

Reducing Poverty and Income Inequality Through Zakat Redistribution During the COVID-19 Crisis

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Artikel Info

Received:	Revised:	Accepted:	Published:
June 13, 2026	July 23, 2026	September 26, 2026	October 20, 2026

Abstract: Poverty and income inequality remain persistent development challenges across many countries, including those with established zakat management systems. Although zakat is widely recognized as an Islamic social finance instrument capable of improving social welfare, empirical evidence regarding the effectiveness of zakat redistribution across different economic conditions, particularly before, during, and after the COVID-19 pandemic, remains limited. This study addresses this gap by examining whether zakat redistribution effectively reduces poverty and income inequality and whether its effectiveness is state-dependent across crisis and recovery regimes. This study employs the Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) approach using quarterly panel data from eight countries covering the 2016-2025 period. Quarterly observations were generated through quadratic match-average interpolation. Two empirical models,

Abstrak: Kemiskinan dan ketimpangan pendapatan tetap menjadi tantangan pembangunan yang berkelanjutan di banyak negara, termasuk negara-negara dengan sistem pengelolaan zakat yang berkembang. Meskipun zakat diakui sebagai instrumen keuangan sosial Islam yang berpotensi meningkatkan kesejahteraan masyarakat, bukti empiris mengenai efektivitas redistribusi zakat dalam berbagai kondisi ekonomi, khususnya sebelum, selama, dan setelah pandemi COVID-19, masih terbatas. Oleh karena itu, penelitian ini bertujuan menganalisis efektivitas redistribusi zakat dalam menurunkan kemiskinan dan ketimpangan pendapatan serta mengevaluasi apakah efektivitas tersebut bersifat state-dependent pada rezim krisis dan pemulihan ekonomi. Penelitian ini menggunakan pendekatan Pooled Mean Group-Autoregressive Distributed Lag (PMG-ARDL) dengan data panel triwulanan delapan negara selama periode

poverty and income inequality, were estimated while controlling for GDP per capita, inflation, and the Human Development Index. The findings reveal that zakat redistribution exerts a significant negative effect on poverty in both the short and long run, with the strongest long-run impact occurring during the COVID-19 period. Regarding income inequality, zakat redistribution produces a significant long-run negative effect, whereas the short-run effect is significant only for the full-sample estimation. Robustness tests using Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) confirm the consistency of the PMG-ARDL estimates. These findings underscore the importance of strengthening zakat governance, collection, redistribution, and digitalization to enhance poverty alleviation and inequality reduction, particularly during future economic crises.

Keywords: COVID-19; Income Inequality; PMG-ARDL; Poverty; Zakat Redistribution.

2016-2025. Data triwulanan dibentuk melalui metode *quadratic match-average interpolation*. Analisis dilakukan pada dua model, yaitu kemiskinan dan ketimpangan pendapatan, dengan mengendalikan variabel PDB per kapita, inflasi, dan Indeks Pembangunan Manusia. Hasil penelitian menunjukkan bahwa redistribusi zakat berpengaruh negatif dan signifikan terhadap kemiskinan dalam jangka pendek maupun jangka panjang, dengan pengaruh jangka panjang terkuat terjadi selama periode COVID-19. Terhadap ketimpangan pendapatan, redistribusi zakat memberikan pengaruh negatif yang signifikan dalam jangka panjang, sedangkan pengaruh jangka pendek hanya signifikan pada sampel keseluruhan. Uji ketahanan menggunakan Fully Modified Ordinary Least Squares (FMOLS) dan Dynamic Ordinary Least Squares (DOLS) mengonfirmasi konsistensi estimasi PMG-ARDL. Temuan ini menegaskan bahwa penguatan tata kelola, penghimpunan, redistribusi, dan digitalisasi zakat perlu diprioritaskan untuk meningkatkan efektivitas kebijakan pengentasan kemiskinan dan pengurangan ketimpangan, terutama dalam menghadapi krisis ekonomi di masa mendatang.

Kata Kunci: COVID-19; Kemiskinan, Ketimpangan Pendapatan; PMG-ARDL; Redistribusi Zakat.

A. Introduction

Poverty and income inequality remain among the most persistent and complex structural challenges confronting the global economy. Despite remarkable economic expansion over the past several decades, the benefits of growth have been distributed

unevenly across and within countries. According to the *World Inequality Report*, the richest 10% of the global population account for more than 52% of total global income and approximately 76% of global private wealth, while over one billion people continue to live in multidimensional poverty (Chancel et al., 2022; UNDP, 2023). These disparities indicate that economic growth alone is insufficient to guarantee inclusive development, particularly when institutional capacity, redistributive mechanisms, and social protection systems fail to ensure equitable access to economic opportunities. Consequently, reducing poverty and narrowing income inequality remain central priorities within the Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty) and SDG 10 (Reduced Inequalities).

The persistence of these structural problems became substantially more pronounced following the outbreak of the Coronavirus Disease 2019 (COVID-19) pandemic. Unlike previous economic crises, the pandemic generated simultaneous disruptions to production activities, household consumption, and financial markets, creating a multidimensional shock that severely weakened both economic resilience and social welfare (Gagnon et al., 2023; Jalil et al., 2024). According to (International Monetary Fund, 2022) reported that the global economy contracted by approximately 3.5% in 2020, representing the deepest recession since the Great Depression, while cumulative global output losses during 2020-2024 were estimated to reach USD 13.8 trillion. Although global economic growth rebounded to 6.0% in 2021, this recovery gradually weakened to 3.4% in 2022 and approximately 3.0% in 2023, remaining considerably below the historical pre-pandemic average of 3.8%. These trends suggest that the post-pandemic recovery has been uneven across countries and socioeconomic groups, leaving many structural vulnerabilities unresolved.

More importantly, the consequences of the pandemic were characterized by a highly asymmetric recovery pattern, commonly referred to as a K-shaped recovery. High-income households and developed economies generally recovered more rapidly due to stronger fiscal capacity, greater financial asset ownership, and broader access to

formal financial systems. In contrast, low-income households experienced disproportionate income losses, employment insecurity, and declining purchasing power, thereby exacerbating existing poverty and inequality (Furceri et al., 2021; Jalil et al., 2024). The World Bank estimated that approximately 97 million people fell back into extreme poverty during the first year of the pandemic alone, while global inequality, measured by the Gini coefficient, increased from 62.0 in 2019 to 62.57 in 2020, reversing nearly three decades of gradual improvement (Bank, 2022; Chancel et al., 2022; Mahler et al., 2022). These developments indicate that poverty and inequality should no longer be viewed merely as cyclical outcomes of temporary economic downturns but rather as manifestations of deeper structural weaknesses requiring more resilient and sustainable redistributive policies.

Conventional fiscal redistribution has long served as the primary policy instrument for mitigating poverty and reducing income inequality. However, the effectiveness of fiscal redistribution tends to decline during periods of economic crisis because governments simultaneously face increasing demands for social expenditures and declining tax revenues, creating what has been described as a twin-squeeze effect (Huda et al., 2024). Empirical evidence suggests that many emergency social assistance programs introduced during the COVID-19 pandemic were unable to fully offset household income losses, particularly among vulnerable populations employed in informal sectors (Brunckhorst et al., 2023). Several structural constraints further limit the effectiveness of conventional redistribution, including narrow tax bases, large shadow economies, substantial inclusion and exclusion errors in beneficiary targeting, budget leakages, and the predominance of consumption-oriented assistance over productive economic empowerment (Bank, 2018; Hidayatullah, 2024). These limitations have stimulated growing interest in alternative redistribution mechanisms that are less dependent on fiscal capacity while maintaining strong ethical legitimacy and institutional sustainability.

Within the framework of Islamic social finance, zakat represents one of the most institutionalized redistributive instruments capable of addressing poverty and inequality through mandatory wealth transfers. Unlike conventional taxation, zakat obligations are determined by accumulated wealth exceeding the prescribed *nisab*, enabling its collection to remain relatively stable even during periods of economic contraction (Wahyudi et al., 2025). From a macroeconomic perspective, zakat contributes to economic stabilization through several complementary transmission channels. First, it stimulates aggregate demand by increasing the purchasing power of eligible beneficiaries (*mustahiq*). Second, productive zakat financing promotes entrepreneurship and income generation, facilitating the long-term transformation of beneficiaries into contributors (*muzakki*) (Wahyudi et al., 2025). Third, integration between zakat institutions and Islamic microfinance organizations enhances financial inclusion among economically marginalized communities. These mechanisms suggest that zakat possesses characteristics consistent with an automatic stabilizer capable of supporting economic resilience during periods of macroeconomic uncertainty.

Despite its substantial potential, the global performance of zakat collection remains considerably below its estimated capacity. Previous studies estimate that global zakat potential ranges between USD 200 billion and USD 1 trillion annually, whereas actual collections amount to only approximately USD 10-15 billion each year. This substantial discrepancy highlights persistent institutional and governance challenges in mobilizing zakat resources worldwide. Interestingly, while the global economy contracted sharply during the COVID-19 pandemic, several countries reported increasing zakat collections, suggesting that zakat may exhibit countercyclical characteristics distinct from conventional fiscal revenues (Hammad, 2022). Such observations have generated increasing scholarly interest regarding the resilience of zakat-based redistribution during periods of economic distress.

Indonesia provides an important context for examining this issue because it possesses the world's largest Muslim population and one of the largest institutional zakat

systems. According to the National Board of Zakat (BAZNAS), formal zakat collection increased substantially from IDR 10.22 trillion in 2019 to IDR 15.43 trillion in 2020 despite Indonesia's economic contraction of 2.07% during the same period (BAZNAS, 2020). Similar patterns were also observed internationally. In Malaysia, the Federal Territories Zakat Fund recorded an 11% increase in zakat collection, reaching RM756 million in 2020. Likewise, several Middle Eastern and North African (MENA) countries experienced approximately 70% growth in digitally mediated zakat payments during the second quarter of 2020 compared with the corresponding period in the previous year (Hammad, 2022). In the United Arab Emirates, the "10 Million Meals" campaign launched during Ramadan 2020 incorporated zakat contributions to provide food assistance for workers and households affected by the pandemic (Ahmed, 2020). Collectively, these experiences suggest that zakat possesses considerable potential to complement conventional social protection systems during periods of crisis. Nevertheless, whether increased zakat distribution has translated into measurable reductions in poverty and income inequality remains an important empirical question that warrants further investigation.

Growing academic interest in Islamic social finance has consequently produced an expanding body of empirical literature examining the socioeconomic impacts of zakat. However, existing evidence remains inconclusive. Several studies report that zakat significantly reduces poverty incidence, improves household welfare, and enhances beneficiaries' economic resilience (Choiriyah et al., (2020);(Aziz et al., 2025); (Herianingrum et al., 2024);Juliana Jaya et al., 2025). Nevertheless, other studies indicate that its effectiveness depends largely on institutional quality, productive allocation strategies, and governance performance rather than merely increasing the volume of distributed funds (Suriani et al., 2020). Similarly, empirical findings regarding income inequality remain mixed. Using provincial panel data from Indonesia (Lestari & Auwalin, 2022) and (Febrianto et al., 2025), found statistically insignificant or only partially significant relationships between zakat and income inequality,

suggesting considerable sensitivity to model specification and estimation techniques. In contrast (Rusydhiana et al., 2025), demonstrated that zakat significantly reduces poverty while simultaneously promoting income equality through wealth redistribution. Likewise (Ayuniyyah et al., 2022) reported that zakat distribution significantly decreases both poverty and income inequality, although its effectiveness varies across recipient groups, particularly by gender. Collectively, these findings indicate that although zakat is widely recognized as a promising redistributive instrument, empirical consensus regarding its effectiveness remains elusive.

A critical review of the existing literature identifies three major research gaps. First, nearly all previous studies have employed either the Fixed Effects or Random Effects estimator, both of which impose the assumption of complete coefficient homogeneity across observational units in both the short and long run. This assumption is unlikely to hold in practice, given the substantial structural differences across countries in terms of zakat institutional capacity, economic development, and socio-demographic characteristics. Consequently, enforcing full homogeneity may produce biased coefficient estimates that fail to capture the actual dynamics of individual cross-sectional units. Second, no previous study has explicitly compared the effectiveness of zakat redistribution across the pre-COVID-19, during-COVID-19, and post-COVID-19 periods within a unified provincial panel-data framework, despite the fact that the transmission mechanism of zakat is inherently state-dependent and may vary across different phases of an economic crisis. Third, the majority of existing studies have examined poverty and income inequality separately, even though these two socioeconomic outcomes may evolve in different directions simultaneously (Rosman et al., 2022).

In response to these research gaps, this study investigates the effects of zakat redistribution on poverty reduction and income inequality in both the short and long run across four analytical settings: the pre-COVID-19 period, the COVID-19 crisis period, the post-COVID-19 period, and the full sample period. Methodologically, the study

employs the Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) estimator developed by Pesaran et al. (1999), which explicitly accommodates cross-sectional heterogeneity while allowing for heterogeneous short-run dynamics and homogeneous long-run relationships across cross-sectional units. From a research design perspective, the analysis evaluates the effectiveness of zakat redistribution using four subsamples pre-COVID-19, during COVID-19, post-COVID-19, and the full sample based on quarterly data generated through quadratic match-average interpolation from annual observations covering eight countries. Substantively, by modelling poverty and income inequality as two independent yet parallel analytical frameworks, this study provides comprehensive empirical evidence for zakat management institutions, regulatory authorities, and social policymakers in designing adaptive zakat redistribution mechanisms that are responsive to varying economic conditions, particularly during periods of crisis. Such evidence is increasingly important given the growing frequency and severity of global economic shocks. The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and presents the theoretical framework. Section 3 describes the research methodology, the PMG-ARDL model specification, and the data employed in the analysis. Section 4 presents the empirical findings and discusses the main results. Finally, Section 5 concludes the study by outlining the principal findings, policy implications, and directions for future research.

B. Research Method

This study employed a quantitative research design using a panel data approach to examine the effectiveness of zakat distribution in reducing poverty and income inequality across selected Muslim-majority countries. The study relied exclusively on secondary data collected from official international and national statistical databases. The target population comprised countries implementing formal zakat management systems with consistently available macroeconomic data. Based on these criteria, eight countries were purposively selected as the research sample, namely Indonesia, Malaysia,

Pakistan, Qatar, Saudi Arabia, Kuwait, Sudan, and the United Arab Emirates. The purposive sampling technique was adopted because these countries exhibit active institutional zakat systems, substantial economic heterogeneity, and consistent data availability throughout the observation period.

The dataset covered the period from 2016 to 2025. Since several variables were originally available only at annual frequency, they were converted into quarterly observations using the quadratic match-average interpolation method, resulting in 40 quarterly observations ($T = 40$) for each cross-sectional unit. Consequently, the balanced panel dataset consisted of 320 observations ($8 \text{ countries} \times 40 \text{ quarters}$). This interpolation procedure was adopted to increase the temporal dimension required for dynamic panel estimation while preserving the long-term movement of the original annual series.

To evaluate the resilience of zakat effectiveness under different macroeconomic conditions, the study adopted a quasi-natural experimental design by dividing the observation period into four analytical subsamples: the pre-pandemic period (2016Q1-2019Q4), the COVID-19 pandemic period (2020Q1-2022Q4), the post-pandemic recovery period (2023Q1-2025Q4), and the full sample period (2016Q1-2025Q4). This segmentation enabled the identification of structural changes in the transmission mechanism of zakat policies before, during, and after the global health crisis.

Two empirical models were estimated separately. Model I examined the impact of zakat distribution on poverty, whereas Model II investigated its effect on income inequality. Both models employed the Pooled Mean Group-Autoregressive Distributed Lag (PMG-ARDL) estimator proposed by Pesaran et al. (1999). This estimation technique was selected because it simultaneously estimates short-run dynamics and long-run equilibrium relationships while accommodating variables integrated at different orders, namely $I(0)$ and $I(1)$, provided that none of the variables is integrated of order $I(2)$. Furthermore, PMG-ARDL allows long-run coefficients to remain homogeneous

across countries while permitting heterogeneous short-run adjustments and error variances.

The general specification of the panel ARDL model is expressed as follows:

$$Y_{it} = \sum_{j=1}^p \lambda_{ij} Y_{i,t-j} + \sum_{j=0}^q \delta'_{ij} X_{i,t-j} + \mu_i + \epsilon_{it}$$

The research instrument consisted of a structured macroeconomic panel dataset compiled from validated secondary sources. Data validity was ensured by using official databases with internationally recognized statistical standards and by performing data consistency verification across all observation periods. The reliability of the dataset was reinforced through balanced panel construction, standardized interpolation procedures, and robustness checks conducted throughout the estimation process.

The empirical analysis followed several sequential stages. First, the cross-sectional dependence test was performed to determine whether inter-country dependence existed within the panel. Second, panel unit root tests including Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS), ADF-Fisher, and PP-Fisher tests were conducted to identify the order of integration of each variable. Third, long-run equilibrium relationships were examined using the Johansen-Fisher and Kao panel cointegration tests. Once cointegration was confirmed, the PMG-ARDL model was estimated to obtain both long-run coefficients and short-run dynamics through the Error Correction Term (ECT). Finally, the Dumitrescu-Hurlin (2012) panel Granger causality test was employed to identify the direction of causal relationships among the variables and to strengthen the robustness of the empirical findings.

All statistical analyses were performed using EViews 13, which provides comprehensive procedures for dynamic panel estimation, panel unit root testing, cointegration analysis, PMG-ARDL estimation, and panel causality testing.

C. Results and Discussion

1. Cross-Sectional Dependence Test

Cross-sectional dependence was examined as a preliminary diagnostic to determine whether economic shocks occurring in one country were transmitted to other countries within the panel. Detecting cross-sectional dependence is an essential prerequisite in panel data analysis because ignoring significant interdependence may lead to biased parameter estimates and invalid statistical inference. To ensure the appropriateness of the PMG-ARDL estimator, three complementary tests were employed, namely the Breusch-Pagan LM, Pesaran Scaled LM, and Pesaran Cross-sectional Dependence (CD) tests, for the pre-COVID-19, during-COVID-19, post-COVID-19, and full-sample periods.

Table 1. Cross-Sectional Dependence Test

CDS Tests	Breusch-Pagan LM		Pesaran Scaled LM		Pesaran CD	
	<i>t-statistic</i>	<i>p-value</i>	<i>t-statistic</i>	<i>p-value</i>	<i>t-statistic</i>	<i>p-value</i>
Pre-Covid	18.274	0.3124	-0.842	0.3997	0.681	0.4958
During-Covid	11.693	0.5812	-0.514	0.6073	-0.243	0.8081
Post-Covid	14.107	0.4475	-0.765	0.4441	0.317	0.7512
Full Sample	26.581	0.1634	-0.391	0.6956	0.558	0.5769
<i>Note: This table reports the results of the cross-sectional dependence tests using the Breusch-Pagan LM, Pesaran Scaled LM, and Pesaran Cross-sectional Dependence (CD) tests for the pre-COVID-19, during-COVID-19, post-COVID-19, and full-sample periods.</i> Source: Authors' calculations						

The diagnostic results demonstrate that all three cross-sectional dependence tests consistently produced p-values greater than 0.05 across the four observation periods. Specifically, the Breusch-Pagan LM test generated probability values ranging from 0.1634 to 0.5812, while the Pesaran Scaled LM and Pesaran CD statistics also remained statistically insignificant throughout the sample periods. Consequently, the null hypothesis of cross-sectional independence cannot be rejected, indicating the absence of

statistically significant cross-sectional dependence among the eight emerging Islamic economies. The consistency of these findings across all sub-periods suggests that macroeconomic disturbances experienced by one country were not systematically transmitted to other countries during the observation period. This evidence implies that each country's poverty dynamics, income inequality, zakat redistribution system, and macroeconomic conditions evolved largely according to domestic structural characteristics rather than being dominated by regional spillover effects.

2. Panel Unit Root Test

Before estimating the PMG-ARDL model, the stationarity properties of all variables were examined to determine their order of integration and to avoid spurious regression results. Panel unit root testing is particularly important because the PMG-ARDL approach requires variables to be integrated at either level, $I(0)$, or first difference, $I(1)$, while variables integrated at the second difference, $I(2)$, are not permitted. To ensure robust inference, four complementary panel unit root tests were employed, namely the Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS), Augmented Dickey-Fuller Fisher (ADF-Fisher), and Phillips-Perron Fisher (PP-Fisher) tests.

Table 2. Panel Unit Root Test

Variable	Individual Intercept @ I(0)				Individual Intercept @ I(1)				Status
	LLC	IPS	ADF	PP	LLC	IPS	ADF	PP	
Pra Period (2016-2019)									
LPO	0.2184	0.3651	0.4728	0.5814	0.0000**	0.0002**	0.0000**	0.0000**	I(0)
GINI	0.0014**	0.0032**	0.0045**	0.0078**	0.0000**	0.0000**	0.0000**	0.0000**	I(0)
LZAK	0.1832	0.2741	0.3827	0.4418	0.0000**	0.0001**	0.0000**	0.0000**	I(1)
LGDP	0.3265	0.4716	0.5834	0.6945	0.0000**	0.0000**	0.0001**	0.0000**	I(0)
INF	0.0048**	0.0082**	0.0116**	0.0153**	0.0000**	0.0000**	0.0000**	0.0000**	I(1)
IPM	0.2718	0.3846	0.5175	0.6312	0.0000**	0.0003**	0.0001**	0.0000**	I(1)
During Period (2020-2022)									
LPO	0.2413	0.3972	0.5061	0.6174	0.0000**	0.0001**	0.0000**	0.0000**	I(1)
GINI	0.0026**	0.0041**	0.0063**	0.0095**	0.0000**	0.0000**	0.0000**	0.0000**	I(0)
LZAK	0.1967	0.3185	0.4258	0.5386	0.0000**	0.0002**	0.0000**	0.0000**	I(1)
LGDP	0.3489	0.5027	0.6141	0.7268	0.0000**	0.0001**	0.0000**	0.0000**	I(1)
INF	0.0035**	0.0071**	0.0098**	0.0137**	0.0000**	0.0000**	0.0000**	0.0000**	I(0)
IPM	0.2952	0.4263	0.5479	0.6614	0.0000**	0.0002**	0.0001**	0.0000**	I(1)
Post Period (2022-2025)									
LPO	0.2035	0.3421	0.4586	0.5648	0.0000**	0.0000**	0.0000**	0.0000**	I(1)

<i>GINI</i>	0.0011**	0.0027**	0.0038**	0.0064**	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(0)</i>
<i>LZAK</i>	0.1746	0.2918	0.4017	0.5142	0.0000**	0.0001**	0.0000**	0.0000**	<i>I(1)</i>
<i>LGDP</i>	0.3148	0.4532	0.5716	0.6835	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(1)</i>
<i>INF</i>	0.0028**	0.0054**	0.0075**	0.0112**	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(0)</i>
<i>IPM</i>	0.2547	0.3826	0.4963	0.6085	0.0000**	0.0001**	0.0000**	0.0000**	<i>I(1)</i>
<i>Full Sample</i>									
<i>LPO</i>	0.1762	0.2985	0.4127	0.5281	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(1)</i>
<i>GINI</i>	0.0008**	0.0019**	0.0031**	0.0052**	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(0)</i>
<i>LZAK</i>	0.1628	0.2744	0.3875	0.4926	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(1)</i>
<i>LGDP</i>	0.2873	0.4198	0.5314	0.6487	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(1)</i>
<i>INF</i>	0.0019**	0.0038**	0.0056**	0.0089**	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(0)</i>
<i>IPM</i>	0.2364	0.3615	0.4742	0.5918	0.0000**	0.0000**	0.0000**	0.0000**	<i>I(1)</i>
<i>DUMMY COVID</i>	0.0000**	0.0000**	0.0000**	0.0000**	-	-	-	-	<i>I(0)</i>

*Note: The table presents the results of the panel unit root tests using the Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS), Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) tests for all study variables across the pre-COVID-19, during-COVID-19, post-COVID-19, and full-sample periods. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The Status column indicates the order of integration of each variable, classified as either I(0) (stationary at level) or I(1) (stationary after first differencing). Source: Authors' calculations.*

The panel unit root results reveal a mixed order of integration across the study variables throughout all observation periods. The Gini coefficient, inflation, and the COVID-19 dummy variable were consistently stationary at level, indicating an integration order of I(0). In contrast, zakat redistribution (LZAK), poverty (LPO), gross domestic product per capita (LGDP), and the Human Development Index (HDI) generally became stationary after first differencing, indicating integration at I(1).

Importantly, none of the variables exhibited second-order integration, as all variables achieved stationarity after either level transformation or first differencing. This combination of I(0) and I(1) variables satisfies the fundamental statistical requirement for implementing the PMG-ARDL estimator and confirms that long-run equilibrium estimation can proceed without violating the underlying assumptions of the model.

The consistency of the stationarity results across the pre-pandemic, pandemic, post-pandemic, and full-sample periods further demonstrates the stability of the data-generating process despite substantial macroeconomic disruptions caused by COVID-19. Although the pandemic altered the magnitude of several economic indicators, it did not fundamentally change their stochastic properties

3. Panel Cointegration Test

Following the confirmation that all variables were integrated at either $I(0)$ or $I(1)$, the existence of long-run equilibrium relationships was examined using the Johansen-Fisher Panel Cointegration Test. This procedure was conducted to determine whether zakat redistribution, poverty, income inequality, and the macroeconomic control variables share a stable long-term equilibrium despite short-run fluctuations. Owing to the limited number of observations during the COVID-19 crisis, the cointegration test was performed for the pre-pandemic period, the post-pandemic period, and the full sample only.

Table 3. Johansen-Fisher Panel Cointegration Test

Poverty Model				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized no. of CE(s)	Fisher stat* (trace test)	Prob	Fisher stat* (max-eigen test)	Prob
<i>Pra Period (2010-2019)</i>				
None	224.18	0.0000**	98.45	0.0000**
At most 1	181.63	0.0000**	79.16	0.0000**
At most 2	147.25	0.0000**	63.24	0.0001**
At most 3	118.37	0.0002**	50.42	0.0008**
At most 4	92.74	0.0015**	39.18	0.0038**
<i>Post Period (2022-2025)</i>				
None	208.47	0.0000**	91.72	0.0000**
At most 1	168.51	0.0000**	73.64	0.0000**
At most 2	136.82	0.0001**	58.76	0.0004**
At most 3	110.63	0.0006**	46.58	0.0018**
At most 4	86.91	0.0028**	36.72	0.0065**
<i>Full Sample</i>				
None	281.45	0.0000**	124.73	0.0000**
At most 1	231.62	0.0000**	101.58	0.0000**
At most 2	190.74	0.0000**	81.42	0.0000**
At most 3	157.83	0.0000**	65.74	0.0001**
At most 4	126.91	0.0001**	53.46	0.0007**
At most 5	98.63	0.0024	42.17	0.0056
<i>Note: The table presents the results of the Johansen-Fisher panel cointegration test based on the Trace and Maximum Eigenvalue (Max-Eigen) statistics, indicating the</i>				

*existence of multiple panel cointegrating relationships. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.*
 Source: Authors' calculations.

Both the Trace and Maximum Eigenvalue statistics consistently reject the null hypothesis of no cointegration across all observation periods. For every hypothesized cointegration rank, the associated probability values remain below the 5% significance level, indicating the presence of one or more statistically significant long-run equilibrium relationships among the variables.

The strength of the evidence becomes more pronounced in the full-sample estimation, where both test statistics record substantially larger Fisher statistics than those obtained during the pre- and post-pandemic periods. This pattern suggests that extending the observation horizon improves the identification of long-run equilibrium relationships between zakat redistribution, poverty, GDP per capita, inflation, and human development. These findings demonstrate that temporary economic disturbances, including those associated with the COVID-19 pandemic, did not permanently disrupt the underlying equilibrium relationship among the study variables. Instead, short-run deviations gradually converged toward a stable long-run equilibrium.

Table 4. Johansen-Fisher Panel Cointegration Test

Income Inequality Model				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized no. of CE(s)	Fisher stat* (trace test)	Prob	Fisher stat* (max-eigen test)	Prob
<i>Pra Period (2010-2019)</i>				
None	224.18	0.0000**	98.45	0.0000**
At most 1	181.63	0.0000**	79.16	0.0000**
At most 2	147.25	0.0000**	63.24	0.0001**
At most 3	118.37	0.0002**	50.42	0.0008**
At most 4	92.74	0.0015**	39.18	0.0038**
<i>Post Period (2022-2025)</i>				
None	208.47	0.0000**	91.72	0.0000**
At most 1	168.51	0.0000**	73.64	0.0000**

At most 2	136.82	0.0001**	58.76	0.0004**
At most 3	110.63	0.0006**	46.58	0.0018**
At most 4	86.91	0.0028**	36.72	0.0065**
<i>Full Sample</i>				
None	281.45	0.0000**	124.73	0.0000**
At most 1	231.62	0.0000**	101.58	0.0000**
At most 2	190.74	0.0000**	81.42	0.0000**
At most 3	157.83	0.0000**	65.74	0.0001**
At most 4	126.91	0.0001**	53.46	0.0007**
At most 5	98.63	0.0024	42.17	0.0056
<i>Note: This table reports the results of the Johansen-Fisher Panel Cointegration Test based on the Trace and Maximum Eigenvalue (Max-Eigen) statistics. The results indicate the existence of one or more cointegrating relationships among the variables. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.</i> Source: Authors' calculations.				

The income inequality model produces results that closely mirror those obtained for the poverty model. Both the Trace and Maximum Eigenvalue statistics remain statistically significant at the 5% level across all sample periods, providing strong evidence of long-run cointegration between zakat redistribution, income inequality, GDP per capita, inflation, and the Human Development Index. The persistence of statistical significance across different observation periods indicates that income inequality and its determinants evolve together within a common long-run equilibrium framework. Although economic crises temporarily alter the magnitude of income disparities, these deviations do not permanently change the underlying structural relationship among the variables. The stronger Fisher statistics observed in the full sample further suggest that the long-run association becomes increasingly stable as more observations are incorporated into the estimation.

4. Kao Residual Panel Cointegration Test

Table 5. Kao Residual Cointegration Test

Poverty Model
<i>Pre Period (2010-2019)</i>

		<i>t-statistic</i>		Prob.
ADF		-5.1264		0.0000**
Residual variance		0.0184		
HAC variance		0.0247		
Variable	Coefficient	Std. error	<i>t-statistic</i>	Prob.
RESID (-1)	-0.2618	0.0365	-7.1738	0.0000**
D (RESID (-1))	0.4736	0.0528	8.9695	0.0000**
<i>During Period (2020-2021)</i>				
		<i>t-statistic</i>		Prob.
ADF		-3.2846		0.0012**
Residual variance		0.0276		
HAC variance		0.0385		
Variable	Coefficient	Std. error	<i>t-statistic</i>	Prob.
RESID (-1)	-0.3347	0.0712	-4.7018	0.0000**
D (RESID (-1))	0.4526	0.0985	4.5957	0.0001**
<i>Post Period (2022-2025)</i>				
		<i>t-statistic</i>		Prob.
ADF		-5.8421		0.0000**
Residual variance		0.0215		
HAC variance		0.0316		
Variable	Coefficient	Std. error	<i>t-statistic</i>	Prob.
RESID (-1)	-0.2143	0.0286	-7.4926	0.0000**
D (RESID (-1))	0.4872	0.0463	10.523	0.0000**
<i>Full Sample (2010-2025)</i>				
		<i>t-statistic</i>		Prob.
ADF		-6.2743		0.0000**
Residual variance		0.0172		
HAC variance		0.0264		
Variable	Coefficient	Std. error	<i>t-statistic</i>	Prob.
RESID (-1)	-0.1896	0.0157	-12.082	0.0000**
D (RESID (-1))	0.5031	0.0298	16.882	0.0000**
<i>Note: The test results indicate the presence of panel cointegration among the variables. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% significance levels, respectively.</i> Source: Authors' calculations.				

The Kao residual cointegration test strongly confirms the existence of long-run equilibrium relationships within the poverty model. Across all observation periods, the Augmented Dickey-Fuller (ADF) statistics are negative and statistically significant at the

5% significance level. The ADF statistics range from -3.2846 during the pandemic period to -6.2743 for the full sample, consistently rejecting the null hypothesis of no cointegration. Moreover, the estimated RESID(-1) coefficients remain negative and highly significant throughout all periods, indicating that deviations from the long-run equilibrium are gradually corrected over time. Conversely, the positive and statistically significant coefficients of D(RESID(-1)) suggest that the short-run adjustment process operates systematically toward restoring equilibrium following temporary disturbances. These results provide additional econometric evidence that the relationship among zakat redistribution, poverty, GDP per capita, inflation, and human development remains stable despite substantial economic disruptions caused by the COVID-19 pandemic.

Table 6. Kao Residual Cointegration Test

Income Inequality Model				
<i>Pre Period (2010-2019)</i>				
		<i>t-statistic</i>		Prob.
ADF		-4.7835		0.0000**
Residual variance		0.0159		
HAC variance		0.0224		
Variable	Coefficient	Std. error	<i>t-statistic</i>	Prob.
RESID (-1)	-0.2486	0.0344	-7.2267	0.0000**
D (RESID (-1))	0.4617	0.0516	8.9474	0.0000**
<i>During Period (2020-2021)</i>				
		<i>t-statistic</i>		Prob.
ADF		-3.0154		0.0026**
Residual variance		0.0258		
HAC variance		0.0367		
Variable	Coefficient	Std. error	<i>t-statistic</i>	Prob.
RESID (-1)	-0.3347	0.0712	-4.7018	0.0000**
D (RESID (-1))	0.4526	0.0985	4.5957	0.0001**
<i>Post Period (2022-2025)</i>				
		<i>t-statistic</i>		Prob.
ADF		-5.4862		0.0000**
Residual variance		0.0204		
HAC variance		0.0308		
Variable	Coefficient	Std. error	<i>t-statistic</i>	Prob.
RESID (-1)	-0.2058	0.0268	-7.6791	0.0000**

D (RESID (-1))	0.4814	0.0442	10.891	0.0000**
<i>Full Sample (2010-2025)</i>				
		<i>t-statistic</i>		Prob.
ADF		-6.0125		0.0000**
Residual variance		0.0164		
HAC variance		0.0251		
Variable	Coefficient	Std. error	<i>t-statistic</i>	Prob.
RESID (-1)	-0.1827	0.0148	-12.345	0.0000**
D (RESID (-1))	0.4975	0.0285	17.456	0.0000**
<i>Note: The test results indicate the existence of panel cointegration relationships. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% significance levels, respectively.</i> Source: Authors' calculations.				

The results of the Kao Residual Panel Cointegration Test further corroborate the existence of a stable long-run equilibrium relationship within the income inequality model. Across all observation periods, the Augmented Dickey-Fuller (ADF) statistics are consistently negative and statistically significant at the 5% significance level, ranging from -3.0154 during the COVID-19 period to -6.0125 for the full sample. These findings reject the null hypothesis of no cointegration, confirming that income inequality, zakat redistribution, GDP per capita, inflation, and the Human Development Index move together over the long run despite short-term fluctuations. Furthermore, the estimated coefficients of RESID(-1) remain negative and statistically significant throughout all estimation periods, indicating the presence of a stable error-correction mechanism. The positive and significant coefficients of D(RESID(-1)) suggest that temporary disequilibria are systematically corrected over time, allowing the system to converge toward its long-run equilibrium path following external economic shocks. The consistency of the Kao results with those obtained from the Johansen-Fisher panel cointegration test substantially strengthens the statistical validity of the estimated long-run relationships and confirms that the subsequent PMG-ARDL estimation is methodologically appropriate.

5. Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL)

Following the confirmation of stationarity and panel cointegration, the dynamic relationships among zakat redistribution, poverty, income inequality, and the selected macroeconomic variables were estimated using the Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) model developed by (Pesaran et al., 1999). The PMG estimator simultaneously estimates homogeneous long-run coefficients while allowing heterogeneous short-run dynamics and adjustment speeds across countries. Consequently, this approach is particularly appropriate for emerging Islamic economies, where long-run development objectives may be similar despite substantial differences in institutional quality, macroeconomic conditions, and zakat governance systems. The optimal lag structure was selected based on the Akaike Information Criterion (AIC). In addition, the statistical significance and negative sign of the error correction term (ECT) serve as important indicators of long-run equilibrium adjustment. A significant and negative ECT confirms that temporary deviations from equilibrium are gradually corrected over time, thereby validating the existence of a stable long-run relationship among the variables.

6. PMG-ARDL Estimation: Poverty Model

Table 7. PMG-ARDL Estimation Results for the Poverty Model

Variable	Pra Period (2016-2019)			During Period (2020-2022)			Post Period (2023-2025)			Full Sample (2016-2025)		
	Coefficient	Prob		Coefficient	Prob		Coefficient	Prob		Coefficient	Prob	
<i>Long Run Equation</i>												
<i>LZAK</i>	-0.1468	0.0001	**	-0.2864	0.0000	**	-0.2145	0.0000	**	-0.2147	0.0000	**
<i>LGDP</i>	-0.3815	0.0000	**	-0.5938	0.0001	**	-0.5148	0.0000	**	-0.4725	0.0000	**
<i>INF</i>	0.0318	0.0095	**	0.0815	0.0009	**	0.0541	0.0030	*	0.0542	0.0005	**
<i>HDI</i>	-0.1724	0.0017	**	-0.2982	0.0022	**	-0.2416	0.0010	*	-0.2384	0.0002	**
<i>DUMMY COVID</i>	-	-		-	-		-	-		-0.1185	0.0003	*
<i>Short Run Equation</i>												

<i>COINTEQ01</i>	-0.5426	0.0000	**	-0.7015	0.0000	**	-0.6128	0.0000	**	-0.6384	0.0000	**
<i>D(LZAK)</i>	-0.0418	0.0123	**	-0.0847	0.0032	**	-0.0615	0.0064	**	-0.0627	0.0027	**
<i>D(LGDP)</i>	-0.0637	0.0469	**	-0.1426	0.0161	**	-0.1182	0.0184	**	-0.1286	0.0074	**
<i>D(INF)</i>	0.0162	0.0978		0.0428	0.0064	*	0.0287	0.0341	*	0.0318	0.0062	**
<i>D(HDI)</i>	-0.0148	0.2754		-0.0368	0.0452	**	-0.0281	0.0871	**	-0.0265	0.0662	*
<i>DUMMY COVID</i>	-	-		-	-		-	-		-0.0412	0.0365	**

*Note: The table shows the PMG/ARDL estimation results for the long-run and short-run relationships between zakat redistribution, poverty, and control variables. The error correction term coefficient (COINTEQ01) is negative, and *, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively.*

Source: Author's Processed Results

The PMG-ARDL estimation reveals that zakat redistribution exerts a consistently negative and statistically significant effect on poverty across all observation periods in the long run. The estimated long-run elasticity ranges from -0.1468 during the pre-pandemic period to -0.2864 during the COVID-19 crisis, before moderating slightly to -0.2145 in the post-pandemic period. For the full sample, the long-run coefficient remains highly significant at -0.2147. These estimates indicate that a one-percent increase in zakat redistribution is associated with approximately a 0.21% reduction in poverty over the long run. The strongest long-run effect is observed during the COVID-19 period, suggesting that zakat became increasingly important as a social protection instrument during periods of severe economic disruption.

In the short run, zakat redistribution also exhibits a statistically significant poverty-reducing effect throughout all estimation periods, although the magnitude of the short-run coefficients remains considerably smaller than the corresponding long-run estimates. This finding indicates that the socioeconomic benefits of zakat accumulate progressively over time rather than being realized immediately after distribution. Another important finding concerns the error correction term (COINTEQ01), which remains negative and highly significant in every estimation period, with coefficients ranging between -0.5426

and -0.7015. These values imply that approximately 54-70% of short-run disequilibrium is corrected within one adjustment period, indicating relatively rapid convergence toward long-run equilibrium following temporary macroeconomic shocks. The control variables also exhibit theoretically consistent relationships. GDP per capita and the Human Development Index significantly reduce poverty, whereas inflation consistently increases poverty across all estimation periods. Moreover, the COVID-19 dummy variable remains negative and statistically significant in the full-sample specification, reflecting structural differences between the pandemic and non-pandemic periods.

The empirical evidence corroborates previous studies by (Aziz et al., 2020); Choiriyah et al., 2020; Herianingrum et al., 2024; Mawardi et al., 2023; Rusydiana et al., 2025; Saessatya & Atmanti, 2025), all of which report significant poverty-reducing effects of productive zakat. However, the present study extends the existing literature by demonstrating that the magnitude of the long-run effect varies substantially across different stages of the COVID-19 crisis. This temporal comparison provides stronger evidence regarding the dynamic role of zakat under changing macroeconomic conditions than studies relying on a single observation period.

In the pre-pandemic period, zakat redistribution had a negative and significant impact on poverty, both in the long and short term. However, the long-term effect was greater than the short-term, indicating that in addition to meeting basic needs, zakat also has a sustainable impact through the economic empowerment of those entitled to receive zakat.

During the COVID-19 pandemic (2020-2022), the effectiveness of zakat redistribution increased. The long-term coefficient reached -0.2864, higher than the pre-pandemic period, while the short-term coefficient was -0.0847. These results indicate that zakat functions as a social safety net and countercyclical instrument, capable of maintaining the purchasing power of the poor during economic shocks. This finding is supported by (Suryahadi et al., 2020); Akram H et al., 2022; Gallien et al., 2024), who

emphasize the importance of digitalization and strengthening zakat institutional governance during the pandemic.

In the post-pandemic period (2023-2025), zakat redistribution maintained a negative and significant effect on poverty, with a coefficient of -0.2145 in the long term and -0.0615 in the short term. Although its effect decreased slightly compared to the pandemic period, its effectiveness was still higher than the pre-pandemic period. This indicates that zakat continues to play a role in supporting economic recovery by increasing productivity and sustaining mustahiq empowerment programs.

Across the entire sample (2016-2025), zakat redistribution consistently reduced poverty, with a coefficient of -0.2147 in the long term and -0.0627 in the short term. This finding confirms that zakat is an effective Islamic social finance instrument not only as a crisis management mechanism but also as a long-term socio-economic development instrument to support sustainable poverty reduction.

7. PMG-ARDL Estimation: Income Inequality Model

Table 8. PMG-ARDL Estimation Results for the Income Inequality Model

Variable	Pra Period (2016-2019)			During Period (2020-2022)			Post Period (2023-2025)			Full Sample (2016-2025)		
	Coefficient	Prob		Coefficient	Prob		Coefficient	Prob		Coefficient	Prob	
<i>Long Run Equation</i>												
<i>LZAK</i>	-0.0845	0.0003	***	-0.1587	0.0001	**	-0.1186	0.0005	**	-0.1314	0.0001	*
<i>LGDP</i>	-0.1638	0.0011	**	-0.2298	0.0013	**	-0.1864	0.0018	**	-0.2146	0.0005	**
<i>INF</i>	0.0186	0.0146	**	0.0361	0.0018	**	0.0227	0.0151	**	0.0248	0.0073	**
<i>HDI</i>	-0.0932	0.0038	***	-0.1546	0.0016	**	-0.1263	0.0032	*	-0.1427	0.0019	*
<i>DUMMY COVID</i>	-	-		-	-		-	-			0.0058	*
<i>Short Run Equation</i>												
<i>COINTEQ01</i>	-0.4618	0.0000	***	-0.6128	0.0000	**	-0.5482	0.0000	**	-0.5862	0.0000	**
<i>D(LZAK)</i>	-0.0124	0.2398		-0.0203	0.2044		-0.0148	0.2045		-0.0317	0.0201	**
<i>D(LGDP)</i>	-0.0287	0.1253		-0.0498	0.1181		-0.0385	0.1398		-0.0476	0.0306	**
<i>D(INF)</i>	0.0068	0.193		0.0145	0.125		0.0104	0.15	**	0.0134	0.03	**

		6			7			69			25	
<i>D(HDI)</i>	-0.0095	0.260 7		-0.0138	0.195 8		-0.0096	0.30 94		-0.0153	0.08 43	*
<i>DUMMY COVID</i>	-	-	-	-	-	-	-	-	-0.0412	0.03 65	**	

*Note: The table shows the PMG/ARDL estimation results for the long-run and short-run relationships between zakat redistribution, inequality, and control variables. The error correction term coefficient (COINTEQ01) is negative, and *, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively.*

Source: Author's Processed Results

The PMG–ARDL estimates indicate that zakat redistribution consistently exerts a negative and statistically significant long-run effect on income inequality throughout all estimation periods. The estimated long-run coefficients range from -0.0845 during the pre-pandemic period to -0.1587 during the COVID-19 crisis, before moderating to -0.1186 in the post-pandemic period. For the full sample, the long-run elasticity remains statistically significant at -0.1314, indicating that a one-percent increase in zakat redistribution is associated with an approximately 0.13% reduction in income inequality over the long run. Unlike the poverty model, however, the short-run impact of zakat redistribution on income inequality is generally insignificant during the pre-pandemic, pandemic, and post-pandemic periods. A statistically significant short-run effect emerges only in the full-sample estimation, where the coefficient of $D(LZAK)$ equals -0.0317 ($p < 0.05$). This pattern suggests that improvements in income distribution require a longer adjustment period before becoming observable at the macroeconomic level. The estimated error correction term (COINTEQ01) is negative and highly significant across all specifications, with coefficients ranging from -0.4618 to -0.6128. These values imply that approximately 46–61% of short-run disequilibrium is corrected within one adjustment period, confirming a relatively rapid convergence toward long-run equilibrium. Among the control variables, GDP per capita and the Human Development Index consistently reduce income inequality, whereas inflation increases inequality across all observation periods. The COVID-19 dummy variable is statistically significant in the full-sample estimation, indicating that the pandemic generated

structural changes in income distribution beyond those explained by the macroeconomic control variables.

These results align with those of (Fadila, 2019; Nurherlina & Rusgianto, 2024; Rusydiana et al., 2025), who emphasized the role of zakat in improving income equality.

During the COVID-19 pandemic (2020-2022), zakat's effectiveness in reducing inequality increased, with a long-term coefficient of -0.1587 ($p < 0.01$), while the short-term effect remained insignificant. These findings suggest that zakat functions as a countercyclical instrument that helps maintain income equality amidst the crisis, supported by increased zakat collection and digitization, as reported by (Gallien et al., 2024; Kasri & Yuniar, 2021; Mustamin et al., (2025). In the post-pandemic period (2023-2025), zakat redistribution maintained a negative and significant long-term effect (coefficient -0.1186), although smaller than during the pandemic, while the short-term effect remained insignificant. These results indicate that the benefits of zakat redistribution continue into the economic recovery phase by increasing the economic capacity of mustahiq (recipients). For the entire sample (2016-2025), zakat redistribution had a negative and significant effect on income inequality in both the long-term (coefficient -0.1314) and short-term (coefficient -0.0317). Overall, these findings indicate that zakat is an effective Islamic social finance instrument for improving income equality, with a stronger and more sustainable impact in the long term.

8. Robustness Check

To test the robustness of the estimation results during the COVID-19 period (2020-2022), this study used the FMOLS and DOLS methods. The focus of the testing was solely on the pandemic period, as it was the primary study period. The PMG-ARDL results for the pre-pandemic, post-pandemic, and full-sample periods were supported by cointegration tests.

Table 9. Fully modified Ordinary Least Square and Dynamic Ordinary Least Square During Period (2020-2022)

Variable	FMOLS		DOLS	
	Coefficient	Prob	Coefficient	Prob.
LZAK	-0.1652	0.0001**	-0.1694	0.0002**
LGDP	-0.2367	0.0008**	-0.2481	0.0011**
INF	0.0356	0.0035**	0.0375	0.0038**
HDI	-0.1514	0.0018**	-0.1576	0.0022**
<i>Note(s): The table shows the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimation results during the COVID-19 crisis. Coefficients, standard errors, t-statistics, and probability values (p-values) are shown for all study variables. The symbols *, **, and *** indicate significance levels of 10% and 5%, respectively.</i> Source(s): Author's Processed Results.				

Table 8 presents the Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) estimation results. The FMOLS results indicate that zakat redistribution has a negative and significant effect on income inequality (coefficient -0.1652; $p < 0.01$). The DOLS results also provide consistent findings with a coefficient of -0.1694 ($p < 0.01$). In addition, GDP per capita and HDI have a negative effect, while inflation has a positive effect on income inequality. The consistent direction and significance of the coefficients in FMOLS, DOLS, and PMG-ARDL indicate that the estimation results are robust.

9. Dumitrescu-Hurlin Causality Test

Table 9. Result of Dumitrescu-Hurlin Causality Test

Null Hypothesis	W-stat	Z-stat	Prob.	Direction
Pre-COVID (2016Q1–2019Q4)				
Poverty Model				
LZAK does not homogeneously Granger-cause LPO	5.618	3.284	0.001 ***	LZAK → LPO
LPO does not homogeneously Granger-cause LZAK	1.836	0.884	0.377	
Income Inequality Model				
LZAK does not homogeneously Granger-cause GINI	2.986	2.146	0.032 **	LZAK → GINI
GINI does not homogeneously	1.638	-0.654	0.514	

Granger-cause LZAK				
During-COVID (2020Q1–2022Q4)				
Poverty Model				
LZAK does not homogeneously Granger-cause LPO	7.824	5.836	0.000 ***	LZAK ↔ LPO
LPO does not homogeneously Granger-cause LZAK	6.412	4.827	0.000 ***	
Income Inequality Model				
LZAK does not homogeneously Granger-cause GINI	6.273	4.519	0.000 ***	LZAK ↔ GINI
GINI does not homogeneously Granger-cause LZAK	5.481	3.874	0.000 ***	
Post-COVID (2023Q1–2025Q4)				
Poverty Model				
LZAK does not homogeneously Granger-cause LPO	5.618	3.284	0.001 ***	LZAK → LPO
LPO does not homogeneously Granger-cause LZAK	1.836	0.884	0.377	
Income Inequality Model				
LZAK does not homogeneously Granger-cause GINI	4.564	2.881	0.004 ***	LZAK → GINI
GINI does not homogeneously Granger-cause LZAK	1.904	0.972	0.331	
Full Sample (2016Q1–2025Q4)				
Poverty Model				
LZAK does not homogeneously Granger-cause LPO	8.941	6.483	0.000 ***	LZAK ↔ LPO
LPO does not homogeneously Granger-cause LZAK	3.827	2.354	0.019 **	
Income Inequality Model				
LZAK does not homogeneously Granger-cause GINI	7.246	5.127	0.000 ***	LZAK ↔ GINI
GINI does not homogeneously Granger-cause LZAK	3.514	2.081	0.037 **	

*Note: This table reports the results of the Pairwise Dumitrescu–Hurlin panel causality test for the pre-COVID-19, during-COVID-19, post-COVID-19, and full-sample periods. The table presents the W-statistic, Z-statistic, p-value, and the direction of Granger causality between the variables. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% significance levels, respectively.*

Source: Authors' calculations.

The Dumitrescu-Hurlin causality test shows that in the pre- and post-COVID-19 periods, there was a unidirectional causal relationship from zakat redistribution to poverty ($LZAK \rightarrow LPO$) and income inequality ($LZAK \rightarrow GINI$). During the COVID-19 pandemic, this relationship changed to a bidirectional one, both between zakat and poverty and zakat and income inequality. This indicates that the increase in poverty and inequality during the pandemic also contributed to an increase in zakat collection and distribution. In the full sample, the bidirectional relationship was also found, indicating a long-term interaction between zakat redistribution, poverty, and income inequality, while also strengthening the PMG-ARDL estimation results.

D. Conclusion

This study demonstrates that zakat redistribution functions as an effective Islamic social finance instrument for alleviating poverty and reducing income inequality across the eight member countries of the Organization of Islamic Cooperation (OIC) included in the analysis. The empirical evidence confirms that zakat consistently exerts a poverty-reducing effect in both the short and long run, while its contribution to reducing income inequality is primarily sustained over the long run. The strongest redistributive impact emerged during the COVID-19 pandemic, indicating that zakat possesses countercyclical characteristics that enable it to mitigate socioeconomic shocks during periods of economic disruption. The convergence of findings obtained from the PMG-ARDL, FMOLS, DOLS, and Dumitrescu–Hurlin causality approaches further strengthens the robustness of these conclusions.

Beyond addressing the research objective, this study advances the literature by providing cross-country evidence that zakat serves not only as a religious redistribution mechanism but also as a macroeconomic stabilizer capable of enhancing social resilience during crises. Methodologically, it demonstrates the value of integrating heterogeneous dynamic panel estimation with long-run robustness tests and panel causality analysis to examine the socioeconomic effectiveness of Islamic fiscal

instruments. From a policy perspective, the findings underscore the importance of strengthening zakat governance, institutional capacity, digital transformation, and productive zakat programs to maximize redistribution outcomes and improve economic resilience. Nevertheless, the generalizability of these findings remains constrained by the limited country coverage, the relatively short crisis observation period, and the use of interpolated quarterly data. Future research is therefore encouraged to incorporate a broader set of countries, extend the observation horizon, and compare alternative zakat distribution models to obtain a more comprehensive understanding of their effectiveness in reducing poverty and income inequality.

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