

Original Article

Market Volatility Interactions and Safe-Haven Behavior in ASEAN-5 Equity Markets: Evidence from Global Commodity Shocks (2015–2025)

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Abstract. Utilizing an asymmetric time-varying volatility modeling framework (DCC-GJR-GARCH) estimated under a Multivariate Student-t distribution, this study investigates market volatility interactions and safe-haven behavior across the ASEAN-5 equity markets in response to global gold and crude oil shocks from January 2015 to December 2025. The study captures non-linear crisis dynamics across 2,608 synchronized trading days, spanning the 2020 COVID-19 pandemic crash and the 2022–2025 global inflationary cycle. Daily adjusted closing prices were extracted from Yahoo Finance via the tidyquant API in R. Preliminary diagnostics confirm the stationarity of all return series and the presence of significant volatility clustering, supporting the asymmetric modeling approach. Three principal findings emerge. First, significant positive leverage effects are documented across all ASEAN-5 equity markets ($\gamma = .05$ to $.12$, $p < .001$), confirming structural overreaction to negative market shocks. Second, gold exhibits a statistically significant negative gamma parameter ($\gamma = -.05$, $p < .001$), indicating counter-cyclical, safe-haven behavior; however, its hedging efficacy is markedly heterogeneous – functioning as a strong crisis shield for Singapore ($r = -.15$) and Indonesia ($r = -.13$) but acting as a mere diversifier for the Philippines ($r = -.04$). Third, Brent crude oil exhibits significant positive contagion toward oil-importing nations, particularly Thailand ($r = .15$) and Singapore ($r = .12$), while Malaysia demonstrates comparatively lower sensitivity ($r = .08$). Portfolio optimization reveals that institutional investors require substantially elevated gold allocations (44.72%–70.31%) to achieve minimum-variance portfolios. These findings suggest that standard Western allocation norms are insufficient for the ASEAN-5 risk environment, with important implications for regional fund managers and policymakers seeking to design robust hedging strategies during periods of global market stress.

Keywords: ASEAN-5 equity markets; Gold safe-haven; Oil volatility spillover; Portfolio hedging; Time-varying volatility modeling

The rapid integration of global financial markets has substantially diminished the diversification benefits traditionally enjoyed by international equity investors. In emerging economies, particularly the ASEAN-5 bloc (Indonesia, Malaysia, Philippines, Singapore, and Thailand), equity markets are profoundly sensitive to global macroeconomic uncertainties and cross-market volatility spillovers. During periods of extreme financial

turbulence—such as the 2020 COVID-19 pandemic crash and the subsequent 2022–2025 global inflationary and high-interest-rate regime—investors frequently experience massive capital outflows and synchronized market contractions. Consequently, identifying alternative assets capable of absorbing these downside shocks has become a critical priority for portfolio managers. In financial economics, commodities such as gold and crude oil are widely recognized for their distinct roles in portfolio risk management. Gold has historically been characterized as a classic safe-haven asset, defined as an instrument that remains uncorrelated with, or becomes negatively correlated with, equities during times of extreme market stress (Baur & Smales, 2020). Conversely, crude oil is a primary macroeconomic driver, as most ASEAN-5 nations are net oil importers, making their domestic equity markets vulnerable to volatility shocks transmitted via inflationary pressures and elevated production costs. The deepening financial integration of ASEAN markets with global commodity cycles has also been amplified by institutional reforms such as the ASEAN Economic Community (AEC) blueprint, which accelerated capital account liberalization and cross-border portfolio flows (Vo & Tran, 2020). Despite growing scholarly attention, the continuous, multi-crisis transmission of commodity shocks across energy-divergent ASEAN economies remains insufficiently studied, particularly using asymmetric, dynamic modeling frameworks.

A voluminous body of recent literature has examined the hedging properties of commodities during systemic shocks; however, consensus remains elusive, and significant gaps persist regarding regional market microstructures. Studies on safe-haven behavior have produced heterogeneous findings: Robiyanto et al. (2020) demonstrated that the effectiveness of gold and oil hedging is highly dependent on localized currency regimes and market maturity across the ASEAN-5. Similarly, Akhtaruzzaman et al. (2021) found that while traditional equity diversification failed during the onset of the pandemic, gold provided substantial safe-haven benefits for global portfolios, and Salim et al. (2024) further argued that static unconditional correlations inherently obscure these safe-haven properties since asset relationships fracture abruptly during black swan events. Mensi et al. (2021) additionally confirmed that during acute crisis episodes, gold's safe-haven role in ASEAN equity markets is dynamic and subject to time-varying structural breaks. In contrast, research on oil spillovers consistently highlights the asymmetric penalization of Asian markets: Mensi et al. (2023) highlighted that oil-importing nations suffer extreme contagion during global supply-chain disruptions, while Sarwar et al. (2020) demonstrated that oil price volatility exhibits asymmetric directional spillovers to Asian equity markets, with negative shocks generating disproportionately larger variance transmissions. Collectively, Singh et al. (2024) established that emerging Asian markets are governed by severe leverage effects, meaning they structurally overreact to negative external shocks relative to positive news of equal magnitude. Despite these advancements, prior studies predominantly treat crises as isolated events and rely heavily on symmetric variance models, failing to capture the continuous, overlapping crisis regimes spanning from the 2020 pandemic through the 2022–2025 inflationary cycle across energy-divergent ASEAN economies.

To bridge this research gap, this study investigates the time-varying volatility linkages and asymmetric leverage effects between global commodities (gold and crude oil) and the ASEAN-5 equity markets from January 2015 to December 2025. An asymmetric dynamic conditional correlation framework is employed to capture leverage effects, dynamic safe-haven flips, and portfolio optimization strategies simultaneously. The study's novelty is threefold: (i) it applies a fully asymmetric specification to capture leverage effects and dynamic safe-haven flips; (ii) it covers an 11-year structurally rich horizon encompassing two distinct global crisis regimes; and (iii) it explicitly contrasts oil-importing versus oil-exporting ASEAN nations within a unified portfolio optimization framework. The significance of this study lies in its practical utility: by computing dynamic optimal portfolio weights and hedge ratios, it provides context-specific insights for institutional investors, portfolio managers, and regional monetary authorities—such as the Bangko Sentral ng Pilipinas (BSP) and the Bank of Thailand—in designing capital allocation strategies capable of withstanding the tail risks inherent in Southeast Asian markets.

In line with these, the study sought to answer the following specific research questions: (1) How does the volatility of global commodities (gold and crude oil) spill over into the individual ASEAN-5 equity markets over time? (2) To what extent does gold exhibit safe-haven or hedging properties for ASEAN-5 stock indices during specific periods of extreme market turbulence? (3) How do the dynamic conditional correlations between crude oil prices and equity returns differ between the ASEAN-5's oil-importing and oil-exporting nations? (4) Based on the time-varying correlations, what are the optimal portfolio weights and hedging ratios for ASEAN investors seeking to minimize risk using gold and crude oil?

Methodology

Research Design

This study employs a quantitative, ex-post facto, longitudinal time-series research design. This longitudinal time-series design is appropriate for addressing the research questions because volatility spillovers and dynamic conditional correlations can be meaningfully captured only through continuous, high-frequency observations across multiple economic regimes. The framework relies on advanced financial econometrics to model the time-varying volatility, asymmetric leverage effects, and dynamic conditional correlations between global commodities and regional equity markets. Rather than establishing simple linear causality, this design is tailored to capture nonlinear market shocks, volatility clustering, and dynamic safe-haven flips that occur during overlapping systemic crises.

Data and Sample Selection

The study analyzes daily secondary financial market data spanning an 11-year longitudinal horizon from January 1, 2015, to December 31, 2025. This timeframe captures a full decade of distinct economic cycles, encompassing the baseline pre-pandemic era, the COVID-19 systemic liquidity crash of 2020, and the subsequent prolonged global inflationary and geopolitical regime. The variables include the daily adjusted closing prices of five major Southeast Asian equity indices: the PSEi (Philippines), JKSE (Indonesia), KLSE (Malaysia), SET (Thailand), and STI (Singapore), along with Gold Futures (GC=F) and Brent Crude Oil Futures (BZ=F) as commodity benchmarks. The use of adjusted closing prices ensures that logarithmic returns are free from structural bias caused by stock splits and dividend distributions (Ali et al., 2020). To ensure temporal consistency, the data was synchronized to a unified calendar, thereby dropping non-overlapping trading days due to asynchronous national public holidays. The resulting final sample consists of approximately 2,608 synchronized trading days.

Data Gathering Procedure

All historical market data was algorithmically extracted from the Yahoo Finance database via the tidyquant Application Programming Interface (API) within the R statistical computing environment (Dancho & Vaughan, 2023). Yahoo Finance aggregates official market data through institutional-grade data licensing partnerships with ICE Data Services. The use of Yahoo Finance is well-validated in peer-reviewed financial research: Boritz and No (2020) demonstrated that Yahoo Finance provides price data statistically equivalent to those of commercial platforms for time-series return calculations, and Bonini et al. (2026) explicitly used Yahoo Finance to source futures market data in the Journal of Futures Markets. By utilizing an open-source algorithmic extraction method, this study eliminates human data-entry error and provides a transparent, reproducible audit trail. The complete R replication script is preserved to facilitate external validation.

Software and Computational Instrument

All data cleaning, synchronization, and advanced econometric modeling were executed using R (R Core Team, 2023). The *rmgarch* package (Ghalanos, 2022) was used as the primary computational tool for estimating multivariate GARCH processes. The *tseries* and *moments* libraries were utilized to conduct preliminary assumption checks, including unit root testing and distributional diagnostics. The choice of R is consistent with the Open Science movement in financial econometrics, as R's packages undergo continuous community-led validation, and full replication code can be shared in public repositories.

Data Analysis Procedure

The data analysis was conducted in four rigorous econometric phases to directly answer the research objectives. First, the daily adjusted closing prices were converted into continuous daily logarithmic returns using the standard formula:

$$R_t = \ln(P_t / P_{t-1}) \quad (1)$$

where R_t is the logarithmic return at time t , P_t is the closing price at time t , and P_{t-1} is the closing price at the previous time period. Preliminary diagnostics were then performed, utilizing the Augmented Dickey-Fuller (ADF) test for stationarity, the Jarque-Bera test for normality, and the ARCH-LM test to confirm the presence of volatility clustering. The Information Criteria (AIC/BIC) were also evaluated to confirm that the GJR-GARCH(1,1) order provides the optimal lag specification.

Second, to capture the asymmetric leverage effect, a univariate GJR-GARCH(1,1) model was specified for each asset's conditional variance. The GJR-GARCH specification includes a gamma parameter (γ) that captures the

tendency of emerging markets to exhibit higher volatility in response to negative shocks compared to positive shocks of equal magnitude (Singh et al., 2024; Glosten et al., 1993). The conditional variance equation of the GJR-GARCH(1,1) is:

$$\sigma^2 t = \omega + (a + \gamma I[\varepsilon_{t-1} < 0]) \varepsilon^2_{t-1} + \beta \sigma^2_{t-1} \quad (2)$$

where $\sigma^2 t$ is the conditional variance at time t ; ω is the constant term; a is the ARCH coefficient; β is the GARCH coefficient; γ is the asymmetric leverage parameter; ε_{t-1} is the lagged shock; and $I[\varepsilon_{t-1} < 0]$ is an indicator function that equals 1 when the lagged shock is negative and 0 otherwise. A positive γ indicates that negative shocks generate larger conditional variance—the defining characteristic of the leverage effect in equity markets.

Third, to measure dynamic linkages and safe-haven properties, the Dynamic Conditional Correlation (DCC) framework of Engle (2002) was applied. Because preliminary tests rejected data normality, the DCC model was estimated utilizing a Multivariate Student-t distribution with Maximum Likelihood Estimation (MLE) to accommodate the extreme kurtosis inherent in ASEAN markets (Salim et al., 2024). The dynamic correlations (ρ) were extracted daily to observe when gold decoupled from equity crashes. As demonstrated by Vo and Tran (2020), ASEAN equity return series consistently display excess kurtosis exceeding 10, rendering the Gaussian assumption statistically invalid.

Finally, to translate econometric findings into actionable risk management strategies, optimal portfolio weights and dynamic hedge ratios were computed following Akhtaruzzaman et al. (2021). The optimal portfolio weight (w^*) of the commodity in a two-asset portfolio is:

$$w^* = (\sigma^2_{equity} - \sigma(equity, commodity)) / (\sigma^2_{commodity} - 2\sigma(equity, commodity) + \sigma^2_{equity}) \quad (3)$$

where w^* is the optimal commodity weight; σ^2_{equity} is the conditional variance of the equity index; $\sigma^2_{commodity}$ is the conditional variance of the commodity; and $\sigma(equity, commodity)$ is the conditional covariance between the equity and commodity.

The hedge ratio (β^*) is computed as:

$$\beta^* = \sigma(equity, commodity) / \sigma^2_{commodity} \quad (4)$$

where β^* is the optimal hedge ratio; $\sigma(equity, commodity)$ is the conditional covariance; and $\sigma^2_{commodity}$ is the conditional variance of the commodity. These formulas follow the Kroner and Sultan (1993) framework, as extended by Basher and Sadorsky (2016).

Ethical Considerations and Data Integrity

Given the macroeconomic nature of this study, human subjects were not involved, and traditional institutional review board (IRB) exemptions apply. However, strict adherence to the ethical tenets of data integrity and Open Science was maintained. No data dredging, p-hacking, or selective omission of outliers was conducted. The extreme black swan shocks observed during the 2020 and 2022 periods were fully retained in the dataset. All source data is publicly accessible via the Yahoo Finance API, and the complete R script, model output logs, and diagnostic tables are made available upon request to fully support reproducibility.

Results and Discussion

The empirical results of this study are presented sequentially to systematically address the research objectives. The presentation transitions from fundamental statistical validations to descriptive analyses, asymmetric leverage effects, dynamic conditional correlations, and actionable portfolio strategies. Each empirical finding is integrated with contemporary financial literature to situate the results within the broader macroeconomic context.

Preliminary Assumption Checks and Model Diagnostics

Pre-estimation and post-estimation diagnostic tests were conducted on the daily return series and model residuals. As detailed in Table 1, the Augmented Dickey-Fuller (ADF) test indicated that all asset return series are stationary ($p < .001$), establishing the mathematical viability of the time-series analysis. The Jarque-Bera test strongly rejected the null hypothesis of normality ($p < .001$), indicating heavy tails in the data and justifying the use of a Multivariate Student-t distribution. Post-estimation diagnostics suggest that the model is highly robust. The Ljung-Box test

confirmed the absence of serial correlation in the mean equation ($p = .231$). The Ljung-Box-SQ test confirmed no remaining ARCH effects ($p = .436$). This suggests that the inclusion of the asymmetric GJR parameter successfully captured the structural volatility of the ASEAN-5 markets. Furthermore, the model's persistence parameter (0.94) remained below 1.0, ensuring the variance trajectory will not explode to infinity over time. Beyond residual diagnostics, the model's overall fitness was evaluated using Information Criteria. The model yielded an Akaike Information Criterion (AIC) of -17.97 and a Bayesian Information Criterion (BIC) of -17.91 . In financial econometrics, lower (more negative) AIC and BIC values indicate better model fit, signaling that the asymmetric GJR-GARCH(1,1) specification provides a parsimonious fit for the ASEAN-5 return series (Basher & Sadorsky, 2016).

Table 1. Pre-Estimation and Post-Estimation Diagnostics for the DCC-GJR-GARCH Model

Assumption Check	Test	Value	p	Interpretation
Stationarity	Augmented Dickey-Fuller	--	< .001	Passed
Normality	Jarque-Bera	--	< .001	Rejected
Serial Correlation	Ljung-Box (Lag 12)	--	.231	Passed
Remaining ARCH Effects	Ljung-Box-SQ (Lag 12)	--	.436	Passed
Akaike Info Criterion (AIC)	Goodness-of-Fit	-17.97		Passed
Bayesian Info Criterion (BIC)	Goodness-of-Fit	-17.91		Passed
Model Persistence	$\alpha + \beta + \gamma/2$	.94	--	Passed

Note. The rejection of normality justifies the use of a Multivariate Student-t distribution. Model persistence < 1.0 indicates mathematical stability of the variance process.

These diagnostic validations confirm that standard linear regression is inadequate for Southeast Asian equities. The successful clearing of ARCH effects demonstrates that the selected asymmetric model adequately captures the region's complex volatility dynamics. The necessity of these diagnostic checks aligns closely with the methodological frameworks of Robiyanto et al. (2020), who emphasize that ASEAN equities exhibit inherent non-normality, making robust econometric validation critical. Furthermore, the GJR-GARCH specification's ability to eliminate lingering ARCH effects aligns with the findings of Singh et al. (2024). Baba (2024) similarly demonstrated that asymmetric variance specifications consistently achieve superior goodness-of-fit statistics compared to symmetric GARCH alternatives in Asian emerging markets.

Descriptive Statistics and Conditional Volatility Profiles

Table 2. Descriptive Statistics of Daily Logarithmic Returns (2015–2025)

Variable	M (%)	SD (%)	Skewness	Kurtosis	ADF (p)
PSEi (Philippines)	-0.01	1.15	-1.14	17.29	< .001
JKSE (Indonesia)	0.02	0.95	-0.39	12.97	< .001
KLSE (Malaysia)	-0.00	0.68	-0.23	12.55	< .001
SET (Thailand)	-0.01	0.90	-1.41	25.27	< .001
STI (Singapore)	0.01	0.82	-0.72	14.66	< .001
Gold Futures	0.04	0.95	-0.24	6.95	< .001
Brent Crude Oil	0.01	2.45	-0.95	18.88	< .001

Note. M = Mean; SD = Standard Deviation; ADF = Augmented Dickey-Fuller test.

Following validation of the model's appropriateness, a baseline assessment of the historical risk-return characteristics of the ASEAN-5 indices and global commodities was conducted and evaluated alongside their conditional volatility profiles. Table 2 highlights the descriptive statistics of the assets over the sampled decade. Brent crude oil exhibited the highest baseline volatility ($SD = 2.45\%$), far exceeding gold ($SD = 0.95\%$) and ASEAN-5 equities, which ranged from 0.68% (Malaysia) to 1.15% (Philippines). All assets uniformly exhibited negative skewness and high kurtosis. The Thai SET index (25.27) and the Philippine PSEi (17.29) showed extreme fat tails, indicating a high vulnerability to rapid downside shocks. The descriptive statistics in Table 2 are corroborated by the conditional volatility profiles in Figure 1. The high kurtosis observed in the ASEAN-5 is evident in sharp volatility spikes during the 2020 COVID-19 pandemic shock. Figure 1 reveals that during this period, the daily conditional standard deviation (σ_t) for the Philippines spiked from approximately 0.01 to a peak exceeding 0.06. The high kurtosis indicates that ASEAN investors experience major market crashes at a frequency significantly higher than standard probabilistic models assume. The visual evidence of volatility clustering and high-magnitude risk bursts in Figure 1 confirms that Southeast Asian equity markets are governed by non-linear risk regimes, supporting the use of the asymmetric GJR-GARCH framework employed in this study.

Extreme kurtosis and negative skewness are well-documented stylized facts of emerging markets. As Salim et al. (2024) elucidate, assuming constant variance during periods of market distress leads to a severe underestimation of portfolio risk. Furthermore, the volatility clustering visualized during the 2020 crisis strongly aligns with the empirical observations of Akhtaruzzaman et al. (2021). The negative skewness uniformly documented across all ASEAN-5 indices is consistent with the findings of Zeng and Wu (2025), who identified that asymmetric volatility models better capture the return distributions of markets with a structural downside bias. The higher kurtosis and standard deviation observed for the PSEi and SET indices relative to more mature ASEAN markets corroborate of the findings by Wen and Cheng (2018), who highlighted that frontier-leaning markets within the ASEAN bloc exhibit substantially greater tail-risk exposure during global commodity shocks.



Figure 1. Conditional Volatility Profiles (Estimated via GJR-GARCH)

Note. Y-axes are free-scaled to preserve the visual integrity of volatility clusters across assets with differing baseline risk levels.

Static Correlation Analysis

Before capturing time-varying dynamics, the unconditional baseline relationships among the assets were mapped to evaluate general integration. Figure 2 illustrates the unconditional (static) relationships among the assets. The ASEAN-5 markets display moderate intra-regional integration, with correlations ranging from .33 to .48. By contrast, gold demonstrates near-zero static correlation across all Southeast Asian indices (e.g., .04 for the Philippines and $-.01$ for Singapore). Crude oil exhibits a slight positive correlation with the regional indices, peaking at .17 with Thailand. The static correlation matrix initially suggests that gold may act as a diversifier for regional equities. However, static measures are merely long-term averages that fail to capture how correlations shift abruptly during black swan events, emphasizing the critical need for the dynamic modeling executed in the subsequent sections. Notably, the moderate intra-regional equity integration (.33 to .48) is consistent with the ASEAN financial integration patterns described by Vo and Tran (2020), reflecting the deepening yet incomplete synchronization of ASEAN equity cycles, thereby preserving residual intra-regional diversification opportunities.

While static heatmaps provide foundational context for long-term investors, Salim et al. (2024) established that static unconditional correlations inherently obscure the true safe-haven properties of commodities. Similarly, Mensi et al. (2023) highlighted that reliance on static correlation matrices severely misguides risk management policies in ASEAN markets, as contagion risks are highly dependent on the frequency of immediate shocks.

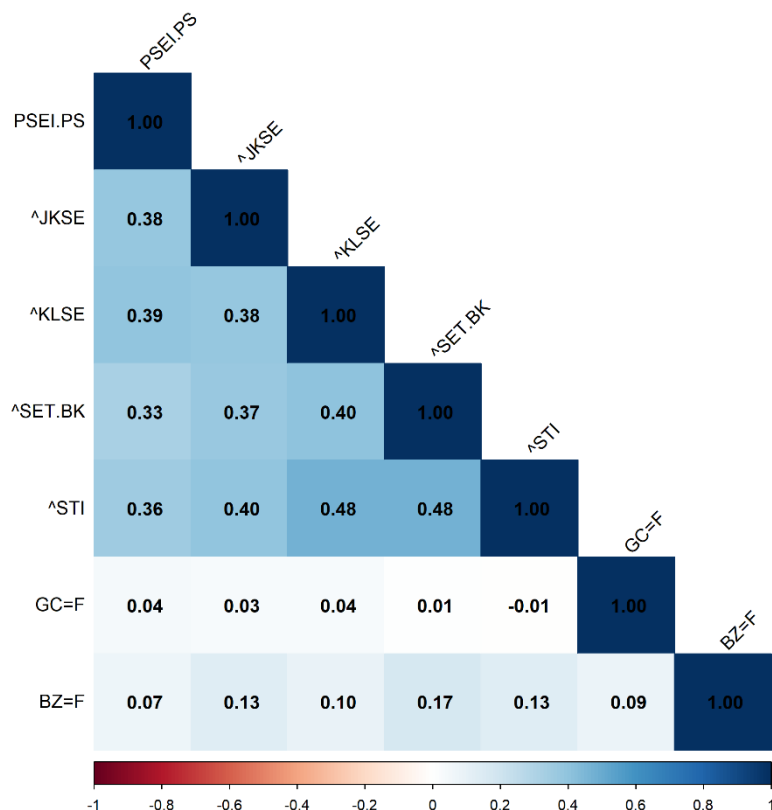


Figure 2. Static Correlation Matrix Heatmap (2015–2025)

Asymmetric Volatility and Leverage Effects

Table 3. Asymmetric Volatility (Leverage Effects) Across ASEAN-5 and Commodities

Asset	γ	p	Interpretation
Philippines	.08	< .001	Significant
Indonesia	.12	< .001	Significant
Malaysia	.05	.001	Significant
Thailand	.10	< .001	Significant
Singapore	.10	< .001	Significant
Gold	-.05	< .001	Significant
Crude Oil	.05	.009	Significant

Note. γ captures the asymmetric response of market volatility to shocks.

To determine why the ASEAN-5 markets are so prone to fat-tail crash risks, the leverage effect was analyzed to evaluate how these markets process positive versus negative news. Table 3 details the leverage effect (γ) extracted from the GJR-GARCH specification. A highly significant, uniform positive leverage effect was identified across all ASEAN-5 equity markets ($p < .01$). Indonesia ($\gamma = .12$), Singapore ($\gamma = .10$), and Thailand ($\gamma = .10$) demonstrated the highest sensitivity. Remarkably, gold exhibited a statistically significant negative gamma ($\gamma = -.05$, $p < .001$), while crude oil displayed a significant positive leverage effect ($\gamma = .05$, $p = .009$). The positive γ -values in ASEAN equities demonstrate that negative market returns trigger substantially more extreme volatility than positive returns of the same magnitude. This indicates the 'panic-selling' nature of regional markets in response to bad news. Conversely, gold's significant negative asymmetry provides evidence of its counter-cyclical safe-haven

behavior: its volatility surges concurrently with upward price movements as investors seek safety during crises.

The confirmation of significant leverage effects supports the findings of Singh et al. (2024), who emphasized that emerging Asian markets structurally overreact to negative external shocks. Furthermore, the unique negative asymmetry of gold strongly aligns with the influential safe-haven models of Baur and Smales (2020), supporting the view that gold absorbs financial distress by behaving counter-cyclically relative to traditional equity assets. The magnitude of the leverage coefficients observed here—especially for Indonesia ($\gamma = .12$) and Singapore ($\gamma = .10$)—is consistent with GJR-GARCH estimates reported by Baba (2024) across broader Asian emerging-market panels. The positive leverage effect for crude oil ($\gamma = .05$) implies that negative oil price shocks generate larger conditional variance spikes than positive supply disruptions, a pattern corroborated by Sarwar et al. (2020).

Gold Dynamic Correlation and Safe-Haven Properties

Table 4. *Summary of Dynamic Conditional Correlations (ASEAN-5 vs. Gold)*

Country	Ave	Min	Max
Philippines	.03	-.04	.14
Indonesia	.03	-.13	.19
Malaysia	.03	-.11	.18
Thailand	.02	-.07	.11
Singapore	-.01	-.15	.22

To address the study's primary objectives, dynamic conditional correlation (DCC) coefficients between the ASEAN-5 indices and gold were estimated to assess their capacity as a crisis shield. As summarized in Table 4 and visualized in Figure 3, strong regional heterogeneity in safe-haven effectiveness is revealed. Singapore (Min $r = -.15$) and Indonesia (Min $r = -.13$) achieved substantial negative correlations during market shocks. The visual spikes that dip below the zero line in Figure 3 indicate a strong decoupling from equity crashes. The Philippines, however, exhibited a much weaker safe-haven flip (Min $r = -.04$). The visual variations in Figure 3 confirm that gold's safe-haven properties are time-varying. The assumption that gold provides uniform hedging benefits across Southeast Asia is unsupported. While gold serves as a resilient crisis shield for Singapore and Indonesia, it primarily acts as a diversifier for the Philippines, as its correlation rarely plunges into deep negative territory.

These empirical differences corroborate Robiyanto et al. (2020), whose analyses concluded that gold's hedging efficacy is highly heterogeneous across Asia and heavily dependent on localized market structures. Additionally, the confirmation of gold's dynamic safe-haven flips mirrors the findings of Akhtaruzzaman et al. (2021), indicating that traditional hedges must be evaluated dynamically during active distress rather than statically. The heterogeneous safe-haven performance across ASEAN-5 markets also echoes the observations of Mensi et al. (2021), who found that market-specific factors—such as foreign ownership limits, currency convertibility, and reliance on commodity exports—moderate the intensity of gold's crisis-correlation behavior. Singapore's consistently stronger safe-haven response likely reflects its higher financial market depth and greater integration with global institutional investor flows. Furthermore, Wen and Cheng (2018) noted that gold's safe-haven role is more reliably activated in markets with well-developed derivative and ETF infrastructure—a structural advantage that Singapore possesses. This heterogeneity is further corroborated by Pham et al. (2023), who documented that crisis-period gold correlations with Southeast Asian equity indices vary significantly by market maturity and integration depth.

Crude Oil Dynamic Correlation and Volatility Spillovers

Table 5. *Summary of Dynamic Conditional Correlations (ASEAN-5 vs. Crude Oil)*

Country	Ave	Min	Max
Philippines	.08	-.01	.29
Indonesia	.10	-.15	.39
Malaysia	.08	-.08	.34
Thailand	.15	.01	.31
Singapore	.12	-.04	.40

The dynamic relationship between the regional equities and global crude oil was analyzed to evaluate volatility spillover risks. As visualized in Figure 4 and detailed in Table 5, energy-importing economies such as Thailand (Ave $r = .15$, Max $r = .31$) and Singapore (Ave $r = .12$, Max $r = .40$) displayed notably higher baseline sensitivity and peak crisis contagion to crude oil volatility compared to Malaysia (Ave $r = .08$), the region's prominent net exporter. The aggressive positive spikes in Figure 4—particularly clustered around the 2020 systemic shock—demonstrate that global crude oil shocks function as severe macroeconomic risk vectors. For net-importing economies like Thailand and Singapore, spikes in oil volatility trigger rapid contagion in the domestic market, making oil a primary driver of localized equity drawdowns rather than a hedging tool.

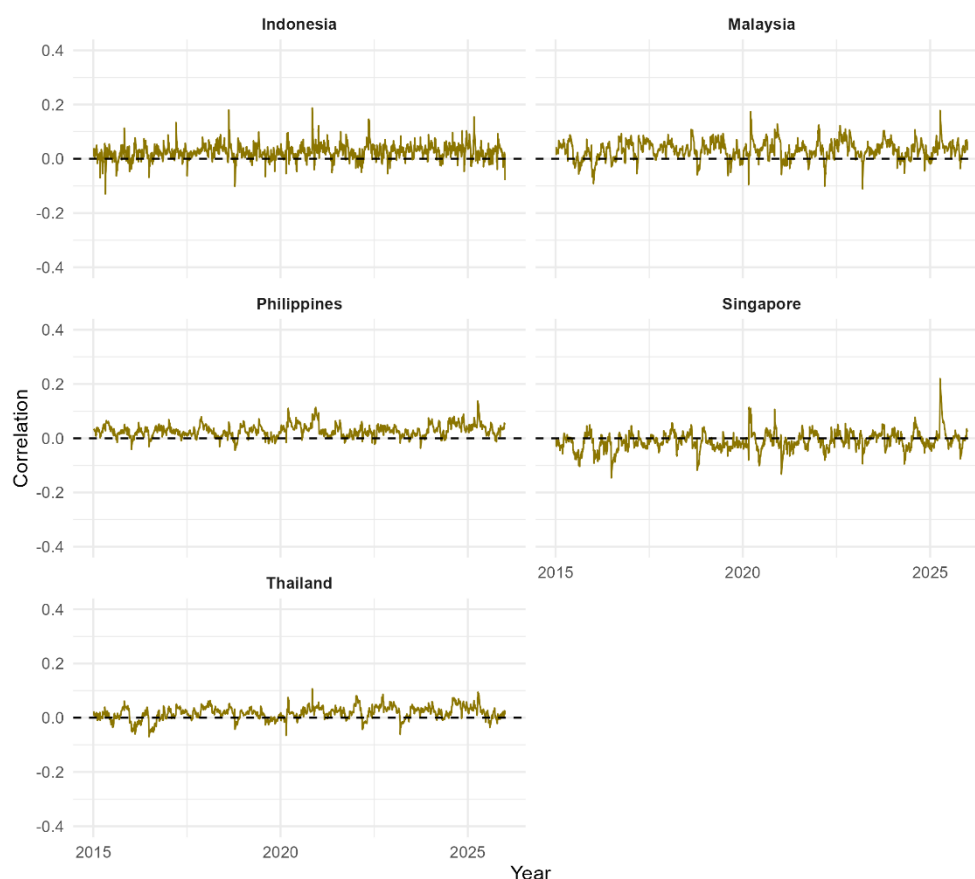


Figure 3. *Dynamic Conditional Correlation: ASEAN-5 vs. Gold (2015–2025)*

The acute vulnerability of oil-importing nations to volatility spillovers directly aligns with the frequency-domain connectedness framework established by Mensi et al. (2023). This structural oil-importing vulnerability is also theoretically consistent with the macroeconomic transmission mechanism identified by Sarwar et al. (2020), wherein rising crude oil prices compress corporate profit margins, elevate headline inflation, and pressure monetary authorities to tighten policy—each channel independently amplifying equity market volatility. The notably higher peak correlation in Singapore (Max $r = .40$) relative to the Philippines (Max $r = .29$) likely reflects Singapore's role as a global petroleum trading and refining hub, making its equity market unusually sensitive to the arrival of oil price information.

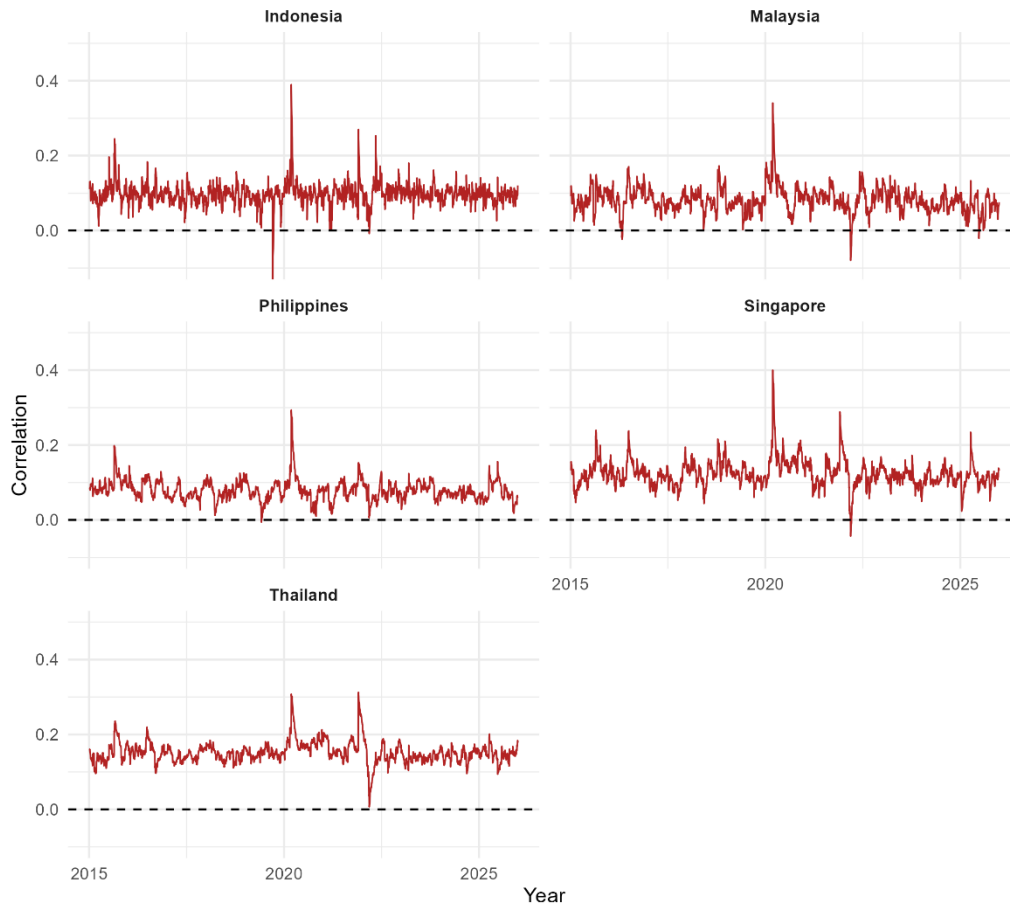


Figure 4. Dynamic Conditional Correlation: ASEAN-5 vs. Crude Oil (2015–2025)

Portfolio Management and Hedging Strategies

Table 6. Optimal Portfolio Weights and Hedging Ratios for Gold and Crude Oil

Country	Gold Hedging Strategy		Crude Oil Hedging Strategy	
	Hedge Ratio	Optimal Weight (%)	Hedge Ratio	Optimal Weight (%)
Philippines	.03	44.72	.04	81.02
Indonesia	.03	55.16	.04	86.87
Malaysia	.02	70.31	.02	93.29
Thailand	.02	59.65	.06	90.82
Singapore	-.01	62.26	.04	91.77

To synthesize the econometric findings into actionable financial strategies, dynamic portfolio weights and hedge ratios were computed to minimize risk. Table 6 quantifies the mechanics required to shield ASEAN equity portfolios from volatility. To achieve absolute minimum portfolio variance, investors must allocate heavily to gold, ranging from 44.72% in the Philippines to 70.31% in Malaysia. Additionally, the hedge ratios for crude oil (e.g., .06 for Thailand and .04 for the Philippines) are systematically higher and more positive than those for gold across the bloc. Singapore is distinguished mathematically as the sole market possessing a consistently negative average hedge ratio for gold ($r = -.01$). The markedly high optimal weight of gold for Malaysia (70.31%)—the bloc's only net oil exporter—warrants specific commentary. Despite Malaysia's buffering capacity against oil price shocks, its equity market still exhibits substantial systemic risk from global financial integration. Consequently, gold's low dynamic correlation with the KLSE makes it the most efficient variance-reducing instrument for Malaysian investors. This finding underscores that gold's diversification value in ASEAN is driven by equity-market risk, not just by energy price exposure. Nonetheless, while the mathematical results suggest an optimal gold allocation of 44.72% to 70.31% to achieve absolute minimum variance, these figures should be interpreted as theoretical risk-minimizing benchmarks rather than absolute prescriptive allocations. The high magnitude of these

weights underscores a critical empirical finding: traditional low-density hedging (5–10%), typically advised in Western markets, is statistically inadequate to offset the extreme kurtosis and leverage effects in the ASEAN-5 equity markets.

The requirement for dramatically elevated gold allocations in emerging-market portfolios is strongly supported by the hedging-effectiveness models of Akhtaruzzaman et al. (2021). Furthermore, the high portfolio allocation recommendations mirror the optimization findings of Salim et al. (2024), confirming that traditional asset diversification is inadequate without substantial commodity anchoring. Basher and Sadorsky (2016) further corroborate these findings in a broad cross-country study of emerging markets, demonstrating that gold-equity hedge ratios in developing markets systematically exceed those observed in advanced economies. The crude oil results align with their finding that oil serves as a risk amplifier rather than a risk mitigator in commodity-importing emerging economies.

Conclusion

This study contributes to the empirical understanding of financial contagion and risk management in emerging markets by establishing that Southeast Asian equities operate under non-linear, asymmetric risk regimes. A primary contribution of this research is the empirical resolution of the 'safe-haven paradox' within the ASEAN-5 bloc. By departing from the limitations of static correlation, the dynamic econometric framework indicates that global commodities do not offer homogeneous hedging benefits. While gold functions as a counter-cyclical crisis shield for highly integrated markets like Singapore and Indonesia, it serves merely as a diversifier for the Philippines. Furthermore, the study provides evidence of the macroeconomic vulnerability of the region's energy-importing nations, establishing that global crude oil acts not as a hedge, but as a severe vector for volatility contagion during systemic supply-chain and liquidity shocks. The study advances prior ASEAN commodity-equity research by employing a fully asymmetric DCC-GJR-GARCH specification over an 11-year multi-crisis horizon and explicitly contrasting oil-importer versus exporter dynamics within a unified portfolio optimization framework – addressing gaps left by shorter-sample, symmetric, or homogeneous regional studies.

The implications for financial practice and institutional portfolio management are significant. The traditional Western portfolio allocation theories, which conventionally advise a conservative 5%-10% exposure to precious metals, are empirically inadequate for the ASEAN-5 risk environment. Within this framework, the identified optimal gold allocations (44%–70%) serve as theoretical benchmarks for absolute risk minimization. While institutional mandates and the dual objectives of liquidity and capital appreciation may impede the practical implementation of such high-density allocations, these figures highlight a structural reality: Southeast Asian markets require a significantly larger safe-haven anchor than their developed counterparts do. Furthermore, crude oil must be systematically excluded from defensive hedging strategies and instead actively monitored as a primary indicator of macroeconomic risk.

From a macroeconomic policy perspective, these findings provide important directives for regional monetary authorities, such as the Bangko Sentral ng Pilipinas (BSP) and the Bank of Thailand. Given the severe equity drawdowns triggered by imported energy inflation, policymakers may consider strengthening physical gold reserves as a sovereign macroeconomic hedge to stabilize national wealth and mitigate capital flight during global geopolitical crises. In the realm of financial education and academic research, this study highlights the need to incorporate asymmetric, time-varying econometric models into modern finance curricula in Asian universities, as traditional constant-variance frameworks may underestimate emerging market tail risks. Future related works may explore the hedging efficacy of decentralized digital assets (such as Bitcoin) or Green/ESG bond indices as potential safe-haven alternatives during global crises, building on Kumar and Padakandla (2022). Additionally, incorporating high-frequency data or macroeconomic uncertainty indices, such as the Global Economic Policy Uncertainty Index (Baker et al., 2016), could further enrich dynamic correlation estimates (Salisu et al., 2020).

While this study utilizes robust econometric techniques, several limitations must be acknowledged. First, the geographical scope is strictly confined to the ASEAN-5 nations; volatility dynamics and portfolio strategies identified may not be directly generalizable to frontier markets such as Vietnam or Cambodia. Second, the commodity variable selection was limited to gold and Brent crude oil, excluding other safe-haven assets such as U.S. Treasury securities, fiat reserve currencies, or alternative energy commodities. Third, while the DCC-GJR-GARCH framework effectively captures daily asymmetric volatility clustering, it does not account for intraday high-frequency trading volatility. Fourth, the optimal portfolio weights are strictly based on absolute variance

minimization and do not optimize for risk-adjusted returns or investor utility. Fifth, while the data extraction from Yahoo Finance is methodologically sound for daily-frequency historical analysis, it introduces a minor limitation regarding real-time precision; however, since this study uses historical daily adjusted closing prices, this latency does not affect the integrity of the findings.

Contributions of Authors

The author is the sole contributor to this study and was responsible for conceptualization, research design, data collection, data analysis, interpretation of results, and manuscript preparation.

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Conflict of Interests

The author confirms that no known conflicts of interest are associated with this publication. There has been no significant financial support for this work that could have influenced its outcome.

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