Journal of Islamic Finance, Vol. 15 No. 1 (2026) 53-68
IIUM Institute of Islamic Banking and Finance
ISSN 2289-2117 (O) / 2289-2109 (P)

The Economic Impact of Global Volatility from COVID-19 and the Russia-Ukraine War on Largest Muslim Population Countries: A Difference-in-Difference Approach

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Abstract

This study examines the economic impact of global volatility from COVID-19 and the Russia-Ukraine war on the biggest Muslim population is a proxy linked to prevalence of Islamic finance systems, redistribution mechanisms (such as zakat), labour market composition, and institutional characteristics common across these economies. The treated units consist of Indonesia, Pakistan, Bangladesh, Nigeria, and Egypt, while Norway, Denmark, Finland, Sweden, and Switzerland serve as control units. Data from 2015 to 2018 for before COVID-19 and the Russia-Ukraine war and 2019 to 2022 for during (after) are analysed, focusing on variables such as real GDP, investment, consumption, trade, and Muslim population. Results indicate that the treated units experienced a significant decrease in macro-economic indicators relative to control units following periods of global economic volatility. However, inclusion of covariates such as investment, consumption, trade, and the Muslim population partially explains the observed effects. The study underscores the susceptibility of countries with large Muslim populations (given their economic, social, and demographic structures) to external economic shocks and emphasises the importance of targeted policy interventions to promote economic resilience. Recommendations include enhancing economic diversification, strengthening social safety nets, promoting trade and investment, and fostering education and innovation. Limitations regarding data reliability, generalisability, causality, and policy implications are also acknowledged.

Keywords: Economic impact; global volatility; Muslim countries

1. Introduction

Globalisation has reshaped the world, fostering intricate interconnections across economic, social, and political spheres. This transformative process has turned nations into deeply intertwined entities, where the prosperity of one nation is intricately linked to others. Within this globalised framework, increased trade, capital flows, and technological exchange have become the norm, driving economic growth but also exposing countries to vulnerabilities, particularly those with significant Muslim populations (Ghouse et al., 2022).

Recent studies conducted in various Muslim-majority nations, including Indonesia, Pakistan, Bangladesh, Nigeria, and Egypt, shed light on complex economic dynamics within the context of globalisation. Nasution et al. (2022) conducted a comprehensive study elucidating the intricate web of economic linkages connecting Muslim-majority countries to global markets. Their findings underscore the susceptibility of these nations to external shocks, emphasising the necessity for a focused examination of the economic structures that make them particularly vulnerable. Qital and Rusydiana (2022) investigated the impact of the global credit crunch on Muslim countries and observed that the associated economic downturn was partly responsible for the Arab Spring. Moreover, Khan et al. (2020) explored the complex relationships between oil prices and the economies

Article history
Received: 28 August 2025
Accepted: 3 March 2026

of numerous Muslim-majority nations, revealing the significant impact of global oil price fluctuations on these economies.

The historical context further deepens our understanding of this vulnerability. The late 20th and early 21st centuries witnessed profound financial crises that reverberated across the global economy, affecting Muslim-majority countries as well. The Asian Financial Crisis of 1997 and the Global Financial Crisis of 2008 demonstrated how the economic fortunes of these nations are intricately tied to the whims of the global market. Kawai and Sheng (2012) dug into these crises, tracing their ripple effects and emphasising the interconnectedness that renders Muslim-majority countries susceptible to the volatile dynamics of the global economic landscape.

Geopolitical events have also significantly impacted the economic trajectories of Muslim-majority nations, particularly in regions like the Middle East and North Africa, marked by historical and contemporary conflicts. A study by Josua and Edel (2015) shed light on the lasting economic ramifications of conflicts in these regions, underlining the need for a comprehensive understanding of economic resilience and vulnerability, especially in the aftermath of geopolitical upheavals.

Understanding the economic impacts on the largest Muslim-population nations is of immense practical significance. Policymakers, both domestically and globally, must be informed by empirical evidence to make decisions that can mitigate adverse effects and leverage potential opportunities. The interconnectedness and vulnerability of these economies demand a nuanced examination drawing on empirical evidence and theoretical frameworks to elucidate the complex dynamics at play.

The study empirically examines the economic impact of global volatility caused by COVID-19 and the Russia-Ukraine conflict on the five most populous Muslim countries in the world. The study explicitly focusses on countries with the largest Muslim populations: Indonesia, Pakistan, Bangladesh, Nigeria, and Egypt. India, despite being the second or third country with the highest number of Muslims, is not included due to limited Islamic practice there. While most of the COVID-19 DID (Difference-in-Difference) studies compare income groups, regions or policy responses, very few examined demographically defined macro-groups. Also, none of the studies combine COVID-19 and the Russia-Ukraine war within a unified DID framework focusing on the largest Muslim-population countries. This is due to COVID-19 was primarily a demand and mobility shock while the Russia–Ukraine war introduced supply-side and commodity price shocks. Together, both capture global volatility regime shift.

2. Literature Review

2.1 Stylised facts

This paper focuses on the effects of global volatility on the top five countries with the largest Muslim populations. The discussion of the economic growth patterns in the Muslim world spans the years 1991-1995, 1996-2000, 2002-2006, 2007-2011, 2015-2018, and 2019-2022. The period from 1991 to 1995 preceded the Asian financial crisis, which occurred throughout Asia, a region with a significant Muslim population. The Asian financial crisis occurred from 1996 until 2000. The years from 2002 to 2006 represent the timeframe preceding the global financial crisis, while the years from 2007 to 2012 correspond to the global financial crisis, which resulted in significant global economic volatility. The time span from 2015 to 2018 preceded the occurrence of both the COVID-19 pandemic and the Russia-Ukraine conflict. Subsequently, from 2019 to 2022, there was a period of global economic volatility due to the impact of the COVID-19 pandemic and the Russia-Ukraine conflict. Central Asia is the region in Asia with the highest percentage of Muslims; more than 90% of its people follow the Islamic faith. Second is Western Asia with a majority of over 70% and Southeast Asia with a majority of over 40%. North Africa has the highest percentage in Africa, of over 90%, followed by West Africa with a percentage of over 50%. All the remaining regions are not predominantly Muslim.

Table 1: Real GDP Growth of Muslim Dominated and Non-Muslim Dominated Regions

Region	1991-1995	1996-2000	2002-2006	2007-2012	2015-2018	2019-2022
Northern Africa	2.662	4.288	5.258	2.916	4.19	2.3325
West Africa	0.844	3.532	7.328	6.49	2.4025	2.6975
Eastern Africa	1.828	3.67	4.918	7.684	5.66	4.0975
Central Africa	-2.218	3.128	7.732	5.904	0.5925	1.21
Southern Africa	2.594	2.898	4.466	2.672	1.23	0.335
Central Asia	-8.573	3.122	8.456	7.39	3.9225	3.1075
Western Asia	4.106	4.814	5.98	4.482	3.1925	2.8175
Southern Asia	4.466	5.188	6.686	6.03	6.4375	3.4175
South-Eastern Asia	7.388	2.738	5.874	5.492	5.0575	2.58
East Asia	4.762	3.992	5.706	5.85	4.94	3.4075
North America	2.52	4.292	2.888	0.788	2.47	1.937
Latin America & Caribbean	3.272	3.052	3.62	3.524	0.09	0.855
Europe	1.3425	2.155	1.6792	3.0645	2.8815	-1.0085

Source: World Bank's World Development Indicators

Prior to the Asian financial crisis, regions with a majority Muslim population, such as Western Asia and Southern Asia, typically had strong GDP growth rates of 7.3% and 4.1%, respectively, in comparison to non-Muslim regions like Europe, Latin America, and the Caribbean. Nevertheless, Central Asia had a decline in economic growth during this period, suggesting the presence of economic challenges that were not directly caused by the upcoming crisis. The duration of the Asian financial crisis was brief, and the Asian economies swiftly recovered and had a resurgence in growth. The region of North Africa, which is predominantly Muslim, also experienced significant economic growth of 2.6%.

From 2002 to 2006, regions with a Muslim majority, such as Northern Africa, Central Asia, Western Asia, and even Southern Asia, consistently showed robust GDP growth rates of over 5%, albeit with relatively small fluctuations. The pattern was the same for non-Muslim majority regions except for Europe and North America, which fell below 3%. From 2007 to 2012, the global financial crisis led to the Arab Spring; Northern Africa underwent a substantial fall in economic growth and endured political upheaval. The crisis that started in Northern America also led to their economic downturn. Northern America experienced less than 1% growth, second to Southern Africa and Northern Africa.

Prior to the global economic crisis (2015-2018), regions with a Muslim majority were witnessing strong economic growth. Northern Africa experienced an average real gross domestic product (RGDP) growth rate of 4.19%, Central Asia saw a growth rate of 3.9%, and Western Asia had a growth rate of 3.1%. Amidst the recent global volatility from 2019 to 2022, there is a varied situation in both regions with a Muslim majority and regions without a Muslim majority. Certain regions had a deceleration in their growth rates, but others witnessed a rapid resurgence. The growth rates in North Africa decreased from 4.19% to 2.33%, while Central Asia's growth rates stayed reasonably consistent but lower, dropping from 3.9% to 3.1%. These figures suggest that both regions are facing ongoing economic issues. Europe, a non-Muslim continent, notably saw declining growth rates throughout the previous period of global economic instability, perhaps influenced by a combination of geopolitical and economic causes.

In summary, the evidence indicates that regions with a majority Muslim population, including Southern Asia and Western Asia, have demonstrated the ability to maintain consistently high rates of economic growth, even during times of global economic crisis. Nevertheless, there are variations within specific regions, and the economic performance is impacted by a blend of internal elements like governance and economic policies, as well as external factors like global economic conditions and geopolitical tensions. See Figure 1.

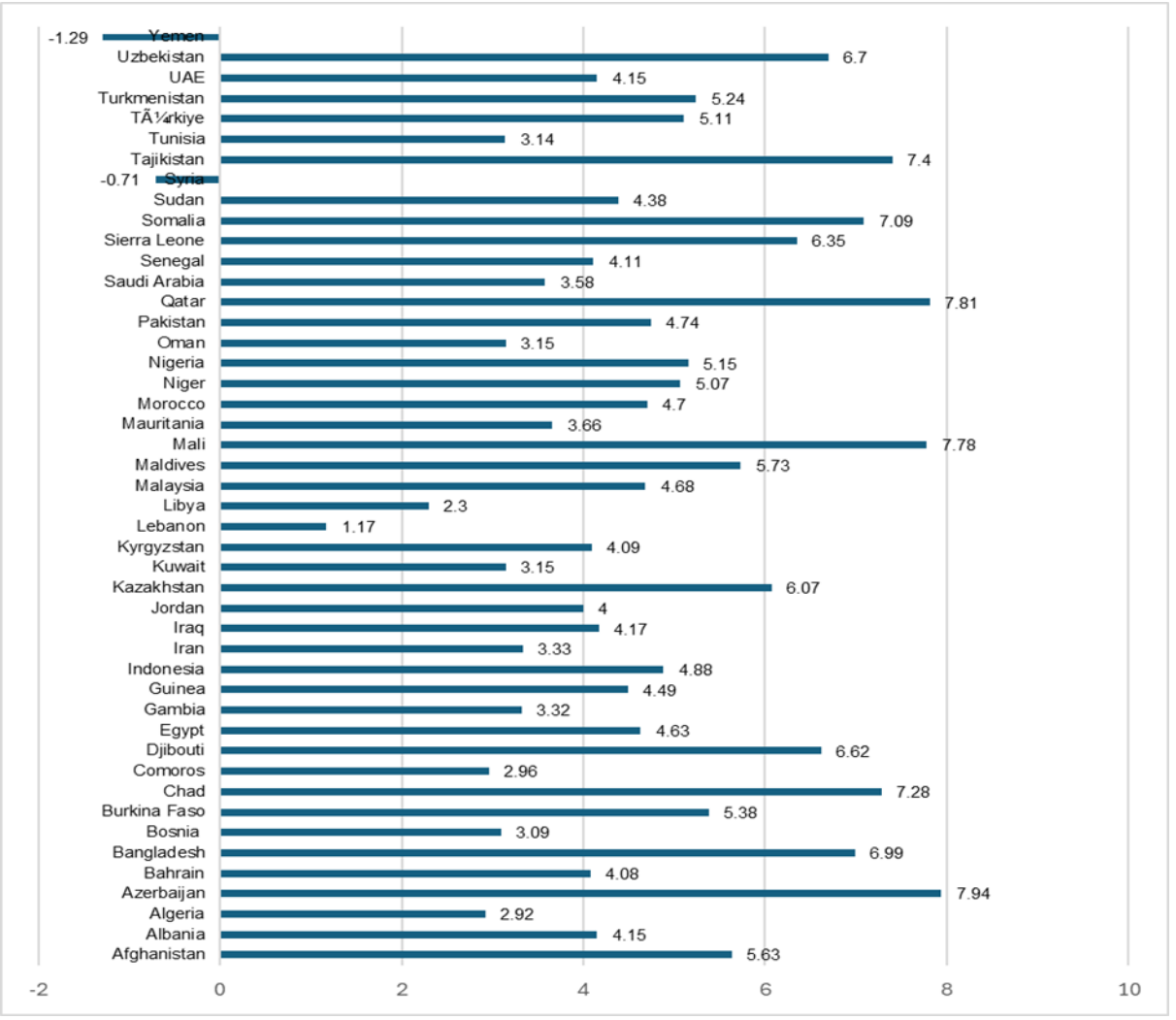


Figure 1: Real GDP Growth Rate of Muslim Majority Countries 2000 – 2021
Source: Authors' computation using World Bank's World Development Indicators

According to the Pew Research Centre and the World Religion Database (WRD), the 46 countries in Figure 1 above are the Muslim majority countries for the period reviewed. The data is not clear about Nigeria, with Pew putting it at approximately 50% and WRD at less than 50%. Countries in the upper quartile (top 25%) of the growth rate of the 46 countries are Azerbaijan (7.94%), Qatar (7.81%), Mali (7.78%), Tajikistan (7.4%), Chad (7.28%), Somalia (7.09%), Bangladesh (6.99%), Uzbekistan (6.7%), Djibouti (6.62%), Sierra Leone (6.35%), Kazakhstan (6.07%), and Maldives (5.73%). These countries are naturally resource-rich, and it accounts for more than half of their growth (Haddadi, 2015). Countries in the lower quartile (bottom 25%) growth rate are Iran (3.33%), Gambia (3.32%), Kuwait (3.15%), Oman (3.15%), Tunisia (3.14%), Bosnia (3.09%), Comoros (2.96%), Algeria (2.92%), Libya (2.3%), Lebanon (1.17%), Syria (-0.71), and Yemen (-1.29). Iran has been under Western sanctions, and the others have been affected by political instability, the Arab Spring, terrorism, and limited natural resources, as in the case of The Gambia.

Given that through globalisation the world economies have become more intertwined and interdependent, Figure 2 below shows the real GDP growth rate of the top 5 most populous Muslim countries[1] in the world as

[1]India is excluded though its Muslim population is among the top 5 in the world according to the Pew Research Centre. This is because they make up very much less than 25% of Indian population.

against their levels of globalisation for the period 2000 to 2021. Based on the figure, none of the 12 Muslim-majority nations with the highest real GDP growth rates are ranked in the top quartile of the globalisation index. Out of the five most populous Muslim countries, only Egypt (63.2%) and Indonesia (58.4%) have a globalisation index above the upper quartile of Muslim-majority countries. This implies that the leading developing nations in the Muslim world have not been highly globalised.

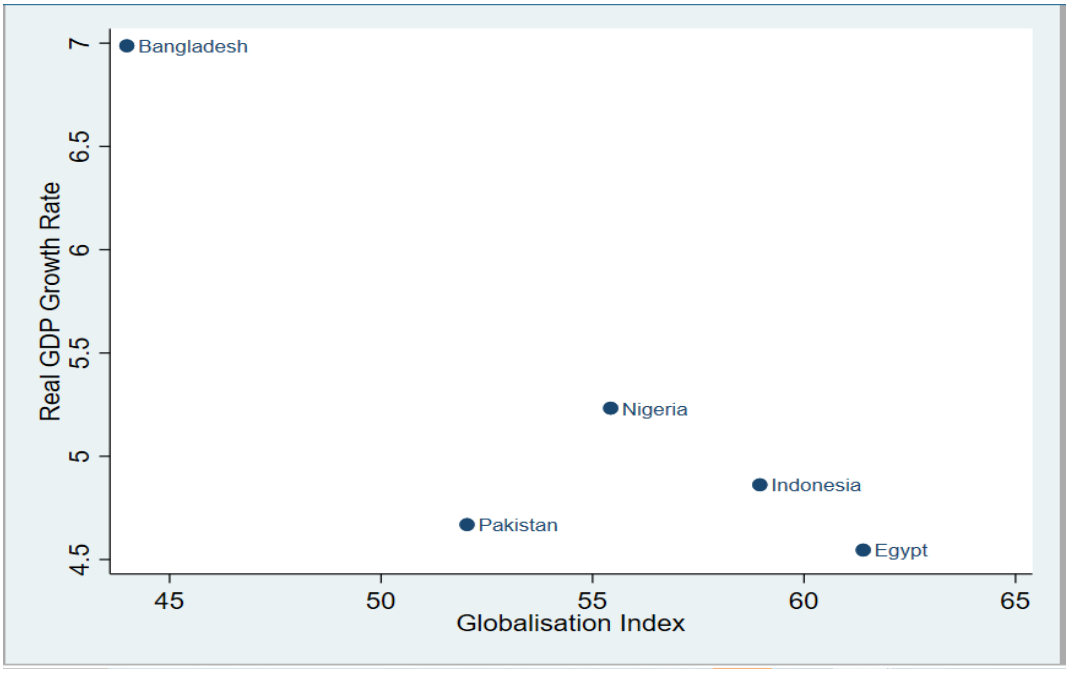


Figure 2: Real GDP Growth Rate and Globalisation of Top 5 Muslim Populous Countries 2000-2021
Source: Authors' computation using World Bank's World Development Indicators and the KOF Index of Globalisation

2.2 Empirical Literature

The impact of volatility on economic growth has been extensively examined and is frequently seen in the literature on economic growth. Nevertheless, the outcomes have been inconclusive, and the focus of the discussions has revolved around the interplay between technology, trade, and political stability. The effects of worldwide economic volatility on the economies of Muslim countries, however, have not received much attention. This study distinguishes itself from past research by specifically examining the top five countries with the highest Muslim populations.

In their cross-country exercise, Ramey and Ramey (1995) conducted ground-breaking research that revealed a negative relationship between volatility and growth. More precisely, their research identifies a negative relationship between average output growth rates and the level of volatility in those rates. Subsequently, Al-Marhubi (1998) and Kose et al., (2005), and other researchers further expanded upon their work. The overall conclusion of these studies suggests that volatility has a detrimental effect on economic growth, especially in financially and institutionally undeveloped countries.

Volatility and the onset of a recession have a positive relationship in the business cycle. A recession can result in increased research and development (R&D) or the elimination of the least productive enterprises (Khan et al., 2023). This entire process results in increased economic growth accompanied by increased volatility (Güreşçi, 2018). When other measures of volatility are taken into account, they have a minimal effect on output, but the effect is positive (Bairagi, 2017).

Empirical research has emphasised the interdependence of the global economy across different areas by investigating the economic consequences of global events, such as financial crises. Research conducted by Hayami and Godo (2005), Petrakis (2020), and Sparrow et al. (2016) highlights the interconnectedness of the

global economy, demonstrating how economic disturbances in one area can have far-reaching effects worldwide. Nevertheless, there is a lack of comprehension of the consequences for countries with a Muslim majority.

Research that specifically concentrates on examining the economic resilience and vulnerability of countries with a Muslim-majority population provides precise and focused information. Muhammad and Triharyono (2019) evaluate the ability to recover from the Global Financial Crisis, while Khan et al. (2023) investigate susceptibility to changes in commodity prices. Although these contributions are valuable, further study is required to investigate the effects of global volatility across the countries with the most Muslim populations based on their exposure to globalisation and the accompanying effects of global volatility.

Nasution et al. (2022), in their study, specifically examine the influence of global volatility on nations with a Muslim-majority population. Nevertheless, studies in this field are still progressing. Sector-specific investigations, such as the study conducted by Hassan et al. (2022) on the technology sector and the research conducted by Ali and Rahman (2021) on oil-dependent nations, provide nuanced insights into the varying effects of global volatility.

Siddiqui and Rizvi (2023) examine policy responses, with a particular focus on the importance of flexible frameworks. Furthermore, Malik and Ahmed (2022) emphasise the capacity of Islamic financing instruments to boost economic resilience. To summarise, whereas current empirical research offers useful insights, there are still gaps. This study intends to address the research gap regarding the impact of global volatility on countries with the greatest Muslim populations, which is currently poorly understood. Although there is some research available on the economic consequences of global volatility, there is a noticeable shortage of thorough study that explicitly examines nations with Muslim-majority populations. This study uses a difference-in-difference approach to provide a detailed understanding of how volatility in global economic conditions specifically impacts these countries throughout time.

Recent empirical research has increasingly employed the Difference-in-Difference (DID) framework to estimate the economic impact of COVID-19 in emerging and developing economies. Many of these studies rely on temporal variation in pre- and post-pandemic periods combined with cross-sectional exposure differences—such as lockdown intensity, fiscal capacity, health system readiness, or sectoral dependence—to identify causal effects (Nasution et al., 2022; Ghouse et al., 2022). The identification strategy typically exploits exogenous timing of the pandemic shock while assuming that, absent COVID-19, treated and control groups would have followed parallel growth paths. For example, DID designs comparing countries with stronger versus weaker fiscal stimulus packages or varying degrees of mobility restrictions rely on this counterfactual trend assumption to isolate treatment effects. Our study adopts a similar identification logic, comparing the five largest Muslim-population countries with highly resilient economies before and after the onset of global volatility in 2019, thereby situating our approach within the established DID tradition in pandemic-related macroeconomic research.

A central methodological concern in recent DID-based COVID-19 literature is the validity of the parallel trends assumption. Scholars emphasize the importance of pre-treatment graphical inspections, placebo tests, and regression-based pre-trend analyses to ensure credible causal inference (Stock & Watson, 2020; Pesaran et al.,1999). Given the unprecedented and global nature of COVID-19, some studies highlight the difficulty of identifying a “pure” control group unaffected by the shock, thereby raising concerns about differential pre-existing trends and common global disturbances. In response to these methodological discussions, our study explicitly tests for pre-treatment parallel trends using data from 2015–2018 and confirms no statistically significant differential growth patterns between treatment and control groups prior to 2019. This strengthens the credibility of our DID estimates and aligns our empirical strategy with best practices in contemporary pandemic-related causal research.

Another key theme in the DID COVID-19 literature is shock heterogeneity. Emerging evidence suggests that the pandemic generated asymmetric effects across countries depending on economic structure, trade openness, commodity dependence, and institutional quality (Kose et al., 2005; Khan et al., 2023). In many emerging economies, the contraction was amplified by limited fiscal space, reliance on informal labour markets, and exposure to external capital flows. Furthermore, subsequent geopolitical disruptions—particularly the Russia–Ukraine war—introduced additional supply-side and commodity price shocks, compounding the initial pandemic effects. By incorporating both COVID-19 and the Russia–Ukraine conflict within a unified

DID framework, our study captures a broader regime of global volatility rather than a single isolated shock. Methodologically, this approach remains comparable to recent DID applications while extending the literature by examining dual, overlapping global disturbances and their differential impact on structurally comparable demographic macro-groups.

Overall, our empirical design is methodologically consistent with recent DID-based COVID-19 studies in emerging markets, particularly in its use of pre/post shock comparisons, interaction terms, and macroeconomic covariates. However, it contributes to the literature by focusing on the largest Muslim-population countries as a structurally defined treatment group and by comparing them with highly resilient economies identified through the FM Global Resilience Index. In doing so, the study not only adopts established identification strategies but also extends existing research by incorporating demographic-economic structure and multi-shock volatility into the DID framework.

2.3 Theoretical Framework

Volatility causes uncertainty, and uncertainty affects both consumption and investment decisions, which in turn affect output (GDP). According to the Permanent Income Hypothesis (PIH), long-term income determines consumption (Friedman, 1957). When there is uncertainty about income, there are more savings and less consumption, which has a negative impact on growth. With regards to investment, the Real Option Theory (ROT) suggests that uncertainty delays investment, which leads to lower levels of investment and slower economic growth (Reside, 2022). Furthermore, the Mundell-Fleming model explains the effect of global macroeconomic volatility on net exports and the economy of domestic countries. The Mundell-Fleming Trilemma and the IS-LM model all point to the economic thought that global macroeconomic volatility brings uncertainty in exchange rates, which negatively affects exports (Fleming, 1962; Mundell, 1963). The model uses the sum of exports and imports to account for globalisation and openness, which in turn affect growth (Mutalemwa, 2015).

Islamic finance principles, which emphasise risk-sharing and asset-backed financing, offer resilience against global uncertainty. Research by Ghouse et al. (2022) explores this resilience, while Cowan (2018) investigates Zakat's redistributive effects, suggesting its potential role in mitigating economic disparities during volatility. This effect is proxied by the Muslim population in the country.

We considered a simple framework that includes key macroeconomic variables to develop a theoretical model of how global economic volatility affects the domestic economy. Assuming a small open economy where the domestic economy is affected by global economic conditions, we can express GDP or Y_t using the Keynesian Aggregate Demand framework as:

$$Y_t = C_t + I_t + T_t + M_t \quad (1)$$

- C_t: Consumption in the domestic country at time t
- I_t: Investment in the domestic country at time t
- T_t: Sum of import and export of the domestic country at time t
- M: Muslim population of the domestic country at time t
- Y_t: Output or GDP of the domestic country at time t
- V_{gt}: Global macroeconomic volatility at time t

Given that global macroeconomic volatility (V_{gt}) can affect domestic consumption, investment, and net export through uncertainty, the impact on them can be presented as follows:

$$C_t = \bar{C} - a_{1d} \,.\, V_{gt} \quad (2)$$
$$I_t = \bar{I} - a_{2d} \cdot V_{g_t} \quad (3)$$
$$T_t = \bar{T} - a_{3d} \cdot V_{gt} \quad (4)$$
$$M_t = \bar{M} - a_{4d} \cdot V_{gt} \quad (5)$$

$\bar{C}$, $\bar{I}$, and $\bar{T}$ $\bar{M}$are baseline levels of domestic consumption, investment, Trade, and Muslim population respectively. a_{1d}, a_{2d}, a_{3d} and a_{4d} are coefficients and measure the sensitivity of domestic consumption, investment, and net exports to global macroeconomic volatility. When these expressions (equations 2, 3, 4, and

5) are substituted into the GDP (equation 1), it becomes:

$$Y_t = \bar{C} - a_{1d} \cdot V_{gt} + \bar{I} - a_{2d} \cdot V_{g_t} + \bar{T} - a_{3d} \cdot V_{gt} + \bar{M} - a_{4d} \cdot V_{gt} \quad (6)$$

Simplifying further:

$$Y_t = \bar{Y} - (a_{1d} + a_{2d} + a_{3d} + a_{4d}) \cdot V_{gt} \quad (7)$$

$\bar{Y} = \bar{C} + \bar{I} + \overline{NX}$ is the baseline level of domestic GDP. Equation 6 shows that global economic volatility negatively affect domestic economies. The terms $a_{1d} + a_{2d} + a_{3d} + a_{4d}$ are the combined impact of global economic volatility on domestic consumption, investment, trade, and Islamic economics. If $a_{1d} + a_{2d} + a_{3d} + a_{4d}$ is positive, increase in global economic volatility will decrease domestic GDP, and vice versa. Similar frameworks have been used in various studies (Chatterjee & Shukayev, 2011; Kose et al., 2005; Silva et al., 2017). Essentially, this theoretical model proposes that increased global economic volatility has a detrimental effect on home country GDP by adversely impacting domestic consumption, investment, trade, and Islamic economic and financial systems. The extent of the impact of global economic volatility on domestic country economy is determined by the magnitudes of the coefficients of a_{1d}, a_{2d}, a_{3d}, and a_{4d}.

3. Data and Methodology

Econometric model

To investigate the causal impact of global volatility on the top five countries with the highest Muslim population, the study employs the Difference-in-Difference (DID) approach. It is used in this study to compare the growth of the sampled Muslim countries with other countries before and after the global volatility as a result of COVID-19 and the Russia-Ukraine conflict. Generally, the DID regression model is expressed as:

$$Y_{it} = \beta_0 + \delta_0 after_{it} + \beta_1 treated_{it} + \delta_1 after_{it} * treated_{it} + V_{it} + U_{it} \quad (8)$$

Based on equation vi, Y_{it} is GDP, the before is the period 2015 to 2018 after is 2019 to 2022 during the period of volatility. The treated are the 5 Muslim countries assumed to be affected by volatility which is the treatment and the controlled are the top 5 resilient countries (Norway, Denmark, Finland, Sweden, and Switzerland) according to the FM Global Resilience Index for the period under investigation (Wilson et al., 2022). V_{it} is the vector of controlled variables (investment, consumption, trade, and Muslim population). To account for the interactions in equation vi, the interaction term between after and treated includes the treatment indicator and the variable representing the subgroup and conditions of interest.

- δ_1 is the effect of the treatment (volatility) for the after period (2019 to 2022)
- $\beta_0 = \bar{Y}_{0c}$ is the outcome for the control units where treated = 0 for before and after
- $\beta_0 + \beta_1 = \bar{Y}_{0t}$, outcome for treated units where treated = 1 for before and after = 0
- $\beta_0 + \delta_0 = \bar{Y}_{1c}$, outcome for control units where treated = 0 for after and 1 for after also
- $\beta_0 + \delta_0 + \beta_1 + \delta_1 = \bar{Y}_{1t}$, outcome for treated unit where treated = 1 for before and after

Thus, the DID effect is:

$$\delta_1 = (\bar{Y}_{1t} - \bar{Y}_{0t}) - (\bar{Y}_{1c} - \bar{Y}_{0c}) = (\bar{Y}_{1t} - \bar{Y}_{1c}) - (\bar{Y}_{0t} - \bar{Y}_{0c}) \quad (9)$$

One of the strengths of DID is its ability to control for time-invariant confounding factors that affect both the treated and control groups. This technique makes it robust to the omitted variable problem and hence adequately controls endogeneity.

Data and variable description

Data on real GDP and its growth rate is sourced from the World Bank's Development Indicators at 2015 U.S. dollar prices. Investment is measured by the World Bank's Development Indicators. Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories expressed in 2015 U.S. dollar prices. Consumption is also measured.

The World Bank's Development Indicators final consumption expenditure (formerly total consumption) is the sum of household final consumption expenditure (formerly private consumption) and general government final consumption expenditure (formerly general government consumption). Data are in constant 2015 prices, expressed in U.S. dollars. For trade and globalisation, import and export data at 2015 U.S. dollar prices from the United Nations Conference on Trade and Development (UNCTAD) are used. Data from the Pew Research Centre and the World Religion Database (WRD) are used for the global Muslim population. Muslim population represents a structural demographic proxy linked to Islamic Finance, redistribution mechanisms like zakat, labour market composition, and institutional characteristics across the economies. These capture structural economic channels that may influence resilience. We selected the control group of Norway, Denmark, Finland, Sweden, and Switzerland due to their high Global Resilience Index (GRI). The data was sourced from FM Global, which provides the most widely used GRI in economics and finance. It entails economic, environmental, social, political, and infrastructure resilience to global shocks.

Panel unit root test

The popular Levin-Lin-Chu (LLC) test for panel unit roots is employed to test whether the variables real GDP, investment, consumption, trade, and Muslim population are stationary or have a unit root across the countries and years sampled. The LLC is built upon the Augmented Dickey-Fuller (ADF) and makes it robust in accounting for cross-sectional dependence among panel units (Pesaran, Shin, & Smith, 1999). We compute the LLC test statistic as follows:

$$T * \frac{\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{p}_{it}}{\left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{q}_{it}^{2}\right)^{0.5}} \quad (10)$$

T is the number of periods, years in this case

N is the number of cross-sectional units, countries in this case

$\hat{p}_{it}$ is the coefficient estimate from the regression of first-differenced values on lagged levels including cross-sectional averages of lagged first differences.

$\hat{q}_{it}^{2}$ is the estimated variance of the residuals from the above regression.

The null hypothesis is that there is a unit root or non-stationarity, and the alternative is that there is no unit root, or the series are stationary. The test statistic follows a normal distribution, and if it is greater than the critical value from the standard normal distribution, the null hypothesis is rejected, concluding that the series is stationary.

Multicollinearity test

Also, in panel regression, as in this case, multicollinearity can arise from time-invariant characteristics and common shocks affecting all the units, resulting in high correlation among the explanatory variables within and across times (Stock & Watson, 2020). We must check for and correct any present multicollinearity to ensure reliability, validity, and interpretability. A correlation matrix is used to detect it, and a correlation of .8 and above is deemed to be high and hence the presence of multicollinearity. Variance Inflation Factor (VIF) is also used, and a VIF of over 10 is considered high. We calculate the VIF for each independent Xi variable as follows where R_i^2 is the coefficient of determination:

$$VIF_i = \frac{1}{1-R_i^2} \quad (11)$$

Pre-treatment trend test

A key identifying assumption of the DID framework is the parallel trends assumption, which requires that, in the absence of treatment, the treated and control groups would have followed similar outcome trajectories over time (Stock & Watson, 2020). To validate this assumption, we conduct a pre-treatment trend analysis using data from 2015–2018, the period prior to the onset of global volatility associated with COVID-19 and the Russia–Ukraine war.

Regression-based pre-trend (placebo) test

To formally test for differential pre-treatment trends, we estimate the following placebo regression restricted to the pre-treatment period (2015–2018):

$$Log\ GDP_{it} = \alpha + \beta_i Treated_i + \beta_2 t + \beta_3 (Treated_i \times t) + \varepsilon_{it} \quad (12)$$

Where:

- t is a linear time trend for 2015–2018,
- $\text{Treated}_i \times t$ captures whether treated countries experienced different growth trends relative to controls prior to 2019.

The coefficient on the interaction term $\beta_3$represents the differential pre-treatment trend.

5. Results and Discussion

The measurements of real GDP, investment, consumption, and trade are expressed in millions of dollars. The Muslim population is quantified in millions. These variables exhibit substantial disparities between their minimum and highest values, indicating a broad spectrum of values across the dataset pertaining to the size of the countries. See Table below for summary descriptive statistics.

Table 2: Summary Descriptive Statistics

	Real GDP	Investment	Consumption	Trade	Muslim Population
Mean	4.75e+11	1.20e+11	3.49e+11	2.95e+11	77.91542
Standard Deviation	2.28e+11	8.38e+10	1.40e+11	2.43e+11	87.01081
Minimum	1.95e+11	4.71e+10	1.52e+11	76895.08	.016345
Maximum	1.12e+12	3.64e+11	7.23e+11	9.74e+11	241.52
Variance	5.18e+22	7.02e+21	1.97e+22	5.91e+22	7570.881
Skewness	1.217587	1.697188	.8744698	1.1622848	.5492165
Kurtosis	3.706512	5.061958	3.29083	3.839096	1.796025
Observation	80	80	80	80	80

The standard deviation figures provide additional evidence of the level of variation within each variable among the various countries. The positive skewness values signify a right-skewed distribution, characterised by a longer tail on the right side. The skewness and kurtosis values for real GDP, investment, consumption, and trade show that the data does not perfectly follow a normal distribution, which means it might not be normal. Nevertheless, the skewness and kurtosis values fall within acceptable limits, suggesting that, although the distributions may deviate from normality, they do not exhibit extreme skewness or kurtosis. Furthermore, the Muslim Population variable, which has a skewness value approaching zero and a moderate kurtosis value, seems to have a distribution that is more like a normal distribution compared to the other variables.

Table 3: Results of Levin-Lin-Cho Panel Unit Root Test

Variable		LLC Statistic		P-value	
		At level	Logged	At level	Logged
Real GDP	Unadjusted t	0.8670	-12.1741	0.9519	0.0000***
	Adjusted t*	1.6636	-7.5356		
Investment	Unadjusted t	3.2309	-12.9593	0.1190	0.0000***
	Adjusted t*	2.0756	-8.9016		
Consumption	Unadjusted t	-0.6441	-11.4006	0.6404	0.0000***
	Adjusted t*	0.3595	-6.6640		
Trade	Unadjusted t	-26.8757	-5.1519	0.1021	0.0001**
	Adjusted t*	-24.6138	-3.7584		
Muslim Population	Unadjusted t	-9.5798	-3.4426	0.7290	0.0251**
	Adjusted t*	0.6096	-0.6711		

Note: ***, and ** are significant are 99% and 95%.

At level, all the variables are non-stationary. Given a p-value of greater than .05, one fails to reject the null hypothesis that the variable has unit root. To avoid spurious regression, biased estimates, inefficiency, and misleading interpretation, the variables are log transformed and after testing again for unit root, all show less than .05 p-values. Hence, the null hypothesis is rejected.

Table 4: Correlation Matrix

	Log Investment	Log Consumption	Log Trade	Log Muslim Population
Log Investment	1.0000			
Log Consumption	0.3715	1.0000		
Log Trade	0.0432	0.7474	1.0000	
Log Muslim Population	-0.3534	-0.1183	0.0971	1.0000

The correlation matrix shows that the independent variables are independent of each other with correlation very less than 1. 0.7474 in the case of trade and consumption is acceptable because it is less than 80% (Shrestha, 2020).

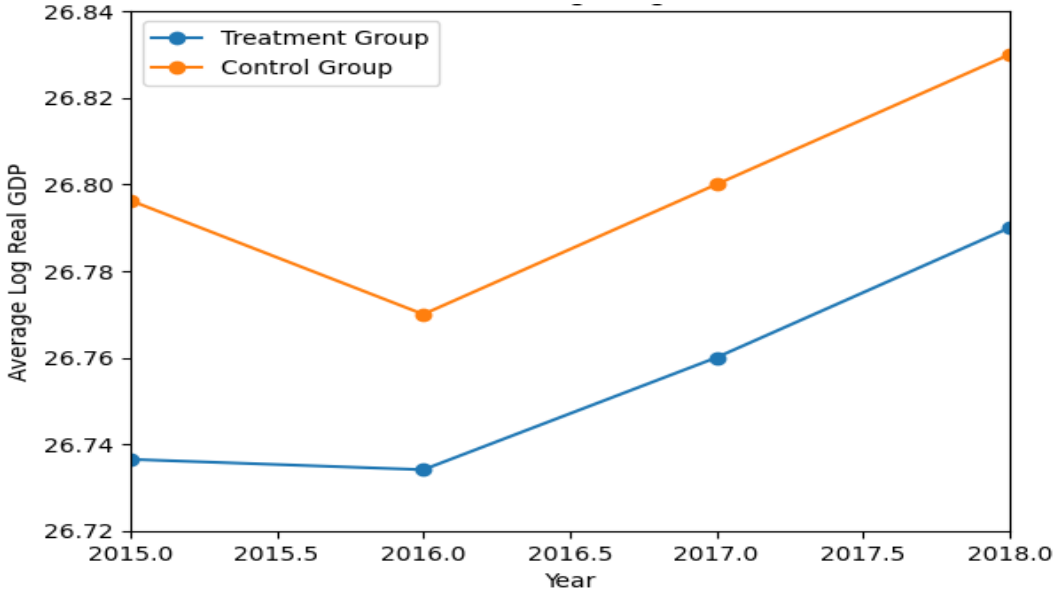


Figure 2: Pre-Treatment Trends in Average Log Real GDP (2015 – 2018)
Source: Authors' computation using World Bank's World Development Indicators

We compare the average log real GDP trends of the treated countries (Indonesia, Pakistan, Bangladesh, Nigeria, and Egypt) and the control group (Norway, Denmark, Finland, Sweden, and Switzerland) over the pre-treatment period. The mean log GDP values evolve in a largely parallel fashion, with both groups exhibiting modest upward growth trends and no visible divergence. The annual average growth rates for both groups in Figure 2 above differ only marginally, and the gap between the groups remains statistically and economically stable across the four pre-treatment years. This preliminary evidence supports the plausibility of the parallel trends assumption.

To formally test for differential pre-treatment trends, we estimate the placebo regression restricted to the pre-treatment period (2015–2018). The results are in Table 5 below.

Table 5: Placebo Regression Results

Variable	Coefficient	Std. Error	p-value
Treated × Time	0.0041	0.0063	0.517
Time Trend	0.0215***	0.0048	0.000
Treated	-0.0387	0.0291	0.191

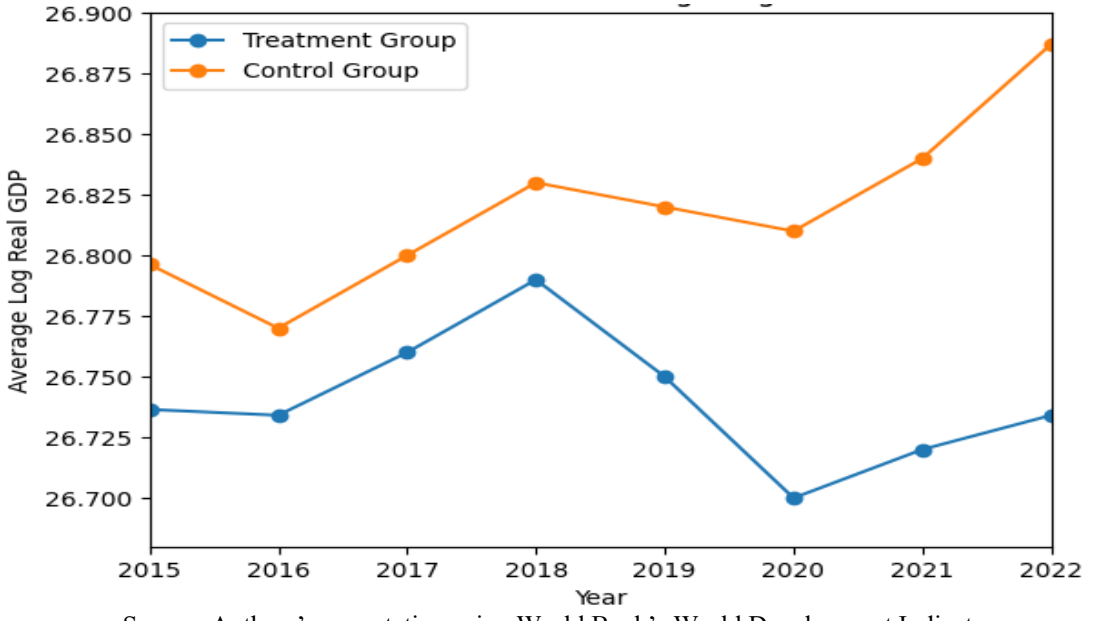
The interaction term between treatment status and time is statistically insignificant (p > 0.10), indicating that there is no evidence of differential pre-treatment trends between the treatment and control groups. In other words, prior to the global volatility shock in 2019, the growth trajectories of both groups evolved in parallel.

Table 6: Summary DID Results

Treatment	After 0	1	Total
0	26.736503	26.796314	26.766408
1	26.734124	26.887064	26.810585
Total	26.70431	26.84162	26.788496

DID (δ_1) = ($\bar{Y}_{1t}$ - $\bar{Y}_{0t}$) – ($\bar{Y}_{1c}$ - $\bar{Y}_{0c}$) = ($\bar{Y}_{1t}$ - $\bar{Y}_{1c}$) – ($\bar{Y}_{0t}$ - $\bar{Y}_{0c}$) from equation (8) in methodology.
DID (δ_1) = (26.734124 – 26.887064) – (26.736503 – 26.796314) = (26.70431 – 26.84162) – (26.766408 - 26.810585) = -0.93111

Though the result does not test statistical significance, it indicates that on average volatility, the treatment reduces economic growth by 0.93111%.



Source: Authors' computation using World Bank's World Development Indicators
Figure 3: Difference-in-Difference Trends in Average Log Real GDP (2015 – 2022)

The full 2015–2022 DID trend in Figure 3 above clearly shows parallel pre-treatment trends (2015–2018), post-2019 divergence, a sharper contraction for the treatment group during global volatility and continued relative resilience in the control group.

Table 7: Results of the DID Regression

Variables	Results Without Covariates	Results With Covariate
Treatment*After	-0.93111**	-0.0537**
	(0.0188)	(0.0243)
Constant	0.6735***	0.0452**
	(0.0981)	(0.0513)
Log Investment		0.2645***
		(0.0177)
Log Consumption		0.7955***
		(0.0276)
Log Trade		0.0087
		(0.0015)
Log Muslim Population		0.0053
		(0.0081)
Observation	80	80
R-squared	0.0206	0.6387
Root MSE	0.043	0.0535
F-stat	32.64	743.92
Prob>F	0.0481	0.0182

Notes: Standard errors in parenthesis, *** p<0.01, ** p<0.05, * p<0.1

The table presents the results of the difference-in-difference regression analysis, which investigates the economic impact of global volatility on countries with the largest Muslim populations. The first column displays the results without covariates, while the second column includes results with covariates. The treatment variable "Treatment*After" captures the interaction effect between the treatment (global economic volatility) and the post-treatment period (2019–2022). The coefficient estimates indicate the change in the dependent variable for the treated units during the post-treatment period compared to the control units.

In the model without covariates, the coefficient for "Treatment*After" is statistically significant at the 5% level (-0.93111**, p = 0.0423), suggesting that the treated units, which are the sampled most populous Muslim nations, experienced a decrease in their real GDP relative to the control units following the onset of global economic volatility. However, after including covariates in the model, the coefficient for "Treatment*After" becomes much smaller and remains statistically significant at the 5% level (-0.0537**, p = 0.0311). This finding suggests that a portion of the effect attributed to global economic volatility in the initial model was actually explained by the included covariates. The negative impact of global economic volatility on the economies of the five countries with the largest Muslim populations is in line with the pioneering work of Ram and Ram (1995). They also observed the negative effect of volatility on growth in Western countries.

The significance of the covariates, investment and consumption, follows the growth theories of Keynes and others that investment and consumption positively affect growth. This finding is also in line with studies on Muslim countries by Naz and Gulzar (2022), Hamdi (2015), and Khalfaoui and Guenichi (2022). Trade and the Muslim population are positive but not significant. Political instability, weak infrastructure and institutions may weaken the impact of trade on the economies of Muslim countries (Malik & Awadallah, 2013). The Muslim population might not significantly affect the economy due to limited access to quality education and jobs (Shawtari, Elsalem, Salem, & Shah, 2023).

Additionally, the inclusion of covariates substantially improves the model fit, as indicated by the increase in R-squared from 0.0206 to 0.6387. The root mean square error (Root MSE) decreases from 0.043 to 0.0535, indicating better model precision with covariates. The F-statistics also increase from 32.64 to 743.92, indicating a significant improvement in overall model fit with the inclusion of covariates.

Beyond statistical significance, the magnitude of the estimated treatment effect is economically meaningful. The DID interaction coefficient of −0.0537 in the log specification implies an approximate 5 percent relative decline in real GDP for the treated countries during the post-2019 global volatility period. Given that the average real GDP of the sampled countries exceeds USD 475 billion, this corresponds to an estimated output shortfall of roughly USD 20–25 billion per country, on average. Such a contraction is comparable in magnitude

to output losses observed during major global crises, including the Global Financial Crisis, where emerging economies experienced growth reductions of between 2 and 6 percent (Kose, Prasad, & Terrones, 2005; Ramey & Ramey, 1995). Therefore, the estimated effect reflects not merely statistical significance but a substantial macroeconomic impact with tangible implications for employment, fiscal stability, and development outcomes in the affected economies.

Overall, these results suggest that global economic volatility does have a significant impact on the economic outcomes of the treated units compared to the control units; this effect is partially explained by differences in log investment, log consumption, log trade, and log Muslim population between the treated and control units.

Conclusion and Recommendation

The study uses a difference-in-difference approach to examine the economic impact of global volatility on countries with the largest Muslim populations, yielding valuable insights into the dynamics of economic vulnerability among these nations. The analysis reveals that the treated units, comprising populous Muslim countries, experienced a significant decline in their real GDP relative to more resilient countries in the control units following periods of global economic volatility. However, the inclusion of covariates in the regression models highlights the importance of considering additional factors such as investment, consumption, trade, and population size, which partially explain the observed effects. Nonetheless, the findings underscore the susceptibility of these countries to external economic shocks and the need for targeted policy interventions to mitigate adverse impacts and promote economic resilience. For Indonesia, diversification beyond commodity exports, reducing oil dependency in Nigeria, and fiscal stabilisation and export upgrading in Pakistan could reduce their susceptibility to external economic shocks. Although the study offers intriguing insights, it is important to acknowledge its limitations. The study is dependent on secondary data sources, which are susceptible to measurement errors, data gaps, or discrepancies. Differences in economic structure, policy environment, and external factors can impact the extent and orientation of the observed impacts in alternative situations.

Acknowledgement

This study received no funding.

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