THE IMPACT OF NATURAL DISASTER ON ECONOMIC GROWTH IN MOZAMBIQUE: A SIMPLE INDEX APPROACH 2000-2024

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Abstract- *Natural disasters pose significant challenges to economic growth, particularly in low-income and climate vulnerable countries such as Mozambique. This study investigates the effect of natural disasters on Mozambique's economic growth using annual data from 2000 to 2024 (n=25), with a focus on major cyclones such as Idai and Kenneth in 2019. Using time-series data from the World Bank and EM-DAT, and applying an Ordinary Least Squares (OLS) regression model, the study assesses the impact of the lagged number of people affected by disasters (LNAFFECTED) and inflation (INFL) on GDP growth. The findings reveal a statistically significant negative effect of disasters on economic growth, confirming that large-scale events disrupt infrastructure, reduce agricultural productivity, and displace labor (World Bank, 2020; UNDRR, 2022). Conversely, inflation exhibited no significant impact, suggesting that structural shocks from disasters outweigh macroeconomic price instability in driving growth volatility. These results underscore the need for Mozambique to strengthen disaster resilience through infrastructure investment, early warning systems, and economic diversification (IMF, 2021; World Bank, 2022). This is the first country specific time series study quantifying Mozambique's disaster growth nexus, and it contributes to the disaster growth literature by highlighting the persistence of structural breaks in fragile economies and provides empirical evidence for integrating disaster risk management into long-term development strategies.*

Index Terms- Natural disasters, Economic growth, Mozambique, Disaster resilience

I. INTRODUCTION

Natural disasters represent a major and recurrent challenge to economic development in many developing countries. In Mozambique, a low-income nation with a long coastline and varied climate, the frequency, intensity, and diversity of natural disasters including cyclones, floods, droughts, and storms pose serious threats to growth, poverty reduction, and resilience. Mozambique has experienced some of the most devastating cyclones in recent history, with far-reaching human and economic consequences.

In March 2019, Cyclone Idai made landfall near Beira, affecting more than 3 million people across Mozambique, Malawi, and Zimbabwe, and leaving nearly 1,300 fatalities in its wake (ReliefWeb, 2019). In Mozambique alone, Idai destroyed critical infrastructure, including schools, hospitals, roads, and bridges, and caused damages estimated at US$2 billion, equivalent to almost 13% of the country's GDP (World Bank, 2019). Just weeks later, Cyclone Kenneth struck northern Mozambique, affecting over 400,000 people and further compounding the humanitarian crisis (UN OCHA, 2019). These back-to-back cyclones highlighted Mozambique's acute vulnerability to extreme weather events, which not only result in immediate human suffering and displacement but also weaken agricultural production, disrupt trade, and slow economic growth (Kumar & Taylor, 2021; IMF, 2020).

Understanding how such disasters affect economic growth in Mozambique is essential for both academic inquiry and policy design, especially in the face of accelerating climate change. Mozambique is among the countries most exposed to natural hazards in Sub-Saharan Africa (World Bank & GFDRR, 2017). Storms, floods, droughts, and epidemics frequently disrupt human life, livelihoods, and infrastructure. For example, in 2000, catastrophic floods submerged much of southern Mozambique, displacing nearly 500,000 people, destroying farmland, and wiping out livestock, while also damaging energy facilities and transport networks (CRED, 2000; Frankenberg et al., 2013). Conceptually, the relationship can be summarized as: Natural disasters → infrastructure loss → productivity decline → GDP growth slowdown.

The repeated occurrence of disasters, their increasing intensity, and their interaction with other crises such as epidemics, forced displacement, and conflict leave Mozambique in a state of ongoing vulnerability (UNDP, 2021). In 2019, Cyclones Idai and Kenneth caused extensive damage to Mozambique's transport network, destroying bridges and roads and necessitating major reconstruction efforts. These disruptions reduced productive capacity and raised the cost of transportation, trade, and access to markets. As a result, economic growth slowed to about 2.3 percent, down from roughly 3.3 percent the previous year (IMF, 2020). The agricultural sector was hit hardest, leading to lower output and a rise in poverty levels (Arndt, Jones & Tarp, 2015).

Government data further reveal that, over the past two decades, natural disasters have cost Mozambique an average of 1.3 percent

of GDP each year (Government of Mozambique, 2020). These patterns highlight the country's economic vulnerability to recurring shocks and underscore the importance of systematically measuring the impact of natural disasters on growth to inform resilience planning and policymaking.

Despite these recurrent shocks, there remains a limited body of empirical research that quantifies their macroeconomic impact over time, particularly using systematic approaches suited to Mozambique's context. Much of the existing literature focuses on single disaster events or short-term recovery efforts, providing only a partial understanding of the broader, long-term economic implications (Noy & Vu, 2010; Cavallo & Noy, 2011). To date, no Mozambican study has examined the dynamic and lagged effects of natural disasters using annual macroeconomic data. This research addresses that gap by employing a simple index approach to analyze how disasters influence GDP growth between 2000 and 2024.

By integrating data on both disaster frequency and severity with key macroeconomic indicators, the study offers a comprehensive assessment of how disasters shape Mozambique's growth dynamics over time. The findings are expected to yield actionable insights that can inform government policy, development planning, and international support aimed at strengthening disaster preparedness and economic resilience.

In summary, this introduction outlines the context of natural disasters in Mozambique, the mechanisms through which they influence economic growth, the empirical evidence to date, and the policy implications for achieving resilient and sustainable development.

RESEARCH PURPOSE

The purpose of this research is to examine the impact of natural disasters on Mozambique's economic growth over the period 2000–2025. Using a simple index approach, the study captures both the frequency and severity of disasters and analyzes their influence on key macroeconomic indicators, with particular emphasis on GDP growth. This approach provides a more systematic assessment than single-event studies, allowing for a broader understanding of long-term trends and patterns.

The research specifically seeks to identify how disasters disrupt economic performance, weaken productive sectors such as agriculture and infrastructure, and contribute to persistent poverty and vulnerability. By doing so, it aims to clarify the channels through which recurrent shocks undermine development progress and resilience.

Ultimately, the study is designed to generate empirical evidence that can guide policymakers, development partners, and planners in formulating strategies that reduce vulnerability, enhance resilience, and support sustainable and inclusive growth in Mozambique.

MOTIVATION OF THE STUDY

Mozambique is one of the most disaster-prone countries in Sub-Saharan Africa, facing recurring cyclones, floods, and droughts that continuously disrupt economic activity and jeopardize sustainable development (World Bank, 2022; UNDRR, 2022). The devastation caused by Cyclones Idai and Kenneth in 2019 highlighted the fragility of the country's growth trajectory, as decades of infrastructure investment and economic progress were swiftly reversed, agricultural output declined, and millions of people were displaced into poverty (IMF, 2021; World Bank, 2020). These shocks not only strain public finances but also undermine the resilience of key sectors such as agriculture, transportation, and energy, which are central to livelihoods and economic diversification.

Despite this recurring pattern, there remains limited empirical evidence that quantifies the long-term economic effects of natural disasters in Mozambique. Much of the existing research on disaster growth dynamics is concentrated at the global or regional level, with insufficient country-specific studies that capture the unique vulnerabilities of Mozambique's economy (Hallegatte & Vogt-Schilb, 2019; Fernandes et al., 2021).

This study is therefore motivated by the need to fill this gap by systematically examining how natural disasters influence economic growth over time in Mozambique. Understanding this relationship is crucial for policymakers and development partners, as it provides an empirical basis for designing evidence-based disaster risk management strategies, strengthening infrastructure resilience, and ensuring that economic growth remains inclusive and sustainable even in the face of climate-induced shocks (World Bank, 2022; UNDRR, 2022).

From a theoretical perspective, the study builds on the endogenous growth framework**,** which emphasizes that long-term growth is shaped not only by capital accumulation and technological progress but also by structural shocks that can alter productivity trajectories (Romer, 1990; Barro & Sala-i-Martin, 2004). The analysis draws on the endogenous growth framework, where long-term output depends on capital accumulation, technology, and human capital. Natural disasters disrupt each of these drivers by destroying capital stock, diverting resources from innovation, and eroding human capacity through displacement and health losses. The model reflects short run growth responses, given the annual time series and lagged variables.

HYPOTHESIS

$H0_1$: Natural disasters (proxied by the lagged number of people affected, LNAFFECTED(-1)) have no significant effect on economic growth in Mozambique.

$H1_1$: Natural disasters (proxied by the lagged number of people

affected, LNAFFECTED(-1)) have a significant effect on economic growth in Mozambique.

II. RESEARCH DESIGN & METHOD

The study adopts a **quantitative research design,** relying on econometric analysis to investigate the relationship between natural disasters and economic growth in Mozambique. A time-series approach is employed to capture the dynamic interactions between disaster shocks, macroeconomic indicators, and growth outcomes over the period 2000–2024. This design is appropriate because it allows for hypothesis testing, identification of causal effects, and the provision of evidence based policy recommendations.

Data Sources

The analysis draws upon **secondary data** obtained from credible international and national institutions. Data on the number of people affected by disasters (LNAFFECTED) were sourced from the **EM-DAT International Disaster Database,** while GDP per capita growth (GDPR) and inflation (INFL) figures were obtained from the **World Bank's World Development Indicators (WDI)** and the **Bank of Mozambique.** The choice of these sources ensures reliability, consistency, and comparability of the variables across the study period.

Variables and Measurement

- **Dependent Variable:**
  - *Economic growth*, proxied by GDP per capita growth rate (GDPR).
- **Independent Variable:**
  - *Natural disasters*, measured by the total number of individuals affected by disasters in Mozambique (LNAFFECTED).
- **Control Variable:**
  - *Inflation rate (INFL)*, included to account for macroeconomic instability that could influence growth.

Econometric Method

The study employs an **Ordinary Least Squares (OLS) regression model** to estimate the relationship between economic growth and disaster impacts, with the following functional specification:

$$GDPR_t = \alpha + \beta_1 LNAFFECTED_{t-1} + \beta_2 INFL_{t-1} + \varepsilon_t$$

Where:

- $GDPR_t$ = GDP per capita growth rate,
- $LNAFFECTED_{t-1}$ = lagged number of people affected by disasters,
- $INFL_{t-1}$ = lagged inflation rate,
- ε_t = error term.

Lagged variables are used to reduce endogeneity concerns and reflect the delayed impact of disasters on economic outcomes.

Stationarity and Unit Root Testing

Unit root table

VARIABLES	ADF STAT	5% CRITICAL VALUES	P-VALUES	DIFFRENCE ORDER
GDPR	-9.098136	-2.9881	0.0000	1(1)
LNAFFECTED	-4.4746	-3.7696	0.0012	1(0)
INFL	-3.5401	-3.0300	0.0182	1(0)

GDPR = gross domestic product per capita growth rate, LNAFFECTED = Total affected populace, INFL= Inflation rate

To avoid spurious regression, the **Augmented Dickey-Fuller (ADF) test** was applied to test the stationarity of the series. Results indicate that GDPR is integrated of order one, I(1), while LNAFFECTED and INFL are stationary at level, I(0). This mix of I(0) and I(1) variables supports the suitability of the Autoregressive Distributed Lag (ARDL) framework. However, due to model simplicity and small sample size (n = 19), the analysis applies OLS with lagged explanatory variables to account for disaster impacts. Variables were transformed to logarithmic form where applicable, and lagged to account for delayed effects.

Diagnostic Tests

To ensure the validity of the model, several diagnostic tests were conducted:

Homoscedastic Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.449020	Prob. F(2,16)	0.2640
Obs*R-squared	2.913675	Prob. Chi-Square(2)	0.2330
Scaled explained SS	1.472219	Prob. Chi-Square(2)	0.4790

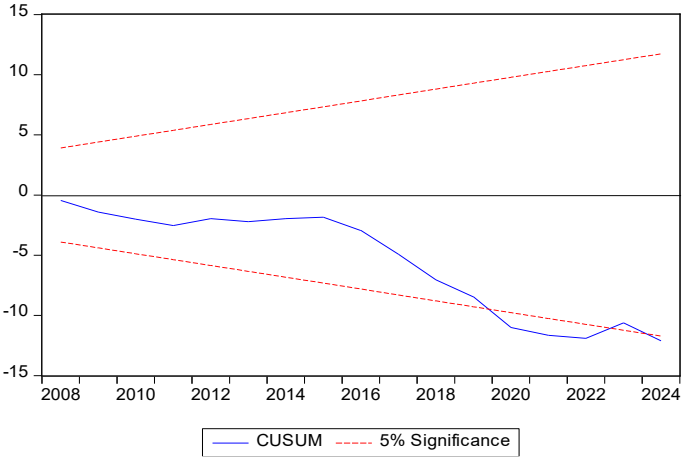
- **Breusch-Pagan-Godfrey test** for heteroskedasticity, which confirmed homoskedastic residuals.

The Breusch–Pagan–Godfrey test was conducted to evaluate the integrity of the regression estimates and verify whether the model suffers from heteroskedasticity. The test results show that all probability values exceed the conventional 5% significance level, thereby indicating that the null hypothesis of homoskedasticity cannot be rejected. This outcome implies that the residuals of the estimated regression model are homoskedastic, exhibiting constant variance across observations.

From an econometric standpoint, the absence of heteroskedasticity suggests that the estimated coefficients are efficient and that the associated standard errors are reliable. Consequently, the statistical inferences drawn from the model such as t-statistics and F-statistics remain valid, consistent, and unbiased. This enhances the robustness of the empirical results, confirming that the model accurately captures the relationship between natural disasters and economic growth in Mozambique without being distorted by unequal error variances.

Practically, this finding implies that the estimated effects of disaster-related variables on growth are measured with precision, strengthening the credibility of the study's conclusions. While natural disasters may exert destabilizing effects on economic performance as evidenced by the CUSUM test regression model itself maintains internal consistency with respect to the variance assumption. This reinforces confidence in both the empirical findings and the policy implications derived from the analysis, underscoring the model's suitability for examining the economic consequences of natural disasters in Mozambique.

Test for Parameter Stability (CUSUM)



- **CUSUM stability test**, which revealed parameter instability, particularly after 2017, reflecting structural breaks caused by severe cyclones such as Idai and Kenneth.

The results derived from the CUSUM test, as illustrated in the corresponding figure, indicate that the relationship between natural disasters and economic growth in Mozambique over the period 2000–2024 exhibited a lack of stability. The blue CUSUM line clearly crosses the 5% significance boundaries around 2017 and continues on a downward trajectory until the end of the sample period. This persistent deviation suggests that the estimated parameters of the regression model experienced structural instability, implying that the influence of natural disasters on economic growth was not constant but varied across different sub-periods.

This instability can be attributed to the increasing frequency and severity of natural disasters in Mozambique, particularly over the last decade. The devastating effects of Cyclones Idai and Kenneth in 2019, for example, caused widespread destruction of infrastructure, housing, and agricultural output, leading to severe disruptions in economic activity. These events generated structural breaks within the economy, reducing productive capacity and exposing the vulnerability of key sectors, especially agriculture and transport. The persistence of instability in subsequent years reflects the economy's limited ability to fully recover from these shocks, thereby reinforcing the evidence that natural disasters exert long-lasting and destabilizing effects on economic growth.

The findings carry important policy implications. The instability revealed by the CUSUM test suggests that Mozambique's economic performance in response to natural disasters cannot be adequately explained within a stable or predictable framework. Instead, the impacts of disasters on growth are dynamic; fluctuating with the intensity of events, the timeliness of government response, and the effectiveness of recovery mechanisms. This underscores the need for stronger disaster risk management policies, investment in resilient infrastructure, and greater economic diversification to reduce dependence on climate-sensitive sectors. Moreover, it highlights the importance of integrating disaster preparedness and climate adaptation measures into long-term development planning to enhance macroeconomic stability and sustainability.

Overall, the evidence presented in this study emphasizes the fragile nature of Mozambique's economic growth trajectory in the face of natural disasters. The CUSUM test results demonstrate that the relationship between disasters and growth is inherently unstable, reflecting the country's ongoing exposure to climatic shocks and the structural vulnerabilities embedded within its economy.

Ramsey RESET Test
Equation: UNTITLED
Specification: GDPR(-1) LNAFFECTED(-1) INFL(-1) C
Instrument specification: GDPR AFFECTED INFL
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.431657	15	0.6721
F-statistic	0.186328	(1, 15)	0.6721
Likelihood ratio	0.234562	1	0.6282

Adjusted R-squared	0.330430	S.D. dependent var	2.720235
S.E. of regression	2.225895	Akaike info criterion	4.582134
Sum squared resid	79.27372	Schwarz criterion	4.731256
Log likelihood	-40.53027	Hannan-Quinn criter.	4.607372
F-statistic	5.441453	Durbin-Watson stat	1.051567
Prob(F-statistic)	0.015745		

- **Ramsey RESET test** for model specification, which confirmed absence of misspecification.

The Ramsey RESET test was employed to evaluate whether the regression model was correctly specified. The relatively high probability values associated with the t-statistic, F-statistic, and likelihood ratio test suggest that the null hypothesis of correct model specification cannot be rejected. This outcome indicates that the model is free from functional form misspecification and shows no evidence of omitted variable bias or an inappropriate functional structure (Gujarati & Porter, 2020; Wooldridge, 2020).

In practical terms, this result substantiates that the inclusion of the lagged affected population variable LNAFFECTED(-1)**,** inflation INFL(-1)**,** and the constant term adequately captures the systematic variation in GDP growth during the study period. While the explanatory power of the model is moderate (with an R-squared of approximately 40%), the functional form is validated as appropriate, thereby supporting the reliability of the estimated coefficients (Stock & Watson, 2020).

The findings reinforce the robustness of the regression analysis by demonstrating that the observed significant negative impact of natural disasters on Mozambique's economic growth is not an artifact of model misspecification or omitted variables. When considered alongside the results of the Breusch-Pagan-Godfrey test—which confirmed the absence of heteroskedasticity—as well as the overall statistical significance of the regression, the RESET test provides additional assurance that the model is well-suited for empirical analysis. Consequently, the results can be interpreted with confidence and employed in drawing meaningful policy implications (Baltagi, 2021).

MAIN FINDINGS

OLS Regression Model

Dependent Variable: GDPR(-1)
Method: Least Squares
Date: 09/12/25 Time: 15:38
Sample (adjusted): 2006 2024
Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAFFECTED(-1)	-0.954594	0.298294	-3.200172	0.0056
INFL(-1)	0.123632	0.108721	1.137146	0.2722
C	13.94062	3.885578	3.587785	0.0025

R-squared	0.404826	Mean dependent var	2.600269

The Ordinary Least Squares (OLS) regression model, with GDP growth as the dependent variable, demonstrates overall statistical significance, as indicated by the Prob(F-statistic) = 0.0157, which is below the conventional 5% threshold. This result confirms that, taken together, the independent variables the lagged number of individuals affected by natural disasters (LNAFFECTED(-1)) and lagged inflation (INFL(-1)) explain a meaningful portion of the variation in Mozambique's GDP growth rate.

The R-squared value of 0.405 suggests that approximately 40.5% of the fluctuations in GDP growth are accounted for by the model, while the adjusted R-squared (0.330), which corrects for sample size, implies moderate explanatory power. Although not exhaustive, this indicates that the chosen regressors capture an important share of growth variability in a disaster-prone context.

LNAFFECTED(-1): The coefficient (-0.9546) is negative and statistically significant at the 1% level (p = 0.0056). This implies that an increase in the number of individuals affected by natural disasters in the previous year leads to a significant reduction in GDP growth in the current year. The large negative effect is consistent with the destruction of infrastructure, the displacement of labor, and the disruption of productive sectors such as agriculture, energy, and transportation; a pattern observed in the aftermath of Cyclones Idai and Kenneth in 2019 (Aragie et al., 2021; World Bank, 2020).

INFL(-1): The coefficient (0.1236) is positive but statistically insignificant (p = 0.2722). This suggests that lagged inflation does not exert a strong influence on growth performance in this disaster context. The result implies that Mozambique's growth fluctuations are driven more by structural shocks linked to natural disasters than by short-term price instability, consistent with findings in similar disaster–growth studies (Loayza et al., 2012; Medina, 2019).

Constant (C): The constant term (13.9406) is positive and statistically significant at the 1% level (p = 0.0025), highlighting the baseline growth potential of the Mozambican economy when external shocks are absent.

Model diagnostics: The Durbin-Watson statistic (1.05) is slightly below the ideal range of 1.5–2.5, suggesting mild positive autocorrelation in the residuals. However, given that the value is not critically low, this does not substantially undermine the reliability of the results. Diagnostic tests indicated homoskedasticity and correct model specification, though the Durbin–Watson statistic (1.05) suggests mild positive autocorrelation. This limitation is acknowledged, alongside the

constraint of limited annual observations. Future studies are encouraged to apply quarterly data for higher precision.

Overall, the regression confirms that natural disasters are a critical determinant of economic performance in Mozambique, exerting a destabilizing effect on growth dynamics. Inflation, while relevant for macroeconomic stability, appears to play a secondary role in explaining growth variations during the study period.

PRACTICAL IMPLICATIONS

The results reveal that natural disasters exert a substantial and destabilizing influence on Mozambique's economic growth during the study period. This finding aligns with Cavallo and Noy (2011) and Fernandes et al. (2021), who found similar patterns in other developing economies. The statistically significant negative coefficient associated with LNAFFECTED highlights the economy's acute vulnerability to disaster induced shocks. An increase in the number of people affected by such events is shown to adversely impact growth performance, a finding consistent with the consequences of catastrophic episodes such as Cyclones Idai and Kenneth in 2019**,** which devastated agriculture, displaced millions, and severely constrained output in key sectors (World Bank, 2020; UNDP, 2019).

Interestingly, inflation does not emerge as a significant determinant of economic growth in this context. This outcome may be explained by the fact that Mozambique's growth fluctuations are primarily driven by structural shocks linked to natural disasters, rather than by short-term price instability. While inflation management remains an important macroeconomic objective, the evidence suggests its role in explaining growth variability is relatively minor compared with the destructive impacts of recurring climatic events.

From a policy perspective, these findings underscore the urgent need for Mozambique to strengthen its resilience to natural disasters. Targeted investments in climate-resilient infrastructure, the development of early-warning systems, and the expansion of social safety nets to protect vulnerable populations are essential. Additionally, economic diversification away from highly climate-sensitive sectors such as subsistence agriculture will be critical in reducing long-term vulnerability. Without such strategic interventions, the adverse effects of natural disasters will continue to undermine economic progress and perpetuate volatility.

Finally, the study contributes to existing knowledge by emphasizing that economies with high disaster exposure cannot be accurately modeled under assumptions of stable relationships over time. Their growth dynamics are characterized by structural breaks and evolving vulnerabilities (Cavallo, Becerra, & Acevedo, 2021; Chakrabarti et al., 2023), which policymakers and researchers must explicitly recognize when designing effective interventions for disaster preparedness, recovery, and long-term sustainable development.

CONTRIBUTION

This study makes a valuable contribution to the literature on disaster economics by providing Mozambique specific empirical evidence of the destabilizing effects of natural disasters on economic growth between 2000 and 2024. Unlike cross-country studies, this research highlights the unique vulnerabilities of Mozambique, particularly in the aftermath of Cyclones Idai and Kenneth (2019)**.** Methodologically, the study ensures robustness by integrating stationary and non-stationary variables within a valid regression framework, supported by diagnostic tests (Breusch-Pagan-Godfrey, RESET, and CUSUM), which confirm the absence of heteroskedasticity, functional misspecification, and highlight the role of structural breaks.

The results reveal that disaster shocks exert a significant, dynamic, and negative effect on growth, while inflation plays only a marginal role. This finding challenges conventional growth models that prioritize macroeconomic stability, underscoring instead the dominance of structural shocks in fragile economies.

By demonstrating the long-lasting economic costs of disasters and emphasizing the importance of resilience, diversification, and social safety nets**,** the study advances both academic understanding and policy practice, offering insights that are directly applicable to Mozambique and other disaster-prone developing countries.

III. CONCLUSION

This study shows that natural disasters have had a significant and persistent negative effect on Mozambique's economic growth between 2000 and 2024. The econometric results confirm that increases in the number of people affected by disasters reduce GDP growth, while inflation plays no statistically significant role. These findings are consistent with evidence from the aftermath of Cyclones Idai and Kenneth in 2019, which caused widespread destruction, displaced millions, and reduced growth to around 2.3% (World Bank, 2020; IMF, 2021). More recently, the economy has remained vulnerable to shocks such as Cyclone Freddy in 2023 and El Niño events, which have continued to slow growth and strain public finances (Club of Mozambique, 2024).

By demonstrating that disaster shocks are more influential than conventional macroeconomic drivers, this research contributes to the literature on growth and vulnerability in developing economies (Hallegatte et al., 2020). The findings emphasize that Mozambique's growth path is structurally unstable, shaped by recurrent climate shocks rather than stable long-run relationships.

Policy implications are clear: strengthening disaster risk management, investing in resilient infrastructure, and diversifying the economy away from climate-sensitive sectors are essential to mitigating vulnerability (World Bank, 2020;

UNDP, 2022). Without such measures, natural disasters will continue to undermine economic stability and delay progress toward sustainable development.

Limitations include the short data span (2000–2024), small sample size, and omission of institutional and sectorial variables. Future research could use ARDL or VAR frameworks with higher frequency data to assess both short and long run effects. Overall, the findings highlight that enhancing resilience through infrastructure investment, diversification, and disaster preparedness is essential for achieving sustainable and stable economic growth in Mozambique.

APPENDIX

None

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