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# When Does Oil Matter for Islamic Equities? Time–Frequency Evidence from Developed and Emerging Markets

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## Abstract

*This study examines when and at which investment horizons crude oil becomes economically relevant for Islamic equity markets. Motivated by a literature that increasingly treats Shariah-compliant equities as a distinct asset class while emphasizing time-varying dependence, diversification, and wavelet-based spillovers, the paper investigates whether the oil–equity nexus differs between developed and emerging Islamic markets. Using daily observations from January 1996 to August 2025, the analysis combines Brent crude oil prices with the Dow Jones Islamic World Developed Market and Dow Jones Islamic World Emerging Markets indices. Returns are evaluated through conventional correlation analysis and wavelet coherence, allowing dependence to vary simultaneously across time and trading-day horizons. The unconditional results show moderate co-movement between developed and emerging Islamic equities, with a correlation of approximately 0.52, but substantially weaker average correlations between Brent oil and developed and emerging Islamic equities, at approximately 0.20 and 0.18, respectively. The time–frequency evidence, however, reveals that these averages conceal pronounced heterogeneity. Developed and emerging Islamic equities display broad and persistent coherence at medium- and longer-term horizons, indicating stronger integration as the investment horizon lengthens, whereas short-run dependence remains more fragmented. In contrast, oil–Islamic equity coherence is episodic rather than permanent, intensifying within specific time–frequency clusters and weakening considerably in others. Phase patterns further suggest that lead–lag relations are not stable across the sample. These findings show that low unconditional oil–equity correlations should not be interpreted as evidence of consistently strong diversification benefits. Oil can become materially connected to Islamic equities during market regimes and holding periods, while cross-market diversification between developed and emerging Islamic equities also diminishes at longer horizons. The study contributes to Islamic asset-pricing and energy-finance research by providing long-horizon comparative evidence that dependence is market-specific, regime-dependent, and horizon-sensitive, with direct implications for portfolio allocation, hedging, and risk management for Shariah-compliant global investors.*

## Keywords

*Islamic Equities, Wavelet Coherence, Portfolio Diversification, Spillovers, Brent Crude Oil*

## Introduction

Oil occupies a distinctive position in global financial markets because it is simultaneously a strategic commodity, a major production input, a source of inflationary pressure, an indicator of global economic conditions, and a financial asset traded by investors with heterogeneous objectives. Changes in crude oil prices can therefore influence equity markets through several channels. Higher oil prices may raise production and transportation costs for energy-consuming firms, alter household purchasing power, affect inflation expectations and discount rates, and redistribute income between oil-importing and oil-exporting economies. At the same time, an increase in oil prices may reflect stronger global demand rather than an adverse supply shock, implying that the equity-market consequences of oil movements cannot be inferred from the direction of the price change alone. The relationship between oil and financial assets is consequently unlikely to be constant across time, market conditions, or investment horizons. Existing research on dynamic interdependence, volatility transmission, and cross-market risk has increasingly emphasised that relationships which appear weak in unconditional statistics can become substantially stronger during episodes or at specific frequencies (In et al., 2001; Marfatia, 2017; Tien & Hung, 2022).

This issue is especially important for Islamic equity markets. Shariah-compliant investment operates within a financial framework that restricts exposure to prohibited business activities and embeds distinctive principles concerning financial transactions, leverage, and permissible economic activity (Ayyub, 2007). Yet the existence of a common Islamic investment identity does not imply that Islamic equities are insulated from global economic and financial forces. Islamic finance has increasingly developed within international markets rather than out-side them (Fang, 2016), and Islamic equity prices remain exposed to macroeconomic conditions, investor expectations, commodity-price movements, financial-market integration, and episodes of heightened uncertainty. Research comparing conventional and Islamic stock markets has documented the importance of tail risk in both market structures (Muteba Mwamba et al., 2017), while evidence of multifractality in Islamic stock markets further suggests that their return dynamics may vary across temporal scales rather than conform to a single homogeneous process (Saâdaoui, 2018). The economic question is therefore not whether Islamic equities are affected by global market forces, but when, to what extent, and over which investment horizons those forces become important.

Oil provides a particularly useful setting in which to examine this question. The relationship between oil and equities is theoretically ambiguous because an oil-price movement can represent different underlying economic shocks and can transmit differently across industries, countries, and financial structures. For Islamic equities, this ambiguity is compounded by the composition of the investable universe. Shariah-compliant indices do not reproduce the sectoral and financial structure of unrestricted conventional benchmarks exactly, while developed and emerging Islamic markets themselves differ in economic structure, sectoral composition, investor participation, financial depth, and exposure to international capital flows. Consequently, an identical oil market disturbance need not generate the same equity response across developed and emerging

Islamic markets. Evidence that financial characteristics can matter for the valuation of Islamic firms (Santosa, 2020), together with research documenting heterogeneous behaviour within Islamic financial markets (Yousaf & Alokla, 2023), cautions against treating the Islamic investment universe as a single homogeneous asset class.

The distinction between developed and emerging markets is particularly consequential from a portfolio perspective. International equity markets can become increasingly interdependent when common information, global risk factors, and cross-border capital flows affect asset prices simultaneously. Research on Asian stock markets has long demonstrated that market interdependence and volatility transmission can intensify during periods of stress (In et al., 2001), while wavelet-based evidence shows that international stock market risk integration can differ meaningfully according to time horizon (Marfatia, 2017). Emerging equity markets also exhibit changing efficiency and exposure to common factors over time (Nazlioglu et al., 2024). These considerations imply that the diversification benefit obtained by allocating between developed and emerging Islamic equities cannot be evaluated adequately from a single full-sample correlation coefficient. A relationship that appears moderate on average may conceal weak short-term dependence, stronger medium-term integration, and near-synchronous long-horizon movements.

The same problem applies to oil diversification. A low average correlation between oil and equities is often interpreted as evidence that commodity exposure can improve portfolio diversification. Such an interpretation may be misleading when dependence is nonlinear, episodic, or horizon specific. Recent asset-pricing research increasingly evaluates diversification and hedging relationships as dynamic rather than permanent characteristics. Wavelet-based studies have examined the diversification role of precious metals during the COVID-19 period (Alqaralleh & Canepa, 2022), time-varying responses of alternative assets to geopolitical risk (Mejri et al., 2025), and the capacity of newer asset classes to hedge traditional financial assets after the pandemic (Zhang et al., 2024). More broadly, diversification itself must be evaluated in conjunction with changing systemic and cross-asset risk rather than assumed to follow mechanically from unconditional correlation (Tasca et al., 2017). For Islamic investors, this raises a practical question: does oil provide a relatively independent source of return throughout the investment horizon, or does its diversification value weaken precisely during periods when markets become more strongly connected?

An expanding energy-finance literature provides strong reasons to investigate this question in the time–frequency domain. (Tien & Hung, 2022), for example, analyse volatility spillovers between oil and Gulf Cooperation Council stock markets through a wavelet-based asymmetric dynamic conditional correlation framework, illustrating the usefulness of distinguishing relationships across frequencies. Dynamic dependence has also been examined between crude oil and foreign-exchange markets (Emenike, 2020), while recent research extends time–frequency methods to interactions between carbon, energy, and sectoral equity markets (L.-T. Zhao et al., 2024). Related studies use wavelet frameworks to examine connectedness among commodities during crisis

periods (Bouri et al., 2023), the response of energy and metal markets to supply-chain pressure (Elsayed et al., 2025), and the relationship between green bonds and carbon-related exchange-traded funds (Karimi et al., 2025a). Collectively, this literature reinforces a central methodological point: financial dependence is often better understood as a surface evolving over both calendar time and investment horizon than as a single parameter assumed to remain stable throughout the sample.

This perspective is especially relevant when the observation period spans several structurally different global episodes. The period from 1996 to 2025 encompasses the Asian financial crisis, the technology-market correction, the global financial crisis, major oil-price expansions and collapses, the COVID-19 pandemic, subsequent inflationary and monetary adjustments, geopolitical tensions, and repeated disturbances to global supply chains. Financial-market responses during such episodes need not be uniform. COVID-19, for instance, generated pronounced financial-market disruptions that have been studied using wavelet methods (Costa et al., 2022), while evidence from Asian capital markets similarly highlights the exceptional character of pandemic-era market behaviour (Adnan, 2023). Research on banking-sector performance during the pandemic further illustrates the broader financial significance of crisis conditions (Demirgüç-Kunt et al., 2021). Analysing a nearly three-decade period therefore provides an opportunity to distinguish persistent relationships from temporary episodes of intensified co-movement.

Against this background, this study examines the relationship among three daily financial series: the Dow Jones Islamic World Developed Market Price Index (EQD), the Dow Jones Islamic World Emerging Markets Price Index (EQE), and Europe Brent Spot crude oil prices (OPB). The sample extends from January 1996 to August 2025 and contains more than 7,700 daily observations. The use of developed and emerging Islamic indices permits a direct comparison of two geographically and economically distinct segments of the global Shariah-compliant equity universe, while Brent crude oil provides an internationally recognised energy benchmark through which the oil–equity relationship can be evaluated. Rather than examining Islamic equities only against conventional stock benchmarks, the study focuses on the internal relationship between developed and emerging Islamic markets and then asks how each segment interacts with oil.

The preliminary unconditional evidence already demonstrates why this distinction matters. Daily returns on developed and emerging Islamic equities exhibit a correlation of approximately 0.52, indicating meaningful but incomplete average co-movement. By contrast, the correlation of Brent returns with developed and emerging Islamic equity returns are only approximately 0.20 and 0.18, respectively. If analysis ended with these coefficients, one might conclude that developed and emerging Islamic equities are relatively integrated whereas oil remains only weakly connected to either equity segment. Such an inference, however, assumes that the observed relationship is stable over the entire 1996–2025 period and identical across investment horizons. That assumption is precisely what the present study relaxes.

The empirical framework therefore employs wavelet coherence to decompose dependence simultaneously across time and frequency. Wavelet analysis is well suited to financial relationships

in which investors operate over heterogeneous horizons and market linkages strengthen or weaken during specific episodes. Instead of asking only whether two return series are correlated, wavelet coherence asks where in the time–frequency plane their movements become strongly associated. The associated phase information also helps identify whether the series move together or in opposite directions and whether one tends to lead or lag the other within regions. The growing application of wavelet methods to international stock-market integration (Marfatia, 2017), crisis-period financial behaviour (Costa et al., 2022), commodity-market co-movement (Bouri et al., 2023), oil–stock spillovers (Tien & Hung, 2022), and energy-related financial markets ((Karimi et al., 2025a; J. L. Zhao et al., 2016) provides a relevant methodological foundation for applying this framework to global Islamic equities.

The study is motivated by three interrelated research questions. First, how does the dependence between developed and emerging Islamic equity markets evolve across time and investment horizons? Second, is the relationship between Brent crude oil and Islamic equities persistent, or does oil become important only during episodes and frequencies? Third, does the time–frequency relationship with oil differ between developed and emerging Islamic equity markets? These questions allow the analysis to distinguish two forms of diversification. The first concerns diversification within the Islamic equity universe, through allocation between developed and emerging markets. The second concerns diversification across asset classes, through the inclusion of oil alongside Shariah-compliant equities.

The distinction is important because the economic meaning of market dependence changes with the investor's horizon. A trader with a holding period measured in days may experience a substantially different dependence structure from a long-term institutional investor whose exposure persists for months or years. Short-horizon movements can be dominated by liquidity, news, sentiment, and temporary repricing, whereas longer horizons may reflect persistent macroeconomic, commodity, and global-market forces. A time–frequency approach therefore provides an economically intuitive bridge between market integration and investor heterogeneity. The relevance of horizon-dependent analysis is reinforced by wavelet research showing that connectedness among financial and commodity assets can change materially across scales (Alqaralleh & Canepa, 2022).

The empirical results point toward a substantially richer pattern than the unconditional correlations suggest. Developed and emerging Islamic equities exhibit broad regions of strong coherence, particularly at medium and longer trading horizons. Short-horizon dependence is more fragmented, but coherence becomes considerably more persistent as the scale increases. This pattern indicates that developed and emerging Islamic equity markets retain some short run heterogeneity while becoming much more closely integrated over longer horizons. The implication is important for international Islamic portfolio allocation: diversification across developed and emerging Shariah-compliant equities may be more effective for short-horizon positioning than for investors whose holding periods extend into medium and long-run frequencies.

The oil–equity relationships display a different structure. Despite relatively low unconditional correlations, Brent crude oil exhibits distinct episodes of heightened coherence with both developed and emerging Islamic equities. These regions are concentrated within time periods and frequencies rather than extending uniformly across the full sample. The relationship therefore appears episodic rather than permanent. Moreover, the phase patterns do not indicate a single stable lead–lag configuration throughout the sample, suggesting that neither oil nor Islamic equities can be characterised as the universal driver of the relationship. Instead, the direction and timing of interaction vary across market episodes and investment horizons. This result is consistent with the broader literature in which energy, commodity, and financial-market relationships are treated as state-dependent and dynamic (Elsayed et al., 2025; Tien & Hung, 2022; L.-T. Zhao et al., 2024).

This finding changes the interpretation of oil as a diversification asset for Shariah-compliant investors. The low full-sample correlations of approximately 0.18–0.20 do not imply that oil consistently behaves independently from Islamic equities. During periods in which coherence strengthens, the diversification benefit associated with combining oil and Islamic equities may decline. Conversely, when coherence is weak, oil can provide a more distinct return source. Diversification is therefore conditional not only on which assets are combined but also on when the portfolio is held and for how long. This conclusion echoes the broader move in portfolio research away from unconditional asset classification toward dynamic assessments of hedging and diversification properties (Alqaralleh & Canepa, 2022; Mejri et al., 2025; Zhang et al., 2024).

The paper makes three principal contributions. First, it contributes to Islamic capital-market research by shifting attention from the conventional question of whether Islamic stocks behave differently from conventional stocks toward the internal time–frequency structure of the global Islamic equity universe itself. Previous research has established that Islamic stock markets possess meaningful risk characteristics (Muteba Mwamba et al., 2017), complex scaling behaviour (Saâdaoui, 2018), and heterogeneous financial dynamics across Islamic market settings (Yousaf & Alokla, 2023). The present study extends this discussion by directly comparing developed and emerging Islamic equity indices and identifying the horizons over which their return dynamics converge or remain differentiated. In doing so, it treats Islamic equities neither as a completely homogeneous asset class nor as merely a screened version of conventional equity markets.

Second, the study contributes to the oil–equity literature by asking not merely whether oil and Islamic equities are related, but when oil matters. Existing research has examined oil spillovers to regional stock markets (Tien & Hung, 2022) and dynamic dependence between oil and other financial variables (Emenike, 2020); however, the present framework simultaneously compares oil dependence across developed and emerging segments of the global Islamic equity market over an unusually long daily sample. The comparison allows the analysis to determine whether the oil relationship is common to Shariah-compliant equities generally or whether its intensity differs according to the economic environment represented by developed and emerging markets.

Third, the paper contributes methodologically by demonstrating the information lost when a long financial sample is summarised through unconditional correlation alone. The difference between the correlation matrix and the wavelet coherence surfaces is economically substantive rather than merely graphical. Moderate developed–emerging correlation conceals much stronger integration at horizons, while weak average oil–equity correlations conceal periods in which dependence becomes materially greater. This reinforces the value of methods that explicitly permit financial relationships to vary across time and scale, consistent with the wider use of wavelets in international stock markets (Marfatia, 2017), commodity markets (Bouri et al., 2023), energy-related assets (Zhao et al., 2024), crisis-period finance (Costa et al., 2022), and contemporary connectedness analysis (Hoque et al., 2024).

The practical implications extend to investors, fund managers, and institutions operating within the Shariah-compliant investment universe. For portfolio managers, the results imply that asset-allocation decisions should incorporate investment horizon explicitly. Developed and emerging Islamic equities should not automatically be treated as equivalent diversification substitutes because their integration strengthens at longer scales. Likewise, Brent oil should not automatically be classified as either a hedge or a diversification asset solely based on its low unconditional correlation with Islamic equity returns. Its portfolio role changes through time. A horizon-aware allocation framework is therefore more appropriate than one based on a single historical correlation matrix, particularly during periods of heightened commodity-market uncertainty or financial stress.

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The findings also have a broader implication for understanding Islamic financial market integration. A common Shariah-compliant identity can coexist with substantial variation in market behaviour. Developed and emerging Islamic equity markets may respond to common global forces over longer horizons while preserving shorter-run differences in information processing, investor composition, liquidity, and regional economic exposure. This interpretation is compatible with evidence that Islamic financial development itself need not evolve uniformly across markets (Cornett et al., 2010). Consequently, the existence of a shared screening and investment framework should not be interpreted as implying a single, invariant global Islamic equity process.

At the same time, the analysis deliberately avoids interpreting coherence as structural causality. Wavelet coherence identifies localised co-movement and phase relationships in the time–frequency domain; it does not by itself establish the economic shock responsible for each region of dependence. A period of strong oil–equity coherence may reflect oil-supply disturbances, common global-demand conditions, changing inflation expectations, financial-market stress, geopolitical uncertainty, or combinations of these forces. Recent wavelet applications to geopolitical risk (Mejri et al., 2025), supply-chain pressure (Elsayed et al., 2025), and crisis-period commodity markets (Bouri et al., 2023) illustrate precisely why the surrounding economic regime matters when interpreting observed dependence. The present study therefore treats the wavelet results as evidence of evolving market connectedness rather than as proof of a single invariant causal channel.

Overall, the evidence supports the central proposition expressed in the title of this study: oil matters for Islamic equities, but it does not always matter equally or over all horizons. The more informative question is consequently not whether Brent crude oil and Islamic equities are correlated on average, but when their relationship intensifies, at which trading horizons it becomes economically meaningful, and whether that pattern differs between developed and emerging Islamic markets. By addressing these questions over the 1996–2025 period, the study provides a long-horizon perspective on Islamic equity integration, oil-market connectedness, and the conditional nature of diversification.

The remainder of the paper is organised as follows. The next section reviews the literature on Islamic equity-market behaviour, oil–stock market interactions, market integration, portfolio diversification, and time–frequency methods, and develops the conceptual basis for the empirical analysis. The methodology section then describes the developed and emerging Islamic equity indices, Brent crude oil data, return construction, descriptive statistics, correlation analysis, and wavelet coherence framework. The empirical results section reports the unconditional relationships and examines the wavelet coherence and phase structures for EQD–EQE, EQD–OPB, and EQE–OPB. The discussion interprets these findings in relation to market integration, oil sensitivity, investor horizons, and diversification. The final section concludes by summarising the principal findings, portfolio implications, limitations, and directions for future research.

## Literature review

### *Islamic Equity Markets, Shariah Compliance, and Market Heterogeneity*

Islamic equity markets occupy a distinctive position within the global financial system. Their investable universe is defined by Shariah principles that restrict participation in prohibited economic activities and impose financial criteria intended to limit excessive leverage, interest-based exposure, and other forms of non-compliant financial activity. These requirements differentiate Islamic equities institutionally from unrestricted conventional investments, even though both are traded within the same global capital-market architecture. The broader principles underlying Islamic finance emphasise the prohibition of *riba*, avoidance of excessive

uncertainty, and a preference for financial transactions connected to permissible economic activity (Ayyub, 2007). As Islamic finance has expanded internationally, however, these principles have increasingly been implemented through financial products, screening practices, and market infrastructures operating within the broader global financial system (Fang, 2016).

This integration creates an important analytical distinction between institutional identity and market behaviour. The designation of an asset as Shariah-compliant determines whether it belongs to the Islamic investment universe, but it does not necessarily imply that all Islamic assets share identical return dynamics, risk structures, or sensitivities to global shocks. Islamic equity indices contain firms drawn from multiple industries, countries, currencies, and stages of economic development. Consequently, the market behaviour of Islamic equities may reflect both the common influence of Shariah screening and the heterogeneous economic environments in which the underlying firms operate.

The existing literature provides several reasons to avoid treating Islamic equity markets as homogeneous. Muteba Mwamba et al. (2017) compares financial tail risks across conventional and Islamic stock markets, illustrating that risk characteristics constitute an important dimension through which the two market structures can be evaluated. Saâdaoui (2018) approaches Islamic stock markets from a different perspective by testing for multifractality, thereby recognising that return behaviour can exhibit complex scaling properties rather than remaining invariant across temporal horizons. Such evidence is especially relevant to the present study because multifractal and scale-dependent behaviour imply that a single unconditional correlation may provide only a partial representation of market dependence.

Heterogeneity is also observable within the wider Islamic financial system. Yousaf and Alokla (2023) analyse herding behaviour within Islamic bank markets in the Gulf region, while Santosa (2020) examines how firm size interacts with financial characteristics and Islamic firm value in the Indonesian equity market. At a broader level, Hassan et al. (2023) investigate convergence in Islamic financial development across Islamic countries. Together, these studies reinforce the view that Islamic financial markets cannot be assumed to converge mechanically merely because they share a religious-financial framework. Institutional development, firm characteristics, market structure, and geographical setting continue to matter.

The same distinction is evident in Islamic banking research. Studies of risk in Islamic banking (Abedifar et al., 2013), the relationship between Islamic banking and economic growth (Imam & Kpodar, 2016), and bank-level heterogeneity in emerging markets (Soedarmono & Yusgiantoro, 2023) demonstrate that Islamic financial institutions respond differently to economic and institutional conditions. Although banking institutions and listed Islamic equity indices represent different units of analysis, this literature is useful conceptually because it cautions against equating common Shariah principles with uniform financial outcomes. The implication for Islamic equity research is that the developed and emerging segments of the global Islamic market may remain economically differentiated even when they are governed by broadly comparable screening principles.

This distinction becomes particularly important for international portfolio allocation. A global Islamic investor may choose between developed-market and emerging-market Shariah-compliant equities, yet the value of such allocation depends on how closely those markets move together. If developed and emerging Islamic indices respond identically to global information, the diversification benefit of holding both will be limited. If their dynamics differ, especially at shorter investment horizons, cross-market allocation may remain economically meaningful. The relevant issue is therefore not simply whether both indices are Islamic, but whether their dependence varies across time and horizon.

### *Developed and Emerging Market Integration*

The question of financial-market integration has a long history in international finance. Market integration generally refers to the extent to which geographically or institutionally distinct markets respond to common information and exhibit persistent co-movement. Early work on national equity-market co-movement employed long-run econometric methods to assess whether stock markets share common equilibrium relationships (Leachman et al., 1994). Subsequent research has shown that integration is not necessarily constant through time and can intensify during episodes of financial stress. For example, In et al. (2001) examine dynamic interdependence and volatility transmission among Asian stock markets in the context of the Asian financial crisis.

Differences between developed and emerging markets further complicate this relationship. Emerging markets may differ from developed markets in liquidity, market depth, institutional quality, information efficiency, foreign-investor participation, and sensitivity to global capital flows. Financial liberalisation itself can alter the degree to which emerging equity markets become connected with international markets (Kim & Kenny, 2007). The efficient-market literature likewise suggests that market characteristics and adjustment processes can differ across geographical and institutional settings. Borges (2010) examines market efficiency across European stock markets, whereas Nazlioglu et al. (2024) study the efficient-market hypothesis in emerging stock markets while allowing for gradual shifts and common factors.

These differences provide a useful theoretical basis for distinguishing developed from emerging Islamic equities. Although Shariah screening imposes a common invest-ability framework, developed and emerging Islamic indices are constructed from firms operating under different macroeconomic, institutional, and financial-market environments. Their sensitivity to global risk, monetary conditions, commodity prices, and investor sentiment may consequently differ. At the same time, globalisation and international portfolio flows can create common forces that increase cross-market integration over longer horizons.

The implication is that market integration should not be regarded as an all-or-nothing characteristic. Two equity markets may be weakly related in the short run yet strongly integrated at longer frequencies. Marfatia (2017) explicitly approaches international stock-market risk integration using a wavelet framework, highlighting the relevance of investment horizon when evaluating cross-market dependence. This perspective is especially appropriate for developed

and emerging Islamic equities because investors themselves operate at different frequencies. Short-term traders, tactical asset allocators, pension funds, sovereign investors, and long-term Islamic investment institutions need not experience the same diversification opportunities even when they hold the same pair of indices.

### *Oil Prices and Financial-Market Transmission*

Oil is one of the most economically significant commodities in the global economy, and its relationship with financial markets operates through multiple channels. A change in crude oil prices can alter firms' input costs, transportation expenses, inflation expectations, household purchasing power, monetary-policy expectations, and the external balances of importing and exporting economies. Oil prices are also affected by global economic conditions, meaning that identical price movements can carry different information depending on whether they originate from demand, supply, geopolitical, or financial-market forces. The connection between oil and equity markets is therefore theoretically ambiguous and empirically likely to vary over time.

The financial transmission of oil shocks also differs according to the asset under consideration. Emenike (2020), for example, studies dynamic interdependence between crude oil prices and the Nigerian foreign-exchange market, illustrating that oil-market movements can interact with other financial variables through country-specific channels. Within equity markets, Tien & Hung (2022) examine volatility spillovers between oil and Gulf Cooperation Council stock markets using a wavelet-based asymmetric dynamic conditional correlation approach. The relevance of this work for Islamic equity research is particularly strong because many Islamic financial markets are in economies where energy conditions have substantial macro-financial significance.

Yet oil exposure should not be interpreted exclusively through the experience of oil-producing markets. Developed and emerging Islamic equity indices are geographically diversified and include firms whose relationship with oil can differ considerably. Some firms benefit directly or indirectly from rising energy prices, whereas others experience higher input and transportation costs. Market-wide indices aggregate these heterogeneous exposures. As a result, a global Islamic equity benchmark may exhibit relatively weak unconditional correlation with oil even though strong relationships emerge during periods or at frequencies.

More recent commodity-finance research supports the view that energy-market relationships are dynamic. L.-T. Zhao et al., (2024) investigate interactions among carbon markets, energy markets, and sectoral stocks through risk-spillover and wavelet-coherence methods. Elsayed et al. (2025) examine the effect of supply chain pressure on traditional energy and metal markets using a wavelet-based quantile-on-quantile approach. Bouri et al. (2023) analyse dynamic co-movement among major commodity markets during crisis periods through wavelet local multiple correlation. Although these studies focus on different asset combinations, they converge methodologically on the proposition that commodity-market relationships vary with both prevailing market conditions and analytical horizon.

This perspective is important for the interpretation of oil as a portfolio asset. A low unconditional correlation between oil and equities may appear to support diversification, but such an average can conceal episodes during which both markets become strongly connected. The economic usefulness of oil for an Islamic equity portfolio therefore depends on whether its relationship with Shariah-compliant equities remains weak during the periods in which diversification is most needed.

### *Portfolio Diversification and Conditional Dependence*

The classical motivation for diversification is that combining imperfectly correlated assets can reduce portfolio risk. In practice, however, the effectiveness of diversification depends on the stability of cross-asset dependence. If correlations rise during periods of market stress, an asset that appears diversifying under normal conditions may provide substantially less protection when volatility increases. Portfolio diversification should therefore be understood as a dynamic property rather than a permanent characteristic attached to a particular asset. This issue appears across several strands of contemporary financial research.

Tasca et al. (2017) examine portfolio diversification and systemic risk in interbank networks, demonstrating the broader importance of evaluating diversification alongside the structure of financial interconnectedness. In a different asset setting, Alqaralleh & Canepa (2022) investigate the role of precious metals in portfolio diversification during the COVID-19 pandemic using a wavelet-based quantile approach. Zhang et al. (2024) examine whether non-fungible tokens can hedge traditional assets following the pandemic, while Mejri et al. (2025) analyse the dynamic responses of Bitcoin, gold, and green bonds to geopolitical risk through quantile wavelet analysis.

The common insight underlying these studies is that hedging and diversification properties depend on market regime, return distribution, and investment horizon. An asset can behave as a useful diversifier in one period but become more closely correlated with the rest of the portfolio in another. This is especially relevant when evaluating oil alongside Islamic equities because oil itself is exposed to macroeconomic, geopolitical, and financial shocks that may simultaneously affect global stock markets.

Crisis periods provide particularly useful evidence of the instability of financial relationships. The COVID-19 pandemic generated large and rapid changes in financial-market behaviour, and wavelet analysis has been employed to examine these dynamics directly (Costa et al., 2022). The broader financial impact of the pandemic is also evident in studies of Asian capital-market performance (Adnan, 2023) and banking-sector performance during the crisis (Demirgüç-Kunt et al., 2021). These episodes reinforce the importance of allowing correlations and connectedness to evolve rather than treating the entire sample as a single homogeneous regime.

The diversification question in the present study therefore has two dimensions. The first concerns cross-equity diversification: whether developed and emerging Islamic equities remain sufficiently distinct to offer portfolio benefits. The second concerns cross-asset diversification: whether Brent

crude oil provides an independent source of return relative to Islamic equities. Both questions require more than unconditional correlation because the relevant dependence may differ between short-, medium-, and long-run horizons.

### *Wavelet Analysis and the Time-Frequency Perspective*

Traditional time-series methods typically describe relationships either in the time domain or in the frequency domain. Financial-market dependence, however, may vary across both dimensions simultaneously. A relationship can be strong during one historical episode and weak during another, while also differing between short-term and long-term fluctuations. Wavelet methods are particularly useful in this setting because they preserve information about both the timing and the scale of co-movement.

The growing application of wavelet techniques across finance reflects this advantage. Marfatia (2017) applies a wavelet approach to the integration of risks across international stock markets, directly linking timescale decomposition with the study of financial integration. Costa et al. (2022) use wavelet analysis to examine the Brazilian financial-market reaction to COVID-19, illustrating its usefulness during periods characterised by substantial structural disruption. In commodity markets, Bouri et al. (2023) employ wavelet local multiple correlation to study dynamic co-movement during crisis periods.

Wavelet coherence extends this framework to the local association between two series. Rather than reducing the relationship to a single coefficient, coherence identifies regions in the time–frequency plane where the two variables move closely together. This property makes the method especially suitable for the present study because oil–equity dependence may emerge only during market episodes or at specific investment horizons. Tien & Hung (2022) combine wavelet analysis with dynamic conditional correlation to examine oil and GCC stock markets, while L.-T. Zhao et al. (2024) use wavelet coherence in analysing interactions among carbon, energy, and sectoral stock markets. Karimi et al. (2025) similarly combine asymmetric econometric modelling with wavelet coherence in the study of green bonds and carbon ETFs.

The methodological appeal of wavelets is not limited to traditional financial assets. Hoque et al. (2024) combine connectedness analysis with wavelet local multiple correlation in examining digital-economy exchange-traded funds, while Mejri et al. (2025) employ a quantile-wavelet framework to analyse the responses of Bitcoin, gold, and green bonds to geopolitical risk. Alaminos et al. (2024) integrate wavelet techniques with ARIMA, EGARCH, and neural-network methods in studying Bitcoin and the US dollar. Outside finance, the Morlet wavelet has also been used to investigate decarbonisation dynamics (Abban et al., 2024), illustrating the broader usefulness of scale-sensitive methods when relationships evolve across time.

For financial interpretation, one of the principal advantages of wavelet coherence is that it can distinguish whether strong dependence is primarily a short-run phenomenon or whether it persists at longer horizons. This distinction is particularly relevant for investors. A high-frequency relationship

may be important to traders and tactical portfolio managers, whereas longer-frequency coherence is more consequential for institutional investors with extended holding periods. The same asset pair can therefore offer diversification to one class of investor while providing substantially less diversification to another.

Wavelet phase information adds a further interpretive dimension. Within statistically meaningful regions of coherence, phase relationships can indicate whether the two variables tend to move in the same or opposite direction and whether one series tends to lead the other. These patterns should not be interpreted automatically as structural causality, but they provide additional information beyond the magnitude of coherence. The importance of combining dependence intensity with direction and horizon is one reason why wavelet-based approaches have become increasingly common in studies of commodity markets, international equities, geopolitical risk, and alternative assets (Bouri et al., 2023; Zhao et al., 2024; Mejri et al., 2025).

### *Research Gap and Positioning of the Study*

The preceding literature reveals several well-developed but still partially disconnected research streams. The first examines the distinct characteristics of Islamic financial and equity markets. Studies have addressed tail risk (Muteba Mwamba et al., 2017), multifractality (Saâdaoui, 2018), firm-level valuation (Santosa, 2020), herding (Yousaf and Alokla, 2023), and convergence in Islamic financial development (Hassan et al., 2023). These contributions establish that Islamic finance possesses meaningful market characteristics while simultaneously exhibiting substantial internal heterogeneity.

The second literature examines financial-market integration. Research on national equity co-movement (Leachman et al., 1994), Asian-market interdependence (In et al., 2001), financial liberalisation in developing economies (Kim & Kenny, 2007), market efficiency in developed and emerging markets (Borges, 2010; Nazlioglu et al., 2024), and wavelet-based international risk integration (Marfatia, 2017) demonstrates that financial connectedness evolves with market structure, institutional development, crises, and investment horizon.

A third stream focuses on oil, commodities, and cross-asset dependence. Oil-related studies examine dynamic interdependence with financial markets (Emenike, 2020) and volatility spillovers to regional stock markets (Tien & Hung, 2022), while the broader commodity literature increasingly applies wavelet and connectedness methods to crisis-period co-movement (Bouri et al., 2023), energy and sectoral stock interactions (Zhao et al., 2024), supply-chain pressure (Elsayed et al., 2025), and environmentally related financial assets (Karimi et al., 2025). This literature establishes that commodity-financial relationships are unlikely to remain constant through time.

Despite these advances, a clear gap remains at the intersection of these three areas. The existing literature represented in the reference base provides extensive evidence on Islamic-market risk, international stock-market integration, oil-related financial spillovers, and wavelet-based dependence, but comparatively little attention is devoted to a direct long-horizon comparison of

developed and emerging Islamic equity markets in relation to a common global oil benchmark. A static distinction between developed and emerging Islamic equities does not reveal whether their degree of integration changes with investment horizon, while a full-sample oil–equity correlation does not reveal when oil be-comes materially connected with either segment.

The present study addresses this gap by combining these perspectives within a single time–frequency framework. It compares the Dow Jones Islamic World Developed Market Index and the Dow Jones Islamic World Emerging Markets Index and evaluates the dependence of each with Brent crude oil over the period 1996–2025. Three pairwise relationships are therefore analysed: developed versus emerging Islamic equities, developed Islamic equities versus Brent oil, and emerging Islamic equities versus Brent oil.

This design generates three contributions to the literature. First, it treats Islamic equity-market integration as a horizon-dependent phenomenon rather than if a common Shariah-compliant classification produces uniform financial behaviour. Second, it evaluates oil not as a permanently diversifying or non-diversifying asset, but as an asset whose relationship with Islamic equities can strengthen or weaken across both time and frequency. Third, it places developed–emerging Islamic equity integration and oil–equity dependence within the same analytical framework, allowing the diversification potential of Islamic equity allocation to be compared directly with the diversification potential of adding oil.

Accordingly, the study expects the unconditional correlations to provide only an incomplete description of the underlying dependence structure. The literature on international market integration suggests that commonality may strengthen over longer horizons (Marfatia, 2017), while the commodity and wavelet literature indicates that oil and related asset relationships can intensify during market regimes (Tien and Hung, 2022; Bouri et al., 2023; Zhao et al., 2024). The empirical analysis therefore does not impose the assumption that developed and emerging Islamic equities, or Islamic equities and oil, must exhibit a stable relationship throughout the sample. Instead, it allows the data to reveal when dependence emerges and at which investment horizons it becomes economically meaningful.

## Methods

### *Research Design*

This study employs a quantitative time-series framework to examine the dynamic relationship between crude oil and Islamic equity markets across both calendar time and investment horizons. The empirical design combines conventional return correlation analysis with wavelet coherence analysis. The former provides an unconditional benchmark of average linear association across the full sample, while the latter permits the strength, direction, and lead–lag structure of market dependence to vary simultaneously over time and frequency.

The use of a time–frequency framework is motivated by the possibility that financial-market relationships are inherently heterogeneous across investment horizons. A dependence structure

observed among daily market movements need not be identical to that observed over several weeks, months, or longer periods. Wavelet-based approaches have increasingly been employed to capture such heterogeneity in international equity-market integration (Marfatia, 2017), oil–equity spillovers (Tien & Hung, 2022), portfolio diversification (Alqaralleh & Canepa, 2022), crisis-period financial behaviour (Costa et al., 2022), commodity-market co-movement (Bouri et al., 2023), and energy-related financial-market interactions (Karimi et al., 2025b; J. L. Zhao et al., 2016). The present study adopts this framework to investigate whether the relationship between oil and Islamic equities differs between developed and emerging markets and whether those relationships remain stable across the nearly three-decade sample period.

The empirical analysis proceeds in four stages. First, daily price observations are transformed into continuously compounded percentage returns. Second, descriptive statistics and Pearson correlation coefficients are used to establish the unconditional characteristics of the three-return series. Third, wavelet coherence is estimated separately for each pair of variables. Finally, the resulting time–frequency maps are interpreted through coherence intensity, statistical significance, phase relationships, and the cone of influence. The analysis therefore does not impose predetermined structural breaks or crisis regimes. Instead, periods of intensified or weakened dependence are allowed to emerge endogenously from the time–frequency structure of the data.

### *Data and Variables*

The study uses daily observations covering the period from 1 January 1996 to 8 August 2025. The source workbook contains 7,725 aligned observations in price levels and 7,724 observations after the construction of first-difference log returns. The resulting return sample begins on 2 January 1996 because calculation of a return requires both the current and preceding price observation.

Three market series are examined. The first is the Dow Jones Islamic World Developed Market Price Index, denoted by EQD. The second is the Dow Jones Islamic World Emerging Markets Price Index, denoted by EQE. The third is the Europe Brent Spot FOB crude-oil price in US dollars per barrel, denoted by OPB. The source workbook records the Islamic equity series under the data codes DJIWDD$ and DJIWEM$, respectively, while Brent crude oil is recorded under the code EIAEBRT. The original data extraction is implemented through the DataStream grid interface recorded in the source workbook.

Table 1 summarises the variables used in the analysis. The use of broad Islamic equity indices rather than individual securities serves two purposes. First, it allows the analysis to focus on market-level Islamic equity behaviour rather than firm-specific shocks. Second, dividing the Islamic investment universe into developed and emerging-market components permits direct examination of whether geographic and economic development characteristics are associated with different sensitivities to oil-market movements.

| Variable | Code | Description | Role |
|---|---|---|---|
| EQD | DJIWDD$ | Dow Jones Islamic World Developed Market Price Index | Developed Islamic equity |
| EQE | DJIWEM$ | Dow Jones Islamic World Emerging Markets Price Index | Emerging Islamic equity |
| OPB | EIAEBRT | Europe Brent Spot FOB, US dollars per barrel | Crude-oil benchmark |

Table 1. Definition of Variables

Brent crude oil is used as the energy-market benchmark because the research question concerns the international oil–Islamic equity nexus rather than exposure to a domestic or country-specific oil price. The resulting empirical setting therefore compares one common global energy benchmark against two distinct segments of the international Shariah-compliant equity market.

The data are organised on the aligned daily date grid contained in the source workbook. No additional interpolation is introduced during the empirical estimation stage. Because the wavelet routine is implemented using an equally spaced observation index, the estimated wavelet periods should be interpreted as observation-day horizons rather than literal calendar-day horizons. This distinction is important because financial series are not observed continuously over weekends and market holidays.

### *Return Construction*

The empirical analysis is performed on returns rather than price levels. Using returns reduces the influence of deterministic price trends and provides an eco-nomically interpretable measure of daily market performance. For each series Pi,t, the continuously compounded percentage return is calculated as:

$$\mathrm{R}_{i,t} = 100\, l_n \left(\frac{\mathrm{p}_{i,t}}{P_{it-1}}\right), \quad (1)$$

where $R_{i,t}$ denotes the return on asset or index i at observation t, Pi,t is the corresponding price level at t, and Pi,t−1 is its preceding observation.

Accordingly, three return series are generated:

$$\mathrm{R}_{EQD,t} = 100\, l_n \left(\frac{\mathrm{EQD}_t}{EQD_{t-1}}\right), \quad (2)$$

$$\mathrm{R}_{EQE,t} = 100\, l_n \left(\frac{\mathrm{EQE}_t}{EQE_{t-1}}\right), \quad (3)$$

and

$$\mathrm{R}_{OPB,t} = 100\, l_n \left(\frac{\mathrm{OPB}_t}{OPB_{t-1}}\right), \quad (4)$$

Multiplication by 100 expresses the continuously compounded returns in percentage terms. All subsequent correlation and wavelet-coherence analyses are performed using these transformed return series rather than the raw price indices.

## *Return Construction*

Before estimating the time–frequency relationships, the study computes a Pearson correlation matrix for the three-return series. For two return variables X and Y, the Pearson correlation coefficient is defined as

$$\rho XY = \frac{\sum_{t=1}^{T} (X_t - X)(Y_t - Y)}{\sqrt{\sum_{t=1}^{T} (X_t - X)^2} \sqrt{\sum_{t=1}^{T} (Y_t - Y)^2}} \quad (5)$$

where T represents the number of observations, while $\bar{X}$ and $\bar{Y}$ denote the corresponding sample means. The Pearson coefficients provide an intuitive benchmark for three pairwise relationships:

1. EQD–EQE: developed versus emerging Islamic equities;
2. EQD–OPB: developed Islamic equities versus Brent crude oil; and
3. EQE–OPB: emerging Islamic equities versus Brent crude oil.

However, Equation 5 summarises the relationship between two variables through a single coefficient calculated over the full sample. It therefore assumes, implicitly, that the strength of association can be meaningfully represented without distinguishing between different historical periods or investment horizons. This limitation is particularly restrictive for financial markets, where connectedness may strengthen during crises and weaken during normal periods, or may differ between high- and low-frequency movements. Evidence from international stock markets (Marfatia, 2017), commodities (Bouri et al., 2023), oil and regional equities (Tien & Hung, 2022), and other financial assets (Hoque et al., 2024) supports the use of approaches capable of accommodating such time-varying dependence. The correlation analysis is therefore interpreted as a descriptive benchmark rather than the principal test of market connectedness. Wavelet coherence constitutes the core empirical method.

## *Wavelet Coherence Framework*

**Continuous Wavelet** Transform Wavelet analysis decomposes a time series into localised components that vary simultaneously across time and frequency. Unlike a conventional Fourier representation, which identifies the frequencies contained in a series without preserving their precise location in time, a wavelet transformation retains both dimensions. This characteristic makes wavelets particularly suitable for financial data in which market relationships can change around crises, commodity shocks, monetary adjustments, or other temporary disturbances.

For a continuous time series *x(t)*, the continuous wavelet transform can be represented as:

$$W\chi(T,S) = \frac{1}{\sqrt{s}} \int_{-\infty}^{+\infty} \chi(t)\psi * \left(\frac{t-T}{s}\right) dt, \quad (6)$$

where Wx(τ, s) denotes the wavelet coefficient of x(t) at location τ and scale s, ψ(·) represents the mother wavelet, and the superscript ∗ denotes complex conjugation.

The parameter τ controls the location of the wavelet through time, while s determines its scale. Smaller values of s correspond to higher-frequency fluctuations and shorter horizons, whereas larger values correspond to lower-frequency movements and longer horizons. Consequently, Equation 6 allows the behaviour of the return series to be examined at multiple investment horizons without assuming that the same temporal structure governs the entire sample.

The empirical implementation adopts the Morlet wavelet specification used by the wavelet-coherence procedure. The Morlet wavelet is particularly suitable for financial-market applications because its complex-valued structure enables both the magnitude and phase of the relationship to be examined. Comparable time–frequency frameworks are widely applied in financial and commodity research.

**Cross-Wavelet Transform** To examine the relationship between two return series, their individual wavelet transformations are combined through the cross-wavelet transform. For variables x and y, this is defined as:

$$W_{xy}(T,S) = W_x(T,S)\, Wy*(T,S), \tag{7}$$

Where $Wy*(T,S)$ denotes the complex conjugate of the wavelet transform of series y. The magnitude:

$$|W_{xy}(\tau, s)| \tag{8}$$

indicates the degree to which the two series display common local power at a particular time and frequency. However, high cross-wavelet power can partly reflect periods in which one or both individual series themselves exhibit high volatility. For this reason, the present study focuses primarily on normalised wavelet coherence rather than cross-wavelet power alone.

**Wavelet Coherence Wavelet** coherence measures the local correlation between two series in the time–frequency domain. Conceptually, it can be understood as a localised counterpart of a squared correlation coefficient. The squared wavelet coherence between x and y is represented as:

$$R^2_{xy}(T,s) = \frac{|S(s^{-1} W_{xy}(T,s))|}{S(s^{-1}|W_x(T,s)|^2)\ S(s^{-1}|W_y(T,s)|^2)} \tag{9}$$

Where S(.) denotes smoothing in both time and scale.

By construction,

$$0 \le R^2_{xy}\ (\tau, s) \le 1. \tag{10}$$

Values approaching zero indicate weak local dependence, whereas values approaching one indicate strong local coherence between the two-return series at a specific point in time and scale. The wavelet-coherence plots therefore reveal not merely whether two markets are related, but when the relationship becomes strong and at what horizon it occurs.

This distinction is central to the present research question. A low full-sample oil–equity correlation may coexist with regions of substantial wavelet coherence if oil becomes strongly connected with Islamic equities during historical episodes. Similarly, moderate unconditional correlation between developed and emerging Islamic equities may conceal considerably stronger coherence at medium or long horizons. Similar applications demonstrate the usefulness of wavelet coherence for identifying changing relationships among financial, commodity, and environmentally related assets (Zhao et al., 2024; Karimi et al., 2025; Tien and Hung, 2022).

**Phase Difference and Lead–Lag Relationships** Wavelet coherence identifies the intensity of local dependence, but the coherence coefficient itself does not distinguish whether the two series move in the same direction or whether one tends to precede the other. This information is obtained from the phase difference.

The phase difference between x and y can be represented as

$$\phi_{xy}(T,S) = atan2\left[\Im\{S(s^{-1}W_{xy}(T,s))\}, \Re\{S(s^{-1}W_{xy}(T,s))\}\right], \quad (11)$$

where $\Im(\cdot)$ and $\Re(\cdot)$ denote the imaginary and real components, respectively. Phase differences are represented graphically through arrows on the wavelet-coherence plots. For each ordered pair (x, y), the arrows are interpreted as follows:

1. arrows pointing to the right indicate that x and y are in phase and therefore move positively together;
2. arrows pointing to the left indicate an anti-phase relationship and therefore movement in opposite directions;
3. arrows pointing upward indicate that the first series, x, leads the second series, y, by approximately π/2;
4. arrows pointing downward indicate that the second series, y, leads the first series, x, by approximately π/2.

Diagonal directions combine these interpretations. For example, a rightward-upward arrow indicates positive co-movement in which the first variable tends to lead the second, whereas a rightward-downward arrow indicates positive co-movement in which the second variable tends to lead the first. Equivalent lead–lag interpretations apply to leftward arrows under negative association.

In the present analysis, the ordering of the variables is therefore important. For EQD–OPB, an upward component implies that developed Islamic equities lead Brent oil, whereas a downward component implies that Brent leads developed Islamic equities. The same principle applies to EQE–OPB and EQD–EQE. Phase relationships are interpreted as temporal ordering rather than structural causality. A leading variable within a coherent region is not automatically assumed to cause the movement of the other variable. Instead, phase patterns indicate how information or common shocks are reflected sequentially across the two series. This distinction is particularly

important because both oil and equities may respond simultaneously to broader macroeconomic, geopolitical, monetary, or financial disturbances.

### *Event-Study Design*

Not every high-coherence region should be interpreted as statistically meaningful. The empirical analysis therefore evaluates the significance of wavelet coherence against simulated autoregressive background processes. Statistical significance is determined through Monte Carlo randomisation using surrogate AR(1) series that preserve relevant persistence characteristics of the underlying return series.

For the publication-level estimations, the number of Monte Carlo randomisations is set to

$$B = 300, \tag{12}$$

and statistical significance is evaluated at the 5% level. Consequently, the significance contours displayed on the wavelet maps identify regions in which the estimated coherence exceeds the corresponding 95% simulated threshold.

The use of simulation-based significance is especially appropriate because the sampling distribution of wavelet coherence is not adequately represented through conventional correlation-based parametric inference. Wavelet applications in financial research similarly place emphasis on identifying statistically meaningful regions rather than interpreting the colour scale alone (Tien and Hung, 2022; Bouri et al., 2023; Zhao et al., 2024; Karimi et al., 2025).

Wavelet estimation is additionally affected by boundary conditions because observations near the beginning and end of the sample do not possess surrounding information on both sides. The cone of influence (COI) identifies the portion of the time–frequency plane in which such edge effects become increasingly important. Results located outside the reliable region bounded by the COI are therefore interpreted cautiously and are not used as the primary basis for substantive conclusions.

This consideration becomes increasingly important at long scales because large wavelets require information over a broader temporal neighbourhood. Accordingly, apparent long-horizon coherence close to 1996 or 2025 is treated as suggestive where it falls into the edge-affected area, whereas the principal interpretation concentrates on statistically significant regions located within the COI.

### *Event-Study Design*

Because the computational time variable is constructed as a sequential observation index,

$$t = 1, 2, \ldots, T, \tag{13}$$

the frequency scale is interpreted in terms of observation-day horizons. The wavelet maps therefore display periods such as approximately 4, 16, 64, 256, and 1,024 observations. Smaller scales correspond to higher-frequency market movements, while larger scales capture increasingly persistent components of the relationship.

The study does not impose rigid ex ante classifications that would treat a particular numerical boundary as universally defining a short-, medium-, or long-term investor. Instead, the terminology is used comparatively. Dependence located near the upper portion of the frequency axis is interpreted as short-horizon behaviour, coherence at intermediate scales as medium-horizon behaviour, and coherence at larger periods as long-horizon dependence.

This approach recognises that investment horizons are heterogeneous and continuous rather than naturally divided into a small number of fixed categories. A short-term trader, an asset manager rebalancing over several weeks, and a long-horizon institutional investor may therefore encounter materially different dependence structures even when observing the same pair of markets. The importance of scale-sensitive interpretation has similarly been emphasised in wavelet studies of international equities (Marfatia, 2017), portfolio diversification (Alqaralleh and Canepa, 2022), commodity markets (Bouri et al., 2023), and dynamic connectedness (Hoque et al., 2024).

### *Pairwise Empirical Specification*

The wavelet analysis is implemented separately for three market pairs:

$$P = \{(EQD, EQE), (EQD, OPB), (EQE, OPB)\}. \quad (14)$$

Each pair answers a distinct economic question. The first specification,

$$WTC\ (EQD, EQE), \quad (15)$$

measures the time–frequency integration between developed and emerging Islamic equity markets. Strong and persistent coherence indicates that the two Islamic equity segments share common return dynamics at the corresponding horizon, while weak coherence indicates greater segmentation and potentially stronger diversification opportunities.

The second specification,

$$WTC\ (EQD, OPB), \quad (16)$$

examines when Brent crude oil becomes connected with developed-market Islamic equities.

The third,

$$WTC\ (EQE, OPB), \quad (17)$$

examines the corresponding relationship for emerging-market Islamic equities.

Comparing the latter two coherence surfaces permits the study to determine whether oil dependence represents a common feature of global Islamic equities or whether its timing, strength, and horizon differ between developed and emerging markets.

## Result and Discussion

### *Descriptive Characteristics and Unconditional Dependence*

Table 2 reports the descriptive characteristics of the daily return series for developed Islamic equities (EQD), emerging Islamic equities (EQE), and Brent crude oil (OPB). The three series display positive average daily returns over the 1996–2025 sample, although the magnitude of the mean is small relative to daily variation. EQD records an average return of approximately 0.0295%, followed by OPB at 0.0170% and EQE at 0.0153%. The more informative distinction concerns volatility. The standard deviation of Brent oil returns, at approximately 2.55%, is more than twice that of developed Islamic equities and substantially exceeds the volatility of emerging Islamic equities. EQE itself is more volatile than EQD, with standard deviations of approximately 1.23% and 1.06%, respectively.

| Window | Mean (%) | Median (%) | SD (%) | Positive (%) | Mean (%) | Median (%) | SD (%) | Positive (%) |
|---|---|---|---|---|---|---|---|---|
| Pre [−3, −1] | 0.462 | 0.299 | 1.348 | 58.06 | 0.728 | 0.057 | 2.568 | 52.38 |
| Announcement [0, +1] | -0.278 | -0.219 | 1.610 | 41.94 | -0.020 | -0.037 | 1.894 | 47.62 |
| Post [+2, +3] | 0.040 | 0.599 | 2.961 | 61.29 | -0.525 | -0.106 | 2.219 | 47.62 |
| Full [−3, +3] | 0.224 | 0.996 | 3.246 | 64.52 | 0.183 | -0.731 | 4.114 | 42.86 |

Table 2. Descriptive Statistics of Daily Returns

All three series are negatively skewed, indicating that extreme negative observations are more pronounced than extreme positive observations. This feature is particularly strong for Brent crude oil. The excess kurtosis statistics also indicate substantial departures from Gaussian behaviour, most dramatically for OPB. The oil return series records an excess kurtosis above 70, compared with approximately 10.5 for EQD and 6.4 for EQE. The result confirms that oil experiences substantially more extreme tail behaviour than either Islamic equity index.

The non-normality of Islamic equity returns is consistent with evidence that Islamic stock markets can exhibit complex tail and scaling characteristics. Muteba Mwamba et al. (2017) document financial tail risks across conventional and Islamic stock markets, while Saâdaoui (2018) identifies multifractal behaviour in Islamic stock indices. The descriptive evidence in Table 2 therefore supports the use of a framework capable of accommodating heterogeneous behaviour across time and scale rather than relying exclusively on constant-parameter relationships.

Figure 1 presents the unconditional Pearson correlations. The strongest unconditional relationship occurs between developed and emerging Islamic equities. Their correlation of 0.524 suggests economically meaningful but incomplete co-movement. The two markets therefore share substantial common variation, yet the coefficient is sufficiently below unity to indicate that developed and emerging Islamic equities are not identical return processes.

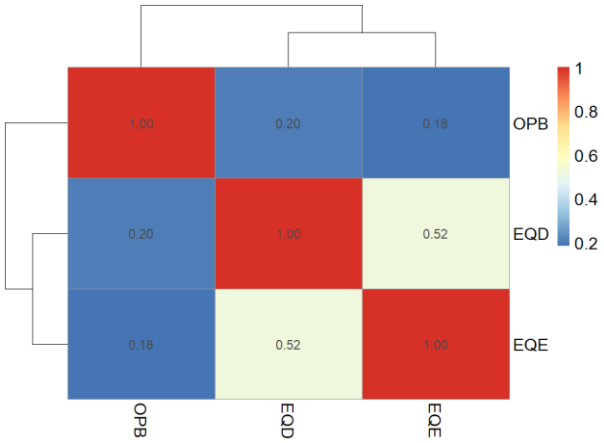

Figure 1. Pearson Correlation Matrix

By comparison, the relationships between Brent crude oil and Islamic equities are considerably weaker. The oil–EQD correlation is approximately 0.202, while the oil–EQE correlation is approximately 0.183. At first sight, these coefficients might suggest that crude oil is largely independent of Islamic equity performance and may therefore offer meaningful diversification potential. Such a conclusion would, however, be premature. A full-sample correlation collapses almost three decades of observations into one average and does not indicate whether dependence strengthens during episodes or whether different investment horizons display different relationships.

This limitation is particularly relevant considering international-finance evidence showing that market integration can change across both time and frequency (Marfatia, 2017). Similarly, oil-related financial spillovers have been shown to vary dynamically rather than remain constant (Tien and Hung, 2022; Emenike, 2020). The correlation matrix should therefore be interpreted as the unconditional benchmark against which the wavelet results are evaluated.

A useful preliminary conclusion emerges already from Table 3. Developed and emerging Islamic equities exhibit considerably greater average integration with each other than exhibits with oil. The critical question, however, is whether this ordering persists across all horizons and historical periods. The wavelet-coherence results show that it does not do so uniformly.

### *Time–Frequency Integration between Developed and Emerging Islamic Equities*

Figure 2 presents the wavelet coherence between EQD and EQE. The horizontal axis represents calendar time from 1996 to 2025, while the vertical axis captures the investment horizon in observation days. Warmer colours indicate stronger coherence, whereas cooler colours indicate weaker coherence. Black contours identify the statistically relevant regions generated by the wavelet procedure, and the cone of influence distinguishes the portions of the plot where boundary effects become increasingly important.

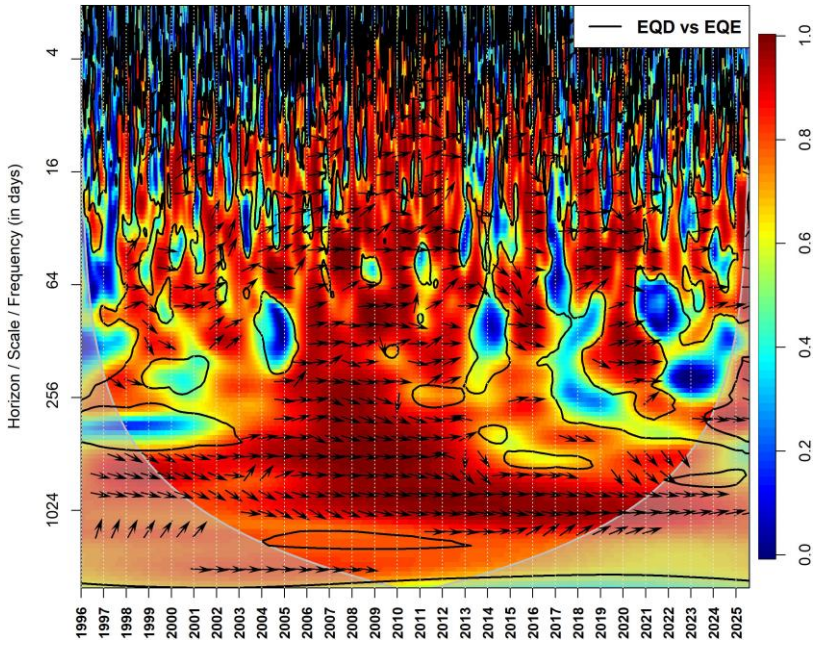


Figure 2. Wavelet Coherence between Developed and Emerging Islamic Equities

Note: EQD denotes the Dow Jones Islamic World Developed Market Price Index and EQE denotes the Dow Jones Islamic World Emerging Markets Price Index. Warmer colours indicate higher wavelet coherence. Black contours indicate statistically relevant regions produced by the wavelet procedure. Phase arrows describe the direction and lead–lag structure of the relationship. Results outside the cone of influence should be interpreted cautiously.

The most striking feature of Figure 2 is the contrast between short and longer horizon dependence. At the shortest scales, particularly around the upper portion of the figure, coherence is highly fragmented. Alternating red, yellow, green, and blue regions indicate that daily and very short-horizon movements between developed and emerging Islamic equities do not remain uniformly synchronised. Strong local coherence appears repeatedly, but these episodes are interspersed with low-coherence regions.

This fragmentation suggests that short-run market-specific forces retain considerable importance. Differences in trading hours, investor composition, market liquidity, regional news, exchange-rate conditions, and local information can generate temporary divergence even though both indices belong to the global Islamic equity universe. The finding accords with the broader argument that emerging-market behaviour can differ as information efficiency and common factors evolve (Nazlioglu et al., 2024). It also supports the proposition developed earlier in the paper that a shared Shariah-compliant classification does not imply identical short-run valuation dynamics.

The picture changes substantially as the horizon lengthens. From approximately the medium-frequency bands toward the 128–512 observation region, much broader areas of orange and red become visible. Particularly across large portions of the 2000s and 2010s, developed and

emerging Islamic equities exhibit strong and persistent coherence. The continuity of these warm regions contrasts sharply with the fragmented appearance at the highest frequencies.

At still longer horizons, a broad high-coherence structure extends through much of the centre of the sample. Although the longest-period observations must be treated cautiously near the cone-of-influence boundary, the central portion of Figure 2 provides strong visual evidence that the degree of integration between the two Islamic equity markets increases with the investment horizon.

This finding is economically significant. The unconditional correlation of 0.524 does not fully describe the relationship. It combines weak or intermittent short-run dependence with considerably stronger medium and long horizon integration. A single correlation coefficient therefore understates the degree to which developed and emerging Islamic equities share common longer-run movements.

The result is consistent with the time-scale interpretation of international market integration proposed in wavelet-based research. Marfatia (2017) shows that international stock-market risk integration depends materially on the horizon considered. The present evidence extends this logic to the Islamic equity universe. Developed and emerging Shariah-compliant markets can remain differentiated at short horizons while responding increasingly to common forces as the horizon lengthens.

The phase arrows strengthen this interpretation. Within many of the medium and longer horizon high-coherence regions, the arrows are predominantly oriented toward the right, although their vertical components change over time. Rightward orientation indicates that EQD and EQE generally move in phase within these regions. Their relationship is therefore primarily characterised by positive co-movement rather than persistent offsetting behaviour.

The changing vertical components of the arrows are equally important. Neither developed nor emerging Islamic equities appear to maintain an invariant leading role over the entire sample. Instead, the lead–lag structure changes across periods and scales. This suggests that integration is reciprocal and dynamic rather than a simple one-directional transmission from developed to emerging markets.

Such a finding is plausible in an increasingly interconnected global capital market. Developed markets may transmit global information rapidly, but emerging markets can also reflect region-specific shocks, commodity exposures, or investor flows that subsequently influence broader market expectations. The wavelet evidence therefore supports integration without requiring a permanent leader–follower hierarchy.

From a diversification perspective, Figure 2 has a clear implication. Investors operating at short horizons may still obtain meaningful diversification from al-locating between developed and emerging Islamic equities because coherence is comparatively unstable and frequently weak. By contrast, investors operating over longer horizons face substantially stronger commonality. The

diversification advantage of combining the two market segments is therefore likely to diminish as the holding period increases.

This conclusion also complements the literature on Islamic equity risk. Islamic stocks may display particular risk characteristics relative to conventional markets (Muteba Mwamba et al., 2017), but this does not imply that diversification within the Islamic universe is constant. The present evidence indicates that horizon is a crucial conditioning variable.

### *Brent Oil and Developed Islamic Equities*

Figure 3 reports the wavelet coherence between developed Islamic equities and Brent crude oil. The structure differs markedly from the EQD–EQE relationship.

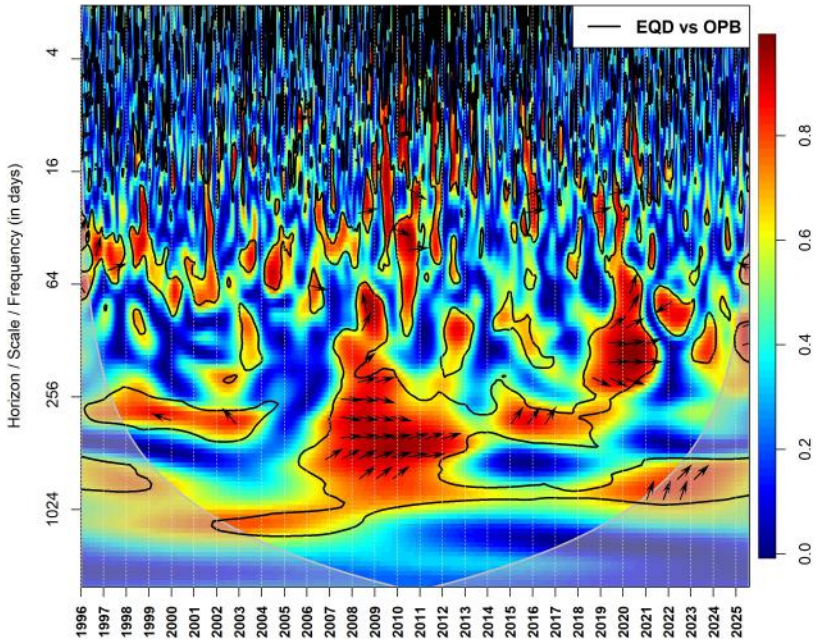


Figure 3. Wavelet Coherence between Developed and Emerging Islamic Equities

Note: EQD denotes the Dow Jones Islamic World Developed Market Price Index and OPB denotes Europe Brent Spot FOB crude oil. Warmer colours indicate stronger wavelet coherence. Phase arrows identify the local direction and lead–lag structure. Areas near and outside the cone of influence should be interpreted cautiously.

Unlike the developed–emerging equity relationship, Figure 3 does not display pervasive high coherence over the entire sample. Instead, strong dependence is organised into distinct time–frequency clusters. Large portions of the plot remain blue or cyan, especially across many short- and medium-horizon intervals. These low-coherence regions explain why the unconditional EQD–OPB correlation is only approximately 0.20.

Nevertheless, the low average correlation conceals economically important episodes. At intermediate and longer horizons, sizeable warm-coloured regions emerge during periods. An early region of elevated coherence appears around the late 1990s and early 2000s at medium-

to-long scales. A more pronounced cluster emerges around the late 2000s and early 2010s, where coherence extends across a relatively wide band of horizons. Additional episodes are visible during the middle and latter part of the 2010s and around the beginning of the 2020s.

These patterns imply that the relevance of oil for developed Islamic equities is conditional rather than permanent. For substantial parts of the sample, Brent price movements provide relatively limited information about developed Islamic equity returns. At other times, however, the relationship becomes strong over economically meaningful horizons.

This result is consistent with the broader oil–equity literature in which dependence is found to vary through time. Tien & Hung (2022), for example, document frequency-dependent volatility spillovers between oil and GCC stock markets. Although the present study uses a different Islamic equity universe and a different empirical comparison, both sets of evidence point against interpreting oil–equity dependence as a constant parameter.

The finding also corresponds with evidence of dynamic interdependence between crude oil and other financial variables (Emenike, 2020). Oil prices simultaneously capture information about production costs, aggregate demand, inflation, geopolitical conditions, and financial-market sentiment. The strength of the equity-market response can therefore vary depending on the dominant economic channel at a particular point in time.

The wavelet map provides another important insight: high coherence is not concentrated exclusively at one frequency. Some episodes occur around relatively short-to-medium horizons, while others extend into substantially longer periods. Consequently, the economic significance of oil depends not only on calendar time but also on the investor's holding horizon.

For a short-horizon investor, many periods of the sample show weak oil–EQD dependence, suggesting potentially useful diversification. A medium or longer horizon investor, however, may encounter periods in which oil and developed Islamic equities become much more closely connected. The unconditional correlation therefore overstates the stability of diversification by averaging these distinct regimes together.

Phase arrows within the stronger coherence regions are frequently rightward or diagonally rightward, indicating that positive co-movement is common during several episodes of heightened dependence. Yet the vertical orientation varies across the time–frequency plane. The lead–lag relationship consequently does not support a simple proposition that oil permanently leads developed Islamic equities, or vice versa.

This is an important distinction. If oil were consistently the leading variable, one might interpret Brent returns as a stable source of predictive information for developed Islamic equities. The present evidence instead suggests a more complicated relationship in which the temporal ordering itself changes according to the period and frequency considered. Such instability is consistent with the idea that oil and equities can respond jointly to broader shocks rather than being connected through one fixed transmission mechanism.

The episodic nature of coherence also resembles findings from contemporary commodity and energy research. J. L. Zhao et al. (2016) demonstrate that interactions among carbon, energy, and sectoral stocks depend on time and market conditions, while Elsayed et al. (2025) show that the relationship between supply-chain pressure and energy or metal markets varies across quantiles and wavelet horizons. The present evidence places Islamic developed-market equities within this broader dynamic-dependence literature.

### *Actual, Expected, and Abnormal Return Patterns*

Figure 4 presents the corresponding relationship between Brent crude oil and emerging Islamic equities. The unconditional correlation between EQE and OPB is 0.183, the lowest of the three pairwise coefficients. If only Table 3 were considered, Brent crude oil might therefore appear to offer slightly greater diversification against emerging Islamic equities than against developed Islamic equities. Figure 4, however, shows that this interpretation is incomplete.

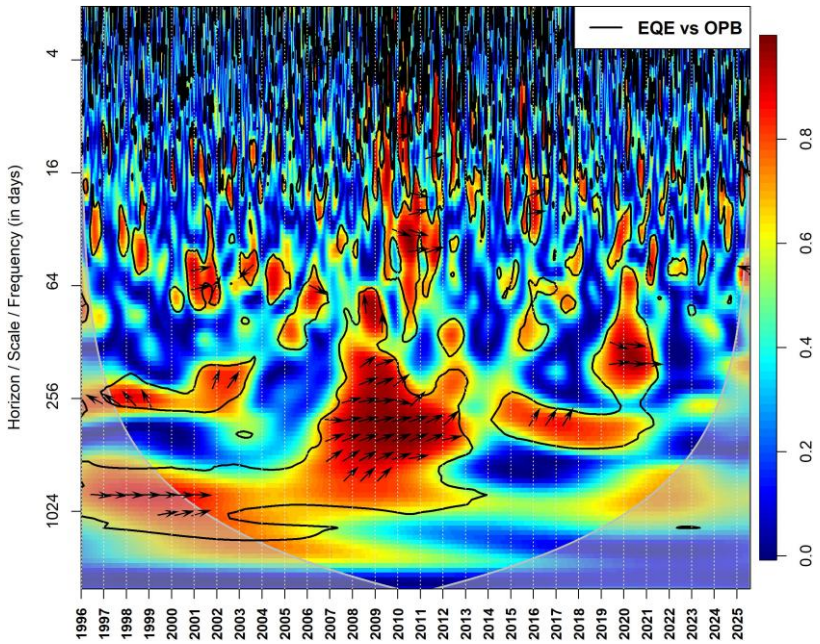


Figure 3. Wavelet Coherence between Developed and Emerging Islamic Equities

Note: EQE denotes the Dow Jones Islamic World Emerging Markets Price Index and OPB denotes Europe Brent Spot FOB crude oil. Warmer colours indicate stronger wavelet coherence. Phase arrows identify the local direction and lead–lag structure. Areas affected by the cone of influence are interpreted cautiously.

As with EQD–OPB, short-horizon coherence is highly fragmented. The upper portion of the figure contains numerous isolated pockets of stronger and weaker dependence rather than one continuous structure. This indicates that daily and very short-horizon oil–EQE interactions are unstable. More substantial coherence emerges at medium frequencies. A notable warm-coloured region appears around the beginning of the 2000s, followed by a particularly broad and

intense cluster around the late 2000s and early 2010s. During this latter period, elevated coherence extends across multiple scales rather than remaining confined to a narrow short-run band.

Additional high-coherence regions appear later in the sample, including around the second half of the 2010s and beginning of the 2020s. These episodes are separated by periods of much weaker dependence. The overall pattern is therefore again one of intermittent coupling rather than permanent oil sensitivity.

The comparison with Figure 3 is revealing. Both developed and emerging Islamic equities exhibit episodic dependence on Brent, suggesting that time variation is a general characteristic of the oil–Islamic equity relationship. Nevertheless, the precise location and intensity of the coherence regions are not identical. This difference indicates that developed and emerging Islamic equities do not transmit or absorb oil-market information in the same manner.

The difference is economically plausible. Emerging-market equities may be exposed to oil through a broader set of channels involving trade balances, exchange rates, fiscal positions, commodity exports, inflation, and international capital flows. Developed-market firms can also have substantial energy exposure, but their financial and economic structures are generally different. The wavelet evidence therefore suggests that a common global oil shock need not produce a homogeneous response across the two Islamic equity segments.

This finding is consistent with the broader emerging-market literature, which emphasises heterogeneity in market adjustment and common-factor exposure (Nazlioglu et al., 2024). It also supports the central argument of this study that Shariah-compliant classification does not erase geographical and structural differences between developed and emerging markets.

The phase arrows again indicate that the relationship changes through time. Within several high-coherence regions, rightward orientations suggest positive co-movement. At the same time, changes in the arrows' vertical orientation imply that the lead–lag direction is not stable. Neither Brent nor emerging Islamic equities therefore appear to dominate consistently across all significant episodes.

The absence of a permanent leading variable is substantively important. It suggests that the observed dependence is unlikely to be reducible to a simple one-way oil-price transmission channel. Instead, both markets may react to broader international conditions whose importance changes across periods. Wavelet-based studies of commodities similarly find that connectedness intensifies and changes structure during periods of disruption (Bouri et al., 2023).

The emerging-market result is also relevant to portfolio diversification. The unconditional correlation of 0.183 indicates relatively weak average association, but investors cannot assume that this relationship remains weak throughout the sample. During the broad high-coherence episodes visible in Figure 4, the diversification benefit of holding oil alongside emerging Islamic equities would have been materially lower than the full-sample correlation suggests.

This interpretation accords with the broader portfolio literature, which increasingly treats diversification as regime dependent. Alqaralleh & Canepa (2022) demonstrate that diversification properties can change across market conditions and frequencies in the context of precious metals, while Zhang et al. (2024) similarly assess whether alternative assets retain hedging properties following the COVID-19 period. The key implication is that low unconditional correlation is not equivalent to a permanent hedge.

### *Comparative Time-Frequency Evidence*

The three wavelet maps collectively reveal a clear hierarchy of dependence. Table 4 summarises the principal findings.

| Pair | Full-Sample Correlation | Short Horizon | Medium/Long Horizon | Main Interpretation |
|---|---|---|---|---|
| EQD-EQE | 0.524 | Fragmented but frequently recurring coherence | Broad and comparatively persistent high coherence | Islamic developed and emerging equities become more integrated as the horizon lengthens |
| EQD-OPB | 0.202 | Generally weak and episodic | Distinct clusters of strong coherence during selected periods | Oil matters conditionally rather than continuously for developed Islamic equities |
| EQE-OPB | 0.183 | Generally weak and fragmented | Pronounced but intermittent coherence at selected medium and longer horizons | Oil dependence is episodic and differs from that of developed Islamic equities |

Table 4. Summary of Pairwise Time-Frequency Results

The first result is that the Islamic equity pair displays a fundamentally different structure from either oil–equity pair. EQD and EQE share relatively broad medium- and long-horizon coherence, whereas oil dependence is organised into isolated or semi-continuous clusters. The developed–emerging equity relationship is therefore more persistent, while the oil relationship is more regime-specific.

This finding helps reconcile the unconditional and wavelet evidence. The 0.524 EQD–EQE correlation reflects a relationship that becomes especially strong at longer horizons but remains less uniform at high frequencies. In contrast, the oil correlations of 0.202 and 0.183 reflect relationships that are weak over large portions of the time–frequency domain but occasionally become very strong.

A static correlation coefficient is therefore unable to distinguish two conceptually different forms of dependence. A pair can have a moderate average correlation because it is persistently related at longer horizons, as in EQD–EQE, or a low average correlation because episodes of strong dependence are separated by long intervals of weak dependence, as in the oil–equity pairs. Wavelet analysis exposes this distinction.

The result supports Marfatia (2017), who emphasises the importance of horizon when assessing international stock-market integration. It also aligns with wavelet applications showing that commodity-market dependence can change materially across periods and scales (Bouri et al.,

2023; Zhao et al., 2024). Thus, the present findings are not simply a graphical reformulation of the correlation matrix; they alter the economic interpretation of the relationships.

### *Dependence Across Episodes of Financial Stress*

Another important feature of the wavelet maps is that several major coherence clusters occur around periods characterised by substantial global financial or economic disturbance. This pattern is most visible around the late 1990s, the late 2000s and early 2010s, and the beginning of the 2020s. The analysis should not interpret temporal coincidence as causal proof, but the concentration of stronger dependence around such episodes is economically consistent with the proposition that common shocks increase cross-market connectedness.

The late 1990s, for example, coincide with the Asian financial crisis, a period in which regional stock-market interdependence and volatility transmission received considerable attention. In et al. (2001) document dynamic interdependence among Asian stock markets in connection with this episode. In the present results, both the Islamic equity pair and portions of the oil-equity maps display elevated coherence around sections of the late-1990s period, especially outside the very shortest horizons.

The late 2000s and early 2010s constitute an even more prominent feature of the figures. All three pairwise relationships exhibit sizeable areas of elevated coherence across parts of this interval, although the strength and frequency bands differ. The fact that developed and emerging Islamic equities become highly coherent is intuitive in an environment dominated by common global financial information. More importantly for the present research question, Brent also becomes more strongly connected with both Islamic equity segments during portions of the period.

This result supports the broader view that diversification structures can deteriorate when common shocks dominate asset pricing. In such circumstances, markets that appear relatively weakly correlated under normal conditions can become increasingly synchronised. Tasca et al. (2017) emphasise the broader connection between diversification and systemic interconnectedness, while commodity research likewise finds changing co-movement during crisis conditions (Bouri et al., 2023).

The beginning of the 2020s provides another informative episode. The pandemic generated unusually large movements across global financial and commodity markets. The descriptive statistics in Table 2 already reveal the exceptional tail behaviour present in the sample, particularly for Brent oil. Wavelet research on financial markets during COVID-19 similarly documents pronounced changes in market behaviour (Costa et al., 2022), while Adnan (2023) identifies significant pandemic-era effects across Asian capital markets.

The present wavelet maps show renewed pockets of strong coherence around this broad period, although the precise scale and persistence differ by pair. The important point is not that every crisis produces identical dependence. Rather, stress periods appear capable of altering the

structure of cross-market relationships, reinforcing the argument that historical average correlations should not be treated as invariant portfolio parameters.

This is particularly important for risk management because diversification is most valuable when market conditions deteriorate. If oil becomes more closely connected with Islamic equities precisely during some episodes of heightened uncertainty, its ex-ante diversification value can be overstated by unconditional correlation statistics.

### *Research Question 1: Does Islamic Equity Integration Depend on the Investment Horizon?*

The first research question asks how the dependence between developed and emerging Islamic equities evolves across time and horizon. The evidence from Figure 2 provides a clear answer: integration is strongly horizon dependent.

At short horizons, the relationship is variable and fragmented. Developed and emerging Islamic equities therefore retain meaningful market-specific dynamics. This may reflect differences in liquidity, investor composition, economic news, market microstructure, and regional exposure.

At medium and longer horizons, however, commonality becomes substantially stronger and more persistent. The two indices increasingly behave as components of a common global Islamic equity environment rather than fully independent regional markets.

This finding contributes to Islamic equity research in two ways. First, it reinforces the evidence that Islamic financial markets exhibit complex risk characteristics rather than a uniform stochastic process. Second, it shows that heterogeneity and integration can coexist. Islamic equity markets can be segmented in the short run but highly integrated over longer horizons.

The portfolio implication is direct. The statement that emerging Islamic equities diversify developed Islamic equities is incomplete unless the investment horizon is specified. Short-term diversification opportunities appear greater than long-term opportunities. Institutional investors with long holding periods may consequently experience considerably less diversification than suggested by short-frequency dynamics.

### *Research Question 2: When Does Oil Matter for Islamic Equities?*

The second research question concerns whether Brent crude oil exerts a persistent or episodic relationship with Islamic equities. Both Figure 3 and Figure 4 point strongly toward the latter interpretation.

For substantial parts of the sample, oil–equity coherence is weak. These low-coherence intervals are consistent with the small unconditional correlations. Yet they are interrupted by clearly defined clusters in which the relationship becomes strong over particular horizons.

Oil therefore matters for Islamic equities conditionally. Its importance depends on both the historical environment and the holding period. This is the central empirical contribution of the paper. Asking whether oil is correlated with Islamic equities produces the relatively uninformative

answer that the average correlation is positive but weak. Asking when oil matters reveal a much richer structure. There are periods during which oil behaves largely in-dependently from the Islamic equity indices and periods in which its movements are tightly connected with them.

The finding closely complements Tien and Hung (2022), whose wavelet-based investigation of oil and GCC equity markets similarly demonstrates that spillovers differ across horizons. It also aligns with studies of time-varying dependence among energy, environmental, and financial assets (Zhao et al., 2024; Karimi et al., 2025).

The result should not be interpreted to mean that every strong-coherence episode is generated by an oil shock. Wavelet coherence measures local dependence, not structural causal origin. Both oil and equity markets may respond to global demand, monetary conditions, financial stress, geopolitical disturbances, inflation expectations, or supply-chain conditions. This caution is important given evidence that energy and commodity relationships respond to broader pressures such as supply-chain disturbances (Elsayed et al., 2025) and geopolitical risk (Mejri et al., 2025).

The appropriate conclusion is therefore narrower but more robust: oil be-comes materially connected with Islamic equities at identifiable time–frequency combinations, and the strength of this connection is not constant over the 1996–2025 period.

### *Research Question 3: Does Oil Affect Developed and Emerging Islamic Equities Differently?*

The third research question compares the two oil–equity relationships. Their unconditional correlations are close: 0.202 for developed Islamic equities and

0.183 for emerging Islamic equities. A purely static analysis might therefore conclude that the two relationships are nearly identical. The wavelet results reject such a simple interpretation.

Although both relationships are episodic, the location, duration, and frequency range of their high-coherence regions differ. Some episodes affect both developed and emerging Islamic equities, suggesting exposure to common global forces. Other coherence clusters differ materially between Figure 3 and Figure 4. Thus, similar unconditional correlations can arise from different underlying time–frequency structures.

This is an important methodological result. Two asset pairs can have almost the same full-sample correlation yet offer different diversification characteristics to investors because the timing of their dependence differs.

The emerging-market relationship appears particularly notable around several medium-horizon episodes, whereas the developed-market relationship contains its own distinct clusters across the sample. This difference is consistent with the broader argument that emerging-market dynamics are shaped by different information structures and common-factor exposures (Nazlioglu et al., 2024).

The finding therefore reinforces the need to avoid referring to "Islamic equities" as though they constitute one geographically homogeneous investment block. Shariah screening provides a common institutional framework, but the economic environments represented by developed and emerging indices continue to shape how those assets interact with global commodity markets.

## Conclusion

This study investigates when crude oil matters for Islamic equities by examining the time–frequency relationships among the Dow Jones Islamic World Developed Market Index (EQD), the Dow Jones Islamic World Emerging Markets Index (EQE), and Brent crude oil (OPB) over the period 1996–2025. Rather than if market dependence remains constant through time, the analysis combines unconditional correlation with wavelet coherence to distinguish relationships across both historical periods and investment horizons. The central finding is that the dependence structure of Islamic equities is substantially more complex than suggested by full-sample correlations. Developed and emerging Islamic equity returns exhibit a moderate unconditional correlation of approximately 0.52, while their respective correlations with Brent oil remain much lower, at approximately 0.20 and 0.18. The wavelet evidence demonstrates, however, that these averages conceal pronounced variation across time and frequency.

Three conclusions emerge from the empirical analysis. First, developed and emerging Islamic equities become increasingly integrated as the investment horizon lengthens. Their short-horizon relationship remains comparatively fragmented, suggesting that market-specific information, liquidity conditions, investor composition, and regional factors continue to generate temporary divergence. At medium and longer horizons, by contrast, coherence becomes considerably broader and more persistent. This finding implies that diversification between developed and emerging Islamic equities is itself horizon-dependent: it may remain meaningful for shorter-term allocation but becomes progressively weaker for investors operating over longer holding periods. The result complements evidence that Islamic equities exhibit complex risk and scaling characteristics and reinforces the broader argument that international market integration should be evaluated across investment horizons rather than through a single unconditional statistic.

Second, oil matters for Islamic equities, but not continuously. The relatively weak unconditional correlations between Brent and the two Islamic equity indices could be interpreted as evidence that oil provides a stable source of portfolio diversification. The wavelet results qualify this interpretation. Both EQD–OPB and EQE–OPB exhibit distinct episodes of strong coherence at frequencies and historical periods, separated by intervals in which the relationship is considerably weaker. Oil–Islamic equity dependence is therefore better characterised as episodic, regime-dependent, and horizon-sensitive than as a permanent structural relationship. This conclusion is consistent with evidence that oil–stock spillovers and commodity-market connectedness vary across time and frequency. It follows that low historical correlation should not automatically be interpreted as evidence of persistent hedging or diversification capacity.

Third, developed and emerging Islamic equities do not respond identically to Brent crude oil. Although their unconditional oil correlations are numerically similar, the wavelet-coherence maps reveal differences in the timing, duration, and frequency composition of high-dependence episodes. This finding demonstrates that a shared Shariah-compliant investment identity does not eliminate geographic and structural heterogeneity. Developed and emerging Islamic markets remain exposed to different economic environments, sectoral structures, investor bases, and transmission mechanisms. Accordingly, the global Islamic equity universe should not be treated as one homogeneous market when evaluating commodity exposure or portfolio risk.

The study contributes to the literature by integrating three areas that are of-ten examined separately: Islamic equity-market behaviour, developed–emerging market integration, and oil–equity dependence. Its principal contribution is to show that these relationships cannot be adequately understood through static correlation alone. The wavelet framework reveals that the economic meaning of market dependence changes with both time and investment horizon. For Shariah-compliant investors, the practical implication is straightforward: diversification should be treated as conditional rather than fixed. Developed and emerging Islamic equities may provide meaningful diversification at some horizons but move increasingly together at others, while oil may act as a relatively independent as-set during certain periods yet become substantially more connected with Islamic equities during episodes of heightened common exposure. Portfolio construction should therefore consider not only which assets are combined, but also when the allocation is made and over what horizon the portfolio is intended to operate.

Several limitations provide directions for future research. Wavelet coherence identifies localised dependence and phase relationships but does not establish the structural economic shock responsible for each episode of heightened coherence. Future studies could therefore distinguish between oil-supply shocks, global-demand shocks, geopolitical disturbances, inflationary pressures, monetary-policy changes, and financial-market stress. The analysis could also be extended through wavelet-based quantile methods, dynamic conditional correlation models, or connectedness measures to examine whether dependence differs between bullish and bearish market states. Further research may also disaggregate the developed and emerging Islamic indices by country or sector to determine whether markets or industries drive the observed global relationships. Nevertheless, the evidence presented here provides a clear answer to the question posed in the title: oil matters for Islamic equities when market regimes and investment horizons bring the two asset classes into stronger alignment. Its importance is therefore conditional on time, frequency, and the segment of the Islamic equity market under consideration.

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