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Military Expenditures and the Environment in MENA Region: The Interaction Effects of Wars and Conflicts

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ABSTRACT

International Humanitarian Law (IHL) propagates the need for environmental sustainability from warfare. Thus, the study explores the effect of Military Expenditures (ME) and their interaction effect with wars and conflicts on the environment in the Middle East and North Africa (MENA) region by using the dataset from 19 MENA countries for the period 1997-2020. The novel spatial econometrics is utilized to find the direct, spillovers, and total effects of military expenditures, renewable energy, economic progress, and wars and conflicts on CO_2 emissions. The results substantiate the Environmental Kuznets Curve (EKC) in the nexus between economic progress and emissions. Moreover, spillovers of CO_2 emissions are found positive in the region. Renewable energy is found helpful in reducing emissions in local economies but could affect them in neighboring counterparts and the entire region. The military expenditures raise emissions in the entire region. Accordingly, military expenditures have adverse local and spillover environmental effects in the region. Moreover, wars and conflicts have positively moderated the connection between ME and emissions in the entire region. Thus, wars and conflicts in the MENA region are responsible for increasing military expenditures and emissions with spillover effects, which are damaging the ecology of this region. The study recommends that governments of this region should increase spending on renewable energy projects and reduce military expenditures. Moreover, the wars and conflicts should be resolved with dialogues to protect the region from CO_2 emissions.

1. INTRODUCTION

International Humanitarian Law (IHL) in the Geneva Conventions prohibits warfare [1], which would lead to damage to the natural environment. IHL aims to protect natural resources by stating the rules and regulations for the protection of ecosystems. For instance, the IHL proposes the law of armed conflict to protect the effects of armed conflict on society, which aims to protect civilians' rights including the protection of the natural environment from warfare [2]. Thus, IHL would be helpful to reduce environmental destruction during conflicts and could help to save ecosystems and human health at the same time. However, increasing Military Expenditures (ME) and operations by the world economies could have environmental problems from different dimensions. For instance, these conflicts could have adverse effects including deforestation, soil destruction, water pollution, and damage to wildlife habitats [3]. In addition, these conflicts would result in bombings and explosions of hazardous materials. Moreover, these are responsible for the destruction of infrastructure, which could have direct environmental problems and would also have indirect environmental problems for the reconstruction of such infrastructure. Military operations also contribute to the hazardous waste from chemicals and residue of weapons [4], which can pollute the soil and water. In addition, the consumption of fuels for military machinery and equipment is more compared to civilian counterparts [5]. Thus, military operations can release more Greenhouse Gas (GHG) emissions compared to civilian counterparts.

On the production side of military equipment, many chemical raw materials and energy are needed for the production of tanks, aircraft, and missiles [6]. Thus, the manufacturing of such equipment and also their transportation needs energy, which could lead to emissions and environmental problems. For instance, these operation needs fossil energy to fuel vehicles, aircraft, and naval ships [7]. Moreover, electricity is also needed to operate their bases, facilities, and infrastructure. If the energy requirement is fulfilled by the fossil fuel sources, then these operations could have long-lasting damage to the environment by emitting GHG emissions and other chemical releases. In this regard, some remedial measures would help to reduce the environmental effects of military operations. For instance, energy efficiency and advanced materials innovation in military machinery and equipment could reduce the emissions from military operations [6]. Moreover, the adoption of renewable energy options for military energy needs would reduce emissions.

Considering the hostile environmental impact of military expenditures, the recent literature has probed the influence of military spending on emissions in North Africa [8], in G20 countries [9], in Sub-Saharan African (SSA) economies [10], in Pakistan [11], in 40 African countries [12], in NATO countries [13], in the USA [14], in nuclear energy-producer economies [15], in Pakistan, India, and China [16], and in G7 [17, 18]. Still, the testing of the effect of military expenditures on emissions is missing in the Middle East and North Africa (MENA) literature. Thus, the present study fills this literature gap by examining 19 MENA economies. Moreover, the moderating effect of wars and conflicts on the nexus between emissions and military expenditures is also tested to increase the novelty of this research. In addition, the novel spatial econometrics is utilized to further raise the novelty of the study and to capture the spillover effects of military spending, wars, and conflicts on emissions.

2. LITERATURE REVIEW

The recent literature realizes the importance of testing the connection between military expenditures and emissions. Idroes et al. [8] conducted a study on North Africa examining the impact of military expenditure, globalization, and Renewable Energy Consumption (REC) on CO_2 emissions from 1995-2021 and reported the insignificant effect of military spending on emissions. Moreover, globalization, REC, and capital formation reduced CO_2 emissions. Nevertheless, manufacturing and tourism amplified them. Uddin et al. [9] probed the G20 panel from 1980-2019 and found that ME and Information and Communication Technology (ICT) raised CO_2 emissions. Thus, it was suggested to regulate military spending and reduce energy usage to achieve environmental sustainability goals. Efayena and Olele [10] examined the influence of military expenditures on CO_2 emissions in 35 SSA countries from 1990-2021 in quantile analyses and revealed that military expenditures increased CO_2 emissions in most quantiles. Moreover, a feedback effect was found between them. Thus, the authors recommended adopting military strategies to promote environmental sustainability.

Muhammad et al. [11] examined the influence of military expenditures on CO_2 emissions in Pakistan from 1971-2014 and concluded that military expenditures and financial development increased CO_2 emissions. However, democratic governments reduce environmental degradation compared to autocratic regimes. Asongu and Ndour [12] explored 40 African countries from 2010-2020 and found that military expenditure increased CO_2 emissions. However, good governance showed the potential to mitigate these effects. The author suggested promoting good governance and reducing military expenditure to enhance environmental sustainability. Li et al. [19] examined the effects of innovations, institutional performance, and trade openness on emissions in the BRICS nations from 1990-2021 and revealed that increasing economic progress and trade openness significantly increased emissions. The Environmental Kuznets Curve (EKC) was also substantiated. Technological innovations reduced nitrous oxide and increased carbon dioxide emissions. However, the effect of institutional performance including internal and external conflicts could not affect emissions.

Pata et al. [13] investigated 15 NATO countries from 1991-2018 and found that energy usage and military spending amplified emissions. Nevertheless, technical progress moderated the negative environmental impact of military expenditures. Though, FMD aggravated this effect. The study suggested NATO countries consider environmental sustainability from military expenditures through technological advancements to mitigate environmental effects. Ben Youssef [14] analyzed the USA to test the relationships between REC, energy trade, military spending, and CO_2 emissions and found that military expenditures raised REC and reduced energy imports and CO_2 emissions. Moreover, arms exports raised REC and energy imports. Jahanger et al. [15] investigated nuclear energy-producing economies from 1990-2018 and indicated an N-shaped EKC. Further, military spending mitigated the ecological footprint. The authors recommended REC transition to avoid the N-shaped EKC.

Husnain and Ali [16] scrutinized the influence of militarization, Foreign Direct Investment (FDI), and REC in Pakistan, India, and China from 1993-2017 and found that ME, economic progress, and FDI increased emissions. However, REC reduced emissions. Thus, the author suggested reducing military expenditures and promoting REC to control emissions. Konuk et al. [17] examined the association between military spending, FMD, economic progress, and emissions in G7 nations from 1971-2019 and found that FMD and energy usage raised carbon emissions. Comparatively, FMD had the greatest effect. However, military spending reduced emissions. Isiksal et al. [18] probed the determinants of emissions in the G7 from 1990-2018 and reported that environmental innovations condensed emissions. However, economic expansion and military expenditures increased emissions. Moreover, military expenditures caused economic expansion, which raised emissions resultantly. The authors recommended to implement eco-friendly strategies to mitigate environmental problems. Erdogan et al. [20] scrutinized and indicated that increasing ME raised carbon emissions.

Ahmed et al. [21] addressed the ecological impacts of militarization in Pakistan from 1971-2016 and found that militarization and energy usage elevated the ecological footprint. Thus, the authors suggested reducing military spending to reduce environmental problems. Zhu et al. [22] explored the impact of innovation, militarization, and economic progress on the ecological footprint in BRICS from 1990-2021 and found that all factors significantly increased the ecological footprint. The study suggested using advanced technology to enhance military capabilities to reduce environmental harm. Mughal et al. [23] investigated NEXT-11 economies from 1984-2018 and reported that economic progress, FMD, and military expenditure significantly increased the ecological footprint. Conversely, governance reduced the ecological footprint. The authors recommended adopting technologies to reduce the pollution effects of ME.

Shahbaz et al. [24] examined the Visegrád group countries from 1990-2019. Using quantile regression, the authors revealed that FMD and military expenditures increased emissions. However, economic progress reduced them. Kwakwa [25] examined Ghana from 1971-2018 and found the EKC. Moreover, population, industrialization, and militarization raised CO_2. Wang et al. [26] analyzed the nexus among oil reliance, CO_2, and militarization in oil-importing countries and found this nexus in China and India. However, cointegration is not found in the US and France. The authors suggested diversifying from oil reliance and developing military technologies to improve energy efficiency and reduce

CO_2 emissions. Ahmed et al. [27] investigated the relationships among militarization, energy usage, CO_2 emissions, and economic progress in Myanmar from 1975 to 2014 and found that military expenditure reduced income and energy usage increased income. Moreover, feedback was observed between energy usage and CO_2 emissions and economic progress caused by energy consumption. However, military expenditure did not cause emissions.

Sparrevik and Utstøl [5] analyzed GHG emissions in the Norwegian defense sector and revealed that military activities raised emissions with an elasticity of 1.1. Moreover, upstream activities were the major contributors to these emissions. Thus, the authors suggested green procurement practices to mitigate emissions. Qayyum et al. [28] probed the ecological effects of military activities in South Asia from 1984 to 2019 and confirmed that military expenditures and internal and external conflicts raised the ecological footprint. Thus, these results highlighted the environmental consequences of militarization. Moreover, the EKC was also substantiated. Gokmenoglu et al. [29] examined Turkey from 1960-2014 and revealed that ME and energy usage amplified emissions. However, FMD improved environmental quality. Zandi et al. [30] analyzed the ASEAN countries from 1995-2017 and showed that military expenditure and corruption significantly increased CO_2 emissions. However, democracy had a mitigating effect on emissions. Thus, the findings suggested that good governance practices and democratic institutions would reduce the environmental effects of military activities.

Some studies also explore the influence of military spending on non-environmental effects. For instance, Dunne and Nikolaidou [31] analyzed Greece from 1960-1996 and concluded that military expenditure harmed Greece's economic performance by depressing savings and the trade balance. Antonakis [32] analyzed Greece from the post-war period to 1990 and revealed that military expenditure reduced economic progress. Gbadebo et al. [33] scrutinized the connection between defense spending and growth in Nigeria from 1960-2021 and found causality from defense spending to income growth without feedback from economic progress to defense spending. Pérez-Cárceles [34] evaluated the effect of military spending on human capital in G20 nations from 1990-2021 and found a positive influence of such expenditures on human capital.

Damla Gönül-Sezer and Demirel [35] analyzed Turkey from 2009-2018 and indicated that reliance on imported military products increased dependency on foreign supplies and reduced overall economic progress resultantly. Demirtaş et al. [36] explored G20 countries and found that military expenditures condensed green investments. Thus, the authors suggested enhancing green investments by improving institutional quality and reducing military expenditures. Aziz and Waheed [37] explored the Saudi economy and highlighted that higher oil prices boosted economic growth. Moreover, military expenditures and exports also improved economic growth, which resulted in higher carbon emissions. Jorgenson and Clark [38] investigated the globe and found that economic development increased ecological footprints and military expenditures raised footprints.

The MENA literature ignores the nexus between military spending and emissions. Thus, this section of the study explores the MENA literature investigating other determinates of emissions. For instance, Mahmood et al. [39] examined MENA economies and found that exports reduced emissions by transferring them to importing countries. However, imports and FDI increased emissions by transferring them from producer to consumer countries. The authors suggested promoting exports and reducing energy-intensive imports to reduce emissions in the region. Abdallh and Abugamos [40] examined the MENA region and substantiated the EKC between urbanization and emissions. Moreover, energy use and economic progress raised emissions. Thus, managing energy and economic progress could reduce pollution. Al-Mulali et al. [41] indicated that rapid urbanization amplified energy usage and emissions in MENA economies The author suggested urban planning strategies to promote energy efficiency and reduce pollution. Guoyan et al. [42] explored MENA countries and found that FDI amplified emissions. Ben Lahouel et al. [43] probed the nexus between ICT and CO_2 emissions and concluded that ICT initially increased emissions but mitigated these emissions after a certain threshold. Thus, the study highlighted the potential of ICT to mitigate emissions in MENA economies.

Ayad et al. [44] examined the EKC hypothesis in 18 MENA nations and found that the EKC did not hold for CO_2 emissions. However, the EKC was validated for the ecological footprint. Moreover, the emissions were increased by population growth and non-REC. Mahmood et al. [45] analyzed the MENA region and found spatial spillovers in emission transfers among neighboring countries. The authors substantiated the EKC and also revealed that oil rents raised emissions. Sadaoui et al. [46] investigated MENA countries and revealed that governance increased CO_2 emissions. However, natural resources mitigated these effects. Thus, the authors advocated enhancing governance regarding resource management would reduce emissions. Alofaysan [47] examined the MENA region and showed that innovation and REC helped raise environmental sustainability. Thus, the authors suggested REC-enhancing policies and innovations to reduce pollution. Sultana and Rahman [48] explored the effects of REC and non-REC in MENA countries and found that non-REC, population, and economic progress elevated pollution. Nevertheless, REC and the service sector reduced them.

Bouchoucha [49] examined MENA countries and concluded that FDI increased CO_2 emissions and governance mitigated these effects. Thus, the authors suggested strengthening institutions to reduce emissions. Zouine et al. [50] investigated the nexus between education and pollution and reported that economic progress raised CO_2 emissions in MENA economies. However, higher education and globalization mitigated CO_2 emissions. Thus, the authors suggested enhancing education and globalization as the solution to environmental challenges. Mahmood et al. [51] examined 17 MENA countries and substantiated the EKC. The authors also found that patents increased CO_2 emissions domestically. However, patents reduced emissions in neighboring countries, which corroborated a net positive environmental total impact. However, industrialization raised CO_2 emissions and urbanization had also a negligible overall effect.

The reviewed literature underscores the significance of the influence of military expenditures on emissions. However, this nexus is ignored in MENA literature, and spatial analyses in this nexus are also scant in global literature. Thus, we are going fill this literature gap by scrutinizing the nexus between ME and CO_2 emissions by using novel spatial techniques. Furthermore, the moderating role of wars and conflicts is also tested in the nexus between ME and emissions to increase the novelty of the study.

3. METHODS

In the determinates of CO_2 emissions, we cannot ignore the role of economic growth. In this regard, Grossman and Krueger [52] are pioneering to suggest a non-linear relationship, which is termed the EKC. For instance, the early economic growth of any economy may ignore the environmental consequences and would result in higher energy consumption. Thus, the overall rise in energy consumption without raising renewable capacity could increase GHG emissions [52], which is a scale effect of growth. However, the economies would realize the importance of a clean environment after a certain level of growth and could shift their industries towards cleaner production processes and lesser polluted industries, which is a composition effect [53]. Moreover, the economies could also initiate research and development activities to generate cleaner production technologies and/or to use cleaner sources of energy, which is a technique effect [54]. Thus, composition and technique effects could help reduce GHG emissions at the later stage of economic growth. So, the study hypothesizes the inverted U-curve impact of economic growth on emissions to test the EKC hypothesis. The basic objective of this research is to test the effect of military expenditures on emissions. Military operations could result in deforestation and are responsible for the destruction of carbon sinks [3]. Moreover, military operations would release hazardous waste [4], and the usage of fossil fuels in military machinery and equipment could be responsible for GHG emissions as well [5]. In addition, the production and transportation of military equipment are pollution-intensive activities [7]. All military activities and operations are financed by the government. Thus, the study hypothesized the positive effect of military expenditures on emissions. Along the same line, empirical literature has found that military operations and expenditures have adverse environmental effects [9-11].

REC would be helpful in reducing the environmental impact of military activities. For instance, the military needs energy for its operations, which is usually met by fossil fuels and can have environmental consequences in terms of GHG emissions [55]. However, by replacing REC with fossil fuel dependence of the military sector, this sector could reduce the GHG emissions and carbon footprint of military activities [56]. For instance, this sector can reduce the environmental problems of military activities by using solar energy, wind energy, and bioenergy for the energy needs of vehicles, aircraft, ships, and military bases [55]. Particularly, electric vehicles and drones could reduce the direct dependence on fossil fuels [57], which can directly reduce emissions. Moreover, the installation of solar or wind systems in military bases could reduce the dependence on fossil fuel electricity generators [55]. Thus, REC could help in raising the overall energy efficiency of the military sector and could help to reduce GHG emissions. Following these arguments, the empirical literature has utilized the REC variable in the military expenditure and emissions model [8, 14, 16]. Following the literature, we also add the REC as a control variable in the model. Collectively, we hypothesize the following model:

$$CO_{2it} = f\ (Y_{it}, Y_{it}^2, ME_{it}, REC_{it}) \tag{1}$$

CO_{2it} is the natural logarithm of CO_2 emissions per capita. Y_{it} is the natural logarithm of Gross Domestic Product (GDP) per capita and Y_{it}^2 is a square of Y_{it}. ME_{it} is taken as a percentage of military expenditures in GDP and REC_{it} is a percentage of REC in GDP. t is the period from 1997-2020 and i shows 19 MENA countries including Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Malta, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, the United Arab Emirates (UAE), and Yemen. Some MENA countries are ignored due to the non-availability of data for the targeted variables and period. Data on all variables are sourced from [58]. Data is taken from 1997-2020 as per the availability from [58]. For instance, data before 1997 on military expenditure is not available for many MENA countries. Moreover, CO_2 emissions data is available up to the year 2020. The wars and conflicts may increase the need for more military expenditures, which could raise CO_2 emissions. Thus, we also aim to test the moderating role of wars and conflicts in the relationship between military expenditures and CO_2 emissions. Caring this moderating role, the model in Eq. (1) can be expressed as:

$$CO_{2it} = f\ (Y_{it}, Y_{it}^2, ME_{it}, D_{it} * ME_{it}, REC_{it}) \tag{2}$$

In Eq. (2), D_{it} is a dummy variable and carries 1 in the years of wars and conflicts in the respective MENA countries and 0 otherwise. Then, the D_{it} is multiplied by ME_{it} to test the moderating effect of wars and conflicts in the relationship between military expenditures and CO_2 emissions.

Mahmood et al. [45] have suggested and corroborated the spatial linkages in CO_2 emissions in the MENA region. Moreover, CO_2 emissions are a global issue, which might transfer across borders and pollute neighboring countries [59]. Moreover, Maddison [60] argued that countries' policies, including trade and environmental decisions, would influence a country because of the policies of neighboring countries, which could also be responsible for spatial linkages of emissions. In addition, many of the MENA countries share similar environmental conditions like air quality and topographical features, which could further be a reason for spatial linkages of emissions in the MENA region. Furthermore, the relationship between military spending and emissions could have spatial spillovers within the MENA region. For instance, the recent Israel-Gaza conflict could pressure other MENA countries to increase spending on military activities and operations. Thus, increasing military spending in one MENA country is responsible for increasing military spending in other MENA countries, which is a strong justification for applying spatial analysis in the relationship between military spending and emissions in this region. Increased military spending and operations in one MENA country are likely to raise emissions not only within its own economy but also in neighboring countries. The MENA literature has corroborated the spatial linkages in CO_2 emissions of MENA economies [45]. However, there is a gap in research when it comes to applying spatial analysis to the relationship between military spending and emissions in the MENA region. Therefore, this study aims to empirically examine the spatial linkages between military spending and emissions, which also takes into account the moderating effect of wars and conflicts in the current political landscape of the MENA region.

Considering these theoretical reasons for spatial linkages, Elhorst [61] suggested testing the spatial effects in the models of non-spatial estimates to validate the potential presence of spatial autocorrelation in the panel model of nearby economies. In this regard, Anselin et al. [62] recommended the LM test to check for spatial autocorrelation in non-spatial models. Moreover, its robustness can be substantiated by using the LM robust test as suggested by Debarsy and Ertur [63]. Thus, Eqs. (1) and (2) will be estimated by the different Fixed Effects (FE) and Pooled Ordinary Least Square (POLS) specifications. Then, the LM and LM robust tests will be utilized to verify spatial dimensions in the models. If spatial autocorrelation is detected in non-spatial estimates, then the Spatial Durbin Model (SDM) is an appropriate initial specification to estimate and compare with other spatial specifications to reach the most robust estimations. The SDM of Eqs. (1) and (2) might be expressed as follows:

$$\begin{aligned} CO_{2\,it} = \alpha_0 + \alpha_1 Y_{it} + \alpha_2 Y_{it}^2 + \alpha_3 ME_{it} + \alpha_4 REC_{it} \\ + \beta_1 W.Y_{it} + \beta_2 W.Y_{it}^2 \\ + \beta_3 W.ME_{it} + \beta_4 W.REC_{it} \\ + \delta_1 W.CO_{2\,it} + v_{1i} + u_{1t} + \Omega_{1it} \end{aligned} \tag{3}$$

$$\begin{aligned} CO_{2\,it} = \alpha_0 + \alpha_1 Y_{it} + \alpha_2 Y_{it}^2 + \alpha_3 ME_{it} + \alpha_4 REC_{it} \\ + \alpha_5 D_{it} * ME_{it} + \beta_1 W.Y_{it} \\ + \beta_2 W.Y_{it}^2 + \beta_3 W.ME_{it} \\ + \beta_4 W.REC_{it} + \beta_5 W.D_{it} * ME_{it} \\ + \delta W.CO_{2\,it} + v_{2i} + u_{2t} + \Omega_{2it} \end{aligned} \tag{4}$$

In Eqs. (3) and (4), the weight matrix (W) has dimensions of 19 rows and 19 columns, which carries the inverse distance between MENA economies and is normalized using the method of Kelejian and Prucha [64]. The coefficients β and δ are the potential spatial effects of the independent variables and CO_2 emissions, respectively, to capture the spillover effect. The SDM will be regressed with both specifications of FE and Random Effects (RE). Later, the best spatial specification of FE or RE will be determined by the Hausman test. Moreover, Elhorst [65] suggested applying the Wald test to the SDM to test its specification against the other spatial techniques of SAR and SEM. All estimation procedures have been adopted by using the commands provided by Belotti et al. [66].

4. DATA ANALYSES

In Table 1, the mean values for all variables are greater than their corresponding Standard Deviations (SD), except for REC_{it} and $D_{it}*ME_{it}$. This indicates that most variables exhibit under-dispersion, which reflects that their values are relatively clustered around the mean and reflect less variability. However, REC_{it} is over-dispersed as the SD is larger than its mean. These results depict that most MENA countries are using a minute figure of REC (less than 1% of the GDP) and some MENA countries are using a high-level REC. For instance, Israel is significantly using more than 12% REC of total energy, which is significantly higher compared to its counterpart MENA countries. Similarly, the variable $D_{it}*ME_{it}$ is showing a high dispersion. It is claimed due to a reason that many MENA countries are having fewer wars and conflicts compared to the other economies.

The MENA countries are expected to have spillovers in military spending and its consequent emissions. To test the expected spillovers, we apply non-spatial models for Eq. (1) as a preliminary step to test the spatial autocorrelation. Table 2 presents the results of the POLS and FE models with different possible specifications and without incorporating spatial dimensions, which can be later tested by applying the spatial tests as suggested by Elhorst [61]. To verify this, LM and robust LM tests are applied as suggested by Anselin et al. [62], which confirm the spatial effects in all estimated non-spatial models at a 1% level of significance. These results indicate that spatial dependency exists in all models, which corroborates the biased estimates from the estimated non-spatial models. Despite this fact of biased estimates, the non-spatial results are just shown to depict a complete view of the spatial and non-spatial analyses. In the non-spatial estimates, the EKC is validated. Moreover, REC is found helpful in reducing CO_2 emissions and military expenditures are raising CO_2 emissions.

Table 1. Descriptive statistics

Variable	Mean	SD	Minimum	Maximum	Observations
CO_{2it}	1.6641	1.2154	-1.1760	3.8640	456
Y_{it}	8.7952	1.3144	5.8835	11.4931	456
Y_{it}^2	79.0792	23.1219	34.6151	132.0924	456
REC_{it}	4.7143	7.4778	0	34.4000	456
ME_{it}	4.3827	2.7283	0.4374	15.4796	456
$D_{it}*ME_{it}$	1.2189	2.3495	0	13.3257	456

Our objectives also include testing the moderating impact of wars and conflicts in the connection between military expenditures and CO_2 emissions. Table 3 shows the estimates from POLS and FE models with different possible specifications and without incorporating spatial dimensions from Eq. (2). LM and robust LM tests substantiate the existence of the spatial effects in all estimated non-spatial models at a 1% level of significance. Thus, spatial dependency also exists in all estimated models from Eq. (2). Thus, the results are biased from the estimated non-spatial models. The results of Eq. (2) are almost the same as those of Eq. (1) in Table 2. In addition, the moderating effect of wars and conflicts is statistically significant. However, all results in Tables 2 and 3 are biased with the proven spatial autocorrelation in Eqs. (1) and (2). Thus, we move to spatial estimations using Eqs. (3) and (4).

Table 4 shows the results from Eqs. (3) and (4) with and without the moderating role of wars and conflicts, which are regressed with both FE and RE to test the most suitable specification. All the mentioned spatial models, SDM-FE and SDM-RE with and without moderating effects of wars and conflicts, are regressed. Then, the Wald test is applied and null hypotheses are rejected at a 1% level of significance. Thus, SDM-FE and SDM-RE with and without moderating effects of wars and conflicts cannot be reduced to SAR and SEM specifications. Thus, the Wald test corroborates that SDM-FE and SDM-RE have better specifications than SAR and SEM. Moreover, the Hausman test is applied to test whether SDM-

RE is superior to SDM-FE. The null hypothesis is rejected for both types of models with and without moderating effects of wars and conflicts. Thus, SDM-FE is the best specification for both models with and without moderating effects of wars and conflicts. Thus, SDM-FE is chosen to interpret the final results.

Table 2. Non-spatial analysis without interaction effect

Regressors	POLS	FE-Countries	FE-Time	FE-Both
Y_{it}	0.9066 (0.000)	0.4446 (0.002)	1.0660 (0.000)	0.3871 (0.003)
Y_{it}^2	-0.0138 (0.287)	-0.0216 (0.010)	-0.0193 (0.082)	-0.0091 (0.241)
REC_{it}	-0.0538 (0.000)	-0.0344 (0.000)	-0.0503 (0.000)	-0.0398 (0.000)
ME_{it}	0.0308 (0.000)	0.0094 (0.074)	0.0239 (0.001)	0.0227 (0.000)
Spatial and diagnostic tests				
LM-lag	485.367 (0.000)	298.856 (0.000)	569.826 (0.000)	783.652 (0.000)
Robust LM-lag	31.852 (0.000)	28.365 (0.000)	45.685 (0.000)	69.854 (0.000)
LM-error	521.429 (0.000)	398.624 (0.000)	865.654 (0.000)	459.514 (0.000)
Robust LM-error	35.654 (0.000)	34.632 (0.0000)	69.847 (0.000)	51.856 (0.000)
σ^2	0.2108	0.0321	0.1534	0.0045
R^2	0.8585	0.9793	0.9023	0.9766

Table 3. Non-spatial analysis with interaction effects of wars and conflicts

Regressors	POLS	FE-Countries	FE-Time	FE-Both
Y_{it}	0.7519 (0.001)	0.4337 (0.003)	0.9731 (0.000)	0.3890 (0.003)
Y_{it}^2	-0.0049 (0.689)	-0.0200 (0.017)	-0.0144 (0.190)	-0.0091 (0.240)
REC_{it}	-0.0567 (0.000)	-0.0342 (0.000)	-0.0521 (0.000)	-0.0398 (0.000)
ME_{it}	0.0450 (0.000)	0.0093 (0.075)	0.0318 (0.000)	0.0228 (0.000)
$D_{it}*ME_{it}$	0.0441 (0.000)	0.0118 (0.032)	0.0321 (0.000)	0.0019 (0.072)
Spatial and diagnostic tests				
LM-lag	254.891 (0.000)	180.235 (0.000)	541.250 (0.000)	358.362 (0.000)
Robust LM-lag	41.524 (0.000)	57.652 (0.000)	29.521 (0.000)	42.638 (0.000)
LM-error	351.254 (0.000)	189.574 (0.000)	632.846 (0.000)	298.638 (0.000)
Robust LM-error	47.652 (0.000)	40.254 (0.0000)	32.854 (0.000)	40.524 (0.000)
σ^2	0.1866	0.0318	0.1492	0.0256
R^2	0.8750	0.9795	0.9052	0.9827

Table 4. Spatial model with weight matrix of inverse distance

Variables	Without Moderation Effect		With Moderation Effect	
	FE-both	RE-both	FE-both	RE-both
Point Effects				
Y_{it}	0.6247 (0.000)	0.6019 (0.000)	0.7106 (0.000)	0.6927 (0.000)
Y_{it}^2	-0.0249 (0.001)	-0.0222 (0.005)	-0.0281 (0.000)	-0.0255 (0.001)
REC_{it}	-0.0313 (0.000)	-0.0328 (0.012)	-0.0303 (0.000)	-0.0319 (0.000)
ME_{it}	0.0112 (0.019)	0.0122 (0.012)	0.0116 (0.013)	0.0126 (0.008)
$D_{it}*ME_{it}$	-	-	0.0012 (0.003)	0.0634 (0.015)
Direct Effects				
Y_{it}	0.6285 (0.000)	0.6050 (0.000)	0.7152 (0.000)	0.6973 (0.000)
Y_{it}^2	-0.0253 (0.002)	-0.0225 (0.006)	-0.0285 (0.000)	-0.0259 (0.001)
REC_{it}	-0.0307 (0.000)	-0.0321 (0.000)	-0.0297 (0.000)	-0.0313 (0.000)
ME_{it}	0.0106 (0.023)	0.0114 (0.015)	0.0113 (0.013)	0.0122 (0.009)
$D_{it}*ME_{it}$	-	-	0.0011 (0.000)	0.0015 (0.096)
Indirect Effects				
Y_{it}	-0.2138 (0.000)	-0.2204 (0.000)	-0.1420 (0.005)	-0.1524 (0.002)
Y_{it}^2	-0.0009 (0.545)	-0.0013 (0.394)	-0.0006 (0.722)	-0.0008 (0.609)
REC_{it}	0.0148 (0.271)	0.0228 (0.126)	0.0106 (0.438)	0.0178 (0.171)
ME_{it}	0.0772 (0.000)	0.0723 (0.000)	0.0761 (0.000)	0.0690 (0.000)
$D_{it}*ME_{it}$	-	-	0.0462 (0.000)	0.0488 (0.000)
Total Effects				
Y_{it}	0.4147 (0.004)	0.3846 (0.010)	0.5732 (0.000)	0.5448 (0.000)
Y_{it}^2	-0.0263 (0.002)	-0.0238 (0.007)	-0.0291 (0.000)	-0.0267 (0.002)
REC_{it}	-0.0158 (0.300)	-0.0097 (0.542)	-0.0191 (0.211)	-0.0135 (0.341)
ME_{it}	0.0878 (0.000)	0.0837 (0.000)	0.0874 (0.000)	0.0812 (0.000)
$D_{it}*ME_{it}$	-	-	0.0473 (0.001)	0.0503 (0.001)
Weighted Effects				
$W*CO_{2it}$	0.0348 (0.025)	0.0504 (0.036)	0.0179 (0.074)	0.0311 (0.057)
$W*Y_{it}$	-0.2307 (0.000)	-0.2454 (0.000)	-0.1572 (0.000)	-0.1689 (0.000)
$W*REC_{it}$	0.0146 (0.275)	0.0230 (0.093)	0.0107 (0.416)	0.0188 (0.165)
$W*ME_{it}$	0.0754 (0.000)	0.0692 (0.000)	0.0746 (0.000)	0.0682 (0.000)
$W* D_{it}*ME_{it}$	-	-	0.0455 (0.000)	0.0485 (0.000)
Spatial and Diagnostic tests				
R^2	0.7963	0.7468	0.7997	0.8491
σ^2	0.0257 (0.000)	0.0269 (0.000)	0.0179 (0.746)	0.0252 (0.000)
Hausman Test	51.57 (0.000)	-	47.14 (0.000)	-
Spatial Lag-Wald Test	84.30 (0.000)	97.63 (0.000)	93.23 (0.000)	125.63 (0.000)
Spatial Error-Wald Test	51.61 (0.000)	53.63 (0.000)	62.10 (0.000)	86.35 (0.000)

In the SDM-FE, the effect of $W*CO_{2it}$ is positive in both models with and without moderation effect. Thus, the CO_2 emissions of one MENA country have spillovers in the neighboring counterparts. This result is matched with the conclusions of [45]. Moreover, the result also validates that CO_2 emissions are global emissions [59]. Thus, increasing CO_2 emissions can be transferred to neighboring countries due to common air quality and topographical features within the MENA region. Moreover, it also corroborates that the environmental policies of the MENA economies are interconnected [60]. Moreover, the effects of W*ME_{it} and W* D_{it}*ME_{it} are also positive. Thus, military expenditures and wars and conflicts of one country are also responsible for transferring CO_2 emissions to the other MENA economies. However, the influence of W*REC_{it} is insignificant and the effect of W*Y_{it} is negative. Thus, the REC of one country could not reduce emissions in neighboring economies with spillovers.

The results further expose that the EKC is substantiated by the positive and negative effects of Y_{it} and Y_{it}^2 in all results. Similarly, the literature has also validated the EKC in the nexus between economic progress and emissions in BRICS [19], in nuclear economies [15], in Ghana [25], and in South Asia [28]. Moreover, some MENA studies also have corroborated the EKC [44, 45, 51]. The presence of the EKC substantiates that the economic progress of this region has environmental problems at an earlier stage, which would be reversed at the later stages of economic progress.

REC has negative effects in point and direct estimates. Thus, REC helps to reduce emissions in the local economies. In military expenditure literature, the pleasant environmental effect of REC has also been substantiated in North Africa [8], the USA [14], Pakistan, India, and China [16], and in G7 economies [18]. Ignoring military spending in the model, some studies also substantiate a negative effect of REC on emissions in MENA economies [47, 48]. However, REC could not reduce CO_2 emissions in indirect and total estimates.

The effect of ME_{it} is positive in all estimates. Ignoring the potential spatial effect, the literature has also verified the positive influence of military expenditures on emissions in G20 economies [9], in 35 SSA economies [10], in Pakistan [11], in 40 African countries [12], in 15 NATO countries [13], and in Pakistan, India, and China [16]. Conversely, some studies also find the negative effect of military expenditures on emissions in the USA [14], in nuclear nations [15], and in G7 economies [17]. In addition, we contribute to the literature substantiating the positive spatial effect of military spending on CO_2 emissions. Military expenditures could raise the emissions in neighboring economies through different channels. For instance, the trade of military products in nearby countries can motivate them to produce and export such products. Thus, the production and exports of these products are energy-intensive activities, which can release emissions. Moreover, military exercises on borders can pollute the bordering economies as well. In the case of non-friend economies, increasing military spending of one economy can force to increase military spending in neighboring economies. Such increased military spending in neighboring economies would raise emissions due to the production activities of military items.

Table 5. Spatial model with the weight matrix of neighboring countries

Variables	Without Moderation Effect		With Moderation Effect	
	FE-both	RE-both	FE-both	RE-both
Point Effects				
Y_{it}	0.3930 (0.003)	0.3752 (0.005)	0.4736 (0.000)	0.4581 (0.001)
Y_{it}^2	-0.0097 (0.021)	-0.0068 (0.039)	-0.0137 (0.084)	-0.0108 (0.182)
REC_{it}	-0.0342 (0.000)	-0.0361 (0.000)	-0.0334 (0.000)	-0.0354 (0.000)
ME_{it}	0.0171 (0.000)	0.0182 (0.000)	0.0168 (0.001)	0.0179 (0.000)
D_{it}*ME_{it}	-	-	0.0003 (0.095)	0.0012 (0.083)
Direct Effects				
Y_{it}	0.3783 (0.005)	0.3596 (0.010)	0.4657 (0.001)	0.4482 (0.002)
Y_{it}^2	-0.0092 (0.255)	-0.0062 (0.451)	-0.0134 (0.010)	-0.0105 (0.213)
REC_{it}	-0.0335 (0.000)	-0.0352 (0.000)	-0.0327 (0.000)	-0.0346 (0.000)
ME_{it}	0.0157 (0.001)	0.0168 (0.000)	0.0156 (0.001)	0.0167 (0.001)
D_{it}*ME_{it}	-	-	0.0003 (0.095)	0.0006 (0.091)
Indirect Effects				
Y_{it}	-0.1139 (0.001)	-0.1192 (0.001)	-0.0846 (0.017)	-0.0940 (0.008)
Y_{it}^2	0.0050 (0.008)	0.0052 (0.009)	0.0038 (0.049)	0.0042 (0.033)
REC_{it}	0.0116 (0.530)	0.0163 (0.353)	0.0111 (0.518)	0.0179 (0.303)
ME_{it}	0.0786 (0.000)	0.0743 (0.000)	0.0741 (0.000)	0.0715 (0.000)
D_{it}*ME_{it}	-	-	0.0390 (0.030)	0.0398 (0.014)
Total Effects				
Y_{it}	0.2644 (0.055)	0.2404 (0.038)	0.3811 (0.036)	0.3542 (0.023)
Y_{it}^2	-0.0042 (0.072)	-0.0010 (0.050)	-0.0096 (0.028)	-0.0063 (0.017)
REC_{it}	-0.0219 (0.292)	-0.0189 (0.324)	-0.0215 (0.260)	-0.0167 (0.383)
ME_{it}	0.0943 (0.001)	0.0911 (0.005)	0.0897 (0.003)	0.0882 (0.006)
D_{it}*ME_{it}	-	-	0.0393 (0.037)	0.0404 (0.027)
Weighted Effects				
W*CO_{2it}	0.1809 (0.002)	0.1864 (0.002)	0.1622 (0.008)	0.1656 (0.007)
W*Y_{it}	-1.0179 (0.000)	-1.0559 (0.000)	-0.8113 (0.005)	-0.8541 (0.004)
W*REC_{it}	0.0151 (0.304)	0.0206 (0.163)	0.0147 (0.315)	0.0197 (0.181)
W*ME_{it}	0.0686 (0.000)	0.0653 (0.000)	0.0671 (0.000)	0.0639 (0.000)
W* D_{it}*ME_{it}	-	-	0.0334 (0.026)	0.0345 (0.023)
Spatial and Diagnostic tests				
R^2	0.8145	0.8287	0.8573	0.8644
σ^2	0.0259 (0.000)	0.0271 (0.000)	0.0256 (0.000)	0.0269 (0.000)
Hausman Test	53.73 (0.000)	-	40.72 (0.000)	-
Spatial Lag-Wald Test	74.02 (0.000)	82.03 (0.000)	38.41 (0.000)	30.94 (0.000)
Spatial Error-Wald Test	55.56 (0.000)	60.91 (0.000)	29.26 (0.000)	41.46 (0.000)

Lastly, the effect of D_{it}*ME_{it} is also found positive in all estimates. Thus, increasing wars and conflicts raise military spending, which will lead to more production and transportation of military equipment and products, which are pollution-oriented activities and contribute to CO_2 emissions. Furthermore, the spillover effect of D_{it}*ME_{it} is also found positive, which explains that increasing wars and conflicts in one MENA country also increase the military spending and emissions in neighboring countries. This result is factual as increasing wars and conflicts in one country can directly contribute to CO_2 emissions in neighboring economies as these are global emissions. Secondly, increasing wars and conflicts in one country would also increase military spending in case of enemy neighboring countries. Thirdly, wars and conflicts in one country can demand military products from neighboring countries, which might pollute these neighboring economies due to involvement in the production of military items. In addition, the robustness of spatial linkages has been tested by employing the weight matrix of neighboring countries, and the results are presented in Table 5. This weight matrix is assumed 1 for neighboring economies and zero otherwise. The results for all weighted variables are consistent with those obtained using the inverse distance weight matrix. Moreover, the results of indirect effects are the same except for the coefficients of Y_{it}^2, which corroborates that the indirect effects of economic growth are U-shaped. However, other all conclusions are the same from direct and total effects. Thus, the robustness checks confirm the consistency and validity of the results from the weight matrix of inverse distance.

5. CONCLUSIONS

Military spending could increase the production, transportation, and utilization of military equipment, which could contribute to pollution emissions. Therefore, we examine the effects of military spending on CO_2 emissions in the MENA region. In addition, the study also tests the moderating effect of wars and conflicts in the nexus between military spending and emissions, which is missing in the global literature. To achieve these objectives, the study uses a novel spatial econometric technique, and a sample of 19 MENA countries for a period of 1997-2020. Moreover, the effects of economic progress and REC on CO_2 emissions are also tested. The results substantiate the nonlinear nexus between economic progress and CO_2 emissions, which substantiates the EKC in the MENA region. Moreover, the spillovers of CO_2 emissions of one country are found positive on CO_2 emissions in neighboring countries, which corroborates that CO_2 is global emissions. The effect of REC is found negative on local economies' CO_2 emissions. Thus, REC reduces CO_2 emissions in local economies. Nevertheless, the spillovers of REC and total regional effects are found insignificant, which recalls the fact that REC is very heterogeneous in amount in all MENA countries.

The effects of military expenditures on CO_2 emissions are found positive in local, neighboring, and the entire region. Thus, military expenditures have environmental consequences in local economies due to the local production, transportation, and utilization of military equipment, which are all pollution-oriented activities. The positive spillovers of military expenditures in local economies on CO_2 emissions of neighboring economies lead to many conclusions. For instance, this result indicates that there can be possible trade of military equipment in the MENA economies. Thus, increasing military spending in one economy would raise CO_2 emissions in neighboring economies. Moreover, it also corroborates that some MENA economies are feeling the pressure of increasing military spending in neighboring economies, which motivates them to do more military spending in local economies in response and polluting their environment. In addition, military spending and exercise on the border of one economy can damage the environment of bordering economies. Furthermore, the positive moderating effect of wars and conflicts is also found in the relationship between military spending and CO_2 emissions in local, neighboring, and the entire region. This result substantiates that increasing wars and conflicts in MENA economies are responsible for more military spending and CO_2 emissions in local economies. Moreover, the spillovers of the moderating effect are also found positive. Thus, increasing wars and conflicts in one MENA country would also increase the military spending and emissions in neighboring countries.

Based on the estimated effect of REC on emissions, we recommend that MENA countries should increase the REC. For this purpose, MENA economies should spend more on the installation of renewable energy projects. Most MENA economies are highly dependent on fossil fuels and the transition toward REC can reduce CO_2 emissions in these economies. Moreover, the MENA governments should provide financial and nonfinancial incentives to the producers and communities for the production and use of renewable sources of energy. In addition, innovation activities in renewable energy markets should be supported by governments to find alternatives to fossil fuels in MENA economies. Moreover, military spending should be reduced to reduce environmental problems out of military spending and operations. The study's findings confirm that military expenditures, along with their interaction with wars and conflicts, contribute to CO_2 emissions not only within individual MENA economies but also in neighboring countries and across the entire region. Therefore, MENA countries are advised to resolve political conflicts to alleviate the burden of military spending on their budgets, reduce the need for extensive military operations, and mitigate the environmental impact of military expenditures and warfare. For instance, all MENA countries should take proactive steps to resolve the ongoing Israel-Gaza conflict to reduce military operations in the region. For this purpose, the MENA countries could seek the assistance of international institutions to restore peace in the region. Furthermore, MENA governments should sign treaties to limit military spending as a percentage of GDP to foster a more stable political and physical environment across the entire region.

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