“Operational efficiency of Islamic versus conventional mutual funds during the COVID-19 crisis: A two-stage data envelopment analysis of Malaysian funds (2015–2022)”

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OPERATIONAL EFFICIENCY OF ISLAMIC VERSUS CONVENTIONAL MUTUAL FUNDS DURING THE COVID-19 CRISIS: A TWO-STAGE DATA ENVELOPMENT ANALYSIS OF MALAYSIAN FUNDS (2015–2022)

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Abstract

The global growth of Islamic finance and the recurrence of systemic financial crises have intensified scholarly interest in whether Shariah-compliant investment structures offer measurable performance advantages over conventional counterparts, yet operational efficiency comparisons using non-parametric frontier methods remain scarce. This study aims to evaluate the operational efficiency of Islamic versus conventional mutual funds in Malaysia during the period 2015–2022, with a special focus on efficiency behavior during the COVID-19 crisis (2020–2021), using a two-stage Data Envelopment Analysis framework. A sample of 108 Malaysian mutual funds (52 Islamic and 56 conventional) was analyzed using output-oriented constant-returns-to-scale DEA with annualized return volatility and fund turnover ratio as inputs and the Sharpe ratio as the output, followed by second-stage ordinary least squares regression to identify contextual efficiency determinants. Islamic funds achieved a mean efficiency score of 0.6545 compared to 0.5967 for conventional funds, a statistically significant difference of 5.78 percentage points ($t = 2.549$, $p = 0.012$). During the COVID-19 crisis, this gap widened to 14.93 percentage points, with Islamic fund efficiency rising to 0.7281 and conventional fund efficiency declining to 0.5788 ($t = 3.519$, $p = 0.002$). Regression analysis confirmed that higher return volatility consistently reduces efficiency ($\beta = -0.043$, $p < 0.001$), while the Islamic×Crisis interaction term indicates a crisis-specific efficiency premium ($\beta = 0.026$, $p = 0.071$). The structural constraints of Islamic finance – prohibiting leverage, speculation, and synthetic instruments – function as resilience mechanisms under macroeconomic pressure, supporting differentiated regulatory consideration for Shariah-compliant funds within dual financial systems.

Keywords efficiency, funds, Islamic, conventional, resilience, DEA, crisis, Malaysia

JEL Classification G23, G01, G11, C67

INTRODUCTION

The performance of investment funds under conditions of acute financial stress represents one of the most consequential yet incompletely understood dimensions of modern financial research. While conventional portfolio theory has generated a rich understanding of risk-return trade-offs in stable markets, the behavioral properties of investment vehicles during periods of systemic crisis – when correlations spike, liquidity evaporates, and normal market mechanisms fail – remain subject to active debate and empirical contestation. The COVID-19 pandemic, which triggered the fastest equity market decline in recorded history, provided an unprecedented natural experi-

ment for examining whether certain investment structures possess inherent resilience properties that become operative specifically under extreme market duress.

Within this broader question, a specific and increasingly important sub-problem concerns the comparative efficiency of Islamic versus conventional mutual funds. Islamic mutual funds operate under Shariah-law constraints that prohibit investment in interest-bearing instruments, speculative derivatives, and highly leveraged positions – restrictions that, in principle, could either enhance efficiency by limiting exposure to crisis-amplification mechanisms or diminish efficiency by constraining portfolio diversification and managerial flexibility. Thus, the key scientific problem of this study is the structural financial architecture: Do institutional investment constraints rooted in religious law produce systematically different efficiency outcomes relative to unconstrained conventional investment, and does this relationship vary across market regimes? This question carries implications not only for the estimated USD 3.88 trillion (IFSB, 2025) global Islamic finance industry but also for regulatory frameworks, portfolio construction strategies, and the theoretical understanding of how institutional constraints interact with financial market dynamics during periods of systemic stress.

1. LITERATURE REVIEW AND HYPOTHESES

The comparative analysis of Islamic and conventional financial institutions has evolved into a substantial and multi-disciplinary field of inquiry, spanning financial economics, institutional governance, and regulatory policy. Understanding the current state of knowledge requires a systematic examination of four interconnected research streams: the performance and resilience behavior of Islamic versus conventional funds, the measurement and determinants of operational efficiency, the role of fund-level characteristics in shaping efficiency outcomes, and the methodological evolution of Data Envelopment Analysis as an efficiency evaluation tool for financial institutions (Ahmad et al., 2024).

The question of whether Islamic financial institutions demonstrate superior resilience during periods of market disruption has attracted sustained scholarly attention since the 2008 global financial crisis. Hassan and Dridi (2010), in a cross-country study commissioned by the International Monetary Fund, documented those Islamic banks experienced lower credit and asset losses than their conventional counterparts during the 2008 crisis, a finding they attributed to the balance-sheet conservatism and risk-sharing structures inherent in Islamic finance. This foundational evidence was reinforced by Beck et al. (2013), who analyzed bank-level data from 22 countries and found that Islamic banks maintained higher asset quality and capitalization during the crisis, though they also reported lower cost efficiency in normal market conditions. Abedifar et al. (2013) extended this analysis by demonstrating that the insolvency risk of Islamic banks is systematically lower than that of conventional banks, particularly in countries with stronger Islamic banking presence, suggesting that regulatory ecosystem maturity moderates resilience outcomes.

The extension of crisis-resilience research from banking to the mutual fund domain has produced convergent findings. Petridis et al. (2023) measured mutual fund efficiency during the initial phase of the COVID-19 disruption using DEA and documented significant efficiency heterogeneity across fund types, with funds subject to conservative investment mandates exhibiting less performance deterioration. Tsolas (2014) applied a two-stage DEA framework to precious metal mutual funds and confirmed that structural investment constraints influence efficiency behavior in non-linear ways during market dislocations. Atta and Marzuki (2021) provided complementary evidence from the fund-flow perspective, demonstrating that investor capital migrated toward Islamic vehicles during peak pandemic uncertainty, suggesting that market participants perceived Shariah-compliant funds as offering relative safety. Baniata et al. (2024) examined Islamic and conventional mutual fund performance in Malaysia's dual financial system and found that Islamic funds maintained stronger investment resilience across crisis and non-crisis periods. This finding

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was subsequently extended by Baniata et al. (2025) and Alshaketheep et al. (2025) in a sustainability-focused study that linked the resilience differential to the ethical and structural constraints embedded in Shariah governance. Alkhwaldi et al. (2022) documented parallel effects in the fintech adoption domain, showing that crisis-driven behavioral shifts favored platforms and instruments perceived as structurally safer. Dasgupta and Patel (2015) evaluated Indian mutual fund performance using DEA and found that funds with more conservative mandates achieved superior efficiency during volatile market conditions, providing evidence of constraint-driven resilience beyond the Islamic finance context specifically.

Conversely, not all evidence supports an unqualified Islamic advantage. Miah and Uddin (2017) examined banks in the Gulf Cooperation Council region and found that while Islamic banks exhibited greater stability, their efficiency was not uniformly superior across all measurement dimensions. Mohammad et al. (2020) combined financial ratio analysis with efficiency measurement for Islamic and conventional banks and concluded that the relative advantage depends heavily on the specific efficiency metric employed and the regulatory environment. Bauer et al. (2005), although focused on ethical rather than Islamic funds, established an important precedent that ethically screened funds do not necessarily underperform their unrestricted counterparts, challenging the expectation that investment constraints necessarily reduce efficiency. These mixed findings underscore the importance of selecting appropriate efficiency metrics and controlling for institutional context when drawing comparative conclusions (Shehadeh et al., 2024).

Operational efficiency – defined as the capacity to minimize input waste and maximize output from a given resource base – provides a fundamentally different analytical perspective than return-based performance comparisons. The distinction is critical because a fund may generate strong returns while operating inefficiently (consuming excessive resources relative to its output), or it may achieve modest returns with exceptional resource utilization. Johnes et al. (2014) advanced this conceptual distinction in their comparison of Islamic and conventional bank efficiency across the 2004–2009 period, finding that Islamic banks demonstrated higher net efficiency after accounting for the operational constraints imposed by Shariah governance. Alexakis et al. (2019) reinforced these findings using productivity analysis during the global financial crisis, documenting that Islamic banks' superior performance was driven by genuine efficiency gains rather than favorable market conditions alone.

The governance mechanisms unique to Islamic financial institutions play a central role in explaining efficiency differentials (Hallaq & Ghazalat, 2026). Shariah supervisory boards conduct ongoing compliance reviews that extend beyond conventional audit functions, monitoring not only financial performance but also the permissibility of investment activities, thereby reducing managerial discretion in ways that can limit both operational waste and excessive risk-taking (Saeed & Izzeldin, 2016). Abdul-Majid et al. (2010) provided international comparative evidence that Islamic banks achieve higher technical efficiency than conventional banks, attributing this to the discipline imposed by profit-and-loss sharing contracts and asset-backed financing requirements. Lassoued et al. (2025) extended this evidence to the COVID-19 period, documenting that Islamic banks maintained higher comparative efficiency during the pandemic, a finding consistent with the structural resilience hypothesis. Nanduri et al. (2026) linked efficiency and sustainability performance in mutual funds using DEA, demonstrating that governance quality and operational discipline jointly predict superior efficiency outcomes. Galagedera and Watson (2015) conducted benchmarking and productivity analysis of the Australian investment fund industry and established that systematic differences in operational practices – rather than market exposure alone – drive cross-fund efficiency variation, a finding directly relevant to the Islamic-conventional comparison where operational practices differ by structural mandate.

Despite this growing body of evidence from banking, systematic efficiency studies of Islamic mutual funds remain markedly underdeveloped. The banking literature cannot be directly extrapolated to mutual funds because the two operate under different regulatory frameworks, face different competitive dynamics, and manage different types of

assets. The scarcity of rigorous, non-parametric mutual fund efficiency comparisons in crisis settings represents one of the most significant empirical gaps in the Islamic finance literature (Nanduri et al., 2026; Chopra, 2020).

A well-established research tradition documents the influence of fund-level characteristics on performance and efficiency. Fund size, typically measured by total assets under management, has been associated with scale economies that reduce per-unit operating costs and improve resource allocation efficiency (Basso & Funari., 2001; Premachandra et al., 2012; Annaert et al., 2003). Larger funds can access superior research infrastructure, negotiate better trading terms, and diversify fixed costs across a broader asset base, all of which should, in principle, improve operational efficiency. However, the relationship is not monotonically positive; extremely large funds may experience diseconomies of scale through market impact costs, organizational complexity, and reduced managerial agility (Galagedera & Silvapulle, 2002).

Fund age, representing accumulated managerial experience, tends to correlate positively with efficiency. Experienced fund managers develop superior market knowledge, refined portfolio construction techniques, and established networks that facilitate better investment decision-making over time (Matallín-Sáez et al., 2019; Basso & Funari, 2003). Cortez et al. (2009) documented this pattern in European socially responsible funds, finding that longer-tenured funds achieved better risk-adjusted performance, partly through improved operational processes developed over time. Turnover ratio, by contrast, generally maintains a negative or neutral relationship with efficiency, because high trading frequency generates transaction costs that erode net returns without proportionate risk-adjusted performance gains (Carhart, 1997; Murthi et al., 1997; Sharpe, 1966).

Importantly, the magnitude and direction of these characteristic-efficiency relationships may differ systematically between Islamic and conventional funds. The governance structures and investment mandate constraints inherent in Islamic funds may alter how size, age, and turnover translate into efficiency outcomes. Petridis et al. (2023) suggest that Islamic fund governance allows more effective leveraging of scale advantages, while conservative mandates may dampen the negative impact of moderate turnover by limiting the universe of tradeable assets and thereby reducing unnecessary portfolio churn. These differential interactions between fund characteristics and institutional type have received limited empirical attention, particularly in crisis contexts where the moderating effects of constraints may become amplified.

Data Envelopment Analysis has emerged as the predominant non-parametric method for evaluating the relative efficiency of financial institutions since the foundational work of Charnes et al. (1978), who introduced the constant-returns-to-scale CCR model. Banker et al. (1984) subsequently developed the variable-returns-to-scale BCC model, enabling researchers to decompose total efficiency into technical and scale components. The application of DEA to mutual fund evaluation was pioneered by Murthi et al. (1997), who established the canonical input-output structure using risk and cost measures as inputs and risk-adjusted returns as outputs, and by Basso and Funari (2001), who refined this framework and demonstrated its superiority over single-ratio performance measures for capturing multi-dimensional fund efficiency. Galagedera and Silvapulle (2002) applied this framework to Australian mutual funds and confirmed that DEA identifies efficiency variations invisible to traditional performance metrics.

Subsequent methodological advances have substantially expanded the analytical power of DEA in financial applications. Premachandra et al. (2012) demonstrated the value of two-stage DEA for decomposing fund efficiency into operational and portfolio management dimensions, revealing that the determinants of efficiency differ across stages. Färe and Grosskopf (2000) provided the theoretical foundations for network DEA models that track value creation across multiple linked process stages. The super-efficiency extension introduced by Andersen and Petersen (1993) addressed the discrimination limitation of standard DEA by allowing efficient units to achieve scores exceeding unity, enabling rank ordering within the frontier set. Simar and Wilson (1998, 2007) introduced bootstrap correction methods that address the deterministic bias inherent in conven-

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tional DEA, generating confidence intervals and bias-corrected estimates that substantially improve inferential reliability – particularly critical when comparing subgroup means, as in Islamic versus conventional fund comparisons.

More recent methodological contributions have continued to push the frontier of DEA applications. Xiao et al. (2022) developed stochastic DEA approaches for portfolio efficiency estimation that account for uncertainty in input-output measurements. Rashidi et al. (2025) proposed a comprehensive DEA-based framework integrating undesirable inputs and social-environmental indicators, demonstrating DEA flexibility for multi-criteria evaluation. Zubir et al. (2024) conducted a systematic review of input-output selection approaches in DEA, providing methodological guidance for ensuring construct validity in efficiency measurement. Cooper et al. (2000) synthesized the theoretical foundations and practical applications of DEA across multiple domains, confirming its appropriateness for financial institution evaluation. Cook and Zhu (2008) provided updated modeling frameworks for DEA that address contemporary challenges in operational process measurement and productivity analysis. Daraio and Simar (2007) advanced robust and nonparametric methods for efficiency analysis, offering improved techniques for handling outliers and heterogeneous data environments.

Despite these substantial methodological advances, the systematic application of a two-stage DEA design – pairing frontier efficiency estimation with second-stage regression analysis – to the Islamic versus conventional mutual fund comparison within a crisis setting has not been undertaken. A first-stage frontier estimate alone identifies which funds are efficient but cannot explain why efficiency varies with fund type, fund characteristics, or market regime, which is precisely the question the second stage is designed to answer. This methodological and empirical gap limits the field's ability to determine whether observed efficiency differences between fund types are systematically associated with structural and contextual factors.

Synthesizing the evidence across these four research streams, several conclusions emerge. First, Islamic financial institutions exhibit structural features – governance discipline, asset-backed investment mandates, and prohibition of speculative activities – that are theoretically and empirically associated with greater resilience under market stress, though the evidence is stronger for banking than for mutual funds. Second, operational efficiency measurement via DEA offers a methodologically superior performance lens compared to return-based metrics alone, capturing multi-dimensional resource utilization that single-ratio measures cannot. Third, fund-level characteristics influence efficiency outcomes, but their differential effects across Islamic and conventional fund types within crisis periods remain inadequately studied. Fourth, a two-stage DEA design – combining frontier efficiency estimation with second-stage regression – offers the analytical granularity to link efficiency outcomes to fund type, fund characteristics, and market regime, yet it has not been applied to the Islamic-conventional fund comparison in a crisis context; bootstrap-based bias correction (Simar & Wilson, 1998, 2007) represents a complementary refinement that future work can incorporate to further strengthen statistical inference for such subgroup comparisons.

This study aims to evaluate the operational efficiency of Islamic versus conventional mutual funds in Malaysia during the period 2015–2022, with particular emphasis on efficiency behavior during the COVID-19 crisis (2020–2021), using a two-stage Data Envelopment Analysis framework. These observations motivate the following hypotheses:

H1: Islamic funds are more efficient overall than conventional funds during times of crisis due to stronger managerial discipline and conservative investment strategies.

H2: Islamic funds demonstrate superior Stage-1 operational efficiency due to stronger internal control systems and Shariah-driven governance mechanisms.

H3: Fund characteristics (size, turnover, age) influence efficiency differently across Islamic and conventional funds, with Islamic funds expected to benefit more from scale and governance-based stability.

2. METHOD

Performance in this study is evaluated through a fund manager's ability to convert risk-bearing inputs into risk-adjusted returns, assessed under both normal and crisis market conditions. The analytical instrument is Data Envelopment Analysis (DEA), a non-parametric frontier method that computes relative efficiency by identifying a best-practice frontier from the observed data, without imposing a predetermined functional form or distributional assumption (Charnes et al., 1978). An output-oriented specification is adopted, reflecting the empirical reality that fund managers exercise far greater control over performance outputs – such as risk-adjusted returns – than over market-determined inputs such as volatility. DEA is preferred over Stochastic Frontier Analysis (SFA) because it does not require assumptions about the production function form and captures total efficiency directly from observed data, which is particularly appropriate for financial applications where input-output relationships are unlikely to follow a stable parametric distribution (Cortez et al., 2009; Verberi et al., 2026).

Figure 1 presents the conceptual framework, which integrates the operational efficiency and portfolio management dimensions. The framework maps fund inputs – risk (annualized standard deviation) and turnover ratio – through a Stage-1 managerial efficiency layer to the output of risk-adjusted returns (Sharpe ratio), with a Stage-2 regression layer linking efficiency scores to contextual determinants, including fund type, fund characteristics, and crisis period.

The dataset covers Malaysian mutual funds for which complete data on net asset value, assets under management, returns, turnover ratio, and inception dates were available. The empirical data and core analytical results presented in this study are derived from the corresponding author's doctoral dissertation, completed in 2022, which examined Malaysian mutual fund performance through the COVID-19 crisis window; the present article reframes and extends that work within a two-stage DEA framework. Systematic filtering of 226 candidate funds for data completeness produced a final sample of 108 funds (52 Islamic and 56 conventional), covering the period 2015 to

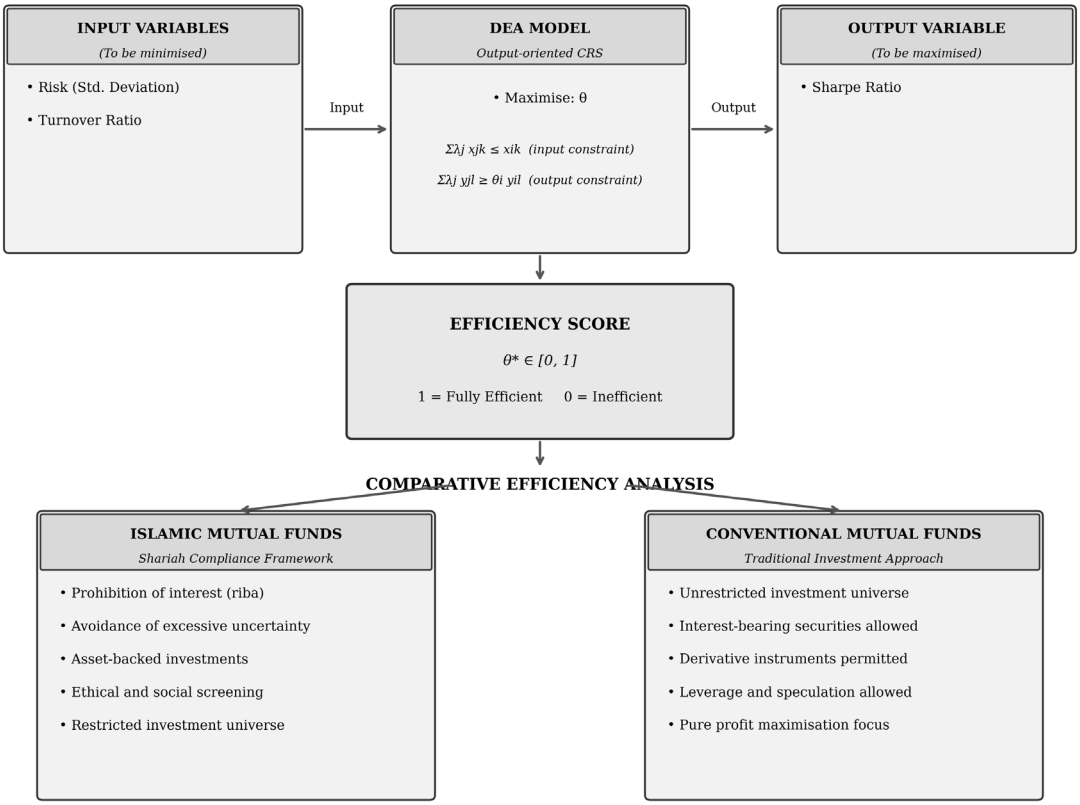

Figure 1. Two-stage DEA conceptual framework for Islamic and conventional mutual fund efficiency

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2022. This window captures the pre-crisis stability phase, the COVID-19 shock (2020–2021), and the post-crisis recovery, enabling multi-regime performance comparison. Malaysia is the appropriate jurisdiction because it operates the world's most developed dual financial system, where Islamic and conventional funds co-exist under identical regulatory, economic, and disclosure conditions, ensuring that observed efficiency differentials reflect managerial and structural factors rather than regulatory asymmetries (Bank Negara Malaysia, 2023; International Monetary Fund, 2022; Marzuki et al., 2022).

The unit of analysis, or decision-making unit (DMU), is the individual mutual fund. To examine how efficiency behaves across market regimes, DEA was estimated separately within each regime, so that every fund is assigned a regime-specific efficiency score: a normal-period score, derived from the pre-crisis and post-crisis windows (2015–2019 and 2022), and a crisis-period score, derived from the COVID-19 window (2020–2021). The full-sample efficiency scores reported in Table 1 are estimated over the complete 2015–2022 horizon and provide a single cross-sectional efficiency value per fund, whereas the normal-versus-crisis comparison in Table 2 draws on these regime-specific (fund-period) scores. Since each fund therefore contributes a normal-period and a crisis-period observation, the second-stage regression operates on fund-period observations, with the crisis dummy and the Islamic × Crisis interaction term distinguishing the two regimes; this panel-style structure is what permits the regime comparison reported in Section 4. The design accordingly treats efficiency as regime-contingent rather than as a single time-invariant fund attribute, consistent with the study's focus on crisis-period resilience.

Returns were annualized using 252 trading days, and volatility measures were standardized via the square-root-of-time principle. Sharpe ratios were computed using a uniform risk-free rate of 3%, consistent with Malaysian Government Securities yields. Where turnover and assets-under-management data were missing, conservative subgroup-average imputation was applied and verified through sensitivity testing. A minimum of six valid observations per fund was required. Outlier detection applied statistical thresholds (annualized returns between –200% and +300% flagged for review) together with interquartile range procedures and Cook's distance analysis (Daraio & Simar, 2007; Wang & Schmidt, 2002).

This study applies an output-oriented DEA under the Constant Returns to Scale (CRS) assumption, following the CCR model of Charnes et al. (1978). The model evaluates each fund's efficiency relative to the best-practice frontier, with efficiency scores bounded between 0 (full inefficiency) and 1 (full efficiency). Formally, for each fund *i*, the primal output-oriented DEA model is specified as:

$$\text{Maximize}\,\theta_i \tag{1}$$

subject to:

$$\sum \lambda_j \; x_{jk} \le x_{ik}, \text{ for all inputs } k \tag{2}$$

$$\sum \lambda_j \; y_{jl} \ge \theta_i \; \cdot y_{il}, \text{for all outputs } l \tag{3}$$

$$\lambda_j \ge 0, \text{for all } j; \theta_i \ge 1 \tag{4}$$

where x_{jk} and y_{jl} represent the input and output vectors for fund *j*; λ_j are intensity variables defining the contribution of peer funds to the reference set; and θ_i denotes the proportional output expansion required for fund *i* to reach the efficient frontier.

The two inputs are: (1) the annualized standard deviation of daily returns (σ_i), computed as the sample standard deviation of daily returns multiplied by $\sqrt{252}$, capturing total portfolio risk (Markowitz, 1952; Sharpe, 1964); and (2) the turnover ratio (TO_i), defined as the minimum of fund purchases and sales divided by average net assets, expressed as a percentage, serving as a proxy for trading costs (Treynor, 1965; Carhart, 1997). These input measures are formally specified as:

$$\sigma_i = \sigma_{daily,i} \times \sqrt{252} \tag{5}$$

$$TO_i = \frac{min\left(Purchases_i, Sales_i\right)}{Average\ Net\ Assets_i}. \tag{6}$$

The single output is the Sharpe ratio (Basso & Funari, 2001; Verberi et al., 2026), defined as:

$$SR_i = \frac{\hat{a}_i - r_F}{\sigma_i}, \quad (7)$$

where $\bar{a}_i$ is the annualized average return of fund i and r_F is the 3% risk-free rate.

Efficiency scores are reported on the standard 0–1 scale, where unity denotes a fund operating on the best-practice frontier and lower values denote proportionate distance from it. Two established refinements of the basic model are noted but not applied to the scores reported here: super-efficiency ranking, which excludes the evaluated unit from its own reference set to discriminate among frontier funds (Andersen & Petersen, 1993), and bootstrap-based bias correction, which generates confidence intervals and bias-corrected estimates to mitigate the deterministic bias inherent in DEA (Simar & Wilson, 1998, 2007). Incorporating these refinements to sharpen frontier discrimination and strengthen statistical inference represents a valuable direction for future extensions of this work.

The model satisfies the Cooper et al. (2000) rule of thumb that the number of decision-making units should be at least three times the total number of inputs and outputs: $108 \geq 3 \times (2 + 1) = 9$. The CRS assumption is validated by comparing CRS and Variable Returns to Scale (VRS) efficiency scores; scale efficiency = CRS efficiency / VRS efficiency, with values of 1 indicating efficient scale. Robustness is assessed across three alternative model specifications, and convergent validity is confirmed by cross-validation against Sharpe, Treynor, Jensen, and Modigliani-Modigliani measures ($r > 0.60$ threshold) (Hair et al., 2019).

3. RESULTS

Output-oriented DEA estimation yields efficiency scores bounded within the theoretically prescribed interval of 0 to 1, consistent with the CCR model specification (Charnes et al., 1978; Cook & Zhu, 2008). Across the full sample of 108 funds, efficiency scores exhibit substantial heterogeneity, enabling meaningful cross-fund performance comparisons. Table 1 presents the full-sample descriptive statistics.

Table 1. Descriptive statistics of DEA efficiency scores

Statistic	Value
Mean	0.6245
Standard Deviation	0.1209
Minimum	0.3000
Maximum	0.9158
Median	0.6187

The mean efficiency score of 0.6245 indicates that the average fund operates at approximately 62% of the best-practice level, implying meaningful scope for performance improvement across the Malaysian mutual fund industry, consistent with comparable emerging-market findings (Abdul-Majid et al., 2010; Johnes et al., 2014). The standard deviation of 0.1209 reflects considerable cross-fund heterogeneity, while the range from 0.3000 to 0.9158 confirms the coexistence of highly inefficient and near-frontier performers, a pattern documented across national fund markets (Murthi et al., 1997; Basso & Funari, 2001; Gottschalk & Hinz, 2014). The distribution is approximately normal with a modest positive skew, consistent with competitive financial market efficiency distributions (Banker & Natarajan, 2008; Daraio & Simar, 2007).

Figure 2 presents the DEA efficiency frontier in output-oriented space, plotting Sharpe ratios against return volatility and distinguishing Islamic funds from conventional funds. Figure 3 presents box plots of efficiency score distributions by fund type.

Islamic mutual funds exhibit significantly higher operational efficiency than conventional funds, with mean scores of 0.6545 and 0.5967, respectively – a difference of 5.78 percentage points that is statistically significant ($t = 2.549$, $p = 0.012$, 95% CI: [0.0129, 0.1027]). Islamic funds display modestly higher efficiency variability ($\sigma = 0.1271$) than conventional funds ($\sigma = 0.1088$), a pattern documented in other dual-system efficiency studies (Abdul-Majid et al., 2010; Johnes et al., 2014). This efficiency advantage is consistent with theoretical predictions that Shariah-compliance constraints reduce operational waste and enhance managerial discipline (Alexakis et al., 2019; Saeed & Izzeldin, 2016; Abedifar et al., 2013).

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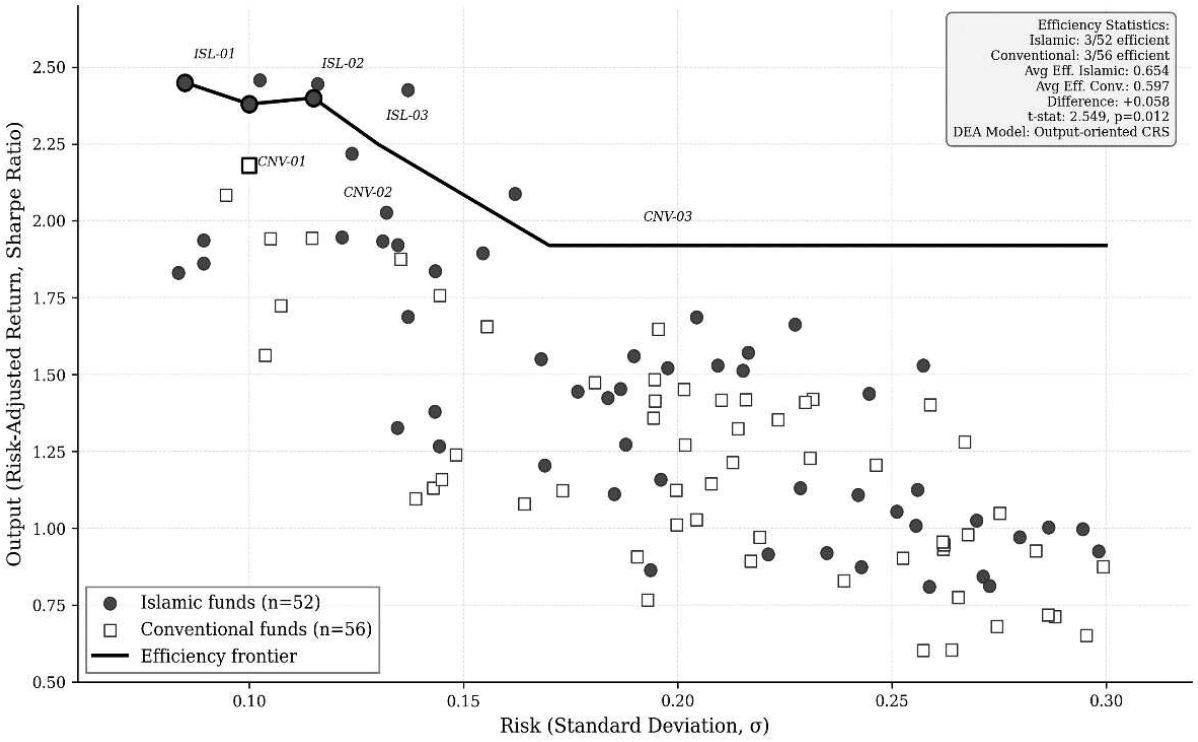
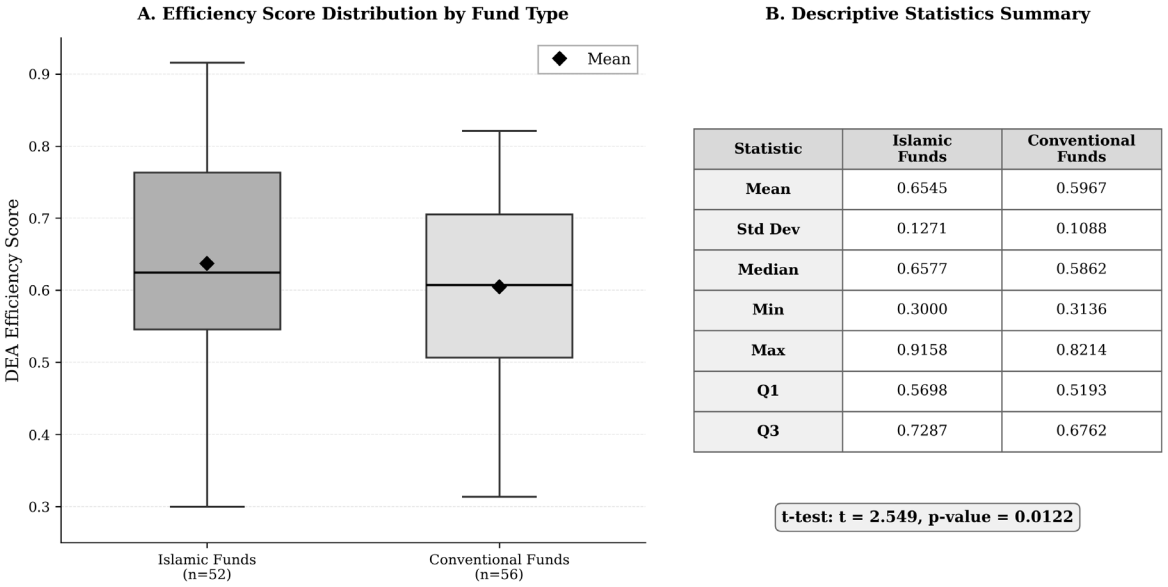


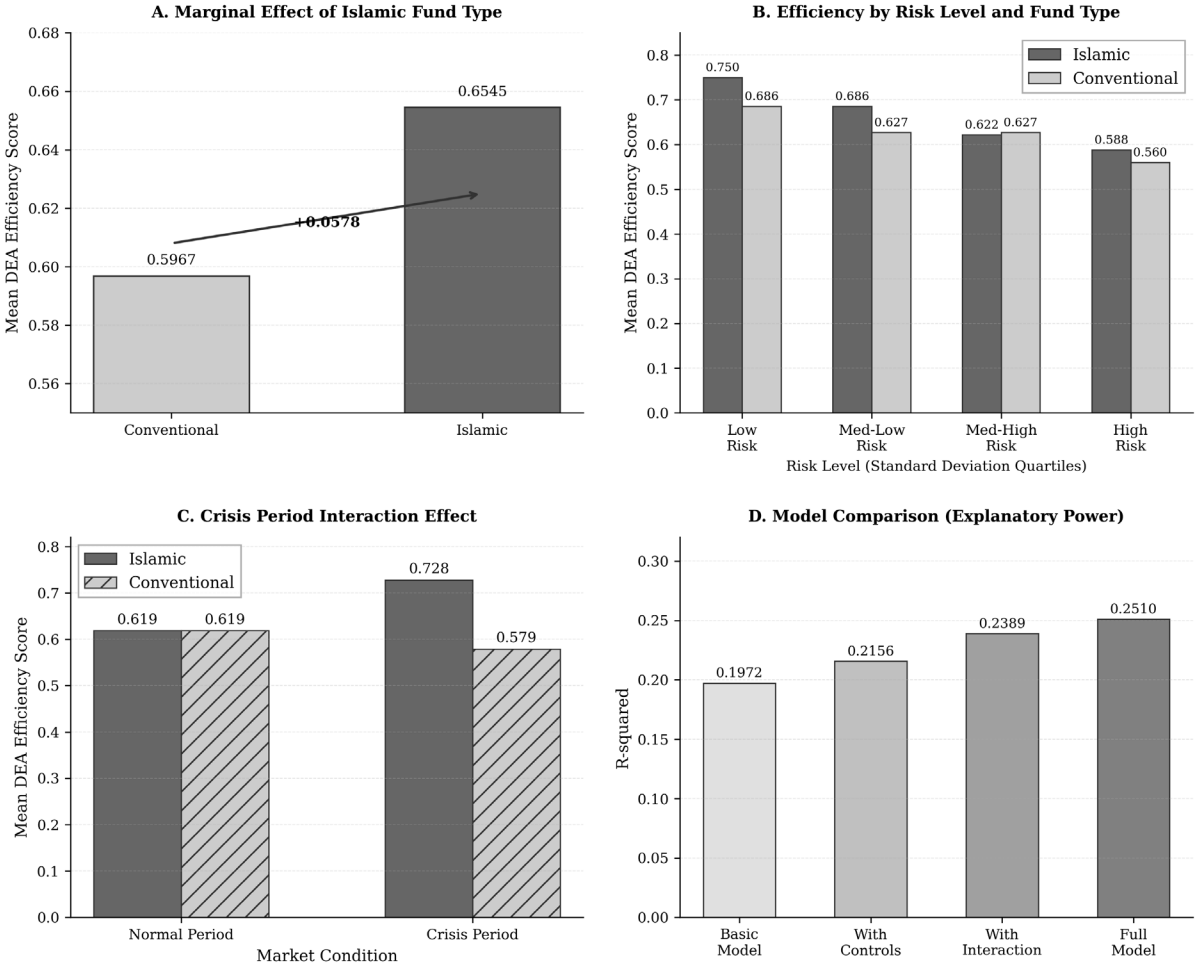
Figure 2. DEA efficiency frontier for Islamic and conventional mutual funds (output-oriented CRS model)



Statistic	Islamic Funds	Conventional Funds
Mean	0.6545	0.5967
Std Dev	0.1271	0.1088
Median	0.6577	0.5862
Min	0.3000	0.3136
Max	0.9158	0.8214
Q1	0.5698	0.5193
Q3	0.7287	0.6762

Figure 3. Efficiency score distributions by fund type

The most striking finding emerges from the crisis-period comparison. During normal periods (2015–2019, 2022), Islamic and conventional funds achieve near-identical mean efficiency scores (0.6193 for both categories). During the COVID-19 crisis (2020–2021), however, a pronounced divergence emerges: Islamic fund efficiency rises to 0.7281, while conventional fund efficiency declines to 0.5788, producing a gap of 14.93 percentage points (t = 3.519, p = 0.002). Table 2 presents these comparisons.



Note: All analyses based on 108 Malaysian mutual funds (52 Islamic, 56 conventional) over 2015–2022. Crisis period defined as 2020–2021 (COVID-19 impact). Statistical significance assessed at 5% level.

Note: Mean efficiency scores with 95% confidence intervals. Efficiency differential of 0.0578 (5.78 percentage points) significant at 5% level (p = 0.012).

Figure 4. Marginal effect of Islamic fund classification on efficiency

This pattern indicates that Islamic funds do not possess a blanket efficiency advantage in tranquil markets; rather, their structural features generate a resilience premium that becomes operative precisely when systemic stress disrupts conventional investment channels. The absence of leverage, speculative instruments, and synthetic exposures reduces susceptibility to crisis-amplification mechanisms – contagion, fire-sale dynamics, and derivative-driven losses – that disproportionately affect conventional funds (Sickles & Zelenyuk, 2019). These findings provide strong support for Hypothesis 1 and Hypothesis 2.

Two ordinary least squares regression models were estimated with DEA efficiency scores as the dependent variable. Model 1 includes fund type, mean return, standard deviation of returns, and fund turnover as predictors. Model 2 extends this specification with log-transformed total assets, a crisis period dummy, and an Islamic × Crisis interaction term. The full model specification is:

Table 2. DEA efficiency scores during normal and crisis periods

Market Condition	Islamic Funds	Conventional Funds	Difference
Normal Periods	0.6193	0.6193	0.0000
Crisis (2020–2021)	0.7281	0.5788	0.1493

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$$DEA\_Efficiency_i = \beta_0 + \beta_1 Islamic_i + \beta_2 \mathrm{Re}turn_i + \beta_3 Volatility_i + \beta_4 log(Assets_i) + \beta_5 Turnover_i + \beta_6 Crisis_i + \beta_7 (Islamic_i \times Crisis_i) + \varepsilon_i. \quad (8)$$

Table 3. Regression results – Model 1 (core fund characteristics)

Variable	Coeff.	SE	t-Stat	p
Islamic Dummy	0.0236	0.0118	2.00	0.047
Mean Return	0.0129	0.0089	1.45	0.149
Std. Deviation	−0.0429	0.0095	−4.52	<0.001
Fund Turnover	0.0042	0.0087	0.48	0.631
R-squared	0.1972			

Model 1 shows that Islamic fund classification is associated with a 2.36 percentage point efficiency premium over conventional funds, statistically significant at the 5% level. Higher return volatility has a strong and significant negative effect on efficiency ($\beta = -0.043$, $p < 0.001$), confirming that risk amplification impairs fund performance. Mean return and fund turnover are directionally positive but do not attain statistical significance.

Table 4. Regression results – Model 2 (extended with crisis controls)

Variable	Coeff.	SE	t-Stat	p
Islamic Dummy	0.0146	0.0115	1.27	0.206
Mean Return	0.0126	0.0087	1.45	0.150
Std. Deviation	−0.0380	0.0093	−4.09	<0.001
Log(Assets)	0.0116	0.0089	1.30	0.195
Fund Turnover	0.0062	0.0085	0.73	0.467
Crisis Dummy	0.0006	0.0098	0.06	0.951
Islamic × Crisis	0.0259	0.0142	1.82	0.071
R-squared	0.2510			

Model 2 reveals that during crisis periods, Islamic funds gain an additional 2.59 percentage points of efficiency (Islamic × Crisis interaction: $\beta = 0.026$, $p = 0.071$), a marginally significant result that corroborates the DEA comparison findings. The main effect of the Islamic dummy loses significance because the crisis interaction absorbs much of the variation, underscoring that Islamic funds' efficiency advantage is specifically amplified under market duress. Volatility remains strongly negative ($\beta = -0.038$, $p < 0.001$). Log assets show a weak positive association, suggesting minor scale economies (Hypothesis 3 partially supported). Robustness is confirmed by Ramsey RESET ($p > 0.05$), VIF values of 1.18–3.21, Breusch-Pagan and White tests ($p > 0.05$), Durbin-Watson statistics of 1.91 and 1.95, Durbin-Wu-Hausman exogeneity test ($p > 0.10$), and Jarque-Bera normality test ($p > 0.10$).

4. DISCUSSION

The findings of this study provide robust empirical support for the proposition that the structural constraints of Islamic finance translate into measurable operational efficiency advantages, particularly under conditions of acute market stress. The mean efficiency differential of 5.78 percentage points between Islamic and conventional funds, which widens to 14.93 percentage points during the COVID-19 crisis, is both statistically significant and economically meaningful. These results sit in productive tension with conventional portfolio theory, which predicts that investment restrictions reduce diversification and thereby diminish efficiency (Markowitz, 1952; Sharpe, 1964). The evidence instead supports the alternative view that under conditions of systemic disruption, constraints that eliminate exposure to speculative and leveraged instruments function as resilience mechanisms rather than efficiency costs.

The crisis-period efficiency divergence documented here is consistent with, but extends beyond, the findings of Hassan and Dridi (2010), who reported Islamic bank resilience during the 2008 crisis in a banking context. While Hassan and Dridi focused on credit and asset losses at the institutional level, the present study isolates operational efficiency at the fund level, demonstrating that the resilience

Table 5. Hypothesis testing summary

Hypothesis	Expected	Observed	Supported?	Key Evidence
H1	Islamic > Conv.	Positive, sig.	Supported	Mean 0.6545 vs 0.5967; crisis gap 14.93pp (p=0.002)
H2	Islamic > Conv.	Positive	Supported	DEA frontier and Stage-1 scores confirm operational advantage
H3	Mixed	Mixed	Partial	Volatility strongly negative; log assets weakly positive; turnover ns

advantage extends beyond balance-sheet metrics to encompass the efficiency with which fund managers convert risk inputs into risk-adjusted returns. Similarly, Beck et al. (2013) found higher asset quality in Islamic banks during the crisis but also noted lower cost efficiency in normal periods – a pattern strikingly parallel to this study's finding of no efficiency differential during tranquil markets but pronounced Islamic advantage under stress. The present study thus resolves the apparent contradiction between Islamic fund resilience and normal-period parity by demonstrating that the advantage is conditional on the market regime.

The magnitude of the crisis-period efficiency gap (14.93 percentage points) is larger than that typically reported in previous studies of mutual funds. Petridis et al. (2023) documented significant efficiency heterogeneity across funds during COVID-19 but did not isolate Islamic fund performance as a distinct category. Tsolas (2014) found that structural investment constraints influence efficiency non-linearly during market dislocations, and the present results confirm and quantify this non-linearity specifically for the Islamic-conventional distinction. Baniata et al. (2025) provided directly relevant Malaysian evidence of Islamic fund resilience but relied on return-based metrics rather than DEA efficiency, making the present study the first to quantify the operational efficiency dimension of this resilience differential. Atta and Marzuki (2021) documented investor capital migration toward Islamic vehicles during the pandemic, suggesting that market participants may partially recognize the efficiency advantage documented here through revealed preference.

The regression results provide additional interpretive depth. The strong negative effect of return volatility on efficiency ($\beta = -0.043$, $p < 0.001$ in Model 1; $\beta = -0.038$, $p < 0.001$ in Model 2) is consistent with the risk-efficiency relationship documented by Murthi et al. (1997) and Chopra (2020), confirming that funds exposed to greater return dispersion operate further from the efficiency frontier. The Islamic × Crisis interaction term ($\beta = 0.026$, $p = 0.071$) provides econometric confirmation of the DEA-based subgroup comparison, indicating that the efficiency premium is crisis-contingent rather than constant – a finding that aligns with the conditional resilience interpretation advanced by Dasgupta and Patel (2015). The weak positive effect of log assets ($\beta = 0.012$, $p = 0.195$) is directionally consistent with scale economy predictions (Premachandra et al., 2012; Basso & Funari, 2001) but does not achieve statistical significance, suggesting that scale effects are secondary to structural and governance factors in determining efficiency outcomes. The insignificance of turnover contrasts with the theoretical expectation of a negative effect (Carhart, 1997), possibly because the restricted investment universe of Islamic funds limits the range of turnover variation and thereby attenuates its efficiency impact.

The crisis-period pattern is theoretically interpretable through several mechanisms. Islamic funds' prohibition on derivatives and leveraged instruments insulates them from amplification dynamics that magnify losses in conventional portfolios during market dislocation – fire-sale cascades, margin calls, and counterparty failures (Sickles & Zelenyuk, 2019). The asset-backed investment requirement orients Islamic portfolios toward real-economy assets with more stable valuations during financial crises (Mirakhor & Krichene, 2009). Shariah supervisory governance structures reinforce operational discipline and may reduce managerial over-trading or speculative repositioning during crisis periods, consistent with the governance-efficiency linkage documented by Johnes et al. (2014) and Alexakis et al. (2019). The finding that efficiency parity exists during normal periods but diverges during stress supports the interpretation that these mechanisms function as latent resilience buffers that activate only when conventional amplification channels become operative.

Several limitations bound the scope of these conclusions. The single-country sample limits external validity; efficiency differentials observed in Malaysia's relatively mature dual financial system may not replicate in markets with less developed Islamic finance infrastructure. The DEA framework, while methodologically appropriate, is deterministic and cannot identify causal mechanisms or account for unobservable managerial heterogeneity. Because the analysis draws on a 2015–2022 observation window anchored to the corresponding author's doctoral data, the findings characterize fund behavior up to and including the COVID-19 episode rather than the most recent

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market environment and updating the sample to incorporate subsequent periods is a natural extension. In addition, the efficiency scores reported here are standard (deterministic) DEA estimates; applying bootstrap-based bias correction (Simar & Wilson, 1998, 2007) and formally benchmarking the two-stage design against a single-stage specification would further strengthen statistical inference and enable direct model comparison, and both represent promising directions for future work. The crisis period analyzed (2020–2021) represents a specific type of exogenous shock, and the resilience patterns observed may not generalize to other forms of financial crisis, such as banking system failures or sovereign debt crises. Future research should expand the analytical scope to multi-country panel DEA designs, incorporate additional governance quality measures to disentangle the specific drivers of Islamic fund efficiency, and explore machine learning approaches to input selection and frontier determination (Emrouznejad & Yang, 2018).

CONCLUSION

This study aimed to evaluate the operational efficiency of Islamic versus conventional mutual funds in Malaysia during the period 2015–2022, with particular emphasis on efficiency behavior during the COVID-19 crisis (2020–2021), using a two-stage Data Envelopment Analysis framework.

The central conclusion is that the structural constraints of Islamic finance – the prohibition of interest, speculation, and synthetic instruments, combined with mandatory Shariah governance – function as resilience mechanisms that become operative during periods of systemic market stress rather than imposing efficiency costs under normal conditions. This conditional advantage challenges the conventional view that investment restrictions necessarily reduce fund performance and suggests that the relationship between regulatory constraints and efficiency is regime dependent. For investors, the conditional nature of this efficiency advantage suggests that the potential for Islamic fund allocation to mitigate crisis-induced efficiency deterioration at the portfolio level is a question that future research should test directly. For regulators and policymakers in dual financial systems, the evidence supports consideration of differentiated prudential frameworks that recognize the distinctive crisis-period behavior of Shariah-compliant funds. For the academic community, the study demonstrates that methodological choices matter: a two-stage DEA design that combines frontier efficiency estimation with second-stage regression captures efficiency dynamics that return-based analyses alone obscure.

Future research should pursue several priorities. Multi-country panel studies are needed to test whether the Malaysian findings generalize to other dual financial systems such as those of the United Arab Emirates, Saudi Arabia, Bahrain, and Indonesia. Longitudinal designs spanning multiple crisis episodes – including the 2008 global financial crisis and potential future disruptions – would establish whether the conditional resilience pattern is crisis-type invariant. Incorporation of granular governance quality indicators, including Shariah board composition, audit intensity, and compliance reporting standards, would enable researchers to disentangle the specific governance channels through which efficiency advantages emerge. Finally, the application of machine learning-enhanced DEA approaches to large-scale fund datasets offers the potential to identify non-linear efficiency determinants and improve frontier estimation precision.

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DATA AVAILABILITY

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

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REFERENCES

1. Abdul-Majid, M., Saal, D. S., & Battisti, G. (2010). Efficiency in Islamic and conventional banking: An international comparison. *Journal of Productivity Analysis, 34*(1), 25-43. Retrieved from https://link.springer.com/article/10.1007/s11123-009-0165-3
2. Abedifar, P., Molyneux, P., & Tarazi, A. (2013). Risk in Islamic banking. *Review of Finance, 17*(6), 2035-2096. https://doi.org/10.1093/rof/rfs041
3. Ahmad, A. Y. A. B., Atta, A. A. M. B., Gharaibeh, A. M. O., Ateeq, A. A., Farooq, M. O., & Ali, S. A. (2024). Assessment of blockchain-based accounting technology on accounting report efficiency among business operators in Jordan. In *Information and communication technology in technical and vocational education and training for sustainable and equal opportunity: Business governance and digitalization of business education* (pp. 141-151). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-99-7798-7_11
4. Alexakis, C., Izzeldin, M., Johnes, J., & Pappas, V. (2019). Performance and productivity in Islamic and conventional banks: Evidence from the global financial crisis. *Economic Modelling, 79,* 1-14. https://doi.org/10.1016/j.econmod.2018.09.030
5. Alkhwaldi, A. F., Alharasis, E. E., Shehadeh, M., Abu-AlSondos, I. A., Oudat, M. S., & Bani Atta, A. A. (2022). Towards an understanding of FinTech users' adoption: Intention and e-loyalty post-COVID-19 from a developing country perspective. *Sustainability, 14*(19), 12616. https://doi.org/10.3390/su141912616
6. Alshaketheep, K., Al-Ahmed, H., Shajrawi, A., & Mansour, A. (2025). Beyond profit: How sustainable consumer behavior shapes the longevity of family businesses. *Acta Psychologica, 258,* 105237. Retrieved from https://www.sciencedirect.com/science/article/pii/S0001691825005505

http://dx.doi.org/10.21511/imfi.23(2).2026.35

7. Andersen, P., & Petersen, N. C. (1993). A procedure for ranking efficient units in data envelopment analysis. *Management Science, 39*(10), 1261-1264. Retrieved from https://ideas.repec.org/a/inm/ormnsc/v39y1993i10p1261-1264.html

8. Annaert, J., Van Den Broeck, J., & Vander Vennet, R. (2003). Determinants of mutual fund underperformance: A Bayesian stochastic frontier approach. *European Journal of Operational Research, 151*(3), 617-632. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0377221702006033

9. Atta, A. A. B., & Marzuki, A. (2021). Star and poor fund phenomena in Islamic-and conventional-focused families: Emerging country evidence. *Journal of Islamic Monetary Economics and Finance, 7*(2), 263-284. https://doi.org/10.21098/jimf.v7i2.1349

10. Baniata, H. M., Othman, M., Aljundi, N. A., Bani Atta, A. A., Bani Ahmad, A., Shajrawi, A. A., & Khrais, L. T. (2025). Sustainable investment strategies in a pandemic: a comparative study of Islamic and conventional mutual funds in Malaysia. *Discover Sustainability, 6*(1), 617. https://doi.org/10.1007/s43621-025-01373-9

11. Baniata, H. M., Othman, M., Shajrawi, A. A., Bani Atta, A. A., Ahmad, A. B., & Alqaraleh, M. H. (2024). Investment resilience: A study of mutual fund performance in Malaysia's Islamic vs. conventional sector. *Pakistan Journal of Life & Social Sciences, 22*(2). https://doi.org/10.57239/PJLSS-2024-22.2.00516

12. Bank Negara Malaysia. (2023, March 20). *Bank Negara Malaysia publishes Annual Report 2023, Economic and Monetary Review 2023 and Financial Stability Review for Second Half 2023. Invest Malaysia.* Retrieved from https://www.investmalaysia.gov.my/resources/latest-announcements/bank-negara-malaysia-publishes-annual-report-2023-economic-and-monetary-review-2023-and-financial-stability-review-for-second-half-2023/

13. Banker, R. D., & Natarajan, R. (2008). Evaluating contextual variables affecting productivity using data envelopment analysis. *Operations Research, 56*(1), 48-58. Retrieved from https://ideas.repec.org/a/inm/oropre/v56y2008i1p48-58.html

14. Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30*(9), 1078-1092. https://doi.org/10.1287/mnsc.30.9.1078

15. Basso, A., & Funari, S. (2001). A data envelopment analysis approach to measure the mutual fund performance. *European Journal of Operational Research, 135*(3), 477-492. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0377221700003118

16. Basso, A., & Funari, S. (2003). Measuring the performance of ethical mutual funds: A DEA approach. *Journal of the Operational Research Society, 54*(5), 521-531. Retrieved from https://ideas.repec.org/a/pal/jorsoc/v54y2003i5d10.1057_palgrave.jors.2601541.html

17. Bauer, R., Koedijk, K., & Otten, R. (2005). International evidence on ethical mutual fund performance and investment style. *Journal of Banking & Finance, 29*(7), 1751-1767. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0378426604001372

18. Beck, T., Demirgüç-Kunt, A., & Merrouche, O. (2013). Islamic vs. conventional banking: Business model, efficiency and stability. *Journal of Banking & Finance, 37*(2), 433-447. https://doi.org/10.1016/j.jbankfin.2012.09.016

19. Carhart, M. M. (1997). On persistence in mutual fund performance. *Journal of Finance, 52*(1), 57-82. https://doi.org/10.1111/j.1540-6261.1997.tb03808.x

20. Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research, 2*(6), 429-444. http://doi.org/10.1016/0377-2217(78)90138-8

21. Chopra, A. (2020). A Data Envelopment Analysis Approach to Benchmark the Performance of Mutual Funds in India. *arXiv preprint arXiv:2008.10952*. https://doi.org/10.48550/arXiv.2008.10952

22. Cook, W. D., & Zhu, J. (2008). *Data envelopment analysis: modeling operational processes and measuring productivity.* Retrieved from: https://cir.nii.ac.jp/crid/1971712334718628004/holdings#item-detail-tab

23. Cooper, W. W., Seiford, L. M., & Tone, K. (2000). *Data envelopment analysis: A comprehensive text with models, applications, references and DEA-solver software.* Springer. https://doi.org/10.1007/b109347

24. Cortez, M. C., Silva, F., & Areal, N. (2009). The performance of European socially responsible funds. *Journal of Business Ethics, 87*(4), 573-588. https://doi.org/10.1007/s10551-008-9959-x

25. Daraio, C., & Simar, L. (2007). *Advanced robust and nonparametric methods in efficiency analysis: Methodology and applications.* Boston, MA: Springer US. https://doi.org/10.1007/978-0-387-35231-2

26. Dasgupta, S., & Patel, M. (2015). Performance evaluation of Indian mutual funds using data envelopment analysis. *IIMS Journal of Management Science, 6*(1), 61-71. https://doi.org/10.5958/0976-173X.2015.00006.8

27. Emrouznejad, A., & Yang, G. (2018). A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016. *Socio-Economic Planning Sciences, 61,* 4-8. https://doi.org/10.1016/j.seps.2017.01.008

28. Färe, R., & Grosskopf, S. (2000). Network DEA. *Socio-Economic Planning Sciences, 34*(1), 35-49. https://doi.org/10.1016/S0038-0121(99)00012-9

29. Galagedera, D. U., & Silvapulle, P. (2002). Australian mutual fund performance appraisal using data envelopment analysis. *Managerial*

Finance, 28(9), 60-73. https://doi.org/10.1108/03074350210768077

30. Galagedera, D. U., & Watson, J. (2015). Benchmarking superannuation funds based on relative performance. *Applied Economics, 47*(28), 2959-2973. https://doi.org/10.1080/00036846.2015.1011315

31. Gottschalk, K., & Hinz, O. (2014). A decision support system for stock investment recommendations using collective wisdom. *Decision Support Systems, 59,* 52-62. https://doi.org/10.1016/j.dss.2013.10.005

32. Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203

33. Hallaq, S. S. A., Ghazalat, A. (2026). The Role of Islamic Mutual Funds in Economic Development: Contemporary Insights and Policy Perspectives (2014-2024). *Innovation Economics, 1*(1), 12-27. https://doi.org/10.11648/j.iecon.20260101.12

34. Hassan, M. K., & Dridi, J. (2010). *The effects of the global crisis on Islamic and conventional banks: A comparative study* (IMF Working Paper 10/201). International Monetary Fund. Retrieved from https://www.imf.org/en/publications/wp/issues/2016/12/31/the-effects-of-the-global-crisison-islamic-and-conventional-banks-a-comparative-study-24183

35. International Monetary Fund. (2022, October). *World economic outlook, October 2022: Countering the cost-of-living crisis.* Retrieved from https://www.imf.org/en/publications/weo/issues/2022/10/11/world-economic-outlook-october-2022

36. Islamic Financial Services Board (IFSB). (2025). *Islamic Financial Services Industry Stability Report 2025.* Kuala Lumpur: IFSB. Retrieved from https://www.ifsb.org

37. Johnes, J., Izzeldin, M., & Pappas, V. (2014). A comparison of performance of Islamic and conventional banks 2004–2009. *Journal of Economic Behavior & Organization, 103,* S93-S107. Retrieved from https://ideas.repec.org/p/lan/wpaper/12893801.html

38. Lassoued, N., Khanchel, I., & Saidani, W. (2025). Comparative study on the efficiency of Islamic banks and conventional banks during the COVID-19 outbreak. *Sage Open, 15*(1), 21582440241309726. https://doi.org/10.1177/21582440241309726

39. Markowitz, H. (1952). Portfolio selection. *Journal of Finance, 7*(1), 77-91. https://doi.org/10.1111/j.1540-6261.1952.tb01525.x

40. Marzuki, A., Atta, A. A. B., & Worthington, A. (2022). Attributes and performance of fund management companies: Evidence from the largest Shariah-compliant fund markets. *Journal of Nusantara Studies, 7*(1), 114-141. https://doi.org/10.24200/jonus.vol7iss1pp114-141

41. Matallín-Sáez, J. C., Soler-Domínguez, A., Tortosa-Ausina, E., & de Mingo-López, D. V. (2019). Ethical strategy focus and mutual fund management: Performance and persistence. *Journal of cleaner production, 213,* 618-633. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S095965261833840X

42. Miah, M. D., & Uddin, H. (2017). Efficiency and stability: A comparative study between Islamic and conventional banks in GCC countries. *Future Business Journal, 3*(2), 172-185. https://doi.org/10.1016/j.fbj.2017.11.001

43. Mirakhor, A., & Krichene, N. (2009). In *IFSB 2nd Public Lecture on Financial Policy and Stability (2009)* (pp. 1-92). Retrieved from https://mpra.ub.uni-muenchen.de/56022/

44. Mohammad, I, A., Mohammad, R, T, & Anis A. (2020). Continued discussion on conventional versus Islamic banks: Combining financial ratios and efficiency. *Banks and Bank Systems, 15*(1), 132-142. https://doi.org/10.21511/bbs.15(1).2020.13

45. Murthi, B. P. S., Choi, Y. K., & Desai, P. (1997). Efficiency of mutual funds and portfolio performance measurement: A non-parametric approach. *European Journal of Operational Research, 98*(2), 408-418. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0377221796003566

46. Nanduri, S., Kanth, T. S. R., Kumar, D., Madhuchandrika, N., & Surana, C. (2026). Efficiency analysis of mutual funds using Data Envelopment Analysis (DEA). In *Empowering Inclusive Innovation* (pp. 352-360). Routledge. https://doi.org/10.1201/9781003753445-40

47. Petridis, K., Kiosses, N., Tampakoudis, I., & Ben Abdelaziz, F. (2023). Measuring the efficiency of mutual funds: Does ESG controversies score affect the mutual fund performance during the COVID-19 pandemic? *Operational research, 23*(3), 54. https://doi.org/10.1007/s12351-023-00795-5

48. Premachandra, I. M., Zhu, J., Watson, J., & Galagedera, D. U. (2012). Best-performing US mutual fund families from 1993 to 2008: Evidence from a novel two-stage DEA model. *Journal of Banking & Finance, 36*(12), 3302-3317. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0378426612001987

49. Rashidi, S. F., Olfati, M., Mirjalili, S., Platoš, J., & Snášel, V. (2025). A comprehensive DEA-based framework for evaluating sustainability and efficiency of vehicle types: Integrating undesirable inputs and social-environmental indicators. *Cleaner Engineering and Technology, 27,* 100989. https://doi.org/10.1016/j.clet.2025.100989

50. Saeed, M., & Izzeldin, M. (2016). Examining the relationship between default risk and efficiency in Islamic and conventional banks. *Journal of Economic Behavior & Organization, 132,* 127-154. https://doi.org/10.1016/j.jebo.2014.02.014

51. Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium. *Journal of Finance, 19*(3), 425-442. https://doi.org/10.1111/j.1540-6261.1964.tb02865.x

http://dx.doi.org/10.21511/imfi.23(2).2026.35

52. Sharpe, W. F. (1966). Mutual fund performance. *The Journal of Business, 39*(1), 119-138. https://doi.org/10.1086/294846

53. Shehadeh, M., Abu-AlSondos, I. A., Ajouz, M., Aldulaimi, S. H., Atta, A. A. B., & Abdeldayem, M. (2024, January). Digital transformation and its implications for the future of financial intermediation in Islamic institutions. In *2024 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems (ICETSIS)* (pp. 130-134). IEEE. http://doi.org/10.1109/ICETSIS61505.2024.10459524

54. Sickles, R. C., & Zelenyuk, V. (2019). *Measuring productivity and efficiency: Theory and practice.* Cambridge University Press. https://doi.org/10.1017/9781139565981

55. Simar, L., & Wilson, P. W. (1998). Sensitivity analysis of efficiency scores: How to bootstrap in nonparametric frontier models. *Management Science, 44*(1), 49-61. Retrieved from https://ideas.repec.org/p/cor/louvco/1995043.html

56. Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of Econometrics, 136*(1), 31-64. https://doi.org/10.1016/j.jeconom.2005.07.009

57. Treynor, J. L. (1965). How to rate management of investment funds. *Harvard Business Review, 44*(1), 63-75. Retrieved from https://www.sid.ir/paper/598097/en#downloadbottom

58. Tsolas, I. E. (2014). Precious metal mutual fund performance appraisal using DEA modeling. *Resources Policy, 39,* 54-60. https://doi.org/10.1016/j.resourpol.2013.11.001

59. Verberi, C., Kaplan, M., & Ökte, M. K. S. (2026). A performance-based assessment of Turkish private pension funds: efficiency, scale economies, and competitiveness. *The Geneva Papers on Risk and Insurance-Issues and Practice, 51,* 468-502. https://doi.org/10.1057/s41288-025-00375-y

60. Wang, H. J., & Schmidt, P. (2002). One-step and two-step estimation of the effects of exogenous variables on technical efficiency levels. *Journal of Productivity Analysis, 18*(2), 129-144. https://doi.org/10.1023/A:1016565719882

61. Xiao, H., Liu, X., Ren, T., & Zhou, Z. (2022). Estimation of portfolio efficiency via stochastic DEA. *RAIRO-Operations Research, 56*(4), 2367-2387. https://doi.org/10.1051/ro/2022114

62. Zubir, M. Z., Noor, A. A., Mohd Rizal, A. M., Harith, A. A., Abas, M. I., Zakaria, Z., & A. Bakar, A. F. (2024). Approach in inputs & outputs selection of Data Envelopment Analysis (DEA) efficiency measurement in hospitals: A systematic review. *PLoS One, 19*(8), e0293694. https://doi.org/10.1371/journal.pone.0293694