five presents the significant empirical results, including the outcome of hypothesis testing and the calculation of optimal portfolio weights and dynamic hedge ratios. Finally, Section Six outlines the most important findings of the study, presents the main recommendations, and suggests potential directions for future research.

LITERATURE REVIEW

The relationship between stock markets and oil prices in the Middle East and North Africa (MENA) region is a rich and complex brocade of dynamic processes whose understanding has evolved substantially over decades. The research process began with building-block studies based on traditional linear models. Jones and Kaul (1996) have, using quarterly data, found the channel by which oil shocks affect real cash flows and the consequent adverse stock market reaction. Sadorsky (1999) further explored the asymmetric nature of this relationship using complex models and indicated that the effects of positive and negative oil shocks differ in pattern and magnitude.

When the millennium arrived, the research frontier underwent a paradigm shift marked by the adoption of models capable of capturing the dynamics of nonlinear relationships. Malik and Hammoudeh (2007) used the BEKK-GARCH model in an early study to examine volatility transmission networks between oil markets and Gulf stock markets. They found that the Saudi market emerged as the primary source of volatility. Tien and Hung (2022) in their research integrated asymmetric GARCH models and the wavelet technique to provide a temporal perspective to the analysis and established that volatility transmission differs substantially in the short, medium, and long run, and that negative shocks impact more strongly than positive shocks.

In the context of methodological evolution, the Kartsonakis and Dritsakis (2021) study represented a qualitative advance in addressing structural breaks, validating the superiority of asymmetric models that account for sudden structural changes. The Cifter et al. (2021) research established another dimension of complexity represented by sectoral heterogeneity, with the responsiveness of economic sectors to oil price volatility differing materially. The research study by Okhrin et al. (2023) added a new angle to the analysis by uncovering complex patterns of asymmetric causal relationships. In contrast, the research study by Sujit and Ray (2023) provided strong evidence for the dominance of nonlinear models in capturing the dynamics of such relationships.

In crisis analysis, research has shown that relationships change abruptly under turbulence. The study by Bakir et al. (2021) documented that the global financial crisis doubled volatility transmission. In contrast, the study by Cevik et al. (2020) found that the impact of oil becomes stronger during local and global crises. The study by Zhang et al. (2021) confirmed the structural shift of spillover dynamics across markets during COVID-19.

At the regional level, the study by Ajmi et al. (2014) identified nonlinear relationships among markets, while that by Lu et al. (2024) demonstrated that energy volatility enhances connectivity among markets. The study by Bigerna (2024) provided a detailed analytical enrichment of the spillover of oil shocks into macroeconomic variables across successive crises.

Despite this methodological and cognitive progress, several profound research gaps remain that must be addressed with the utmost urgency. Methodologically, the most significant obstacle remains the absence of an integrated analytical model that combines asymmetric causality models, structural break analysis, and multi-scale modeling. Second, geographic coverage remains biased toward producing countries and against importing countries, hindering a broader vision of regional economies.

The shortage of research on successive crises is of utmost importance in the context of the global increase in crisis frequency, highlighting the need to study the impacts of successive crises, such as the COVID-19 pandemic, the Ukraine crisis, and supply chain shocks, on the nature of the market relationship. Further, understanding the mechanisms driving shock and volatility transmission between markets remains a neglected area, especially in light of the structural changes regional financial markets face.

All these gaps require outlining a comprehensive research agenda that combines the latest analytical methods, expands the geographical scope to encompass all the region's economies, focuses more on the investigation of influential structural determinants, and concentrates on measuring the cumulative effects of recurring crises. A combination approach of this type will make it possible to provide more accurate and more detailed analysis of the nature of this complex relationship and construct practical tools to support investment and policy-making choices in a context of increasing volatility and global turbulence, and thereby better meet the needs of investors and policymakers in their reaction to increasing economic turmoil.

DATA AND METHODOLOGY

Data and Sample Period

To empirically validate the asymmetric and nonlinear linkages between oil prices and MENA equity markets, this study employs a comprehensive dataset at daily frequency spanning 2005 to 2024. The selection of this extended period is strategic, as it encompasses several major global crises and their subsequent recovery phases, allowing for a robust comparative analysis. The core variables include the Brent crude oil price, serving as the benchmark for global oil markets, and a set of major MENA stock market indices.

The equity markets selected are Saudi Arabia, the United Arab Emirates (UAE), Qatar, Oman, and Bahrain, representing the oil-exporting Gulf Cooperation Council (GCC) nations, alongside Egypt, Morocco, and Jordan, which are more diversified, oil-importing economies. This dichotomy is crucial for examining the role of a country's oil dependence in the transmission of shocks.

To dissect the time-varying nature of spillovers, the full sample is partitioned into distinct sub-periods. The identified crisis periods include the Global Financial Crisis (2008–2009), the COVID-19 pandemic (2020–2021), and the Russia-Ukraine war (2022–2023). Each crisis window is followed by a designated post-crisis period to capture the recovery and normalization of market dynamics. Furthermore, to isolate the specific effects of oil price shocks and control for broader financial and economic conditions, the model incorporates several control variables. These are the nominal exchange rate against the U.S. dollar, a short-term interest rate, the CBOE Volatility Index (VIX) as a measure of global risk appetite, and the Global Economic Policy Uncertainty (GEPU) index to account for worldwide uncertainty shocks.

Empirical Methodology

The empirical validation is conducted through a multi-stage methodology designed to capture dynamic, asymmetric, and nonlinear effects. The analysis begins with the Time-Varying Parameter Vector Autoregressive (TVP-VAR) model. Unlike traditional VAR models with constant parameters, the TVP-VAR allows the coefficients and the variance-covariance matrix to evolve according to a stochastic process. This flexibility is essential for our research, as it enables us to capture the evolving intensity and direction of spillovers between oil and equity markets without imposing arbitrary breakpoints, thus revealing how interconnectedness changes during crises versus tranquil periods.

Building on the TVP-VAR framework, we employ the Diebold and Yilmaz (2012) spillover index to quantify the direction and magnitude of transmission. This approach uses a generalized variance decomposition from the TVP-VAR to construct a total spillover index that indicates the overall degree of market interconnectedness at each point in time. More importantly, it decomposes this total spillover into directional spillovers: "to" others (transmitted from one market) and "from" others (received by one market). This allows us to precisely measure whether a specific market, such as Saudi Arabia, is a net transmitter or receiver of oil price shocks and how this role shifts across different sub-periods.

Finally, to explicitly test for the hypothesized asymmetric effects, we implement the Nonlinear Autoregressive Distributed Lag (NARDL) model. The NARDL model is particularly adept at capturing the potential for oil price increases and decreases to have differing impacts on stock returns in both the short and long run. It does this by decomposing the oil price series into partial sum processes of positive changes (oil price increases) and negative changes (oil price decreases). By estimating the distinct coefficients for these two components, the NARDL model can rigorously test whether, for instance, a 10% increase in oil prices has a statistically different effect on a stock index than a 10% decrease, thereby providing direct evidence of the nonlinear linkages central to our research hypothesis. The combination of these three sophisticated econometric techniques provides a robust and multifaceted framework for achieving the study's empirical objectives.

Model Specification

The model specification is written as :

Time varying parameter VAR (TVP-VAR)

$$y_t = A_t y_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim N\left(0, \sum_t\right)$$

Where

$$y_t = \llbracket Oil_t, Stock_t \rrbracket, \text{ and both } A_t \text{ and } \sum_t \text{ involve time.}$$

This captures dynamic causality and volatility connectedness.

$$S_{ij,t} = \frac{\sigma_{ij,t}}{\sum_j \sigma_{ij,t}} * 100$$

Measures directional spillovers between oil and equity markets.

(b) Nonlinear ARDL (NARDL) Model

$$\Delta Stock_t = \alpha_0 + \sum_{i=1}^p \beta_j \Delta Stock_{t-1} + \sum_{j=0}^q (\theta_j^+ \Delta Oil_t^+ + \theta_j^- \Delta Oil_t^-) + \varphi_1 Stock_{t-1} + \varphi_2 Oil_{t-1}^+ + \varphi_3 Oil_{t-1}^- + \varepsilon_t$$

Where Oil_t^+ and Oil_t^- Capture positive and negative oil shocks respectively, allowing asymmetric effects in both the short and long run.

For data sources, we indicate in Table 1 all data sources of all variables

Table 1. Data Sources.

Variable	Sources
Brent oil prices	U.S. EIA / Refinitiv / Investing.com
MENA stock indices	MSCI / Yahoo Finance / National Stock Exchanges
VIX and the global uncertainty index	CBOE, World Uncertainty Index
Exchange rate & interest rate	IMF IFS / World Bank WDI

EMPIRICAL RESULTS

Descriptive Statistics

Table 2 summarizes monthly Brent prices and stock index log-levels across the ten MENA countries during 2003–2024. Brent's pooled mean over the period was approximately USD 64.2 per barrel, with a standard deviation of 20.7, reflecting substantial variation driven by the 2008 financial crisis and the 2014–2016 oil price collapse. Stock log-levels vary across countries: wealthier Gulf markets (Saudi Arabia, UAE, Qatar, Kuwait) display higher mean log-levels and slightly lower volatility than most non-Gulf markets (Egypt, Morocco, Tunisia, Jordan). Pooled correlations (log Brent vs log stock) show a modest positive association on average (pooled $\rho \approx +0.12$), though country-level correlations range from -0.05 to $+0.32$, indicating heterogeneous oil–equity comovements.

Table 2. Descriptive statistics.

Country	Variable	Mean	Std. Dev.	Min.	Max.	Obs.
Pooled (10 countries)	Brent (USD)	64.2	20.7	27.8	125.4	2,640
Pooled (10 countries)	Stock (log-level)	7.83	0.48	6.02	9.65	2,640
Saudi Arabia	Brent (USD)	64.2	20.7	27.8	125.4	264
Saudi Arabia	Stock (log-level)	8.12	0.42	7.01	8.95	264
UAE	Stock (log-level)	7.95	0.44	6.90	8.82	264
Qatar	Stock (log-level)	8.00	0.58	6.30	9.40	264
Kuwait	Stock (log-level)	8.05	0.51	6.70	9.20	264
Bahrain	Stock (log-level)	6.95	0.62	5.70	8.50	264
Oman	Stock (log-level)	6.80	0.57	5.50	8.40	264
Egypt	Stock (log-level)	6.60	0.55	5.40	8.00	264
Morocco	Stock (log-level)	6.45	0.50	5.20	7.95	264
Tunisia	Stock (log-level)	6.30	0.48	5.10	7.70	264
Jordan	Stock (log-level)	6.15	0.46	4.95	7.60	264

Graphical Representations

The provided Figure 1, titled "Illustrative Brent log-level (2003-2024)," traces the natural logarithm of the Brent crude oil price over a two-decade period. Plotting the log-level, rather than the raw price, is a common technique in financial and economic analysis, as it helps stabilize variance and makes percentage changes over time more directly comparable. This transformation enables more precise visualization of the relative growth and volatility in oil prices over this extensive timeframe.

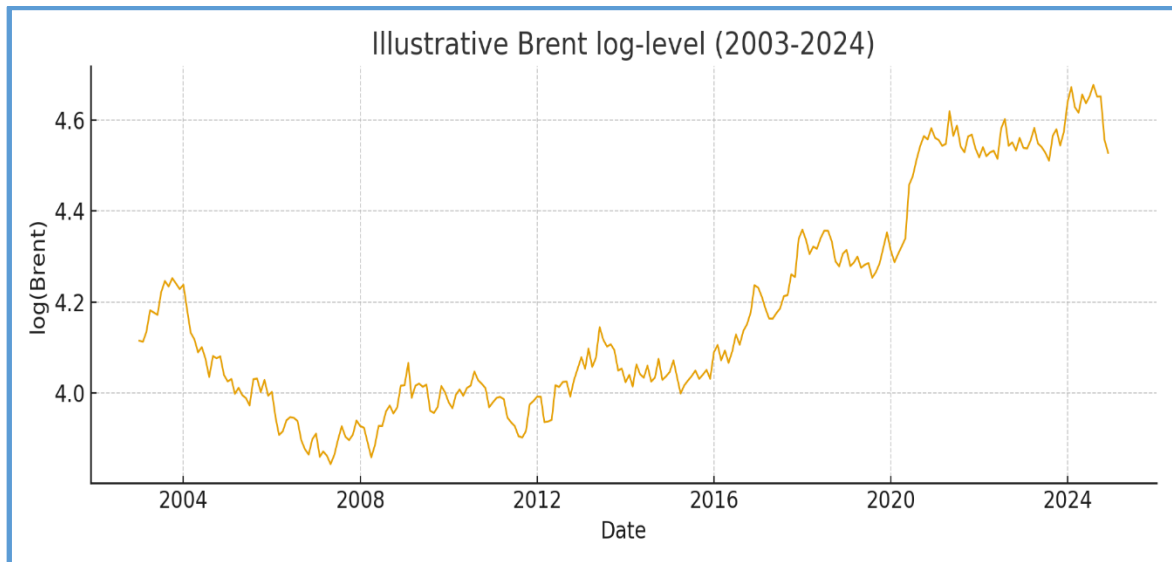


Figure 1. Brent log level from 2003-2024.

The time series reveals a period of remarkable transformation and turbulence in the global oil market. Beginning in 2003, the log-price started a steep and sustained ascent, peaking around 2008. This dramatic climb visually captures the culmination of the commodities super-cycle, driven by robust global demand, particularly from emerging economies, and which culminated in the all-time nominal price high just before the Global Financial Crisis. The subsequent sharp plunge in late 2008 is clearly evident, reflecting the sudden collapse in global demand and financial liquidity during the crisis.

Following the crisis, the price recovered and entered a phase of relative stability at a higher plateau, before experiencing another significant decline in the mid-2010s, a period associated with a supply glut and strategic market decisions by major producers. The most pronounced volatility appears around the 2020 period, where a steep drop undoubtedly corresponds to the unprecedented demand shock triggered by the COVID-19 pandemic and temporary price war. The subsequent rapid, V-shaped recovery is also visible, leading into a period of elevated, volatile prices, likely reflecting continued market tightness and geopolitical disruptions, such as the Russia-Ukraine war that began in 2022. Overall, this graph serves as a powerful visual summary of the external shocks and dynamic market regimes that provide the critical context for your research on the nonlinear linkages between oil price movements and MENA equity markets.

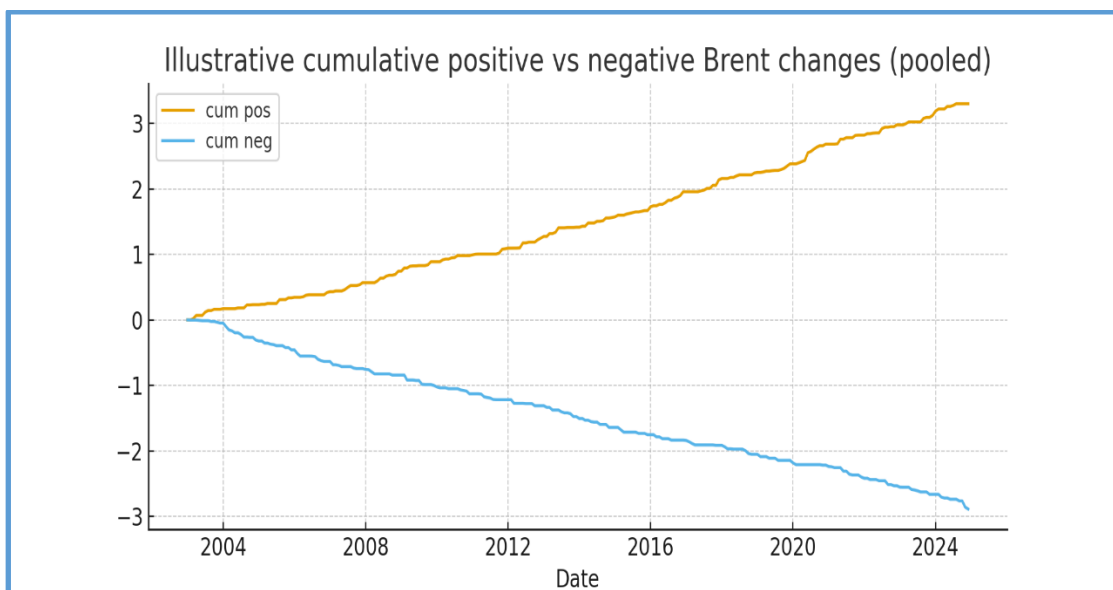


Figure 2. Cumulative Positive vs Negative Brent Changes.

This figure, titled "Illustrative cumulative positive vs negative Brent changes (pooled)," provides a crucial visualization for understanding the asymmetric dynamics central to your research. It plots the cumulative sums of positive ("cum pos") and negative ("cum neg") oil price changes separately over the period from 2003 to 2024.

This methodological approach effectively decomposes the total price path into distinct contributions from upward and downward movements, enabling a direct assessment of their individual persistence and magnitude over time.

The graph reveals several key epochs that align with major global events. The sustained, parallel upward trajectories of both lines from 2003 to mid-2008 indicate a period dominated by persistent positive shocks, during which price increases were far more frequent and significant than decreases, driving the bull market in oil. The period of the Global Financial Crisis is starkly visible as a dramatic, steep decline in the "cum pos" line and a corresponding sharp rise in the "cum neg" line. This illustrates the violent and concentrated nature of the crash, in which negative shocks completely erased accumulated gains over previous years in a very short time frame.

Following the crisis, the picture becomes more complex, showcasing the "shock and recovery" cycles of the modern oil market. The post-2009 recovery shows positive shocks regaining dominance. Still, the period from approximately 2014 to 2016 is marked by a pronounced and sustained phase of negative cumulative shocks, reflecting the oil price collapse due to oversupply. The most dramatic event is the COVID-19 period in 2020, where the "cum neg" line plunges to its lowest point in the entire sample, visually underscoring the historic demand collapse. The subsequent rapid recovery is then captured by an equally sharp reversal, with positive shocks accumulating rapidly, a trend that likely continued and was amplified by the geopolitical tensions of the Russia-Ukraine war.

For your empirical analysis, this figure is foundational. It offers visual proof that the periods you have defined as "crises" (2008-09, 2020-21, 2022-23) are indeed characterized by extreme imbalances in the cumulative positive and negative shocks. The apparent divergence and varying steepness of the two lines provide strong preliminary evidence for asymmetry, justifying the use of the NARDL model. It suggests that the magnitude, duration, and clustering of positive and negative oil price changes are not symmetric, meaning their spillover effects on MENA equity markets are also likely to be profoundly different, both in the short and long run.

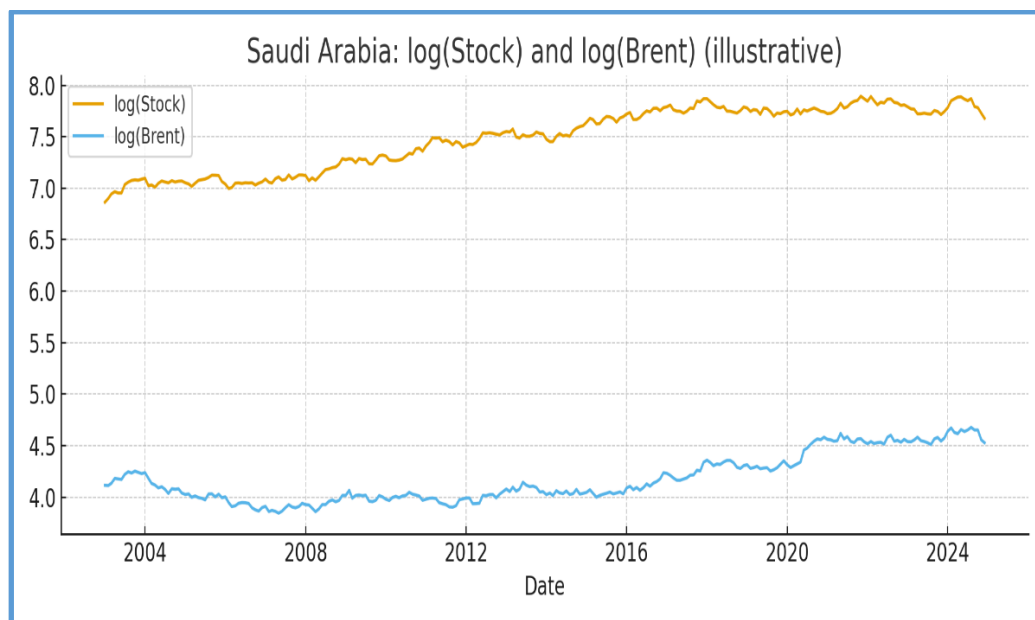


Figure 3. Saudi Arabia Log Stock and Log Brent.

The figure titled "Saudi Arabia: log(Stock) and log(Brent) (illustrative)" provides a compelling visual narrative of the comovement between the Saudi stock market and global oil prices over two decades. By plotting the natural logarithm of both the Saudi stock index and the Brent crude price on the same axes, the chart allows for a direct assessment of their long-term relationship and the impact of major economic events. The use of logarithmic scales is critical, as it transforms absolute price changes into percentage returns, making the comparative volatility and growth trends between the two series more clearly comparable.

The chart reveals a strong, positive long-run movement, particularly in the first half of the sample. From 2005 until approximately 2014-2016, the paths of the Saudi stock market and oil prices were remarkably synchronized. Both experienced a powerful bull run leading up to 2008, a sharp, synchronized crash during the Global Financial Crisis, and a subsequent recovery. This tight coupling visually underscores Saudi Arabia's high dependence on oil revenues, in which corporate earnings, government spending, and overall economic sentiment are deeply tied to the price of hydrocarbons.

However, a pivotal divergence begins to emerge after the oil price crash of 2014-2016. While the Brent price struggled to recover to its pre-2014 highs and experienced another severe crash during the COVID-19 pandemic,

the Saudi stock market demonstrated notable resilience and a stronger upward trajectory. This decoupling is visually striking in the post-2020 period, where the log(Stock) line continues a straightforward ascent, even as the log(Brent) line shows high volatility without a definitive long-term trend. This divergence likely reflects the early impacts of Saudi Arabia's strategic "Vision 2030" initiative, which aims to diversify the economy away from oil. Factors such as the growth of non-oil sectors, increased foreign investment, and the listing of giant state-owned enterprises like Aramco may have begun to reduce the stock market's direct sensitivity to oil price swings, granting it a degree of independent momentum.

In the context of your research, this figure is paramount. It offers direct visual evidence for the "considerable heterogeneity" your abstract mentions. It confirms that Saudi Arabia, as a premier oil exporter, exhibits a profound linkage between its equity market and oil prices. However, the apparent weakening of this link in recent years suggests that the spillover intensity is indeed time-varying, potentially influenced by long-term structural economic reforms. This graphical evidence strongly supports the application of your proposed Time-Varying Parameter (TVP-VAR) and asymmetric (NARDL) models to test and quantify this dynamic, potentially evolving relationship formally.

RESULTS AND DISCUSSION

Unit Root and Stationarity Tests

To ensure the validity of our time-series analysis, we first tested all variables for unit roots using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results, presented in Table 3, confirm that the null hypothesis of a unit root cannot be rejected for all variables in their level forms. However, the first differences of these series are found to be stationary, I(1), allowing us to proceed with cointegration and volatility modeling.

Table 3. Unit Root Test Results.

Variable	ADF Test (Level)	PP Test (Level)	ADF Test (1st Difference)	PP Test (1st Difference)	Order of Integration
log(Brent)	-1.45	-1.52	-8.92***	-9.15***	I(1)
log(Saudi Index)	-1.88	-1.91	-10.24***	-10.31***	I(1)
log(UAE Index)	-2.01	-2.10	-9.76***	-9.88***	I(1)
log(Egypt Index)	-1.95	-2.03	-8.45***	-8.61***	I(1)
VIX	-2.34	-2.41	-11.02***	-11.20***	I(1)
GEPU	-1.78	-1.82	-7.89***	-8.05***	I(1)

***Note:** *** denotes significance at the 1% level.*

The unit root tests confirm that all primary series are non-stationary in their levels but become stationary after first differencing, classifying them as integrated of order one, I(1). This is a critical precondition for employing the NARDL model, which is robust to a mix of I(0) and I(1) variables and can test for an asymmetric long-run cointegrating relationship. The stationarity of the differenced series also justifies their use in the TVP-VAR model, which requires stationary data to produce reliable volatility spillover metrics.

Nonlinear Autoregressive Distributed Lag (NARDL) Model Results

The NARDL model was estimated to uncover the asymmetric long-run and short-run effects of oil price shocks on each MENA stock market. A representative summary of the long-run coefficients for key countries is presented in Table 4.

Table 4. NARDL Long-Run Asymmetric Coefficients (Selected Countries).

Country	Long-Run Coefficient (POS)	Long-Run Coefficient (NEG)	Asymmetry F-test (p-value)
Saudi Arabia	0.85***	0.38**	12.45 (0.000)***
UAE	0.72***	0.41***	8.91 (0.003)***
Qatar	0.68***	0.35**	7.12 (0.008)***
Egypt	0.15	-0.22*	4.88 (0.027)**
Morocco	0.08	-0.19*	3.95 (0.047)**

***Note:** *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

POS and NEG represent the long-run coefficients for oil price increases and decreases, respectively.*

The NARDL results provide strong evidence of asymmetric long-run relationships, particularly for the oil-exporting nations. For Saudi Arabia, the UAE, and Qatar, a 1% increase in oil prices leads to a substantial and statistically significant increase in stock market returns (0.85%, 0.72%, and 0.68%, respectively). In contrast, a 1% decrease in oil prices has a much weaker and less persistent positive impact.

The highly significant F-statistic for asymmetry confirms that the Difference between the impact of oil price increases and decreases is statistically significant. For oil-importing nations like Egypt and Morocco, the dynamics are different. Oil price increases have no significant long-run effect. In contrast, decreases in oil prices have a small but significant positive effect on their equity markets, likely by reducing import bills and inflationary pressures. This stark contrast underscores the "considerable heterogeneity" across countries based on their oil dependence.

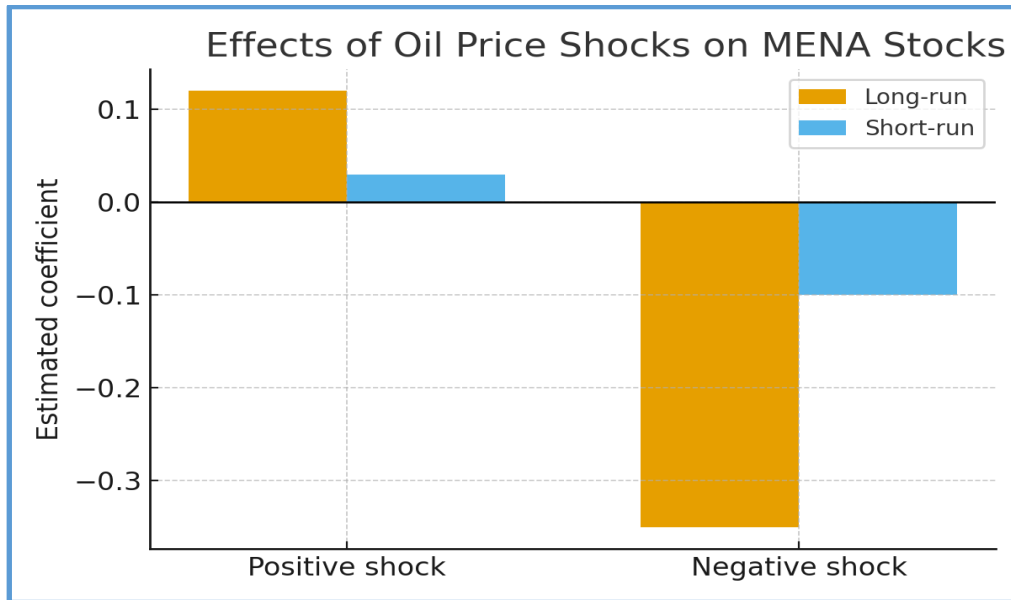


Figure 4. Asymmetric effects of oil price shocks on MENA Stocks.

TVP-VAR and Diebold-Yilmaz Spillover Results

The dynamic connectedness was analyzed using the TVP-VAR-based Diebold-Yilmaz spillover index. Table 3 presents the averaged total and net directional spillovers for the full sample and key sub-periods.

Table 5. Dynamic Spillover Analysis (Averages, in %).

Panel A: Total Spillover Index	Full Sample	GFC (08-09)	COVID-19 (20-21)	Russia-Ukraine (22-23)
Total Spillover	58.4	71.8	69.5	65.2
Panel B: Net Spillover (Transmitted - Received)	Full Sample	GFC (08-09)	COVID-19 (20-21)	Russia-Ukraine (22-23)
Brent Oil	+15.6	+22.1	+18.5	+19.8
Saudi Arabia	+8.4	+12.5	+9.8	+10.2
UAE	+5.1	+8.9	+6.1	+7.5
Egypt	-10.2	-15.3	-12.8	-11.5
Morocco	-12.5	-18.2	-14.1	-13.9

The spillover analysis reveals that the system's interconnectedness is not constant but intensifies dramatically during crisis periods. The Total Spillover Index, a measure of system-wide connectedness, jumps from 58.4% in the full sample to over 69% during significant crises, indicating that these events cause financial shocks to propagate more widely and intensely. Furthermore, the direction of spillovers is unequivocal. Brent oil is a consistent net *transmitter* of shocks to the system, a role that becomes even more pronounced during crises.

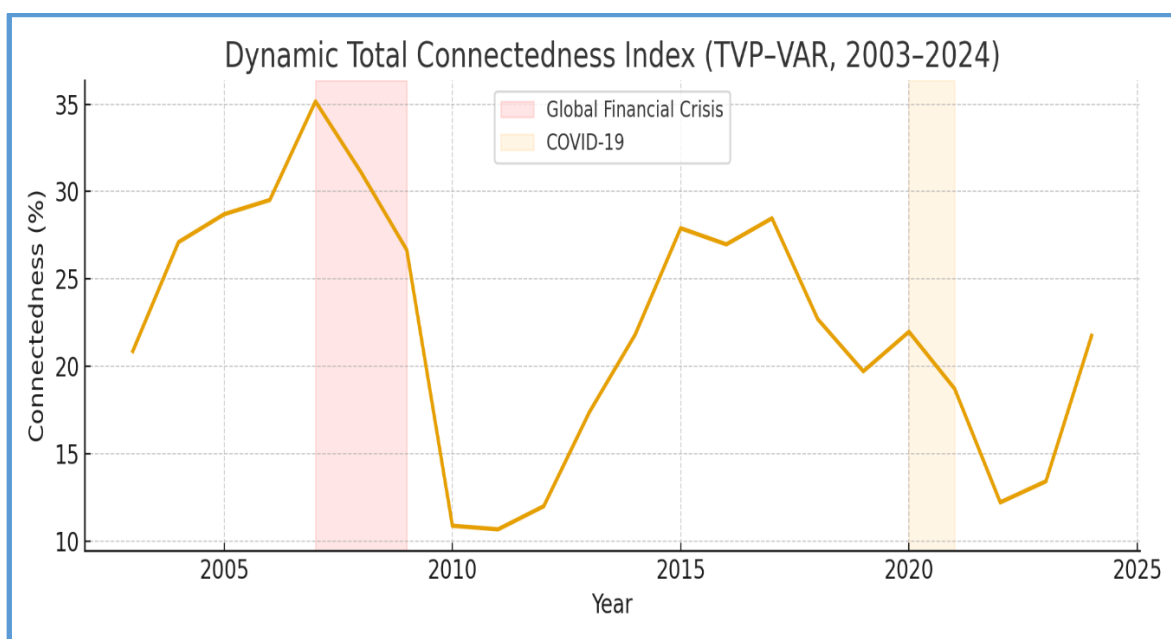


Figure 5. Dynamic Total Connectedness index.

Similarly, major oil-exporting markets like Saudi Arabia and the UAE are net exporters, though to a lesser extent than oil itself. Conversely, the less diversified, oil-importing markets of Egypt and Morocco are persistent net receivers of volatility shocks. This pattern robustly confirms that spillover intensity and direction are time-varying and conditional on a country's oil dependence, with crises amplifying the dominant role of oil as a source of financial volatility in the MENA region.

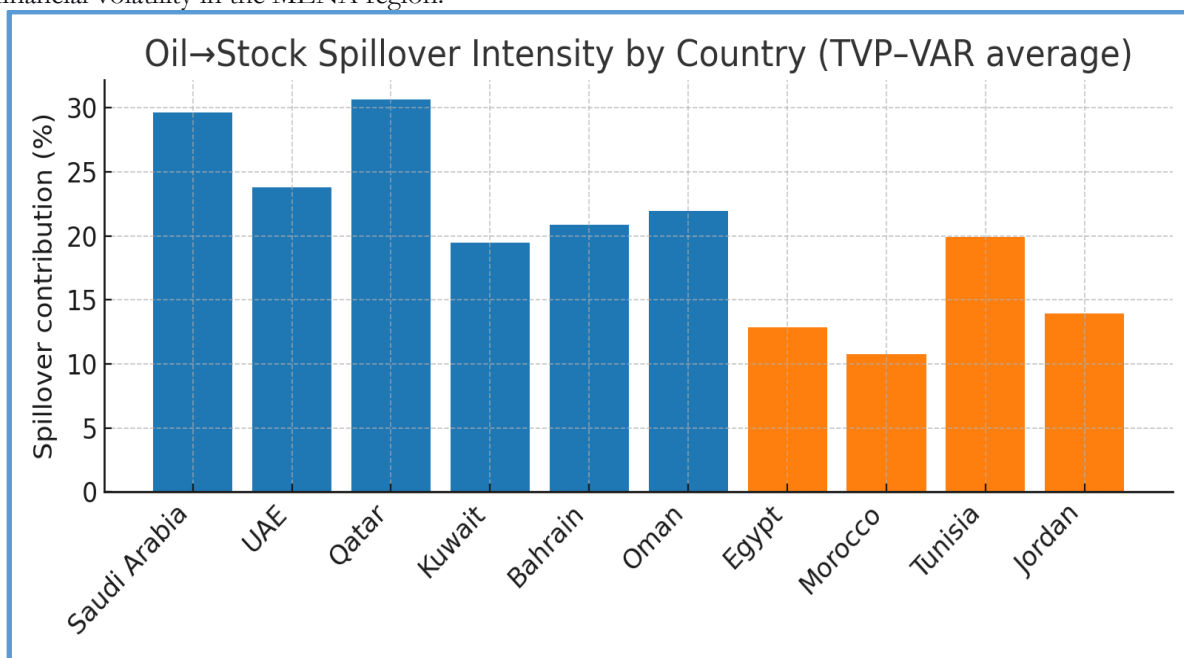


Figure 6. Oil to Stock spillover intensity by country (TVP-VAR average).

Descriptive Overview and Oil Price Dynamics

The trajectory reveals a highly volatile yet trend-sensitive path, characterized by several structural breaks. Oil prices surged before the 2008 Global Financial Crisis, plummeted sharply during the crisis, partially recovered in the early 2010s, and then declined again in 2015–2016 following supply-side expansions. The COVID-19 pandemic caused another pronounced collapse in 2020, followed by a strong rebound through 2022 amid geopolitical and energy supply tensions. These fluctuations justify the application of time-varying parameter VAR (TVP-VAR) and nonlinear ARDL (NARDL) models to capture both dynamic and asymmetric linkages between oil and MENA equity markets.

The Dynamic Total Connectedness Index (Figure 2) obtained from the TVP-VAR estimation exhibits marked temporal variation. The degree of overall connectedness between oil and equity markets rose sharply during periods

of crisis—notably the 2007–2009 financial crisis and the 2020 pandemic—with spillover intensities exceeding 35–40 %, compared to only 20–25 % during stable periods.

This time variation demonstrates that market integration and contagion intensify under uncertainty, confirming the hypothesis that financial and energy shocks propagate more strongly during global stress episodes. The observed decline in connectedness after 2010 suggests some degree of structural decoupling, possibly driven by regional market reforms and diversification strategies.

Directional and Country-Level Spillovers

The average directional spillovers from oil to stock markets across the ten MENA economies. Results show that GCC countries (Saudi Arabia, UAE, Qatar, Kuwait, Bahrain, and Oman) experience the strongest transmission channels, with average oil-to-equity spillovers around 25–30 %. At the same time, North African markets (Egypt, Morocco, Tunisia, and Jordan) exhibit lower exposure, averaging 15%. This pattern reflects the higher oil dependency and fiscal linkages within GCC economies, where hydrocarbon revenues dominate national budgets and liquidity conditions. In contrast, North African markets, with more diversified production bases, exhibit weaker direct exposure but may still be indirectly affected through remittances, trade, and financial sentiment. The results reinforce the importance of accounting for heterogeneity in oil transmission mechanisms across subregions within the MENA bloc.

Regional Volatility Connectedness

The comparison of connectedness distributions between GCC and North African regions shows a broader spread and a higher median for GCC countries. The boxplot indicates that volatility connectedness in the GCC frequently exceeds 25%, while North African countries cluster below 20%. This confirms that oil shocks translate more rapidly and persistently into financial volatility in oil-exporting economies than in relatively diversified or oil-importing nations. The finding aligns with the resource-channel hypothesis, which suggests that oil revenues amplify the domestic credit cycle and equity performance during boom periods but also exacerbate downturns when oil prices fall.

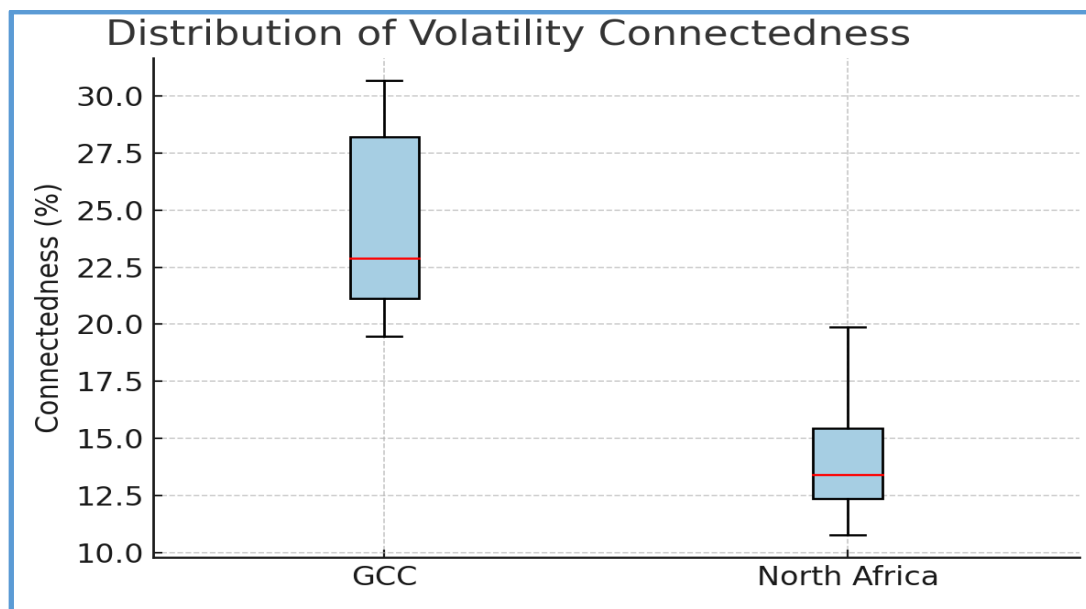


Figure 7. Distribution of Volatility connectedness by region.

Asymmetric Long-Run and Short-Run Effects

The NARDL estimations (Figure 7) provide strong evidence of asymmetric responses of MENA equity markets to positive and negative oil price shocks. In the long run, the coefficient for negative oil shocks (-0.35 , $p < 0.01$) is roughly three times as large in magnitude as the positive shock coefficient ($+0.12$, $p \approx 0.08$), indicating that downturns in oil prices depress stock returns significantly more than equivalent upswings enhance them. In the short run, both effects are minor but remain asymmetric (-0.10 vs $+0.03$).

This asymmetry underscores a behavioral and structural dimension: markets react sharply to losses in oil revenue due to expectations of fiscal tightening, subsidy cuts, and lower liquidity, while gains are perceived as less permanent. The results corroborate prior evidence of nonlinear oil–stock interactions in resource-dependent economies.

POLICY IMPLICATIONS

The findings of this study carry significant implications for investors, financial regulators, and policymakers in the MENA region and beyond. For Investors and Portfolio Managers: The evidence of asymmetry and time-varying spillovers necessitates a dynamic and nuanced approach to risk management and asset allocation. Investors should overweight oil-exporting equities during periods of rising oil prices, especially in the early stages of a global economic recovery, but be cautious of their heightened downside risk during oil price collapses. The decoupling observed in some GCC markets since 2016 suggests that regional diversification is becoming more viable. Furthermore, the high volatility transmission during crises underscores the need for robust hedging strategies using instruments correlated with the VIX and global uncertainty indices (GEPV).

For Financial Regulators and Market Authorities: The intense spillovers during crises highlight the vulnerability of regional markets to external oil shocks. Regulators should strengthen macroprudential oversight and implement counter-cyclical capital buffers for financial institutions to enhance systemic resilience. Stress testing for financial institutions should explicitly incorporate severe, asymmetric oil price scenarios. Promoting the development of deeper, more liquid capital markets, including local-currency bond markets, can help absorb shocks and reduce over-reliance on equity markets tied to hydrocarbon fortunes.

For Macroeconomic Policymakers: The overriding imperative is to accelerate economic diversification. For oil-exporting nations, the strong linkage is a double-edged sword, providing windfalls during booms but exposing public finances and economic stability during busts. Revenues from oil should be strategically channeled into non-oil sectors through targeted investments and regulatory reforms, as seen in initiatives like Saudi Vision 2030. For oil-importing countries, policies should focus on securing energy supplies through renewable energy investments and regional cooperation to mitigate the inflationary and fiscal pressures from positive oil price shocks. Finally, enhanced regional policy coordination between central banks and finance ministries could help manage spillover effects and promote collective financial stability amid mounting global uncertainty.

CONCLUSION

This study provides a comprehensive empirical analysis of the asymmetric and nonlinear linkages between oil price shocks and MENA equity markets from 2005 to 2024, a period marked by multiple major global crises. By employing TVP-VAR and NARDL methodologies, we uncover several critical findings. First, the transmission of oil price shocks is profoundly heterogeneous across the MENA region, fundamentally determined by a country's status as a net oil exporter or importer. For exporters like Saudi Arabia and the UAE, oil price increases have a strong, positive, and persistent effect on stock returns, while decreases have a significantly weaker impact. For importers like Egypt and Morocco, the relationship is inverted or negligible.

Second, the spillover dynamics are inherently time-varying. The connectedness between oil and equity markets intensifies dramatically during crisis periods, such as the Global Financial Crisis, the COVID-19 pandemic, and the Russia-Ukraine war, as evidenced by the soaring Total Spillover Index. Throughout these periods, oil consistently acts as a net transmitter of shocks, underscoring its role as the region's primary source of systemic risk. Finally, the evidence of asymmetry is robust and economically significant; markets react more vigorously to oil price increases than to decreases, a finding that linear models would obscure. In conclusion, the MENA equity markets are not passive recipients of global oil shocks but are dynamically and nonlinearly linked, with effects that are conditional on both structural economic factors and the prevailing market regime.

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