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Nexus among Militarization, Economic Development, FDI, Stock Market Development and Renewable Energy Usage and CO2 Emissions

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Abstract

CO2 significantly contributes to greenhouse gas (GHG) emissions. This investigation determines the impact of militarization, economic growth (EG), FDI, renewable energy usage on CO2 emissions in three highly militarized countries of Asia: Pakistan, India, and China (PIC). This research used strata software and employed an ARDL approach to test the hypothesized relationships by using data from sampled countries for the years ranging from 1993 to 2017. The results revealed that military expenditures, EG, and FDI positively impact CO2 emissions, whereas renewable energy sources reduce CO2. The results provide some useful insights for regulators and policymakers to control environmental pollution in PIC countries. Further, this research sets guidelines for future research.

Keywords: CO2 emissions, economic growth, stock market development, foreign direct investment (FDI), military expenditure.

1. Introduction

CO2 significantly contributes to greenhouse gas (GHG) emissions and their intensity has considerably increased over time. In 2016, the average concentration of CO2 was 403 ppm, which is 40% greater than the typical concentration of the mid-1800s (Ahmed et al., 2022). Human actions, especially energy use contribute to two-thirds of GHG emissions and 80% of CO2 emissions (IEA 2017). The significant increase in GHG emissions is resulting in global warming and climate disruption, threatening humankind, and the biosphere (Pachauri et al. 2014). Global climate risk index 2016 reported that the world had witnessed over 15,000 disastrous weather incidents in the middle of 1995 and 2014, resulting in the deaths of over 525,000 humans and loss of $2.97 trillion of wealth (Kreft et al. 2016).

These issues attracted the sizable attention of scholars investigating factors contributing to climate change (Ahmed et al., 2022; Zhang & Zhou, 2016; Jorgenson et al., 2023; Chang et al., 2023).

The extant literature investigating factors contributing to CO2 emissions, includes EG (Lin & Raza, 2019; Khan et al., 2019, Hassan et al., 2019), FDI (Bakhsh et al., 2017; Apergis & Ozturk, 2015), industrial development (Usman et al., 2020; Shahzad et al., 2017), and the urbanization (Shaheen et al., 2020; Ali et al. 2019). Aspects of tourism (Sharif et al., 2017), inflation (Hussain et al., 2019), income inequality (Khan, 2019), and agriculture activities (Gokmenoglu & Taspinar, 2018) also appear to contribute to CO2 emissions. However, with a few exceptions (see Ahmed et al., 2022; Solarin et al., 2018; Bildirici, 2017a; Bildirici, 2017b), the role of militarization has rarely been investigated. Militarization is a highly environmentally destructive human endeavor (Ahmed et al., 2022). Wars have long contributed to environmental degradation, including the demolition of plants and animals, the digression of rivers, and the scorched-earth practices. Further, nuclear bombs and weapons testing resulted in radioactive fallout spread over the earth through water, wind, and homo sapiens (Jorgenson et al., 2012). Militarization's environmental impacts are not limited to wars and testing of nuclear weapons instead caused by the creation of large-scale social infrastructure, the developments of military technologies, the experimentation of weapons and equipment, and the transportation of soldiers, equipment, and weapons to distinct locations (Jorgenson & Clark, 2012).

Countries around the globe are spending a major portion of their budget on defense-related activities to overcome their internal and external security threats. It has been reported in 2019 that global militarization spending has reached $1917 billion, accounting for 2.2 percent of the worldwide GDP (SIPRI, 2020). The deep-seated changes in military expenditures worldwide have become a solid reason for the increase in CO2 emissions. Previous research investigating the link between militarization and CO2 emissions targeted the OECD countries, US, and G7 countries and ignored the context of highly militarized countries of Asia. This research is targeted to investigate the link between militarization and CO2 emissions in Pakistan, India, and China, along with other factors of EG, FDI, SMD, and renewable energy usage, considered crucial in contributing to CO2 emissions.

This research brings contribution to the extant literature on the following grounds. It extends the current debate on the link between militarization and CO2 emissions in emerging markets (Saint-Akadiri et al., 2019; Bildirici, 2017a). We found global research on the relationship between military expenditures and CO2 emissions, but none for neighboring PIC countries, i.e., Pakistan, India, and China. It is the first study on PIC to explain how changes in military spending affect CO2 emissions. There are multiple grounds to conduct the study in the context of Pakistan, India, and China. Firstly, these countries are highly militarized, and disputes exist between them. Since the inception of Pakistan, India has been in constant conflict with Pakistan over Kashmir, and they have fought at least three major wars up till now. Similarly, a dispute over the Sino-Indian border exists between India and China, and they had a war in 1967. The conflict between these neighboring countries is perhaps the most significant reason for maintaining and building the region's most prominent military equipment and installations. Secondly, these countries are spending a considerable portion of their budget on military facilities and equipment. According to SIPRI (2020), Pakistan spent 4.03%, India spent 2.7%, and China spent 1.9% of its GDP in 2019 on militarization. China, India, and Pakistan appeared to be the second, third, and nineteenth big spenders of the defense budget in the world in 2019 (SIPRI, 2020). Finally, two countries included in the study appeared to be among the most significant contributors to greenhouse gases. CO2 is the primary source of greenhouse gases (GHGs). China releases 21.6% of CO2, and India releases 17% of CO2 globally, while Pakistan releases less than one percent of CO2 of the world (World Bank, 2017).

This remainder research is structured as. The following two sections discuss the literature review and development of hypotheses. The methodology of this research is discussed in section 4. The outcomes of the data analysis are presented in the fifth part. The research findings, limitations, and future research ideas are presented in the concluding part.

2. Snapshot of Extant Literature

Table 1 contains the summary of factors contributing to environmental degradation. The empirical studies examining the determinants of CO2 emissions focused on developed countries and to a lesser extent on emerging markets. Further, these studies have highlighted different factors contributing to environmental degradation. Trade openness, globalization, growth, and energy usage are the widely investigated elements. Extant literature has shown that EG positively influences environmental degradation (You & Lv, 2018; Bildirici, 2017b; Sohag et al., 2019; Shahbaz et al., 2013; Jorgenson & Givens, 2014). Contrary to EG, globalization shows a differential impact on CO2 emissions, since some studies presented a positive impact of globalization on environmental degradation (Saint-Akadiri et al., 2019), while others have documented the negative relationship between globalization and environmental degradation (Shahbaz et al., 2019; Haseeb et al., 2018).

In addition to the above, trade openness also showed a differential impact on ecological quality because some studies show that trade openness increases environmental degradation (Kumar & Managi, 2009; Le et al., 2016), while others show that it improves the condition of the environment (Li et al., 2015; Zhang et al., 2017). Consistent with EG, energy consumption contributes to CO2 emissions (Shahbaz et al., 2013; Saint-Akadiri et al., 2019; Nasreen et al., 2017). Additionally, numerous other factors such as tourism growth, technological innovation, corruption, democracy, financial stability, and urbanization contribute to CO2 emissions. The extant literature has revealed that variables of EG (Shahbaz et al., 2013; Jorgenson & Givens, 2014; Nasreen et al., 2017), SMD (Tamazian &Rao, 2010; Abbasi & Riaz, 2016), FDI (Tang &Tan, 2015; Chandran & Tang, 2013; Paramati et al., 2016), and renewable energy usage (Shahbaz et al., 2013; Saint-

Akadiri et al., 2019; Nasreen et al., 2017) appear to contribute to environmental degradation. Despite numerous factors contributing to climate change, very limited studies have investigated the role of militarization in contributing to climate change (see Ahmed et al., 2022; Solarin et al., 2018; Bildirici, 2017a; Bildirici, 2017b). Those studies targeted OECD, US, and G7 countries and ignored the context of highly militarized countries of Asia, which is an important research setting.

Table 1: Literature Review on Determinants of Environmental Degradation

Author	Variables	Country	Time Period	Results
You and Lv (2018)	EG, CO2	83 Countries	1985-2013	U-shaped link between GDP and CO2
Saint-Akadiri et al. (2019)	Tourism growth, real income, globalization, EC, Carbon Emissions	15 Countries	1995-2014	Tourism growth (-), real income (-), globalization (+), EC (+) Globalization-tourism-induced EKC-hypothesis exists through EC, globalization, real income
Jorgenson & Givens (2014)	GDP per capita, CO2 emissions	191 countries	1997-2012	Per capita GDP and CO2 **(+)**
Bildirici(2017a)	Military expenditure, CO2 emissions	US	1960-2013	Military expenditure and CO2 (+)
Bildirici (2017b)	Military expenditure, EC, CO2 emissions	G 7 Countries	1985-2015	Military spending and CO2 (+) EC and CO2 (+)
Sohag et al. (2019)	Cleaner energy, technological innovation, Military expenditure, EG	Turkey	1980-2017	Cleaner energy & EG(+), Technological innovation & EG(+) Military spending & EG(-)
Zandi et al. (2019)	Corruption, democracy, and militarism on CO2 emissions	ASEAN Countries	1995-2017	Corruption & CO2 (+), Military spending & CO2 (+), Democracy and CO2 (-)
Usman et al. (2020)	Militarization on EG and environmental degradation	Pakistan and India	1985-2018	Militarization and economic development (+), militarization and carbon emissions (-)
Doytch and Uctum (2016)	FDI and environmental degradation		1984-2011	FDI in the manufacturing sector increases pollution while in services sector benefits the environment. FDI in low-and middle-income nations negatively hurt the environment,

				while in high-income nations contribute to the environment quality
Li et al. (2015)	CO2 and air quality	134 countries	1961-2004	CO2 and air quality (-)
Shahbaz et al. (2019)	Globalization and CO2 emissions	87 countries	1970-2012	Contrary to middle-and-high income countries, globalization is positively contributing to low-income status countries' ecological degradation.
Kumar & Managi (2009)	Trade-openness and CO2	76 countries	1963-2000	Trade openness & CO2 (+)
Zhang et al. (2017)	Trade openness and Co2 emissions	Ten countries	-	Trade openness & CO2 (-), GDP & CO2 (+), Energy & CO2 (+)
Le et al. (2016)	Trade openness and environmental quality	88 countries	-	Trade openness contributes to environment quality in rich nations, while hurting the quality in low-income nations
Shahbaz et al. (2013)	EG, EC, FD, TO, and CO2 emissions	Indonesia	1975-2011	EG and CO2 (+), EC and CO2 (+), FD and CO2 (-), TO and CO2 (-)
Nasreen et al. (2017)	Financial stability, EC, EG, and CO2 emissions	South-Asia	1980-2012	Financial stability and CO2 (-) EC and EG increases CO2
Haseeb et al. (2018)	EC, FD, globalization, EG, urbanization, and CO2	BRICS economies	1995-2014	CO2 are impacted by EC and FD, whereas globalization and urbanization negatively impact CO2.
EG: Economic Growth, EC: Energy Consumption, TO: Trade Openness, FD: Financial Development				

3. Development of Hypothesis

3.1 Militarization and CO2 Emissions

The Hooks and Smith (2004, 2005) were the first to use a theory of the "Treadmill of Destruction" to explain the link between militarism and its environmental consequences. According to theorists, militarization compromises environmental considerations even in war and peacetime (Ahmed et al., 2022). It claims militarism is not a byproduct of the capitalist system and its dynamics have far-reaching environmental consequences (Hooks & Smith, 2004). Militarization is widely regarded as humanity's most harmful activity (Gould, 2007). Due to perceived and actual regional threats, countries heavily invest in their military developments. Over time, the race to acquire the latest weapons and warfare technology has substantially increased to gain regional supremacy. Militaries are now using many resources to design, develop, and test planes, boats, equipment, and weapons to accomplish the agenda of regional supremacy (Clark et al., 2010). The development of new equipment and technologies requires substantial resources, including fuel, to meet military needs (Shaw, 1988). Warfare generates massive ecological damage. The use of lethal weapons, which release a wide variety of toxins and chemicals into ecosystems, the destruction of landscapes, and the consumption of vast quantities of fossil fuels during military operations all contribute significantly to environmental destruction (Clark et al., 2010). Military activities and related technologies utilize a significant quantity of non-renewable energy (Roberts & Wiedmann, 2003) that cause enormous carbon emissions (Clark et al., 2010). Militaries generate not only a massive quantity of carbon emissions but also toxic waste. With military spending, environmental degradation increases, and the population's available biological capacity reduces (Bradford & Stoner 2014).

It has been reported that warfare machinery and equipment, including warships, submarines, tanks, planes, aircraft, and helicopters, consume many fossil-fuel energy sources, including oil (Bildirici, 2017a; Smith, 2012). High-tech helicopters consume between 1500 and 1700 gallons of fuel within an hour (Jorgenson & Clark, 2012). Militaries consume a lot of fossil fuel energy (Bildirici, 2017a). Fossil fuel is regarded as one of the primary sources of carbon emissions. Besides these ecological impacts, nuclear weapons and bomb testing further magnified the situation (Bildirici, 2017a). The use of technical weapons in the latest wars, especially in the late century and the first decade of the twenty-first century, has further damaged the environmental quality (Hooks & Smith (2005). It has been reported using metals, including aluminum, copper, nickel, and platinum during these wars (Renner, 1991). The usage of these metals significantly contributes to environmental pollution. Further, the quantity of weapons used in the first few weeks of the Gulf war 1991 were substantially greater than the number used during the protracted Vietnam War (Levy & Sidel, 2008). Enough empirical evidence supports the notion that militarization contributes to CO2 emissions. Some studies state that militarism contributes to increased carbon emissions (Bildirici, 2017a; Bildirici, 2017b; Ahmed et al., 2019). Based on the prediction of the theory and empirical evidence, it is proposed that militarism causes CO2 emissions.

- H1: Militarization significantly impacts CO2 emissions.

3.2 Economic Growth (EG) and CO2 Emissions

The Environmental Kuznets Curve (EKC) theory posits an inverted link between economic development and pollution: an initial increase, followed by a plateau, and ultimately, a reduction (Dutt, 2009; Apergis & Ozturk, 2015). However, the empirical evidence regarding this relationship remains inconclusive. Some studies challenge the EKC, suggesting that real GDP per capita may be a driving force behind CO2 emissions (Aslanidis & Iranzo, 2009). The influx of capital contributes to economic expansion, escalating production, energy consumption, and CO2 emissions. This heightened economic activity necessitates increased energy use, resulting in pollution and elevated CO2 emissions. In a similar vein, Charfeddine and Ben-Khediri (2016) scrutinized the impact of EG on CO2 emissions in the UAE from 1975 to 2011. Their findings indicated that factors such as urbanization, trade openness, and power usage play significant roles in environmental degradation. Conversely, in contrast to the above, Bozkurt and Akan (2014) concluded that rapid EG can enhance ecological conditions. Jaunky (2011) conducted a study using data from 36 high-income nations to examine the EKC, revealing a U-shaped relationship between EG and environmental degradation at the national level. Considering the extant literature, we propose the following hypothesis:

- H2: Economic growth significantly impacts CO2 emissions.

3.3 Stock Market Development (SMD) and CO2 Emissions

There are conflicting arguments about the link between SMD and CO2 emissions. Scholarships suggesting a negative association between them argue that stock markets promote business activities by allowing businesses to access additional funding sources and equity financing (Paramati et al., 2018). The increasing business growth results in an increase of energy consumption demand and, consequently, CO2 emissions (Sadorsky, 2011). Rising stock market activities create wealth by diversifying consumer and business risks, which affects energy consumption and CO2 emissions (Mankiw & Scarth, 2008). SMD is an indicator of EG, which boosts business and consumer confidence. Economic confidence results in manufacturing products, services, and carbon emissions (Sadorsky, 2011). Contrary to this, authors suggesting the negative link between SMD and CO2 argue that stock markets, by enforcing stringent regulations, may force businesses to adopt greener technologies, thereby increasing energy efficiency and reducing carbon emissions (Lanoie et al., 1998; Paramati et al., 2018). Effective stock markets rate and compare environmental performance of their listed firms and encourage them to lower their pollution (Lanoie et al., 1998). Stock markets may boost funding for clean energy initiatives, which result in reduction of CO2 emissions (Paramati et al., 2016; Kutan et al., 2018; Paramati et al. 2018). We propose the following hypothesis in line with the conflicting arguments and empirical evidence.

- H3: Stock market development significantly impacts CO2 emissions.

3.4 Foreign Direct Investment (FDI) and CO2 Emissions

The link between FDI and CO2 emissions is based on two competing hypotheses. The first hypothesis is based on the 'pollution haven' argument suggesting a positive relationship between FDI and CO2 emissions (Walter & Ugelow, 1979; Zhang & Zhou, 2016). This theory holds that multinational corporations relocate industries with high pollution levels to nations with laxer environmental laws to avoid high litigation costs in their home countries. As a result, developing nations experience more significant ecological pollution and become "pollution havens" (Zhang & Zhou, 2016). Country to this, the pollution halo hypothesis predicts an inverse relationship between FDI and CO2 emissions. This hypothesis assumes that MNCs transfer their clean technology to hosting countries, causing a reduction in environmental impact (Kim & Adilov, 2012). Empirical literature presents inconclusive results on the relationship between FDI and CO2 emissions. Some studies suggest a significant positive relationship (Pao & Tsai, 2011; Zhang & 2012), whereas some studies show a significant negative relationship between them (Zhang & Zhou, 2016; List & Co, 2000; Sbia et al., 2014). Contrarily, some studies show an insignificant relationship between FDI and CO2 emissions (Perkins & Neumayer, 2009; Hoffmann et al., 2005; Atici, 2012). Considering the theoretical arguments and empirical literature, we propose a non-directional hypothesis.

- H4: Foreign direct investment significantly impacts CO2 emissions.

3.5 Renewable Energy Usage and CO2 Emissions

Mitigating climate change entails the adoption of green technologies, enhancing energy efficiency, water conservation, and safeguarding forests. The exploration of renewable energy sources is widely acknowledged as a key strategy for reducing CO2 emissions, with the potential to meet half of global energy needs by 2050. Abulfotuh (2007) emphasizes the urgency of altering the composition of the energy resource portfolio to avert environmental threats. Domac et al. (2005) posit that the incorporation of renewable energy can enhance a nation's macroeconomic efficiency. On the contrary, non-renewable energy not only exerts a detrimental impact on EG but also contributes to increased CO2 emissions (Shafiei & Salim, 2014; Arouri et al., 2012). Studies exploring the relationship between energy consumption and pollution present mixed findings. Bilgili et al. (2016) demonstrate a negative correlation between the use of renewable energy sources and CO2 emissions, whereas Apergis and Payne (2010) contend that renewable energy does not necessarily result in reduced CO2 emissions. Considering the diverse empirical evidence, we propose the following non-directional hypothesis:

- H5: Renewable energy usage significantly impacts CO2 emissions.

4. Research Methodology

This study employs time series data from 1993 to 2018 from three highly militarized countries of Asia, including Pakistan, India, and China. CO2, GDP, SMD, military expenditure, and FDI were taken from the world development indicators (World Bank, 2017). A detailed description of the variables is presented in Table 2.

Table 2: Description of Variables

Variable	Measurement	Reference	Source
CO2 emissions	CO2 emissions (Metric tons per-capita)	Shahbaz et al. (2013)	WDI
Military expenditures (ME)	Total military expenditures (% of GDP)	Bildirici (2017a), Jorgenson & Clark (2012)	WDI
Economic growth (EG)	GDP Per Capita	Shahbaz et al., (2016), You and Lv (2018)	WDI
Stock market development (SMD)	Stock market capitalization (% of GDP)	Sharma et al., (2021), Sadorsky (2010)	WDI
FDI	FDI (% of GDP)	Aller et al., (2021)	WDI
Renewable energy usage (REC)	Renewable energy usage (% of total energy)	Sharma et al., (2021), Pao and Tsai (2011)	WDI
WDI: World Development Indicators			

This research uses ARDL approach by Pesaran et al. (2001) to examine the effect of militarization, EG, SMD, FDI, and renewable energy usage on CO2 emissions in PIC countries. This technique has the capability to test the short run and long run effects. Further, there are fewer chances of endogeneity issues as it is free from residual correlations. The general econometric equation which shows the desired relationship among variables of this study is as below:

$$CO_{2_t} = B_0 + B_1 ME_t + B_2 GDP_t + B_3 SMD_t + B_4 FDI_t + B_5 REC_t + \epsilon_t \;\ldots\ldots (1)$$

The model, which is based on the F-Statistic (bound test), captures the long-run relationship between variables and is evaluated across selected nations by translating data into log form as:

$$lnCO2_t = \beta_0 + \Sigma\tau_i\, lnCO2_{t-i} + \Sigma\delta_i\, lnME_{t-i} + \Sigma\psi_i\, lnGDP_{t-i} + \Sigma\lambda_i\, lnSMD_{t-i} + \Sigma\varphi_i\, lnFDI_{t-i} + \Sigma\eta_i\, lnREC_{t-i} + \mu_t \ldots \;\ldots. \;\ldots. (2)$$

The short-run association is calculated using the catering first difference operator Δ, which is combined with a lagged error correction term derived from the long-run association, as shown below:

$$\Delta lnCO2_t = \alpha_0 + \Sigma\tau_j\, \Delta lnCO2_{t-j} + \Sigma\delta_j\, \Delta lnME_{t-j} + \Sigma\psi_j\, \Delta lnGDP_{t-j} + + \Sigma\lambda_j\, \Delta lnSMD_{t-j} + \Sigma\varphi_j\, \Delta lnFDI_{t-j} + \Sigma\eta_j\, \Delta lnREC_{t-j} + \omega_j\, ECM + \mu_t \ldots\ldots\ldots (3)$$

To enhance the reliability of our ARDL model, we employ both CUSUM and CUSUM square estimations. Before estimating the ARDL model, we assess the stationarity of each time series in PIC countries using the augmented Dickey-Fuller test. The rejection of the null hypothesis indicates that the data series attains stationarity at a specific level. Furthermore, diagnostic tests are applied to scrutinize heteroscedasticity in the estimated models. These include the Breusch Godfrey LM test for serial correlation, Ramsey RESET for functional form, and the Breusch–Pagan–Godfrey test to examine heteroscedasticity in the estimated models.

5. Empirical Findings and Results

5.1 Descriptive Statistics

Table 3 depicts the descriptive analysis of study variables from 1993 to 2018. CO2 emissions differ significantly between China, India, and Pakistan. Pakistan's lower mean (0.835) and negatively skewed distribution indicate a concentration of lower emissions instances, whereas China has the highest mean emissions (4.760), showing the need for strong emission controls. India's distribution is skewed to the right, with a low mean of 1.212. China's policy should promote smart emission reduction technologies and green initiatives. While India considers finding a compromise between strict emission controls and EG, Pakistan may continue to push toward sustainable development. The three countries spend vastly different amounts on their militaries; Pakistan spends the highest (4.258), followed by India (2.657), and China (1.904). Pakistan's high mean and variability speak to a sizable military expenditure, emphasizing the importance of effective and open policy. While China's efficient military spending (low variability) supports continued focus on strategic expenditures and technological advancements, India's lower mean demands both. All three nations should prioritize maintaining a balance between economic discipline and national security concerns. As seen by highest GDP growth mean (3230.724) and variability, China's economy looks to be diverse and vigorous. The moderate mean (825.661) and variability of Pakistan indicate a more stable yet diversified economy, whereas India's higher mean (899.417) and moderate variability indicate a dynamic economic climate. Policy implications include maintaining stability while addressing inequality in China, limiting growth for long-term sustainability in India, and sustaining and diversifying EG in Pakistan. The development of stock markets varies greatly; China's stock market has the highest mean (79.360) and variability, indicating a highly developed and dynamic market. Pakistan has a rising market with a moderate mean (30.457) and high variability, whereas India has a more developed market with a higher mean (52.980) and moderate variability. Maintaining development and investor trust in India, attracting investment and ensuring market stability in Pakistan, and implementing stability laws in China's sophisticated stock market are all policy problems. The three nations have varying amounts of FDI, with China drawing the highest with a mean of 3.727 and less variation, suggesting a very favorable business climate. Pakistan's moderate mean (1.180) and higher variability indicate possibility for advancement, but India's slightly higher mean (1.317) and moderate variability indicate a moderately favorable environment. The primary aims of policy should be to enhance Pakistan's investment climate, maintain and diversify FDI in India, and ensure sustainable and balanced FDI flows into China. There are significant inequalities in the use of renewable energy. China, with the lowest mean (20.778), may need to increase its efforts in this area, whereas Pakistan, with the highest mean (48.857), shows a substantial focus on renewables. India is in the center, embracing renewables but experiencing concentration issues. In keeping with worldwide sustainability goals, authorities should promote the maintenance and expansion of renewable energy projects in Pakistan, address concentration issues in India, and increase efforts to increase China's usage of renewable energy.

Table 3: Descriptive Statistics

	CO2	ME	GDP	SMD	FDI	REC
Panel A: Pakistan						
Mean	0.835	4.258	825.661	30.457	1.180	48.857
SD	0.102	0.996	338.259	35.458	0.865	2.884
Max	0.988	6.427	1464.993	130.190	3.668	54.196
Min	0.666	3.265	434.465	0.221	0.376	44.276
Skew	-0.157	0.941	0.411	1.612	1.764	0.409
Kur	-1.655	-0.569	-1.293	2.061	2.808	-1.186
Panel B: India						
Mean	1.212	2.657	899.417	52.980	1.317	46.367
SD	0.336	0.174	518.079	15.202	0.807	6.937
Max	1.818	2.957	1981.651	93.971	3.621	56.983
Min	0.780	2.343	301.159	28.964	0.197	36.021
Skew	0.533	0.180	0.519	0.785	0.889	-0.221
Kur	-1.163	-1.007	-1.165	0.958	0.932	-1.558
Panel C: China						
Mean	4.760	1.904	3230.724	79.360	3.727	20.778
SD	1.975	0.131	2844.338	75.276	1.160	7.948
Max	7.557	2.175	8879.439	355.520	6.187	31.678
Min	2.443	1.675	377.390	10.555	1.349	11.696
Skew	0.244	-0.032	0.753	2.022	-0.003	0.164
Kur	-1.690	-0.392	-0.936	5.978	0.180	-1.874
Note: Min: Minimum, Max: Maximum, SD: Standard Deviation; Skew: Skewness; Kur: Kurtosis						

The mean value of CO2 per capita in a sample of China is 4.76 metric tons, while the military expenditure as a percentage of GDP is 1.904. The average per capita GDP is

$3230.7, the stock market value traded is $79.36, FDI is 3.727 per cent of GDP, and the renewable energy usage is 20.778 per cent of total energy consumption. All the variables are positively skewed, except ME and FDI, which are negatively skewed. Because the value of kurtosis is less than 3, all variables except SMD have platykurtic behavior, with less peaked and thinner tails. SMD's kurtosis value is 5.97, indicating leptokurtic patterns because the value is more than 3.

5.2 Unit Root Test

We conducted a stationarity test on the data under three different assumptions: constant, constant with the trend, and no constant and trend. The results, as presented in Table 4 using the Augmented Dickey-Fuller (ADF) test, indicate that all variables are stationary at the first difference, denoted as I(1), except for military expenditure and FDI, which exhibit stationarity at the level, i.e., I(2) (0). In the India dataset, with the exception of GDP, all other variables are integrated at their first difference, i.e., I(1) (0). Similarly, in the China dataset, all variables are integrated at the first difference, except for SMD, which remains stationary at the level, i.e., (0). Given the mixed levels of integration (I(0) and I(1)) observed in the variables, the results from the unit root test suggest that the ADRL technique is more suitable for analysis.

Table 4(a): Unit Root Analysis

	Augmented Dickey Fuller Test Statistics					
	I (0)	**I (1)**	**I (0)**	**I (1)**	**I (0)**	**I (1)**
Variables	**Constant**		**Constant & trend**		**No constant & trend**	
Panel A: Pakistan						
ln_CO2	-1.19	-5.91***	-2.00	-5.79***	1.86	-5.05***
ln_ME	-3.03**	-	-0.81	-5.03***	-2.60**	-3.77***
ln_GDP	1.2	-3.84***	-2.06	-5.05***	-4.10***	-
ln_SMD	-2.37	-2.82*	-2.43	-2.8	-1.73*	-2.88***
ln_FDI	-2.67*	-3.11**	-2.59	-3.31*	-1.43	-3.18***
ln_REC	-1.72	-4.96***	-1.35	-5.33***	-1.68*	-4.54***
Panel B: India						
ln_CO2	-0.17	-3.96***	-1.55	-3.82**	1.59	-2.50**
ln_ME	-2.19	-4.04***	-3.26*	-4.00**	-0.56	-4.14***
ln_GDP	-3.77***	-	-4.54***	-	-1.98**	-
ln_SMD	-1.57	-4.07***	1.74	-3.55*	-0.28	-4.17***
ln_FDI	-2.82*	-4.64***	-2.57	-4.79***	-2.51**	-4.60***
ln_REC	-0.27	-3.04**	-3.68**	-4.85***	-2.06**	-2.10**
Panel C: China						
ln_CO2	-0.07	-3.03**	-2.86	-3.95**	1.37	-2.31**
ln_ME	-1.93	-5.4***	-2.02	-5.28***	-0.25	-5.51***
ln_GDP	1.15	-3.81**	1.36	-3.82**	1.68	-0.71
ln_SMD	-3.25**	-6.74***	-4.14**	-	1.51	-6.85***
ln_FDI	-1.35	-5.15***	-2.41	-5.03***	-2.04*	-4.67***
ln_REC	-1.13	-3.48**	-2.61	-3.52**	-1.93*	-2.00**
Critical Values						
1% level	-3.753		-4.394		-2.665	
5% level	-2.998		-3.612		-1.956	
10% level	-2.639		-3.243		-1.609	

Table 4(b): Unit Root Analysis

	Phillips-Perron Test Statistics					
	I (0)	**I (1)**	**I (0)**	**I (1)**	**I (0)**	**I (1)**
Variables	**Constant**		**Constant & trend**		**No constant & trend**	
Panel A: Pakistan						
ln_CO2	-1.18	-5.91***	-1.94	-5.77***	2.26	-5.05***
ln_ME	-2.75*	-3.94***	-0.68	-4.54***	-2.47**	-3.77***
ln_GDP	3.33	-4.75***	-2.38	-9.03***	10.15	-2.96***
ln_SMD	1.70	-2.91*	-1.65	-3.75**	-1.32	-2.97***
ln_FDI	-2.03	-3.11**	-1.97	-3.89**	-1.15	-3.18***
ln_REC	-1.75	-4.96***	-1.35	-5.33***	-1.75*	-4.54***
Panel B: India						
ln_CO2	-0.14	-3.96***	-1.54	-3.8**	0.75	-2.33**
ln_ME	-2.20	-4.48***	-2.62	-4.62***	-0.61	-4.62***
ln_GDP	-3.82***	-	-3.74**	-8.24***	-1.72**	-8.59***
ln_SMD	-1.8	-4.06***	-1.96	-3.93**	-0.28	-4.16***
ln_FDI	-2.68*	-4.64***	-2.60	-4.8***	-2.51**	-4.61***
ln_REC	-0.24	-3.04**	-1.55	-3.15**	-3.84***	-
Panel C: China						
ln_CO2	-0.30	-3.01***	-1.75	-3.99**	2.03	-2.24**
ln_ME	-2.01	-5.42***	-2.23	-5.37***	-0.25	-5.51***
ln_GDP	2.36	-3.12**	-1.09	-3.45**	4.48	-1.81*
ln_SMD	-2.58	-11.33***	-4.12**	-10.11***	-1.51	-9.74***
ln_FDI	-1.23	-5.25***	-2.38	-5.11***	-2.38**	-4.67***
ln_REC	-0.87	-3.48**	-1.38	-3.52*	-2.47**	-2.99***
Critical Values						
	-3.753 -2.998 -2.639		-4.394 -3.612 -3.243		-2.665 -1.956 -1.609	

5.3 Bound Test

We used bound test for long run relationships among the focal variables. The bound test approach was used for testing the long-term connections. Table 5 shows that the F-statistics for Pakistan, India, and China are 8.75, 7.59, and 17.66, respectively are higher than upper bounds suggesting a long-term link between variables.

Table 5: Bound Test

	Pakistan		**India**		**China**	
F-value	8.76		F-value	7.60	F-value	17.65
	1(0)	**1(1)**	**1(0)**	**1(1)**	**1(0)**	**1(1)**
At 1%	3.27	4.39	3.06	4.15	2.66	4.05
At 5%	2.63	3.62	2.39	3.38	2.04	3.24
At 10%	2.33	3.25	2.08	3.00	1.75	2.87

5.4 Long-Run ARDL Analysis

Without any short-run deviations, the long-run findings illustrate the relationship between variables. The results of the long-run coefficient show that military spending has a positive and significant impact on carbon dioxide emissions in Pakistan, India and China. Positive changes in military spending increase emissions in the atmosphere. This suggests that militarization is also a factor for environmental damage. Militarization depletes resources while also causing waste. The findings are similar to those of Jorgenson et al. (2010), who reported similar outcomes for 72 nations from 1970 to 2000. Jorgenson and Givens (2014) and Bildirici (2017a) are other researchers that have found that militarization causes environmental damage. Additionally, spending for the military increases CO2 emissions, which worsens the state of the environment. This finding lends credence to the destruction argument concerning China, India, and Pakistan. According to the destruction thesis, militarism causes environmental damage whether or not there is an armed conflict (Jorgenson et al., 2023). This outcome was predicted since military financing devastates the environment by using a lot of resources and creating a lot of rubbish that pollutes the land and water. Furthermore, military utilize nonrenewable energy for operations, transportation, and training. Again, military infrastructure, such as bases and structures, lowers the quantity of land used. Military wars wreak havoc on biodiversity, reduce biocapacity, and increase CO2 emissions. Our sample includes rising nations that have not showed any obvious technological breakthrough in military R&D that could mitigate the detrimental effects of military spending on the country. Earlier study by Qayyum et al. (2021), Chang, Chen and Song, (2023), Gokmenoglu et al. (2021) and Ahmed et al. (2020b) revealed similar results for the OECD, Turkey, and Pakistan, respectively.

In addition to militarization, the armed forces require natural resource maintenance (Clark & Foster 2006). A fierce rivalry between Pakistan and India puts strain on natural resources. Shaw (1998) argues that it is dependent on non-renewable energy-based equipment. Degreasers, fuels, and insecticides are used excessively in militarized environments (Singer & Keating 1999). Furthermore, the GDP significantly and positively impacts carbon emissions. At the start of their development, developing countries primarily focus on promoting growth while allowing the environment to deteriorate (Murshed et al. 2021). This finding is consistent with prior study on Pakistan by Majeed et al. (2021), the BRICS by Usman and Makhdum (2021), Nigeria by Solarin et al. (2021), and Turkey by

Gokmenoglu et al. (2021). As a result of this shift in demand, producers in PIC countries consume more energy to supply the demand, resulting in CO2 emissions. After investigating how renewable energy affects the environment, Kartal et al. (2023) and Jamil et al. (2022) conclude that renewable energy can reduce environmental degradation. This is also consistent with previous study (Usman & Hammar, 2021), which indicates that employing renewable energy sources is one approach to mitigate environmental change. Most of Asia-Pacific countries rely substantially on energy. Traditional energy supplies, such as oil, are heavily imported by countries such as China, Japan, and South Korea. The adoption of renewable energy has reduced long-term dependency on fossil fuels, slowing emissions (Sharma et al., 2021). The impact of FDI on carbon emissions is large and positive, supporting the pollution haven theory. Regarding FDI, more FDI means more carbon emissions since the country sees EG due to FDI without considering environmental regulations and laws. The sample countries have not been successful in allocating their financial resources to initiatives that lower environmental wellbeing, as evidenced by the positive coefficient of financial development which are consistent with the findings of Eregha, Vo and Nathaniel (2022). In Pakistan, 600 international corporations' profit from their operations. Most of the FDI in Pakistan goes to oil exploration, power, and the chemical and textile industries, all of which stimulate EG and, in turn, raise carbon emissions. FDI and carbon emissions have a favorable long-run connection, according to Mahmood (2012). Furthermore, we discover that policies aiming at increasing investment in renewable energy usage reduce carbon emissions while simultaneously improving environmental health. Therefore, PIC countries should continue with a higher level of renewable energy usage. The EKC hypothesis argues that CO2 emissions rise with wealth until it stabilizes, then fall as income rises. Moreover, several investigations backed up the same findings (Kostakis, 2020). Finally, the SMD is insignificant for Pakistan and India while it contributes negatively to CO2 omission in China.

Figure 6: Long-Run Coefficients - ARDL Model on CO2 Emissions

Regressors	Beta	Standard Error	t	p-value
Panel A: Pakistan				
Ln_ME	.023	.005	4.663	.004
Ln_GDP	.046	.023	1.977	.074
Ln_SMD	-.005	.010	-.475	.651
Ln_FDI	.073	.018	4.095	.007
Ln_REC	-.799	.195	-4.086	.001
Panel B: India				
Ln_ME	.072	.031	2.311	.037
Ln_GDP	.271	.101	2.679	.018
Ln_SMD	.004	.008	.478	.646
Ln_FDI	.053	.016	3.282	.013
Ln_REC	-1.086	.308	-3.531	.009
Panel C: China				
Ln_ME	.043	.015	2.976	.009
Ln_GDP	.092	.041	2.246	.075
Ln_SMD	-.048	.010	-4.681	.005
Ln_FDI	.319	.086	3.705	.006
Ln_REC	-.473	.040	-11.886	.000

Estimating Long run ARDL by following equation;

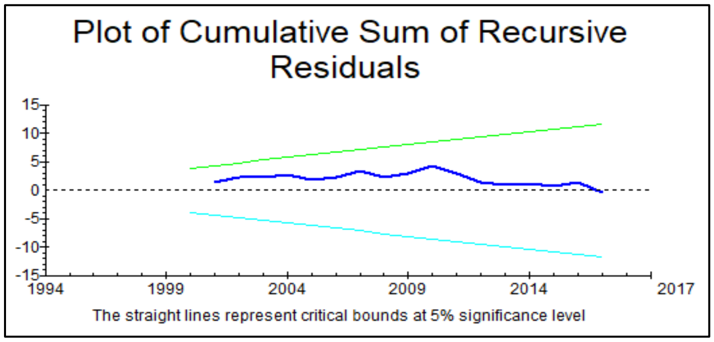
$$lnCO_2 = \beta_0 + \Sigma\psi_i \, lnGDP_{t-i} + \Sigma\beta_i \, lnGDP2_{t-i} + \Sigma\lambda_i \, lnSMD_{t-i} + \Sigma\delta_i \, lnME_{t-i} + \Sigma\varphi_i \, lnFDI_{t-i} + \Sigma\eta_i \, lnREC_{t-i} + \mu_t$$

5.5 Short-Run ARDL Analysis

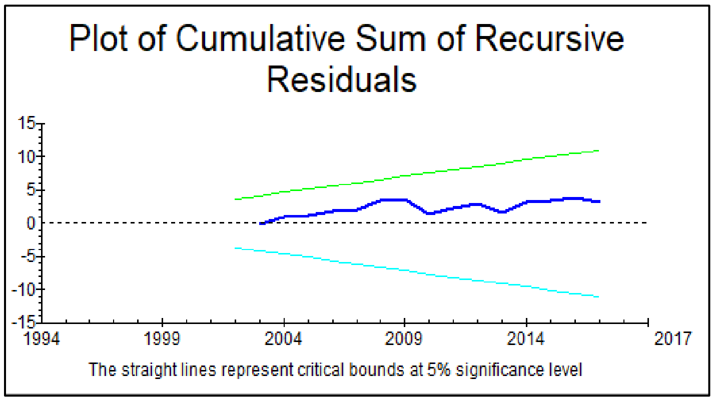
The short-run dynamics of ARDL capture the divergence and rate of adjustment from disequilibrium to equilibrium. Table 7 shows the short-run results indicating the short-run elasticities. The data confirm the existence of short- and long-term feedback loops between military spending, GDP growth, SMD, FDI, renewable energy use, and CO2 omission. In Pakistan, the findings show that militarism and GDP have a significant short-term impact on carbon dioxide emissions. The coefficient sign of GDP confirms the presence of the EKC hypothesis at a 5% significance level. In Pakistan, the value of stocks traded has no significant impact on carbon dioxide emissions. FDI has a favorable influence on CO2 in Pakistan; however, renewable energy use has a negative effect. In India, short-term outcomes reinforce the militarization of CO2 emissions. In the short run, carbon emission elasticity is essential for GDP, FDI, and renewable energy use but not for SMD. Jalil and Mahmud (2009) discovered that the elasticity of carbon dioxide emissions with military spending, GDP, and FDI is highly positive in China but strongly negative for renewable energy utilization. Furthermore, the F-statistic probability values less than 5% for all modes, indicating that the calculated models are stable.

Figure 7: Short-Run Coefficients - ARDL Model on CO2 Emissions

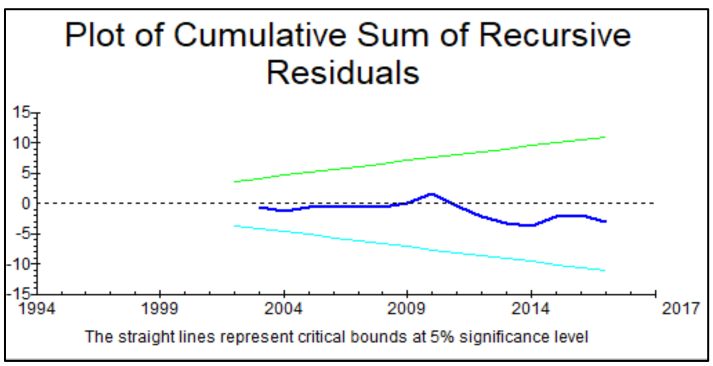
Regressors	Beta	Standard error	t	p-value
Panel A: Pakistan				
Ln_ME	.007	.003	2.327	0.005
Ln_GDP	.023	.003	6.942	0.001
Ln_SMD	.001	.003	1.265	0.253
Ln_FDI	.028	.005	5.686	0.001
Ln_REC	-.131	.121	-1.077	0.323
ECM (– 1)	-1.035	.083	-12.319	0.000
F-value =34.160, P-value=0.000, DW=2.260				
Panel B: India				
Ln_ME	.057	.011	5.039	0.002
Ln_GDP	.017	.008	2.106	0.049
Ln_SMD	.264	.236	1.116	0.301
Ln_FDI	.410	.066	6.156	0.001
Ln_REC	-1.052	.406	-2.595	0.018
ECM (– 1)	-2.015	.186	-10.830	0.000
F-value =43.840, P-value=0.000, DW=2.450				
Panel C: China				
Ln_ME	.292	.157	1.874	0.000
Ln_GDP	.012	.002	7.054	0.015
Ln_SMD	-.001	.016	-0.083	0.936
Ln_FDI	.356	.043	8.256	0.000
Ln_REC	-1.618	.178	-9.083	0.000
ECM (– 1)	-1.847	.126	-14.708	0.000
F-value =43.840, P-value=0.000, DW=2.310				
Estimating short-run ARDL by Equation; $\Delta lnCO_2 = \beta_0 + \Sigma\psi_i \Delta lnGDP_{t-i} + \Sigma\lambda_i \Delta lnSMD_{t-i} + \Sigma\delta_i \Delta lnME_{t-i} + \Sigma\varphi_i \Delta lnFDI_{t-i} + \Sigma\eta_i \Delta lnREC_{t-i} + ECM + \mu_t$				



Country Name: Pakistan



Country Name: India



Country Name: China

Figure 1: Plot of the CUSM for PIC – Pakistan, India and China

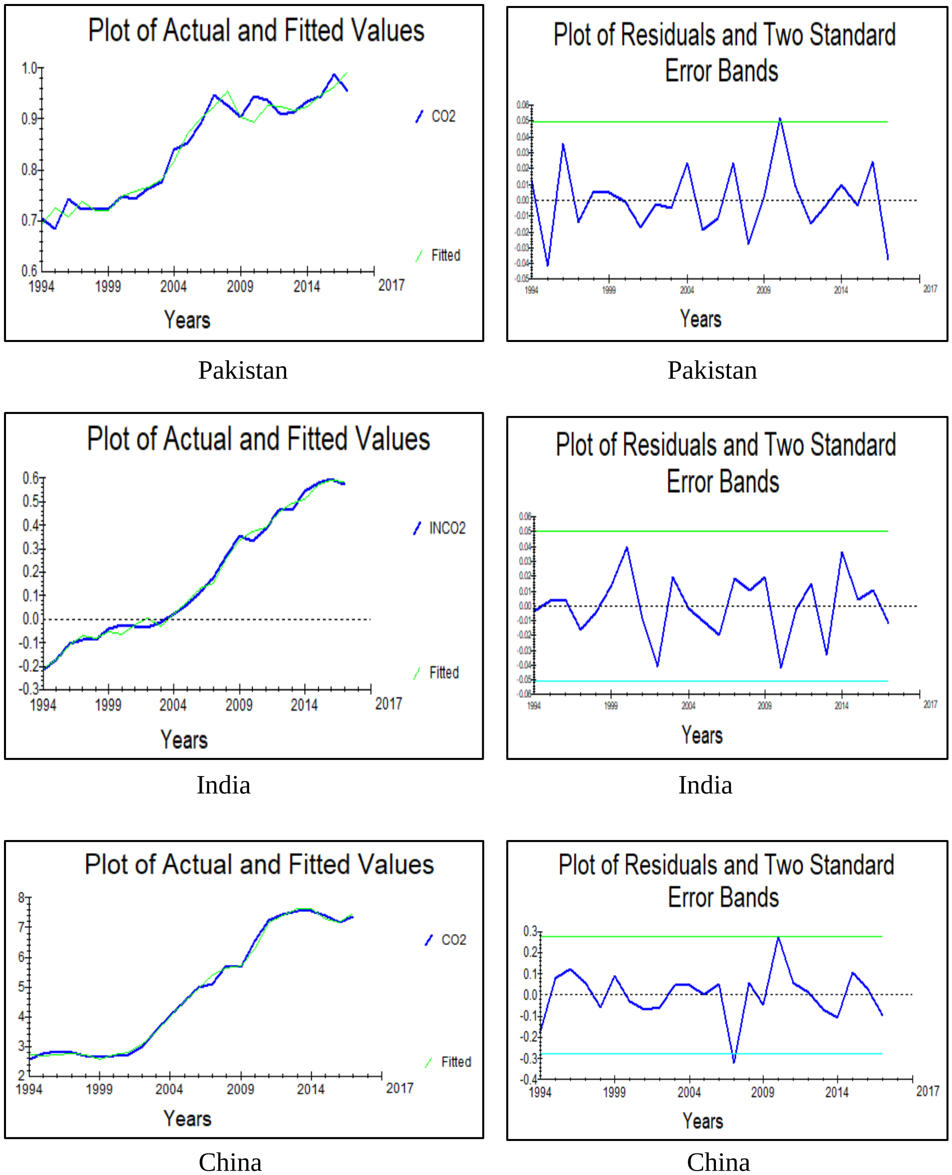
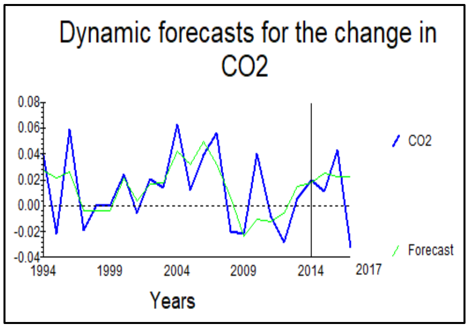
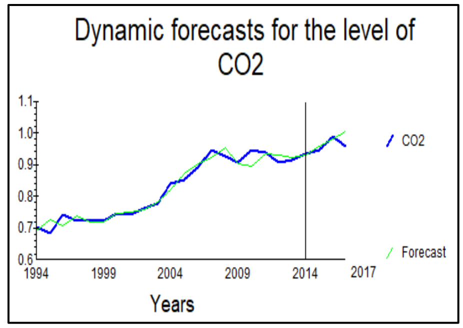


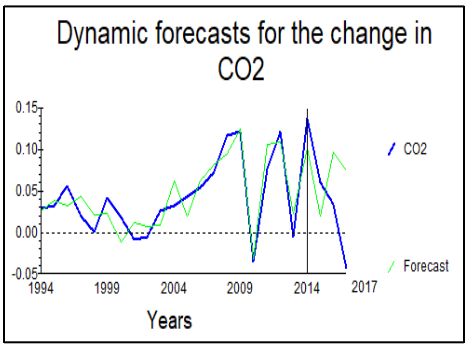
Figure 2: Plot of the in-sample actual values, fitted values and residual for Pakistan, India and China – PIC countries



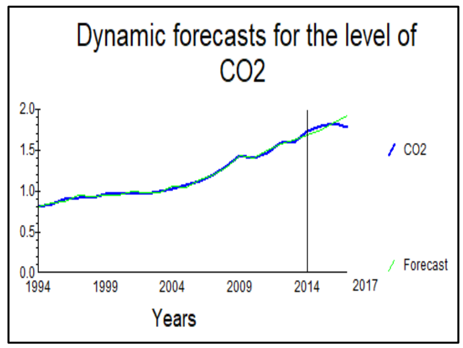
Pakistan



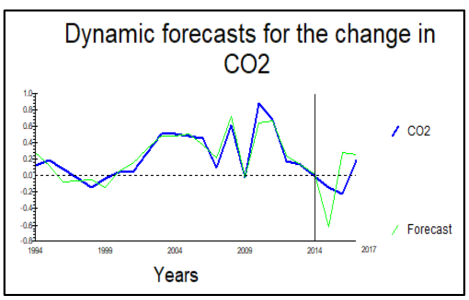
Pakistan



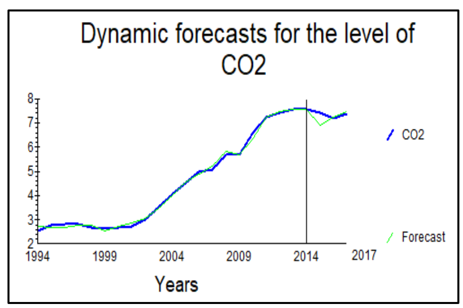
India



India



China



China

Figure 3: Plot of the dynamic forecasts for change & level of CO2 in PIC- Pakistan, India and China countries

5.6 Diagnostic Test

Table 8 lists the several statistical tests performed on the data to test the suitability of analysis models. The Jarque Bera test shows that the data is normally distribution. Further, Breusch-Godfrey LM test revealed no evidence of serial correlation. Husman test revealed that heteroscedasticity is not an issue in the dataset. Thus, diagnostics tests suggest that the model appears to be statistically stable and fit.

Table 8: Diagnostic Tests

	Pakistan	**India**	**China**
Normality	0.745	0.970	0.524
Serial correlation	0.136	0.132	0.260
Heteroscedasticity	0.251	0.249	0.345

5.7 USUM and Square of CUSUM statistics for Coefficients Stability

There is a possibility that structural change may have occurred in time series data, therefore, the model's stability must be verified. Stability test determines the smoothness and consistency of a model across time (Bahmani-Oskooee, 2001). Webster et al. (1975) used CUSUM statistics to measure the stability of regression coefficients against critical boundaries. It is used to check the structural breaks and stability of the estimated model over time. The result shows that estimated models are stable (Figure 1). Additionally, the CUSM square also depicts the stability of the model. As a result, the econometric model is determined to be stable. Furthermore, figure 2 plots the in-sample actual values, the fitted values, and the residuals for all the sample countries. Similarly, figure 3 plots the dynamic forecasts for change and level of CO2 in PIC countries.

6. Discussion and Conclusion

This study examines the impact of militarization, economic expansion, SMD, FDI, and renewable energy use on CO2 emissions in Pakistan, India, and China. This study used the ARDL method to examine the long- and short-term variables contributing to CO2 emissions. The long-run coefficient results show that military spending, EG, and FDI positively impact CO2 emissions in Pakistan, India, and China; however, renewable energy usage reduces carbon emissions in the sample countries. Furthermore, the SMD is insignificant for Pakistan and India, whereas it contributes negatively to CO2 emissions in China. The study's finding reveals that the environmental costs of militarization are worse since PIC's army is labor-intensive, requiring more fuel for soldier transportation, training, and protection. Therefore, we found evidence of the 'destruction hypothesis' in the sample countries. Similarly, capital inflows drive economic expansion, which increases production and energy use, and hence CO_2 emissions. It necessitates energy use, resulting in pollution and CO_2 emissions. Our results also support the 'pollution haven' argument suggesting a positive relationship between FDI and CO_2 emissions. According to this argument, multinational firms shift highly pollution intensive industries to countries with laxer environmental legislation to avoid paying expensive regulatory compliance expenses in their own countries. Furthermore, we find empirical support for policies aiming at increasing investment in renewable energy usage reduces carbon emissions. Therefore, PIC countries should continue with a higher level of renewable energy usage.

6.1 Practical Contributions

Given the evident impact of military expenditures, EG, and FDI on CO_2 emissions, it is crucial for PIC countries to develop and implement effective environmental policies. These policies should address climate challenges and promote sustainable practices, striking a delicate balance between EG and environmental goals. Policymakers need to foster cleaner technologies and sustainable practices to align these objectives. With shared challenges among PIC countries, a collaborative, long-term perspective is essential. Policymakers should work collectively to implement monitoring mechanisms and regulations, particularly focusing on controlling the environmental impact of military-related activities. Moreover, recognizing the positive correlation between renewable energy usage and CO_2 reductions, strategic investments in renewable energy infrastructure are recommended to reduce dependence on carbon-intensive sources. This comprehensive approach can steer PIC countries towards a sustainable and environmentally conscious future.

6.2 Research Limitations and Future Research Directions

Despite the use of reliable econometric tools to unravel the link between focal variables and CO_2 emissions in PIC setting, this investigation has certain limitations. This study did not make a comparison between developed and developing economies, therefore, comparative analysis at regional and national level will unearth some intriguing facts about the contribution of defense sector towards environmental deterioration. Such kind of research will highlight the consequences of the current arms race between states and regions on climate change. Further, future research should focus on the elements contributing to environmental deterioration using large dataset, which will aid government officials and policymakers in developing policies to reduce CO_2 emissions.

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