

ROLE OF MILITARY EXPENDITURES TO THE ENVIRONMENTAL DEGRADATION: AN EVIDENCE
FROM HIGH INCOME NATIONS

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Abstract

Growing environmental concerns have intensified the debate over the key drivers of environmental degradation. This study contributes to that discussion by examining the impact of military expenditures (ME) on environmental degradation (ED). To address this objective, annual data for a panel of 38 high-income countries from 2000 to 2021 are utilized. Several diagnostic tests are conducted to evaluate data quality and validate model assumptions. The results support the use of second-generation panel techniques to assess stationarity and the Westerlund cointegration test to confirm the existence of a long-run relationship. Furthermore, the Panel Quantile Regression Model (PQM) is employed to investigate the hypothesized relationship and to capture distributional heterogeneity across different emission levels. The findings reveal a positive and statistically significant relationship between ME and ED across lower, middle, and upper quantiles in high-income economies. Overall, the study contributes to the limited literature on the environmental consequences of military spending and provides important policy insights for aligning national defense priorities with global climate commitments.

Keywords: CO₂ emissions, military expenditure, environmental sustainability, Quantile Regression, High-Income Countries, PQM

INTRODUCTION

Environmental degradation, particularly the escalation of CO₂, has received considerable academic and policy attention in recent decades. Within this broader environmental crisis, militarization has been identified as a significant yet often overlooked contributor to ecological harm. Militarization represents one of the most destructive human endeavors for the environment, given its extensive resource consumption and pollutant emissions (Gould, 2018). Countries often allocate substantial resources to defense systems or large-scale arms purchases, which not only strain natural resources but can also disrupt the balance of power and economic stability between nations (Jane & Ojaghlo, 2024). It is an established truth that geopolitical and regional considerations have a significant influence on the militarization trends of the nations. The study of military expenditure is very beneficial for those countries that have recently gained independence or have close political relations with others (Farzanegan, 2012). The requirement for defense spending rises dramatically when there is an increase in conflict inside the nations' region. Furthermore, when industrialized or central nations invest in military, it has a ripple effect on peripheral nations, who then attempt to rise their own defense spending. In order to share the risk resulting from the countries that have developed breakthrough technology, other developed or center nations also invest in complementary technologies (Martin & Camerone, 2025; Sadiq et al., 2025). Military operations are inherently energy-intensive and often reliant on fossil fuels, contributing significantly to CO₂. Military expenditure damages the environment and cause pollution. Even without war, their daily activities pollute the environment, which is harmful to plants and animals and also disrupts the balance of nature (Smith et al., 2014; York, 2008 ; Jorgenson , 2005; Ali et al., 2022).

It is very important to know about negative impact of military expenditure on environment (Adams et al., 1991; Park, 1993). Despite pledges to achieve net-zero emissions and align with the Paris Agreement and SDG 13 (Climate Action), military activities and their carbon emissions are often exempt from international reporting requirements (Belcher et al., 2019; Crawford et al., 2022). The Paris Agreement promotes economy-wide emission reductions but does not explicitly require the inclusion of military-related emissions in national inventories (Michaelowa et al., 2022). This omission represents a critical research and policy gap, particularly given the scale of defense budgets in high-income countries. Earlier work (Parsons, 1997) and more recent studies (Ali & Rehamn, 2015; Erdogan et al., 2022; Vogler, 2024) have called for greater attention to the environment-military nexus, yet empirical evidence on this relationship remains limited.

Mostly existing research on the military-environment nexus has focused on conflict zones or developing nations, leaving a notable gap in understanding the environmental consequences of defense spending in high-income nations. Michaelowa et al. (2022), and Tan & Lee (2025) argued that an important sector is usually overlooked on all levels of climate policy is military. Michaelowa & Koch (2001) addressed this gap more than two decades ago in a systematic research article, policymakers have turned a blind eye to this question until the present day. GHG emissions from military activities and wars are usually not included in total national GHG inventories. Only a few academic researchers Crawford (2019), Belcher et al. (2019) , Parkinson (2020) and Weir et al. (2021) have raised the issue. Most prior studies focus on single-country or regional analyses, with limited cross-country panel evidence covering high-income economies where the contrast between military spending and environmental commitments is particularly striking (Rizwan & Iqbal, 2025).

This research presents a critical research gap: how do military expenditures influence environmental degradation across different levels of CO₂? First, it provides novel empirical evidence on the simultaneous role of military expenditures in shaping environmental degradation in 38 high-income countries. Second, the collaboration of technological innovation, forest area, economic growth, and renewable energy consumption has not been adequately studied using advanced econometric frameworks. Third, following the studies of Koenker & Bassett (1978), Yu & Moyeed (2001), Perepolkin et al. (2023), the present study employs the novel PQM -robust technique, which captures the heterogeneous effects of explanatory variables across the entire conditional distribution of CO₂ emissions (Bary & Hakim, 2025). Unlike traditional mean-based regressions, this model allows for deeper insights into how policy impacts vary at different emission levels, offering nuanced policy implications for countries aiming to balance economic, security, and environmental priorities. The results reveal a positive and significant relationship between military spending and CO₂, especially in countries at the higher end of the emissions distribution. These findings suggest that military activity may undermine sustainability efforts, even in environmentally advanced economies. These findings imply that militarization may act as a hidden barrier to achieving sustainability goals, even in environmentally aware nations. Moreover, this study aligns with the United Nations' broader sustainability agenda, contributing to SDG 13 (Climate Action) by highlighting an overlooked driver of emissions, and to SDG 17.

STUDY AREA: HIGH INCOME ECONOMIES

The selection of 38 high-income countries is particularly significant for this research due to their dual role as both major contributors to global CO₂ and leaders in financial innovation. These nations allocate considerable budgets to military expenditures, which may counteract environmental efforts through high carbon footprints. Furthermore, high-income countries often possess strong institutional frameworks, advanced technologies, and comprehensive environmental policies making them ideal for examining the complex interactions between military spending, and environmental outcomes.

LITERATURE REVIEW

THEORETICAL LITERATURE

The relationship between military spending and environmental outcomes can be explained through several economic perspectives, including public goods theory (Samuelson, 1954), the crowding-out hypothesis (Ricardo, 1820), and externality theory (Pigou, 1920). From the standpoint of public goods and resource allocation theory, military defense is considered a non-rival, non-excludable public good. Governments with finite fiscal capacity must allocate resources among competing priorities such as defense, health, education, and environmental protection. In many cases, increased military spending diverts public funds away from investments in environmental infrastructure, renewable energy, and regulatory enforcement, potentially exacerbating environmental degradation (Ali, 2015; Ito & Zhang, 2025). This diversion implies an under-provision of environmental public goods, leading to higher CO₂. The crowding-out hypothesis, rooted in both Keynesian and neoclassical economics, also helps explain this linkage. It suggests that excessive government spending in one sector (e.g., military) limits the fiscal space available for other critical areas such as environmental sustainability. High military expenditure can suppress public and private investment in clean energy, innovation, and carbon-reducing technologies. Consequently, the opportunity cost of militarization includes foregone environmental protection efforts, further aggravating CO₂ (Lopez & Peters, 2025).

Moreover, environmental externalities theory, particularly the Pigovian framework (Pigou, 1920), is relevant in this context. Military activities including weapons testing, large-scale training exercises, and fossil fuel-intensive logistics generate significant environmental externalities. These operations often result in high levels of CO₂ and land degradation, yet the environmental costs are not internalized by military institutions. This leads to a misallocation of resources and a failure to account for the social cost of carbon, thereby reinforcing environmental degradation. From a political economy perspective, high levels of defense spending may reflect national priorities that emphasize security over sustainability. In militarized states or during periods of geopolitical tension, governments may weaken environmental regulations or deprioritize environmental governance. This can reduce the effectiveness of environmental institutions and delay progress toward de-carbonization goals.

EMPIRICAL SUPPORT TO STUDY

Husnain & Ali (2023) investigate that how stock market growth, economic development and military expenditure effect on CO₂ in China, Pakistan and India from 1993 to 2017. ARDL method was used in this study and they establish that FDI, military expenditure and economic development enhance the CO₂ but renewable energy decreases them. The stock market development of India and Pakistan had not effected but reduced emissions in China. The study concludes that foreign investment and military expenditure increase the pollution but renewable energy can helpful to decrease pollution. Erdogan et al. (2022) used four developed countries (Spain, Greece, Italy and France) data from 1965 to 2019 to examine the effects of military expenditure on environmental sustainability. The (GVAR) model was used to check the relationship between military expenditure and CO₂. The results of this study explain that the increase in military expenditure damage the environment not only in one country but universally. This research suggests that to control the globally pollution the only one country effort is not enough all countries collaboration is essential. The recommendation of this study for globally environment sustainability is that military expenditure should be reduced for long term. Idroes et al. (2024) define that how in North African countries (Tunisia, Egypt, Morocco, Algeria and Libya) environmental degradation affected by different economic factors. To check these factors, data was taken from 1995 to 2021. To examine the long term special effects (ARDL) model was used and Granger causality test is applied for consequences. This study explores that military expenditure,

economic development, mass production of goods and tourism enhance CO₂ and the eco-friendly energy, global integration and capital accumulation decrease them. The study also recommends on the behalf of results that North Africa should encourage sustainable energy, enhance investment in trained labor and capital. This research also suggests that principles should be clarified that would reduce factors that cause damage to the environment. However, after reviewing the above literature, it is observed that military expenditure (ME) significantly affects environmental degradation (ED). Therefore, the present study tests the following hypothesis, using CO₂ emissions as a proxy for environmental harm:

H1: "There is a positive significant relationship between ME and ED"

CONCEPTUAL MODEL OF THE STUDY

On the bases of empirical evidences, the conceptual model of the study is present in figure 1.

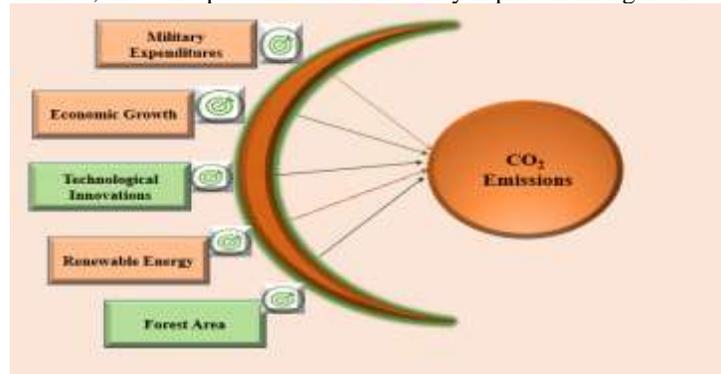


Figure 1: Conceptual Model of the study

ECONOMETRIC METHODOLOGY

DATA SOURCES

To examine the relationship among the variables of interest, this study employs panel data covering the period 2000–2021. Data on CO₂ emissions and key control variables, economic growth (Iqbal et al., 2022; Chen & Yu, 2025), technological innovation ((Hascic & Migotto, 2015), renewable energy consumption (Abbas et al., 2022; Marc et al., 2025), and forest area (Waheed et al., 2018) were obtained from the World Development Indicators (WDI) and the OECD database. These variables are widely recognized as important determinants of environmental quality (Dogan & Seker, 2015; Sulehri et al., 2025). Table 1 provides detailed descriptions of all variables and their respective proxies.

Table 1: Description of variables

Variable	Notation	Form of Variables	Measurement	Data Source
Environmental Degradation		ED	Carbon dioxide Emission	WDI
Military Expenditures		ME	Domestic currency	WDI
Economic Growth		GDP	GDP PER Capita(constant LCU)	WDI
Technological Innovation		TI	Total Patents	OECD
Renewable Energy		RE	(% of total energy consumption)	WDI
Forest Area		FA	Forest Area (% of Land Area)	WDI

MODEL SPECIFICATION/ ECONOMETRIC FORM OF VARIABLES

The quantile regression model is specified as:

$$Q_{\tau}(lnED_{it}|X_{it}) = \beta_{1\tau}lnME_{it} + \beta_{2\tau}lnGDP_{it} + \beta_{3\tau}lnTI_{it} + \beta_{4\tau}lnRE_{it} + \beta_{5\tau}lnFA_{it} \quad (1)$$

In the above model $Q_{\tau}(lnED_{it}|X_{it})$ is the conditional quantile of CO₂, ME is military expenditures, GDP is economic growth, TI technological innovations, RE is renewable energy and FA represents the forest area. *i* and *t* indicate cross sections and time respectively. *ln* of all the variables is taken to smooth the data.

ECONOMETRIC DIAGNOSTIC TESTS AND ESTIMATION TECHNIQUES

Prior to model estimation, several diagnostic procedures were performed to ensure the reliability and robustness of the panel data, including the normality test (Jarque & Bera 1987), multicollinearity test (Shrestha, 2020), outlier detection test, cross-sectional dependence (Pesaran, 2004) test, panel unit root test (Pesaran, 2007), and cointegration test (Westerlund, 2005). Based on the outcomes of these preliminary assessments, the PQR (Koenker & Bassett, Regression Quantiles, 1978) model with a Markov Chain Monte Carlo (MCMC) specification was identified as the most appropriate approach for examining the relationship between environmental degradation and military expenditures. A comprehensive summary of the econometric techniques employed in this study is depicted in Figure 2.

RESULTS AND DISCUSSIONS

Analysis of the current study begins with the descriptive statistics. The statistical summary of the model is presented in table 1. The number of observations ranges from 798 to 836, showing minor variations in data availability. In the dataset, GDP has the greatest mean value (3.53×10^4), followed by FA and CO₂, suggesting their dominance. Significant differences across

countries are seen in the significant standard deviations and the wide differences between the minimum and maximum values. For example, ME varies from 0 to 4.93×10^{14} , whereas CO₂ range from 3.83×10^{11} to 9.95×10^{14} . TI exhibits considerable variability but comparatively mild values. Overall, the findings show significant variation across nations in terms of energy consumption, environmental effect, and economic activity, corroborating the application of sophisticated econometric methods to take these variations into consideration.

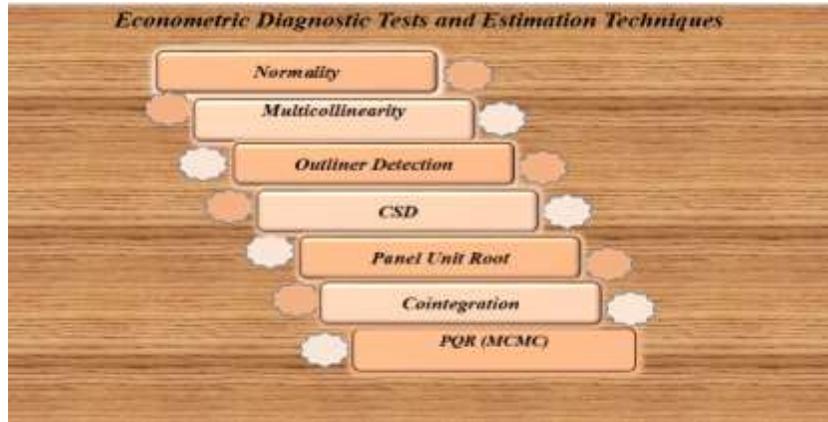


Figure 2: Graphical Illustration of Econometric Diagnostic Tests and Estimation Technique

Consideration of data's normality is critical to obtain desire. Present study, therefore, uses Jarque-Bera test (Jarque & Bera, 1987) to detect the problem of normality. The significant test statistics of Jarque-Bera, reported in Table 2, leads to the rejection of null hypothesis. This implies that the data for the current study suffers from the issue of normality.

Table 1: Descriptive Statistics

Variables	CO ₂	ME	GDP	TI	RE	FA
N	798	814	836	798	824	836
Mean	2.71e+14	2.11e+13	3.53e+14	3222058	2.17e+13	3.36e+14
Median	2.35e+14	1.23e+10	3.33e+14	206268	152.5	3.32e+14
Minimum	3.83e+11	0	2.31e+09	1	0	187
Maximum	9.95e+14	4.93e+14	9.99e+14	4.24e+07	9.89e+14	9.93e+14
Std. Dev.	1.91e+14	7.10e+13	2.42e+14	8140306	1.27e+14	2.13e+14

Table 2: Test of Normality

Variables	Jarque-Bera	P-value	Decision
CO ₂	459.2***	2.e-100	"Data is not normally distributed"
ME	7357***	0.000	"Data is not normally distributed"
GDP	65.23***	0.000	"Data is not normally distributed"
TI	5258***	0.000	"Data is not normally distributed"
RE	5.5e+04***	0.000	"Data is not normally distributed"
FA	33.52***	5.3e-08	"Data is not normally distributed"

The results are further validated using graphical methods, specifically the histogram and kernel density plots. As illustrated in Figure 3, the distributional analysis indicates that all variables except GE deviate from normality, as their distributions are visibly asymmetrical. The Kernel Density Plot, following Silverman (1998), also confirms that the variables are not normally distributed.

Figure 4 appears to show box plots with whiskers for six study variables across 38 high income nations for 22 years, likely from a panel dataset. Most variables show high dispersion with notable outliers, particularly in CO₂, GDP, and ME, indicating significant variation across units. TI and FA are mostly concentrated at lower values, with few extreme cases. RE also shows skewness, suggesting uneven adoption. Overall, the data exhibit heteroskedasticity and potential skewness, highlighting the need for PQR (Koenker, 2005).

The issue of CSD is very common in the panel data, and the results of normality test also signposts. Therefore, the detection of this problem by using an appropriate test is crucial. Present study uses (Pesaran, 2004) test for the detection of CSD. The significant probability values presented in Table 4 indicates the rejection of null hypothesis and confirm the presence of CSD in the data except GDP and FA. The nature of results advocates the use of 2nd generation unit root and cointegration techniques to get the efficient, robust, and consistent findings.

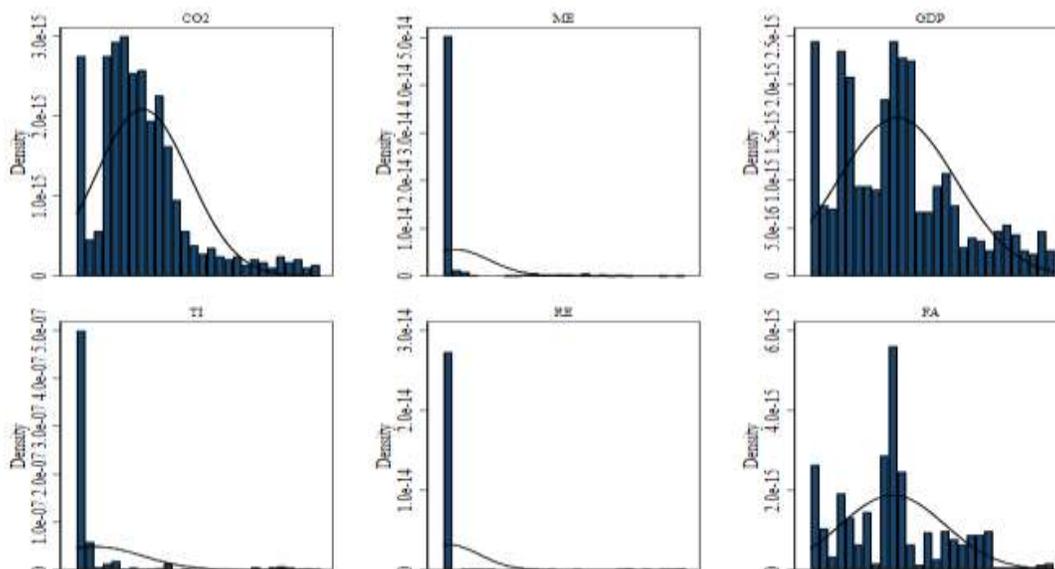


Figure 3: Kernel Density Plot for Variable

Table 3: VIF Test Outcome

Variable	VIF	1/VIF
ME	1.03	0.97
GDP	1.02	0.98
TI	1.04	0.96
RE	1.01	0.99
FA	1.03	0.97
Mean VIF	1.02	

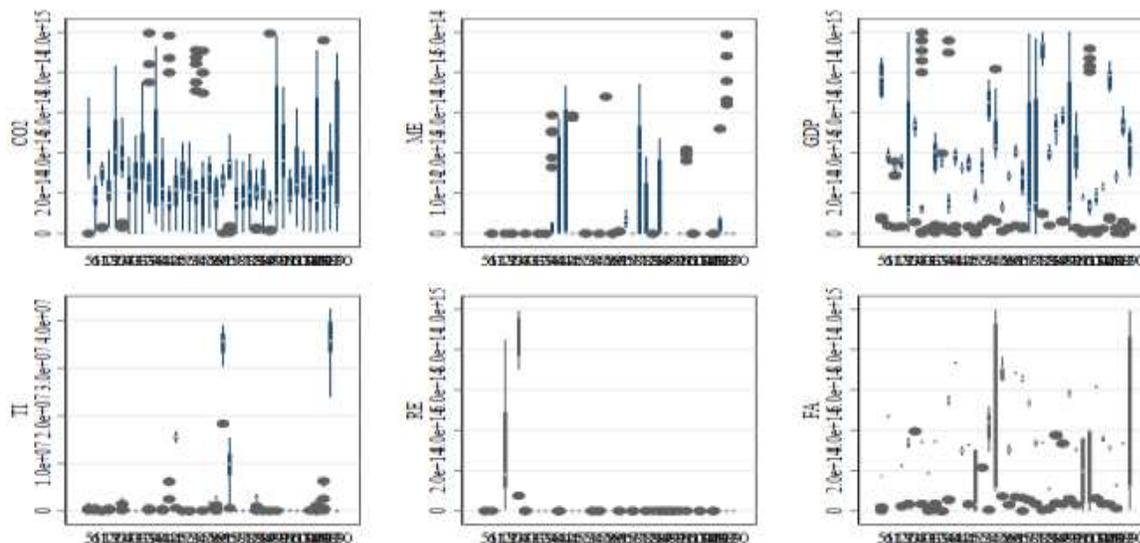


Figure 4: Boxplots for Detecting Outlier

Table 4: Outcomes of CSD Test

Variables	Statistics	p-value	Decision
CO ₂	19.475***	0.000	"CSD is present"
ME	22.293***	0.000	"CSD is present"
GDP	0.216	0.829	"CSD is not present"
TI	12.885***	0.000	"CSD is present"
RE	22.722***	0.000	"CSD is present"
FA	0.379	0.704	"CSD is not present"

Table 5 presents the results of unit root tests for study variables. The tests are conducted both at level and first difference, with and without a trend. According to the results, CO₂, GDP, and TI are stationary at level, as the test statistics are significant in both the cases with and without a trend. This means these three variables are integrated of order zero, or I(0), and do not require differencing to achieve stationarity. On the other hand, ME, RE, and FA are non-stationary at level but become stationary after first differencing, suggesting they are integrated of order one, or I(1).

Westerlund (2005) cointegration test is used to adjust for CSD in panel data. When the assumption of independence between units is violated, this feature makes sure that the results are still reliable. Cointegration results presented in Table 6 shows that variables have long run relationship.

The quantile regression results reveal a consistently positive and statistically significant relationship between military expenditures (ME) and CO₂ across lower, middle, upper (25th, 50th, 75th) quantiles. This suggests that military expenditures significantly contribute to higher CO₂ emissions in high-income nations. Control variables behave largely as expected: Economic growth (GDP) showed a mixed effect. At lower quantile, GDP is positively associated with emissions but decrease emissions at middle and higher quantiles, possibly due to improved energy efficiency or cleaner technologies adopted in advanced stages of growth consistent with the Environmental Kuznets Curve hypothesis (Grossman & Krueger, 1995). Technological innovation shows a negative effect at all quantiles, suggesting that advanced technologies may support cleaner environment through reduction in CO₂. Renewable energy consumption is significantly associated with reduction in emissions at lower quantiles, but increase emission at higher quantiles. This implies that using renewable energy is still linked to higher CO₂ in economies with higher emissions. It could be because of transitional inefficiencies, partial fossil fuel replacement, or rising energy demand that cancels out the benefits of renewable energy. Forest area also exhibits insignificant relationship with CO₂ at lower quantile but at middle and higher quantiles reduce the emissions, highlighting the role of afforestation in climate mitigation. These results indicate that while technological innovations and forest area adoption are beneficial but their positive effects may be offset by increasing militarization, especially in countries with large defense budgets.

Table 5: Unit-Root Test

Variables	Level		First-Difference		Order of integration
	Without trend	With trend	Without trend	With trend	
CO ₂	-2.357***	-4.156***	-3.377***	-3.997***	I(0)
ME	-0.695	-2.262***	-1.651	-2.884***	I(1)
GDP	-2.955***	-4.495***	-3.107***	-4.441***	I(0)
TI	-2.878***	-4.270***	-3.081***	-4.230***	I(0)
RE	3.198	-11.243	-1.169	-9.075	I(1)
FA	-2.390	-3.541***	-2.359	-3.729***	I(1)

Where “***” represents the level of significance at the level of 1%”

Table 6: Cointegration Test Westerlund (2005)

Variance ratio	P-values
Statistics	2.519*** 0.006

Table 7: Outcomes of PQM

Quantile	Quantile 25 %	Quantile 50 %	Quantile 75 %
lnME _{it}	0.0180***	0.008***	0.008***
lnGDP _{it}	0.007*	-0.016***	-0.0163***
lnTI _{it}	-0.012***	-0.004***	-0.003**
lnRE _{it}	-0.005	0.009***	0.009***
lnFR _{it}	0.007	-0.134***	-0.014***

DISCUSSION AND CONCLUSION

This study provides empirical evidence that military expenditures have a significant and positive impact on CO₂ emissions in high-income countries, particularly at higher levels of emission intensity. Using a PQM approach with MCMC estimation over the 2000-2021 period, the findings underscore the environmental cost of militarization that is an area often overlooked in environmental sustainability discussions. The inclusion of key control variables like economic growth, technological innovation, renewable energy, and forest area confirms that while progress in these areas can mitigate emissions, the adverse effects of military spending may counteract such gains. The results suggest a pressing need to integrate defense policy within the broader framework of sustainable development and environmental governance. This research fills a critical gap in the literature by focusing on military spending in developed countries, offering a fresh perspective on the military-environment nexus. The findings of this study hold particular significance for global governance under the United nations SDGs, especially SDG 13 and SDG 17, which underscores the need for strong partnerships and coordinated policy frameworks to tackle global challenges such as climate change. The exclusion of military emissions from international agreements undermines collective progress on SDG 13 and limits the effectiveness of global carbon accounting. As such, integrating military sectors into climate governance frameworks, through international cooperation and transparent reporting, is imperative.

REFERENCES

- Abbas, S. J., Hussain, M. M., Salman, M., Shahid, S., & Iqbal, A. (2022). Economic Growth, Energy Consumption and Environment Relationship: A Panel Data Analysis of South Asian Countries. *Journal of Policy Research*, 8(4), 143-151.
- Adams, F. G., Behrman, J. R., & Boldin, M. (1991). Government Expenditures, Defense, and Economic Growth in the Ldcs: A Revised Perspective. *Conflict Management and Peace Science*, 11(2), 19–35.
- Ahmad, N., Iqbal, A., & Mahmood, H. (2013). CO Emission, Population and Industrial Growth Linkages 2 in Selected South Asian Countries: A Co-Integration Analysis. *World Applied Sciences Journal*, 21(4), 615-622.
- Ali, A. (2015). *The impact of macroeconomic instability on social progress: an empirical analysis of Pakistan* (Doctoral dissertation, National College of Business Administration & Economics Lahore).
- Ali, A., & Rehman, H. U. (2015). Macroeconomic instability and its impact on gross domestic product: an empirical analysis of Pakistan. *Pakistan Economic and Social Review*, 285-316.
- Ali, A., Audi, M., Senturk, I., & Roussel, Y. (2022). Do sectoral growth promote CO2 emissions in Pakistan? time series analysis in presence of structural break. *International Journal of Energy Economics and Policy*, 12(2), 410-425.
- Bary, E., & Hakim, I. (2025). Pollution Haven or Pollution Halo? Green Investment and Environmental Outcomes in Asia. *Journal of Energy and Environmental Policy Options*, 8(3), 51-62.
- Belcher, O., Bigger, P., Neimark, B., & Kennelly, C. (2019). *Hidden Carbon Costs of the “Everywhere War”: Logistics, Geopolitical Ecology, and the Carbon Boot-Print of the US Military*.
- Chen, M. T., & Yu, F. (2025). Dissecting Global Oil Shocks: Implications for Taiwan’s Output, Inflation, and External Sector. *Journal of Energy and Environmental Policy Options*, 8(2), 50-59.
- Crawford, N. (2019). *Pentagon Fuel Use, Climate Change, and the Costs of War*. Boston University.
- Crawford, N. (2022). *The Pentagon, Climate Change and War*.
- Dogan, E., & Seker, F. (2015). An Investigation on the Determinants of Carbon Emissions for OECD Countries: Empirical Evidence from Panel Models Robust to Heterogeneity and Cross-Sectional Dependence. *Environmental Science and Pollution Research*.
- Erdogan, S., Gedikli, A., Cevik, E. I., & Oncu, M. A. (2022). Does Military Expenditure Impact Environmental Sustainability in Developed Mediterranean Countries? *Environmental Science and Pollution Research*, 29, 31612–31630.
- Farzanegan, M. R. (2012). Military Spending and Economic Growth: The Case of Iran. *Defence and Peace Economics*, 25(3), 247–269.
- Gould, K. (2018). The Old Militarized Humanitarianism: Contradictions of Counterinsurgent Infrastructure in Cold War Guatemala. *Critical Military Studies*.
- Grossman, G. M., & Krueger, A. B. (1995). Economic Growth and the Environment. *The Quarterly Journal of Economics*, 110(2), 353-377.
- Hascic, I., & Migotto, M. (2015). Measuring environmental. OECD Environment Working Papers No. 89, OECD Publishing Paris.
- Husnain, M., & Ali, W. (2023). Nexus among Militarization, Economic Development, FDI, Stock Market Development and Renewable Energy Usage and CO2 Emissions. *Pakistan Journal of Commerce and Social Sciences*, 17(3), 646-676.
- Idroes, G. M., Rahman, H., Uddin, I., Hardi, I., & Falcone, P. M. (2024). Towards Sustainable Environment in North African Countries: The Role of Military Expenditure, Renewable Energy, Tourism, Manufacture, and Globalization on Environmental Degradation. *Journal of Environmental Management*, 368.
- Iqbal, A., Hassan, S., Mahmood, H., & Tanveer, M. (2022). Gender Equality, Education, Economic Growth and Religious Tensions Nexus in Developing Countries: A Spatial Analysis Approach. *Heliyon*, 8(11).
- Ito, Y., & Zhang, R. (2025). Examining Economic and Technological Drivers of Carbon Dioxide Emissions in Developing Countries: A Policy Perspective. *Journal of Energy and Environmental Policy Options*, 8(2), 1-12.
- Jane, M., & Ojaghlu, M. (2024). Defence Spending, Economic Growth and Regional Balance: Evidence from Azerbaijan and Armenia. *Bulletin of Economic Theory and Analysis*, 9(2), 397-426.
- Jarque, C. M., & Bera, A. K. (1987). A Test for Normality of Observations and Regression Residuals. *International Statistical Review*, 55(2), 163-172.
- Jorgenson, A. K. (2005). Unpacking International Power and the Ecological Footprints of Nations: A Quantitative Cross-National Study. *Sociological Perspectives*, 48(3).
- Koenker, R. (2005). *Quantile Regression*. Cambridge University Pres.
- Koenker, R., & Bassett, G. (1978). Regression Quantiles. *Econometrica*, 46(1), 33-50.
- Lopez, B., & Peters, M. (2025). Ecological Governance and Organisational Resilience: A Structural Model of Environmental Risk in Pandemic Conditions. *Journal of Energy and Environmental Policy Options*, 8(2), 26-36.
- Marc, A. (2025). Bridging Equity and Ecology: The Impact of Income Inequality on Green Growth Dynamics. *Journal of Energy and Environmental Policy Options*, 8(2), 60-71.
- Marc, A., Poulin, M., Ahmad, K., & Ali, A. (2025). Modeling disaggregate globalization to carbon emissions in BRICS: A panel quantile regression analysis. *Sustainability*, 17(6), 2638.

Martin, P., & Cameron, G. (2025). Green Economic Growth and Environmental Governance: A Panel Analysis of G-20 Countries. *Journal of Energy and Environmental Policy Options*, 8(3), 17-27.

Mehmood, S., & Kaewsang-on, R. (2024). Quantile Lens on Carbon Footprints: Renewable Energy, Tourism, Financial Development, and the Pursuit of Sustainable Development Goals 2030. *European Journal of Tourism Research*, 38.

Michaelowa, A., & Koch, T. (2001). Military Emissions, Armed Conflicts, Border Changes and the Kyoto Protocol. *Climatic Change*, 50(4), 383-394.

Michaelowa, A., Koch, T., Charro, D., & Gameros, C. (2022). *Military and Conflict-Related Emissions: Kyoto to Glasgow and Beyond*. Perspective Climate Group.

Park, K. Y. (1993). 'Pouring New Wine into Fresh Wineskins': Defense Spending and Economic Growth in LDCs with Application to South Korea. *Journal of Peace Research*, 30(1), 79-93.

Parkinson, S. (2020). The Environmental Impacts of the UK Military Sector, Scientists for Global Responsibility (SGR). Lancaster.

Parsons, R. J. (1997). The Fight to Save the Planet: US Armed Forces, Greenkeeping, and Enforcement of the Law Pertaining to Environmental Protection During Armed Conflict. *Geo. Int'l Env'tl. L. Rev.*, 10(441).

Perepolkin, D., Goodrich, B., & Sahlin, U. (2023). The Tenets of Quantile-Based Inference in Bayesian Models. *Computational Statistics and Data Analysis*.

Pesaran, M. (2007). A Simple Panel Unit Root Test in the Presence of Cross-Section Dependence. *Journal of Applied Economics*, 22(2), 265-312.

Pesaran, M. H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *Journal of Econometrics*, 69(7).

Pigou, A. C. (1920). *The Economics of Welfare*. London: Macmillan.

Qayyum, U., & Anjum, S. (2021). Armed Conflict, Militarization and Ecological Footprint: Empirical Evidence from South Asia. *Journal of Cleaner Production*.

Ricardo, D. (1820). *Essay on the Funding System*.

Rizwan, M., & Iqbal, W. (2025). Decarbonization Pathways in Developing Economies: Digitalization, Finance, and Renewable Energy in Pakistan. *Journal of Energy and Environmental Policy Options*, 8(3), 38-50.

Sadiq, K., Ali, A., Usman, M., & Sulehri, F. A. (2025). Nexus among Ecological Footprint, Green Finance and Renewable Energy Consumption: A Global Perspective. *Annual Methodological Archive Research Review*, 3(3), 101-127.

Samuelson, P. A. (1954). The Pure Theory of Public Expenditure. *The Review of Economics and Statistics*, 36(4), 87-389.

Shrestha, N. (2020). Detecting Multicollinearity in Regression Analysis. *American Journal of Applied Mathematics and Statistics*, 8(2), 39-42.

Silverman, B. W. (1998). *Density Estimation for Statistics and Data Analysis*.

Smith, C. L., Hooks, G., & Lengefeld, M. (2014). The War on Drugs in Colombia: The Environment, the Treadmill of Destruction and Risk-Transfer Militarism. *Journal of World-Systems Research*, 185-206.

Sulehri, F. A., Ali, A., & Alam, M. (2024). Assessing the Pathways of Sustainable Development: A Structural Equation Modeling Investigation of Regulatory Framework, Innovation and Economic Indicators. *Journal of Asian Development Studies*, 13(1), 970-984.

Tan, C., & Lee, E. (2025). Financial Development, Energy Consumption, and Environmental Quality: Testing the EKC Hypothesis in ASEAN Countries. *Journal of Energy and Environmental Policy Options*, 8(3), 28-37.

Vogler, A. (2024). On (In-) Secure Grounds: How Military Forces Interact With Global Environmental Change. *Journal of Global Security Studies*, 9(1).

Waheed, R., Chang, D., Sarwar, S., & Chen, W. (2018). Forest, Agriculture, Renewable Energy, and CO2 Emission. *Journal of Cleaner Production*, 172, 4231-4238.

Weir, D., Neimark, B., & Belcher, O. (2021). How the World's Militaries Hide their Huge Carbon Emissions. The Conversation.

Westerlund, J. (2005). New Simple Tests for Panel Cointegration. *Econometric Reviews*, 24(3).

York, R. (2008). DeCarbonization in Former Soviet Republics, 1992-2000: The Ecological Consequences of De-Modernization. *Social Problems*, 55(3), 370-390.

Yu, K., & Moyeed, R. (2001). Bayesian Quantile Regression. *Statistics & Probability Letters*, 54(4), 437-447.

Appendix A

Australia	Cyprus	Greece	Korea, Rep	Panama	United Kingdom
Austria	Czechia	Hungary	Latvia	Poland	United States
Barbados	Denmark	Iceland	Lithuania	Portugal	Uruguay
Belgium	Estonia	Ireland	Luxembourg	Slovak Republic	
Bulgaria	Finland	Israel	Netherlands	Slovenia	
Canada	France	Italy	New Zealand	Spain	
Croatia	Germany	Japan	Norway	Switzerland	