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Downside Risk Connectedness and Hedging Strategies between Islamic Sectoral Stocks and Green Bonds

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ABSTRACT

Purpose - This study examines the influence of Islamic sectoral equity risk and green bond/green sukuk market volatility on hedging effectiveness, with Market Stress positioned as a conditional risk factor in the Indonesian Islamic capital market.
Design/methodology/approach - This study employed a quantitative explanatory design. Data were collected from Islamic capital market investors in Indonesia and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS.
Findings - The findings show that Islamic Basic Materials Sector Risk, Islamic Oil and Gas/Energy Sector Risk, Islamic Financials Sector Risk, Islamic Healthcare Sector Risk, and Market Stress significantly reduce Hedging Effectiveness. Market Stress also strengthens the adverse effect of Islamic sectoral equity risk on hedging performance, indicating that hedging strategies become less effective under stressed market conditions.
Research limitations/implications - Future research should expand the model by including additional Islamic stock sectors, longer time-series data, high-frequency market indicators, and cross-country comparisons across Islamic capital markets.
Practical implications - Islamic investors, asset managers, regulators, and green sukuk issuers should develop dynamic, sector-sensitive, and stress-aware hedging strategies to improve portfolio resilience during downside market conditions.
Originality/value - This study contributes to Islamic finance and sustainable investment literature by integrating Islamic sectoral downside risk, green bond/green sukuk volatility, market stress, and hedging effectiveness into a single portfolio-risk framework.

1. Introduction

The rapid growth of sustainable finance has changed the risk landscape of Islamic capital markets. Investors increasingly combine Sharia-compliant stocks with environmentally oriented financial instruments to improve diversification and portfolio resilience. Green bonds and green sukuk are designed to finance environmentally responsible projects while also providing potential risk-management benefits during periods of conventional market volatility. In Indonesia, this development is increasingly relevant because the Islamic capital market is supported by official Sharia stock indices, including the Indonesia Sharia Stock Index (ISSI), Jakarta Islamic Index (JII), and JII70. In addition, the sustainable finance framework has expanded from green bonds to sustainability-based sukuk following POJK 18/2023, creating a stronger institutional foundation for green Islamic finance instruments and aligning with the broader rise of ESG-oriented finance in ASEAN emerging economies (Seow and Chua, 2026).

Islamic sectoral equities represent a broad range of Sharia-compliant assets with different risk characteristics. Sectors such as basic materials, oil and gas, financials, and healthcare respond differently to macroeconomic shocks, commodity price movements, regulatory changes, and investor sentiment. Previous studies show that Islamic sectoral markets may act as both transmitters and receivers of risk depending on market conditions, especially during downturns and periods of financial uncertainty (Billah et al., 2024a; Tiwari et al., 2023). Therefore, examining Islamic equities only at the aggregate index level may overlook important sector-specific downside risk patterns. For Indonesian investors, sectoral analysis is particularly important because Sharia-compliant investment strategies often involve sector rotation, defensive positioning, and portfolio risk mitigation.

The literature on green bonds and Islamic financial assets has expanded considerably, but several important gaps remain. Existing studies have examined risk transmission among green bonds, Islamic stocks, sukuk, commodities, and conventional financial markets using connectedness, wavelet, quantile, and time-frequency approaches (Karim and Naeem, 2022; Naeem et al., 2023; Umar et al., 2023). However, many of these studies focus on global indices and provide limited attention to Indonesia as a country-specific Islamic capital market. Moreover, the relationship between downside risk connectedness and practical hedging effectiveness remains underexplored, particularly when green sukuk is considered alongside green bonds as sustainable, Sharia-compliant financial instruments.

This study investigates how Islamic basic materials sector risk, Islamic Oil and gas/energy sector risk, Islamic financial sector risk, Islamic healthcare sector risk, and green bond/green sukuk market volatility affect hedging effectiveness among Islamic capital market investors in

Indonesia. It also examines market stress as a conditional risk factor that may intensify the relationship between sector-specific downside risk and hedging outcomes. The study is grounded in the connectedness framework, which explains shock transmission among financial assets; frequency connectedness theory, which captures risk transmission across different horizons; and the CoVaR approach, which evaluates systemic downside risk contribution (Adrian and Brunnermeier, 2016; Baruník and Křehlík, 2018; Diebold and Yilmaz, 2012; Long et al., 2024).

This study offers three main contributions. First, it shifts the analytical focus from broad global Islamic indices to the Indonesian Islamic capital market. Second, it integrates Islamic sectoral equity risks with green bond and green sukuk volatility within a single framework for evaluating hedging effectiveness. Third, it links downside risk connectedness with investor-oriented portfolio strategy, making the model more relevant for Sharia-compliant investors, asset managers, regulators, and sustainable finance issuers. By doing so, this study contributes to the Islamic finance and sustainable portfolio literature while offering practical insights to improve hedging, diversification, and risk management in Indonesia's Islamic capital market.

The rest of this article is organized as follows. Section 2 presents the critical review, theoretical foundation, hypothesis development, and conceptual framework. Section 3 explains the research design, population and sample, data sources, variable measurement, and data analysis technique. Section 4 presents the empirical results, including the measurement model assessment, the structural model assessment, the direct effect analysis, the market stress interaction analysis, the hypothesis testing, the model fit, the predictive performance, and the discussion. Section 5 concludes the study by summarizing the main findings, theoretical and practical implications, limitations, and future research directions.

2. Critical Review

2.1 Systemic Risk Connectedness and Islamic Portfolio Diversification

Systemic risk connectedness explains how financial shocks are transmitted across assets, sectors, and markets, making it highly relevant for Islamic portfolio diversification. In Islamic capital markets, sectoral stocks are influenced not only by general market fluctuations but also by commodity cycles, macroeconomic uncertainty, geopolitical events, and investor sentiment. The connectedness framework developed by Diebold and Yilmaz (2012) provides a basis for identifying whether an asset acts as a risk transmitter or risk receiver, while Baruník and Křehlík (2018) extends this approach by measuring connectedness across short-, medium-, and long-term frequencies. From a downside-risk perspective, CoVaR explains how distress in one asset or sector can amplify broader portfolio risk (Adrian and Brunnermeier, 2016). Recent studies show that Islamic equities, sukuk, and green bonds may provide diversification benefits, although their hedging effectiveness varies during crises and market-stress conditions (Billah and Adnan, 2024; Karim and Naeem, 2022; Naeem et al., 2023). Therefore, understanding systemic risk connectedness is essential for constructing resilient Islamic portfolios that combine Sharia-compliant sectoral stocks with green bond and green sukuk instruments.

2.2 Sectoral Islamic Equity Risk and Hedging Effectiveness

Islamic sectoral equity risk significantly affects hedging effectiveness because each Sharia-compliant sector has distinct sensitivities to downside volatility, macroeconomic shocks, and portfolio spillover effects. The basic materials sector commonly responds to commodity prices, construction cycles, exchange-rate movements, and global demand uncertainty. In Islamic markets, downside risk connectedness between sectoral stocks and green bonds varies across market conditions, indicating that sector-level analysis provides deeper insight than aggregate index analysis (Billah et al., 2024a; Billah and Adnan, 2024; Diebold and Yilmaz, 2012; Tiwari et al., 2023). Although green bonds may improve diversification and hedging, their effectiveness depends on the direction and intensity of risk transmission across equity sectors (Adrian and Brunnermeier, 2016; Baruník and Křehlík, 2018; Chopra and Mehta, 2023). Therefore, Islamic Basic Materials Sector Risk may influence the ability of green bond and green sukuk instruments to reduce portfolio risk.

The Islamic oil and gas sector is particularly sensitive to energy market shocks, geopolitical uncertainty, and transition-risk dynamics. Oil shocks have been shown to affect green bonds, sukuk, and conventional bonds, implying that energy-sector risk can reshape the risk-return profile of Islamic investment portfolios (Billah et al., 2024a,b; Billah and Adnan, 2024; Mensi et al., 2022; Umar et al., 2023). Since green bonds and green sukuk are closely linked to sustainable energy financing, their hedging performance may change when Islamic energy stocks experience high volatility or downside pressure (Chopra and Mehta, 2023; Naeem et al., 2023; Tiwari et al., 2023). This suggests that Islamic oil and gas sector risk can directly affect hedging effectiveness through both financial connectedness and energy-transition channels.

Risk in the Islamic financial sector is also important because Islamic banks, takaful firms, and other Sharia-compliant financial institutions are closely linked to liquidity, investor confidence, regulatory expectations, and systemic market conditions. Research on Islamic and green financial assets shows that Islamic equities, sukuk, and green bonds tend to become more interconnected during crises, reducing their diversification benefits as market risk increases (Karim and Naeem, 2022; Naeem et al., 2023; Umar et al., 2023). The financial sector may act as either a risk transmitter or a risk receiver depending on market stress and portfolio composition (Adrian and Brunnermeier, 2016; Billah et al., 2024a,b; Billah and Adnan, 2024; Diebold and Yilmaz, 2012). Consequently, risk in the Islamic financial sector may affect the stability and effectiveness of hedging strategies involving green bonds and green sukuk.

The Islamic healthcare sector is generally viewed as more defensive than cyclical sectors, yet it remains exposed to downside risk, valuation uncertainty, and broader market spillovers. Evidence from green bond and sectoral stock research indicates that green bonds can act as hedge or safe-haven assets for several stock sectors, but their effectiveness differs across industries and market regimes (Billah et al., 2024a; Chopra and Mehta, 2023; Ren et al., 2023). In addition, spillovers between green bonds and Islamic stocks suggest that sustainable and Sharia-compliant assets may still transmit risk during downturns or adverse market conditions (Baruník and Křehlík, 2018; Karim and Naeem, 2022; Tiwari et al., 2023). Therefore, risk in the Islamic healthcare sector and volatility in green bonds/green sukuk are expected to influence hedging strategies in Islamic portfolio management.

- **H1:** Islamic Basic Materials Sector Risk has a significant effect on Hedging Effectiveness.
- **H2:** Islamic Oil and Gas Sector Risk has a significant effect on Hedging Effectiveness.
- **H3:** Islamic Financials Sector Risk has a significant effect on Hedging Effectiveness.
- **H4:** Islamic Healthcare Sector Risk has a significant effect on Hedging Effectiveness.
- **H5:** Green Bond and Green Sukuk Market Volatility has a significant effect on Hedging Effectiveness.

2.3 *Market Stress and Risk-Return Transmission*

Market stress alters the structure of risk-return transmission because financial assets generally become more interconnected during periods of uncertainty, crisis, and downside market pressure. In Islamic portfolio management, this condition is important because Sharia-compliant sectoral stocks may partially lose their diversification benefits when volatility increases and investor sentiment becomes more defensive. The connectedness framework explains that financial shocks can spread across assets and sectors through directional spillovers, while downside-risk models suggest that extreme losses in one market can increase risk exposure in other markets (Adrian and Brunnermeier, 2016; Baruník and Křehlík, 2018; Diebold and Yilmaz, 2012). Empirical evidence shows that Islamic equities, sukuk, green bonds, and conventional assets tend to experience stronger connectedness during crisis periods, making hedging strategies more sensitive to market conditions (Karim and Naeem, 2022; Naeem et al., 2023; Umar et al., 2023).

In the basic materials sector, market stress can heighten risk transmission because it is closely linked to commodity prices, global industrial demand, exchange-rate exposure, and construction cycles. During periods of rising market uncertainty, downside movements in basic materials stocks may destabilize portfolios and increase the need for effective hedging. Previous research indicates that green bonds and Islamic sectoral equities do not always move independently, especially under downside or extreme market conditions (Billah et al., 2024a,b; Billah and Adnan, 2024; Mensi et al., 2022; Tiwari et al., 2023). Consequently, market stress may strengthen the effect of the Islamic basic materials sector risk on hedging effectiveness by changing the correlation and spillover structure between Sharia-compliant stocks and green bond or green sukuk instruments.

The oil and gas sector is particularly sensitive to oil price shocks, geopolitical events, and energy-transition uncertainty. During stressed market conditions, energy-sector shocks can spill over to sukuk, green bonds, and Islamic equities because investors reassess risk exposure, inflation expectations, and future energy demand. Umar et al. (2023) show that oil shocks are connected with green bonds, sukuk, and conventional bonds, while studies on green bond connectedness suggest that hedging benefits may decline or shift during bearish market conditions (Chopra and Mehta, 2023; Mensi et al., 2022; Ren et al., 2023). Thus, market stress may strengthen the effect of the Islamic Oil and gas sector risk on hedging effectiveness through stronger energy-risk transmission and changes in investor allocation behavior.

Market stress may also reshape the relationships among Islamic financials, Islamic healthcare, green bond/green sukuk volatility, and hedging effectiveness. Islamic financial stocks are closely linked to liquidity, regulatory confidence, and systemic market expectations, while healthcare stocks may behave more defensively but remain exposed to broader downside spillovers. Green bonds and green sukuk may offer diversification benefits, but their safe-haven role depends on the level of stress and the intensity of cross-market connectedness (Billah and Adnan, 2024; Karim and Naeem, 2022; Naeem et al., 2023). Under high-stress conditions, volatility in green bond and green sukuk markets may either improve hedging demand or weaken hedging effectiveness if sustainable assets become more correlated with equity markets (Adrian and Brunnermeier, 2016; Ren et al., 2023; Tiwari et al., 2023).

- **H6:** Market stress strengthens the effect of Islamic Basic Materials Sector Risk on hedging effectiveness.
- **H7:** Market stress strengthens the effect of Islamic Oil and gas sector risk on hedging effectiveness.
- **H8:** Market stress strengthens the effect of Islamic financial sector risk on hedging effectiveness.
- **H9:** Market Stress strengthens the effect of Islamic healthcare sector risk on hedging effectiveness.
- **H10:** Market stress strengthens the effect of green bond and green sukuk market volatility on hedging effectiveness.

2.4 *Conceptual Framework*

Building on the theoretical foundation and hypothesis development, this study proposes a conceptual framework that explains how sector-specific Islamic equity risks and volatility in the green bond/green sukuk market influence hedging effectiveness in Indonesia's Islamic capital market. The framework positions Islamic Basic Materials Sector Risk, Islamic Oil and Gas Sector Risk, Islamic Financials Sector Risk, Islamic Healthcare Sector Risk, and Green Bond/Green Sukuk Market Volatility as key explanatory variables, while Hedging Effectiveness is positioned as the outcome variable. Market Stress is incorporated as a conditional factor that can amplify risk-return transmission during periods of uncertainty, crisis, oil price shocks, geopolitical pressure, and downside market movements. Thus, the model captures both direct portfolio-risk effects and the influence of market stress on hedging outcomes. The proposed conceptual framework is presented in Figure 1.

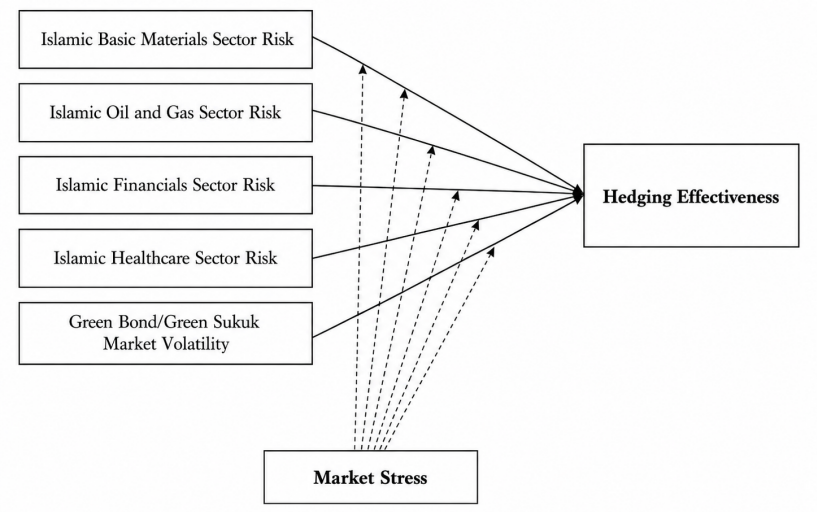

Figure 1. Conceptual Framework

Table 1. Sample Profile

Category	Sub-category	Frequency	Percentage
Gender	Male	220	55.00%
Gender	Female	180	45.00%
Age	18–25 years	96	24.00%
Age	26–35 years	148	37.00%
Age	36–45 years	92	23.00%
Age	>45 years	64	16.00%
Education	Diploma/Bachelor	252	63.00%
Education	Master's/Doctoral	88	22.00%
Education	Other	60	15.00%
Occupation	Private employee	132	33.00%
Occupation	Entrepreneur/UMKM	92	23.00%
Occupation	Civil servant/state employee	64	16.00%
Occupation	Professional/lecturer/analyst	56	14.00%
Occupation	Student/other	56	14.00%
City	Jakarta	80	20.00%
City	Surabaya	60	15.00%
City	Bandung	60	15.00%
City	Medan	50	12.50%
City	Makassar	50	12.50%
City	Yogyakarta	50	12.50%
City	Semarang	50	12.50%
Investment experience	<1 year	72	18.00%
Investment experience	1–3 years	156	39.00%
Investment experience	4–6 years	108	27.00%
Investment experience	>6 years	64	16.00%
Total		400	100.00%

3. Research Methodology

3.1 Research Design

This study employs a quantitative explanatory research design to investigate the relationships among Islamic sectoral equity risk, green bond/green sukuk market volatility, market stress, and hedging effectiveness in the Indonesian Islamic capital market. A quantitative explanatory approach is suitable because the study tests causal and predictive relationships among variables based on theory-driven hypotheses, structured constructs, and measurable indicators (Creswell and Poth, 2018; Hair and Alamer, 2022). The research combines investor-based analysis with financial market measurement by using primary data from Islamic capital market investors and secondary data on Islamic sectoral stocks, green bonds, green sukuk, and relevant market indicators. The use of sectoral risk, connectedness, and hedging measures is consistent with previous studies on downside risk transmission, green bond–Islamic stock connectedness, and portfolio hedging across Islamic and sustainable financial assets (Billah et al., 2024a,b; Billah and Adnan, 2024; Tiwari et al., 2023; Umar et al., 2023). Hedging Effectiveness is positioned as the outcome variable, while Market Stress is included as a conditional factor that may intensify risk-return transmission during periods of uncertainty and downside market pressure (Baruník and Křehlík, 2018; Diebold and Yilmaz, 2012).

3.2 Population and Sample

This study focuses on Islamic capital market investors in Indonesia who have experience or knowledge of Sharia-compliant investment instruments, including Islamic stocks, sukuk, Islamic mutual funds, Islamic exchange-traded funds, and green sukuk. Participants were selected through purposive sampling because the study requires respondents who meet criteria aligned with the research objectives. These criteria include being at least 18 years old, having investment experience or self-identifying as a capital market investor, understanding Sharia-based investment products, and being willing to participate in the survey. A total of 400 respondents from seven major Indonesian cities, namely Jakarta, Surabaya, Bandung, Medan, Makassar, Yogyakarta, and Semarang, were surveyed because these cities represent important economic and investment centers. The detailed respondent profile is presented in Table 1.

3.3 Data Sources

This study uses both primary and secondary data to capture investor perceptions and market-based risk dynamics in the Indonesian Islamic capital market. Primary data were collected through a structured questionnaire distributed to Islamic capital market investors in Jakarta, Surabaya, Bandung, Medan, Makassar, Yogyakarta, and Semarang. The questionnaire was designed to measure investor-based assessments of hedging effectiveness, market stress, and Sharia-compliant portfolio behavior. Secondary data were obtained from official and credible financial data sources, including the Indonesia Stock Exchange, Otoritas Jasa Keuangan, Bank Indonesia, and published market databases for Islamic sectoral stocks, ISSI, JII, JII70, green sukuk, green bonds, oil price indicators, and macro-financial uncertainty measures. The combination of primary and secondary data enables the study to evaluate both behavioral investment responses and objective market-risk indicators. This data structure is consistent with previous studies on Islamic stock connectedness, green bond/sukuk volatility, downside risk transmission, and hedging effectiveness in sustainable finance portfolios (Billah and Adnan, 2024; Karim and Naeem, 2022; Umar et al., 2023).

3.4 Variable Measurement

The variables in this study were measured using indicators adapted from prior studies on Islamic sectoral equity risk, green bond/green sukuk volatility, systemic connectedness, market stress, and hedging effectiveness. The independent variables consist of Islamic Basic Materials Sector Risk, Islamic Oil and Gas/Energy Sector Risk, Islamic Financials Sector Risk, Islamic Healthcare Sector Risk, and Green Bond/Green Sukuk

Table 2. Variable Measurement

Variable	Code	Indicator	Source Support
Islamic Basic Materials Sector Risk	X1.1	Daily return volatility	(Billah et al., 2024b,a)
Islamic Basic Materials Sector Risk	X1.2	Downside return risk	(Billah et al., 2024b,a)
Islamic Basic Materials Sector Risk	X1.3	CoVaR	(Adrian and Brunnermeier, 2016)
Islamic Basic Materials Sector Risk	X1.4	Maximum drawdown	(Yarovaya et al., 2021)
Islamic Basic Materials Sector Risk	X1.5	Sectoral beta	(Tiwari et al., 2023)
Islamic Oil and Gas/Energy Sector Risk	X2.1	Energy-sector volatility	(Umar et al., 2023)
Islamic Oil and Gas/Energy Sector Risk	X2.2	Oil-shock exposure	(Umar et al., 2023)
Islamic Oil and Gas/Energy Sector Risk	X2.3	Downside semi-variance	(Billah et al., 2024b,a)
Islamic Oil and Gas/Energy Sector Risk	X2.4	Dynamic correlation	(Mensi et al., 2022)
Islamic Oil and Gas/Energy Sector Risk	X2.5	Tail-risk spillover	(Baruník and Křehlík, 2018)
Islamic Financials Sector Risk	X3.1	Financial-sector volatility	(Billah et al., 2024b,a)
Islamic Financials Sector Risk	X3.2	Islamic banking-equity connectedness	(Billah et al., 2024a)
Islamic Financials Sector Risk	X3.3	CoVaR contribution	(Adrian and Brunnermeier, 2016)
Islamic Financials Sector Risk	X3.4	Spillover receiver/transmitter	(Diebold and Yilmaz, 2012)
Islamic Financials Sector Risk	X3.5	Diversification sensitivity	(Naeem et al., 2023)
Islamic Healthcare Sector Risk	X4.1	Healthcare-sector volatility	(Chopra and Mehta, 2023)
Islamic Healthcare Sector Risk	X4.2	Downside deviation	(Billah et al., 2024b,a)
Islamic Healthcare Sector Risk	X4.3	Safe-haven sensitivity	(Ren et al., 2023)
Islamic Healthcare Sector Risk	X4.4	Correlation with green bond/sukuk	(Tiwari et al., 2023)
Islamic Healthcare Sector Risk	X4.5	Defensive-sector risk reduction	(Mensi et al., 2022)
Green Bond/Green Sukuk Volatility	X5.1	Indonesian green sukuk volatility	(Billah and Adnan, 2024)
Green Bond/Green Sukuk Volatility	X5.2	Green bond return volatility	(Nguyen et al., 2021)
Green Bond/Green Sukuk Volatility	X5.3	Green bond downside risk	(Chopra and Mehta, 2023; Ren et al., 2023)
Green Bond/Green Sukuk Volatility	X5.4	Green bond connectedness index	(Karim and Naeem, 2022)
Green Bond/Green Sukuk Volatility	X5.5	Green bond safe-haven potential	(Naeem et al., 2023)
Market Stress	Z1	Global uncertainty	(Karim and Naeem, 2022; Long et al., 2024)
Market Stress	Z2	Oil price shock	(Umar et al., 2023)
Market Stress	Z3	Geopolitical risk exposure	(Billah and Adnan, 2024)
Market Stress	Z4	Crisis-period dummy	(Yarovaya et al., 2021)
Market Stress	Z5	Extreme quantile condition	(Tiwari et al., 2023)
Hedging Effectiveness	Y1	Optimal portfolio weight	(Billah et al., 2024b)
Hedging Effectiveness	Y2	Optimal hedge ratio	(Billah et al., 2024b; Naeem et al., 2023)
Hedging Effectiveness	Y3	Variance reduction	(Mensi et al., 2022)
Hedging Effectiveness	Y4	Risk-adjusted return	(Ren et al., 2023)
Hedging Effectiveness	Y5	Diversification benefit	(Diebold and Yilmaz, 2012)

Volatility. Market Stress is included as a conditional market factor, while Hedging Effectiveness is positioned as the outcome variable. Each construct is measured using five indicators to ensure conceptual consistency and empirical comparability with previous studies. The complete variable measurement is presented in Table 2.

3.5 Data Analysis Technique

The data were processed through multiple stages to analyze downside risk connectedness, hedging effectiveness, and market-stress impacts in the Indonesian Islamic capital market. Initially, descriptive statistics were used to assess the distribution of each variable, including the mean, standard deviation, minimum, maximum, skewness, and kurtosis. Next, a correlation matrix was used to explore initial relationships among Islamic sectoral equity risk, green bond/green sukuk volatility, market stress, and hedging effectiveness. Third, downside risk connectedness was estimated to determine the direction and strength of risk transmission among Islamic sectoral stocks and green instruments using the connectedness framework (Baruník and Křehlík, 2018; Diebold and Yilmaz, 2012). Fourth, CoVaR and related downside-risk metrics were used to measure the contribution of extreme risk under adverse market conditions (Adrian and Brunnermeier, 2016; Billah et al., 2024a,b). Fifth, hedging effectiveness was assessed using optimal portfolio weights, hedge ratios, variance reduction, risk-adjusted returns, and diversification benefits (Mensi et al., 2022; Naeem et al., 2023; Umar et al., 2023). Finally, hypothesis testing involved examining coefficient signs, t-statistics, p-values, and market-stress interaction effects for H1–H10.

4. Result

4.1 Measurement Model Assessment

The assessment of the measurement model aimed to examine indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. The findings indicate that the reflective measurement model meets the recommended PLS-SEM standards. Indicator reliability is confirmed, as all outer loading values exceed the minimum threshold of 0.70. As shown in Table 3, the outer loadings range from 0.788 to 0.864, demonstrating that each indicator strongly correlates with its corresponding latent construct. The lowest loading is observed in MS5, while the highest loading is observed in HE3. Since all indicators exceed the recommended threshold, no indicator needs to be removed from the model.

Internal consistency, reliability, and convergent validity are also established. Cronbach's alpha values range from 0.864 to 0.904, exceeding the recommended threshold of 0.70. Composite reliability values range from 0.902 to 0.929, indicating strong construct reliability. In addition, the average variance extracted values range from 0.648 to 0.724, surpassing the minimum threshold of 0.50. These results indicate that each construct explains more than half of the variance in its indicators. Hence, the constructs in this study demonstrate adequate reliability and

Table 3. Measurement Model Assessment

Construct	Indicator	Loading	Alpha	CR	AVE
Islamic Basic Materials Sector Risk	BM1	0.804	0.883	0.915	0.682
Islamic Basic Materials Sector Risk	BM2	0.813			
Islamic Basic Materials Sector Risk	BM3	0.862			
Islamic Basic Materials Sector Risk	BM4	0.826			
Islamic Basic Materials Sector Risk	BM5	0.821			
Islamic Financials Sector Risk	FS1	0.842	0.890	0.919	0.694
Islamic Financials Sector Risk	FS2	0.818			
Islamic Financials Sector Risk	FS3	0.835			
Islamic Financials Sector Risk	FS4	0.820			
Islamic Financials Sector Risk	FS5	0.852			
Hedging Effectiveness	HE1	0.860	0.904	0.929	0.724
Hedging Effectiveness	HE2	0.849			
Hedging Effectiveness	HE3	0.864			
Hedging Effectiveness	HE4	0.854			
Hedging Effectiveness	HE5	0.826			
Islamic Healthcare Sector Risk	HS1	0.845	0.893	0.921	0.700
Islamic Healthcare Sector Risk	HS2	0.856			
Islamic Healthcare Sector Risk	HS3	0.822			
Islamic Healthcare Sector Risk	HS4	0.833			
Islamic Healthcare Sector Risk	HS5	0.826			
Market Stress	MS1	0.817	0.864	0.902	0.648
Market Stress	MS2	0.800			
Market Stress	MS3	0.812			
Market Stress	MS4	0.807			
Market Stress	MS5	0.788			
Islamic Oil and Gas/Energy Sector Risk	OGE1	0.816	0.875	0.909	0.665
Islamic Oil and Gas/Energy Sector Risk	OGE2	0.824			
Islamic Oil and Gas/Energy Sector Risk	OGE3	0.811			
Islamic Oil and Gas/Energy Sector Risk	OGE4	0.821			
Islamic Oil and Gas/Energy Sector Risk	OGE5	0.805			

Table 4. Fornell–Larcker Criterion

Construct	BM	FS	HE	HS	MS	OGE
BM	**0.826**					
FS	0.186	**0.833**				
HE	-0.477	-0.445	**0.851**			
HS	0.167	0.139	-0.387	**0.836**		
MS	0.311	0.281	-0.512	0.211	**0.805**	
OGE	0.172	0.178	-0.387	0.129	0.232	**0.816**

Table 5. Heterotrait–Monotrait Ratio

Relationship	HTMT
FS ↔ BM	0.207
HE ↔ BM	0.530
HE ↔ FS	0.495
HS ↔ BM	0.187
HS ↔ FS	0.157
HS ↔ HE	0.430
MS ↔ BM	0.352
MS ↔ FS	0.318
MS ↔ HE	0.579
MS ↔ HS	0.240
OGE ↔ BM	0.193
OGE ↔ FS	0.200
OGE ↔ HE	0.430
OGE ↔ HS	0.142
OGE ↔ MS	0.265

convergent validity.

Discriminant validity was initially evaluated using the Fornell-Larcker criterion. As shown in Table 4, the square root of AVE for each construct exceeds its correlations with other constructs. For instance, the diagonal value of Hedging Effectiveness exceeds its correlations with Islamic Basic Materials Sector Risk, Islamic Financials Sector Risk, Islamic Healthcare Sector Risk, Market Stress, and Islamic Oil and Gas/Energy Sector Risk. Similarly, the diagonal values for all other constructs are greater than their inter-construct correlations. This confirms that each construct is empirically distinct and that it demonstrates stronger explanatory power for its own indicators than for those of other constructs.

The HTMT results further confirm discriminant validity. As shown in Table 5, all HTMT values are below the conservative threshold of 0.85.

Table 6. Collinearity Assessment

Relationship	VIF
Islamic Basic Materials Sector Risk → Hedging Effectiveness	1.155
Islamic Financials Sector Risk → Hedging Effectiveness	1.126
Islamic Healthcare Sector Risk → Hedging Effectiveness	1.074
Market Stress → Hedging Effectiveness	1.261
Islamic Oil and Gas/Energy Sector Risk → Hedging Effectiveness	1.096
Market Stress × Islamic Healthcare Sector Risk → Hedging Effectiveness	1.088
Market Stress × Islamic Oil and Gas/Energy Sector Risk → Hedging Effectiveness	1.076
Market Stress × Islamic Financials Sector Risk → Hedging Effectiveness	1.132
Market Stress × Islamic Basic Materials Sector Risk → Hedging Effectiveness	1.135

The highest value is found in the relationship between Market Stress and Hedging Effectiveness, which remains well below the recommended cut-off. This indicates that the constructs are distinct both conceptually and statistically. Overall, the measurement model exhibits satisfactory indicator reliability, internal consistency, convergent validity, and discriminant validity, thereby enabling progression to the evaluation of the structural model.

4.2 Structural Model Assessment

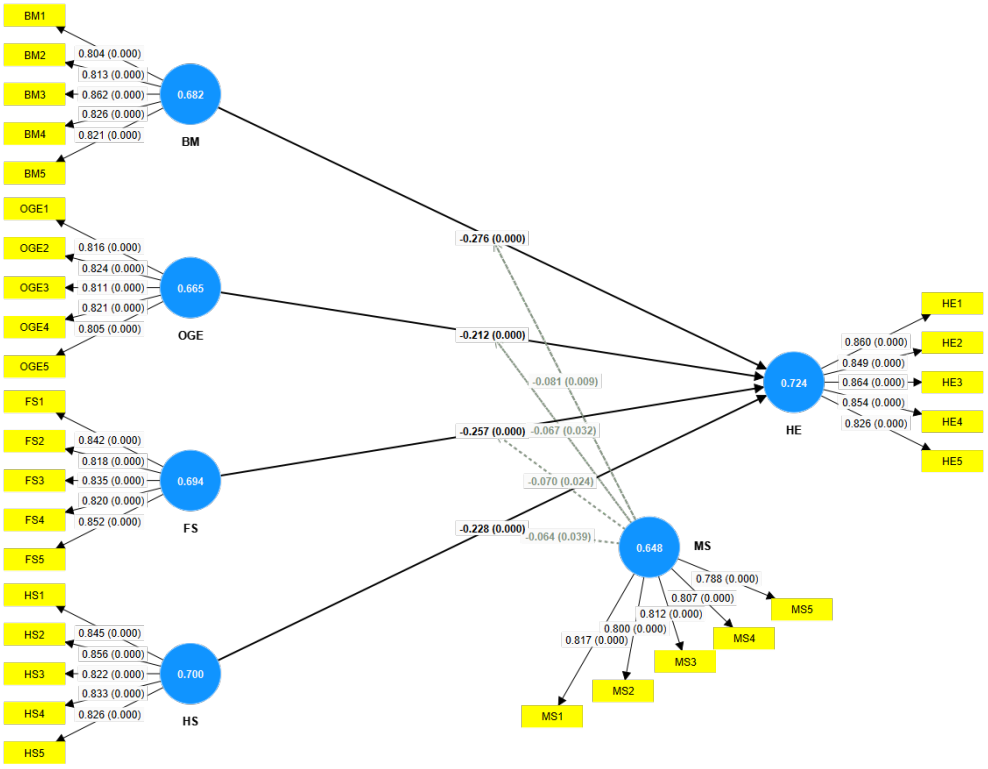

Figure 2. Structural Model

After the measurement model fulfilled the reliability and validity criteria, the structural model was evaluated to examine the predictive relationships among the constructs. The assessment includes the structural model figure, collinearity assessment, coefficient of determination, effect size, and predictive relevance. The structural model shows that Islamic Basic Materials Sector Risk, Islamic Financials Sector Risk, Islamic Healthcare Sector Risk, Islamic Oil and Gas/Energy Sector Risk, and Market Stress are directly linked to Hedging Effectiveness. In addition, the model includes interaction terms between Market Stress and Islamic sectoral risk variables to examine whether market stress strengthens the risk-transmission effect on hedging effectiveness.

Collinearity was assessed using the variance inflation factor. As presented in Table 6, all VIF values are below the recommended threshold of 3.30 and far below the maximum acceptable threshold of 5.00. The inner VIF values range from 1.074 to 1.261, indicating that the model does not suffer from multicollinearity problems. Therefore, the structural paths can be interpreted reliably.

The quality of the structural model was further assessed using the coefficient of determination, effect size, and predictive relevance. The R-squared of 0.576 indicates that Islamic sectoral risks, Market Stress, and their interaction account for 57.60

4.3 Direct Effect Analysis

The analysis of direct effects aimed to assess how Islamic sectoral equity risk and Market Stress influence Hedging Effectiveness. As shown in Table 8, all relationships are negative and statistically significant at the 5% level. Islamic Basic Materials Sector Risk has the strongest negative influence, indicating that increased risk in this sector reduces hedging effectiveness. Islamic Financials Sector Risk also significantly reduces hedging effectiveness, followed by Market Stress, Islamic Healthcare Sector Risk, and Islamic Oil and Gas/Energy Sector Risk. These results suggest that rising sectoral risks and market stress reduce the effectiveness of hedging strategies in Islamic portfolios.

Table 7. Structural Model Quality Assessment

Assessment	Construct/Relationship	Value
Coefficient of determination	Hedging Effectiveness	$R^2 = 0.576$
Coefficient of determination	Hedging Effectiveness	Adjusted $R^2 = 0.566$
Effect size	Islamic Basic Materials Sector Risk → Hedging Effectiveness	$f^2 = 0.155$
Effect size	Islamic Financials Sector Risk → Hedging Effectiveness	$f^2 = 0.138$
Effect size	Market Stress → Hedging Effectiveness	$f^2 = 0.127$
Effect size	Islamic Healthcare Sector Risk → Hedging Effectiveness	$f^2 = 0.115$
Effect size	Islamic Oil and Gas/Energy Sector Risk → Hedging Effectiveness	$f^2 = 0.096$
Effect size	Market Stress × Islamic Basic Materials Sector Risk → Hedging Effectiveness	$f^2 = 0.013$
Effect size	Market Stress × Islamic Oil and Gas/Energy Sector Risk → Hedging Effectiveness	$f^2 = 0.011$
Effect size	Market Stress × Islamic Financials Sector Risk → Hedging Effectiveness	$f^2 = 0.010$
Effect size	Market Stress × Islamic Healthcare Sector Risk → Hedging Effectiveness	$f^2 = 0.009$
Predictive relevance	Hedging Effectiveness	$Q^2 = 0.406$
Predictive relevance	Hedging Effectiveness	SSO = 2000.000
Predictive relevance	Hedging Effectiveness	SSE = 1188.107

Table 8. Direct Path Coefficients

Relationship	Coefficient	STDEV	t-statistic	p-value
BM → HE	-0.276	0.035	7.823	0.000
FS → HE	-0.257	0.033	7.714	0.000
HS → HE	-0.228	0.034	6.678	0.000
MS → HE	-0.261	0.034	7.677	0.000
OGE → HE	-0.212	0.033	6.400	0.000

Table 9. Interaction Effect Coefficients

Relationship	Coefficient	STDEV	t-statistic	p-value
MS × BM → HE	-0.081	0.031	2.608	0.009
MS × FS → HE	-0.070	0.031	2.258	0.024
MS × OGE → HE	-0.067	0.031	2.146	0.032
MS × HS → HE	-0.064	0.031	2.067	0.039

Table 10. Simple Slope Analysis

Relationship	Low Market Stress	High Market Stress	Interpretation
MS × BM → HE	Weaker negative effect	Stronger negative effect	Market stress intensifies the negative effect of BM on HE
MS × FS → HE	Weaker negative effect	Stronger negative effect	Market stress intensifies the negative effect of FS on HE
MS × OGE → HE	Weaker negative effect	Stronger negative effect	Market stress intensifies the negative effect of OGE on HE
MS × HS → HE	Weaker negative effect	Stronger negative effect	Market stress intensifies the negative effect of HS on HE

4.4 Market Stress Interaction Analysis

The interaction analysis shows that all market-stress interaction paths have negative and significant effects on Hedging Effectiveness. As shown in Table 9, the strongest interaction effect is found in MS × BM → HE. This means that as Market Stress increases, the negative effect of Islamic Basic Materials Sector Risk on Hedging Effectiveness intensifies. In practical terms, hedging strategies involving basic materials stocks become less effective during stressed market conditions.

The second strongest interaction effect is MS × FS → HE. This result indicates that Market Stress also strengthens the negative effect of Islamic Financials Sector Risk on Hedging Effectiveness. Since the financial sector is closely related to liquidity, investor confidence, and systemic market conditions, higher market stress reduces the ability of hedging instruments to protect Islamic financial-sector portfolios. The interaction between Market Stress and Islamic Oil and Gas/Energy Sector Risk is also significant, suggesting that increased market stress makes oil and gas/energy sector risk more detrimental to hedging effectiveness. Likewise, the interaction between Market Stress and Islamic Healthcare Sector Risk is significant, although it is the weakest among the four interaction paths.

Table 10 confirms the pattern observed in the interaction coefficients. Under low market-stress conditions, the negative impact of each Islamic sectoral risk on Hedging Effectiveness is weaker. Conversely, under high market-stress conditions, the negative effect intensifies across all sectoral risk variables. This interpretation indicates that Market Stress does not reverse the relationship; rather, it amplifies the negative influence of sectoral Islamic equity risk on Hedging Effectiveness.

4.5 Hypothesis Testing

Hypothesis testing involved analyzing the path coefficient, t-statistic, and p-value for each proposed relationship. The findings demonstrate that all hypotheses are supported because each path has a p-value below 0.05. The direct effects of Islamic Basic Materials Sector Risk, Islamic Financials Sector Risk, Islamic Healthcare Sector Risk, Islamic Oil and Gas/Energy Sector Risk, and Market Stress on Hedging Effectiveness are negative and statistically significant. Furthermore, all interaction effects between Market Stress and Islamic sectoral risks are also negative and significant. These results suggest that increased sectoral risk and heightened market stress decrease hedging effectiveness, with market stress amplifying the negative influence of sectoral risk on hedging performance. Overall, the results confirm that all direct and interaction effects are statistically meaningful. The strongest direct effect is observed in BM → HE, while the strongest interaction effect is observed in MS × BM → HE. This indicates that Islamic Basic Materials Sector Risk is the most influential predictor of Hedging Effectiveness and the most responsive to

Table 11. Hypothesis Testing Results

Hypothesis	Relationship	Coefficient	t-statistic	p-value	Decision
H1	BM → HE	-0.276	7.823	0.000	Supported
H2	OGE → HE	-0.212	6.400	0.000	Supported
H3	FS → HE	-0.257	7.714	0.000	Supported
H4	HS → HE	-0.228	6.678	0.000	Supported
H5	MS → HE	-0.261	7.677	0.000	Supported
H6	MS × BM → HE	-0.081	2.608	0.009	Supported
H7	MS × OGE → HE	-0.067	2.146	0.032	Supported
H8	MS × FS → HE	-0.070	2.258	0.024	Supported
H9	MS × HS → HE	-0.064	2.067	0.039	Supported

Table 12. Model Fit and Predictive Performance

Assessment	Indicator/Index	Value	Comparison
Model fit	SRMR	0.043	Threshold < 0.080
Model fit	d_ULS	0.872	–
Model fit	d_G	0.305	–
Model fit	Chi-square	720.731	–
Model fit	NFI	0.896	Close to 0.900
PLSpredict	HE1 Q^2predict	0.402	> 0
PLSpredict	HE1 RMSE	0.887	LM RMSE = 0.909
PLSpredict	HE2 Q^2predict	0.421	> 0
PLSpredict	HE2 RMSE	0.872	LM RMSE = 0.920
PLSpredict	HE3 Q^2predict	0.403	> 0
PLSpredict	HE3 RMSE	0.886	LM RMSE = 0.911
PLSpredict	HE4 Q^2predict	0.365	> 0
PLSpredict	HE4 RMSE	0.914	LM RMSE = 0.951
PLSpredict	HE5 Q^2predict	0.394	> 0
PLSpredict	HE5 RMSE	0.892	LM RMSE = 0.946
PLSpredict	Hedging Effectiveness Q^2predict	0.550	> 0
PLSpredict	Hedging Effectiveness RMSE	0.674	–
PLSpredict	Hedging Effectiveness MAE	0.536	–
CVPAT	PLS loss	0.793	IA loss = 1.314
CVPAT	PLS loss	0.793	LM loss = 0.860
CVPAT	Overall p-value	0.000	< 0.05

market-stress conditions.

4.6 Model Fit and Predictive Performance

Model fit and predictive performance were assessed using SmartPLS fit indices and PLSpredict outcomes. The fit results show an SRMR of 0.043, below the 0.08 threshold, indicating a good model fit. The NFI value of 0.896 reflects acceptable model quality. Predictive performance is confirmed because all Hedging Effectiveness indicators have positive Q^2predict values, ranging from 0.365 to 0.421. At the construct level, Hedging Effectiveness has a Q^2 of 0.550, indicating strong predictive power. Overall, the model exhibits acceptable fit and sufficient predictive ability, as summarized in Table 12.

4.7 Discussion

The findings of this study demonstrate that Islamic sectoral equity risk has a significant negative effect on Hedging Effectiveness in the Indonesian Islamic capital market. The negative coefficient of BM → HE indicates that higher risk in the Islamic Basic Materials sector reduces the effectiveness of hedging strategies. This result is theoretically consistent with the connectedness framework, which argues that assets or sectors with stronger volatility spillover may transmit risk to the broader portfolio rather than provide protection (Diebold and Yilmaz, 2012). In the context of basic materials, the sector is closely linked to commodity prices, global demand, exchange-rate movements, and construction-related cycles. Therefore, when downside risk increases in this sector, green bond or green sukuk instruments may not fully offset the loss exposure. This finding supports Billah et al. (2024b), who show that Islamic sectoral stocks and green bond markets have meaningful downside risk connectedness, especially under adverse market conditions.

The significant negative effect of OGE → HE also confirms that Islamic Oil and Gas/Energy Sector Risk weakens the effectiveness of hedging. This finding is important because the energy sector is highly sensitive to oil price shocks, geopolitical uncertainty, inflationary pressures, and the dynamics of the global energy transition. Umar et al. (2023) explains that oil shocks are linked to green bonds, sukuk, and conventional bonds, implying that energy-related uncertainty can alter the risk-return relationship among Islamic and sustainable financial assets. In this study, the negative coefficient indicates that as oil-and-gas/energy risk increases, the ability of hedging instruments to reduce portfolio risk weakens. This result is also consistent with Mensi et al. (2022), who argue that the connectedness between green bond and stock markets differs across bearish and bullish market states. Thus, green bond and green sukuk instruments may provide diversification benefits, but those benefits can decline as energy-sector pressure intensifies.

The finding for FS → HE shows that Islamic Financials Sector Risk significantly reduces Hedging Effectiveness. This result indicates that Islamic financial stocks are sensitive to systemic market expectations, liquidity conditions, investor confidence, and broader financial-market uncertainty. Since Islamic financial institutions are part of the intermediation system, risk in this sector may spread rapidly to investor portfolios. This finding is aligned with Karim and Naeem (2022), who show that global factors can drive interconnectedness among green, Islamic, and conventional financial markets. It also supports Naeem et al. (2023), who find that sukuk and green bonds may behave differently before

and during crisis periods. Therefore, the hedging ability of sustainable Islamic instruments cannot be assumed to be stable across all market conditions, particularly when Islamic financial-sector risk increases.

The result for HS → HE indicates that the Islamic healthcare sector risk also has a significant negative effect on hedging effectiveness. Although healthcare is often considered a defensive sector, this study shows that its risk still weakens hedging performance. This implies that defensive characteristics do not completely eliminate downside exposure when market-wide stress or cross-asset spillover occurs. Chopra and Mehta (2023) explains that green bonds can act as a hedge or safe haven for stock-sector risk, but this role differs across sectors. Similarly, Ren et al. (2023) shows that the safe-haven function of green bonds depends on market conditions and the type of equity exposure. Therefore, even relatively defensive Islamic healthcare stocks may reduce portfolio protection when downside volatility, valuation uncertainty, or sector-specific risk increases.

Market stress also has a significant negative direct effect on Hedging Effectiveness. This result confirms that high uncertainty, crisis pressure, oil price shocks, and geopolitical risk reduce Islamic investors' ability to maintain stable hedging outcomes. The finding is consistent with the CoVaR perspective of Adrian and Brunnermeier (2016), which suggests that distress in one part of the financial system can increase downside risk in other parts of the system. It is also consistent with Baruník and Křehlík (2018), who explain that financial connectedness may differ across time horizons and may become stronger under stressed conditions. In the Indonesian Islamic capital market, this means that green sukuk and green bond instruments may still support diversification, but their effectiveness becomes more limited when market stress increases.

The interaction results provide additional evidence that Market Stress strengthens the negative relationship between Islamic sectoral equity risk and Hedging Effectiveness. The strongest interaction effect is found in MS × BM → HE, suggesting that the basic materials sector is the most sensitive to market-stress conditions. This is reasonable because the sector depends heavily on commodity cycles, industrial demand, and macroeconomic stability. The significant interactions of MS × FS → HE, MS × OGE → HE, and MS × HS → HE further indicate that market stress intensifies the transmission of downside risk across all tested Islamic sectors. These findings support the argument that hedging effectiveness is determined not only by the individual risk characteristics of each sector but also by the broader market environment in which investors allocate their portfolios.

Overall, the study contributes to Islamic finance and sustainable investment literature by showing that green bond and green sukuk-based hedging strategies are condition-dependent. While sustainable Islamic instruments can support diversification, their protective function weakens when Islamic sectoral risks and market stress increase simultaneously. This result extends previous evidence on Islamic equity–green bond connectedness (Billah et al., 2024b; Tiwari et al., 2023) by placing the analysis within the Indonesian Islamic capital market context. In practice, the findings suggest that Islamic investors, asset managers, and regulators should not rely solely on static hedging strategies. Instead, they need dynamic portfolio allocation, sector-specific risk monitoring, and stress-sensitive hedging strategies to improve portfolio resilience in down markets.

5. Conclusion

This study examined how Islamic sectoral equity risk and Market Stress influence Hedging Effectiveness in the Indonesian Islamic capital market. The results reveal that hedging effectiveness is significantly shaped by sector-specific downside risk, market uncertainty, and the interaction between Islamic equity risks and stressful market conditions. The Islamic basic materials sector risk has the strongest negative effect on Hedging Effectiveness, indicating that volatility in commodity-related and industrial sectors can weaken the protective function of hedging strategies. Islamic Financials Sector Risk, Islamic Healthcare Sector Risk, Islamic Oil and Gas/Energy Sector Risk, and Market Stress also significantly reduce hedging effectiveness, confirming that Sharia-compliant portfolios remain exposed to sectoral shocks, systemic market pressure, and cross-asset risk transmission.

The interaction results further show that market stress strengthens the negative relationship between Islamic sectoral equity risk and hedging effectiveness. This means that hedging strategies become less effective when sectoral risk arises amid high uncertainty, downside pressure, oil price shocks, geopolitical tensions, and financial market instability. The strongest interaction is observed between Market Stress and Islamic Basic Materials Sector Risk, suggesting that this sector is particularly sensitive to stress-driven risk transmission. These findings imply that green bond and green sukuk instruments may support portfolio diversification, but their protective role is not constant across market regimes. Under stressed market conditions, stronger connectedness among Islamic stocks, green bonds, and green sukuk can reduce hedging benefits.

This study contributes to Islamic finance, sustainable investment, and systemic risk connectedness literature by developing an integrated portfolio-risk framework that links Islamic sectoral equity risk, green bond/green sukuk volatility, market stress, and hedging effectiveness. It advances previous research by shifting the focus from broad Islamic stock indices to sector-specific risk behavior in the Indonesian Islamic capital market. The findings support the connectedness framework, frequency connectedness theory, and the CoVaR perspective by showing that downside risk transmission strengthens under adverse market conditions. Thus, hedging effectiveness in Islamic portfolios should be understood as a dynamic outcome influenced by both sectoral characteristics and changing market regimes.

The findings provide practical implications for Islamic investors, asset managers, regulators, and green sukuk issuers. Islamic investors should avoid relying only on static diversification and instead adopt dynamic, sector-sensitive, and stress-aware hedging strategies. Asset managers need to monitor sectoral downside risk, oil price movements, geopolitical pressure, and market-stress indicators when constructing Sharia-compliant portfolios. Regulators and issuers should strengthen the role of green sukuk and sustainable Islamic finance instruments by improving transparency, market liquidity, investor education, and the availability of reliable risk information. In this context, green bonds and green sukuk instruments should be positioned not only as sustainable financing tools but also as part of a broader Islamic portfolio risk management strategy.

This study has several limitations. First, the model focuses on selected Islamic sectors, namely basic materials, oil and gas/energy, financials, and healthcare; future studies may include additional sectors such as consumer goods, infrastructure, technology, transportation, and telecommunications. Second, this study uses an investor-based quantitative approach supported by market risk indicators; future research may use longer time-series data, high-frequency market data, or dynamic econometric models to capture more detailed risk-transmission patterns. Third, future studies may compare Indonesia with other Islamic capital markets, such as Malaysia, Saudi Arabia, the United Arab Emirates, and Turkey, to determine whether the findings are consistent across different regulatory, market, and Sharia governance environments.

Overall, this study concludes that improving hedging effectiveness in Islamic portfolios requires more than the inclusion of green bond or green sukuk instruments. It requires a comprehensive understanding of sectoral downside risk, systemic connectedness, and market-stress dynamics. The results emphasize that Islamic portfolio resilience depends on investors' and asset managers' ability to adjust hedging strategies in response to sector-specific exposures and changing market conditions. Therefore, a dynamic and stress-sensitive portfolio framework is

essential for strengthening sustainable Islamic investment and improving risk management in the Indonesian Islamic capital market.

Ethical Statement

The authors declare that there is no conflict of interest regarding the publication of this article. The research was conducted independently, and no personal, financial, or institutional relationships influenced the study design, analysis, interpretation, or manuscript preparation.

Informed Consent Statement

Informed consent was obtained from all respondents prior to data collection. Participants were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of their responses.

Author Contributions

Yofhi Septian Panglipurningrum contributed to the conceptualization, research design, theoretical framework, data interpretation, and manuscript preparation. Tri Widianto contributed to methodology development, data analysis, validation, literature review, and manuscript revision. All authors have read and approved the final version of the manuscript.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to respondent confidentiality and research ethics considerations, the raw survey data are not publicly shared.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article. The research was conducted independently, and no personal, financial, or institutional interests influenced the study design, data analysis, interpretation, or manuscript preparation.

Declaration of Generative AI and AI-Assisted Technologies

The authors used artificial intelligence tools only for language refinement, formatting assistance, and technical editing during manuscript preparation. All conceptual development, data analysis, interpretation, arguments, and final scholarly responsibility remain with the authors.

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