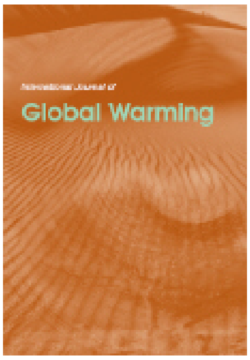

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Appraising the role of energy subsidy on the environmental sustainability in Arab Nations - is it compatible or confronting?

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Appraising the role of energy subsidy on the environmental sustainability in Arab Nations – is it compatible or confronting?

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Abstract: The current study assesses the influence of energy subsidies as an independent variable, as well as, economic progress, energy usage, and trade openness as control variables on carbon dioxide emissions in Arab countries which are considered both top energy subsidy providers and carbon dioxide (CO_2) emitters, called the United Arab Emirates, Saudi Arabia, Qatar, Libya, Kuwait, Iraq, Egypt, Bahrain and Algeria from 2010 to 2019 using pooled ordinary least squares (OLS), fixed effects, and random effects approaches. The findings signify that energy subsides, economic progress, and energy usage are all significantly and positively connected with environmental deterioration except trade openness has a negative influence. The pairwise panel causality results indicate that both carbon dioxide and economic progress cause trade openness. It may put pressure on policymakers to expedite the transition to low-carbon energy subsidies, implement carbon taxes on consumer goods that use fossil fuels in the manufacturing process, and promote energy efficiency.

Keywords: energy subsidy; economic growth; energy consumption; CO_2; Arab countries.

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1 Introduction

Industrial emissions, liberalisation, and the technology age, which launched around the globe at the beginning of the nineteenth century, expanded energy requirements because new automated production techniques necessitated the growth of the energy industry. In order to expand their economies and minimise inequality, developing countries, in particular, drive their economic operations to increase industrialisation and output levels. As a result, economic activities aimed at advancing the economy increase the demand for energy subsidies (Wrigley, 2013). So, many national governments have taken steps to address the situation. In accordance with the Intergovernmental Panel on Climate Change (IPCC), GHGs, mainly CO_2 emissions, have been the foremost driver of climate warming. Also, with the goal of keeping global warming below 2°C and ongoing attempts to keep it below 1.5°C, the 2015 Paris Climate Conference interacts with the ability to cope with climatic change issues after 2020 (Delbeke et al., 2019).

Environmental risk, according to the World Economic Forum 2021, such as climatic change, resource exhaustion, and extreme meteorological events, has become the highest-ranking global risk owing to conventional fossil energies (WEF, 2021). It is now commonly acknowledged that any objective for reducing global CO_2 emissions cannot be met unless developing countries, which account for more than one-half of world CO_2 emissions, commit to doing so. Numerous developing nations, comprising a few in Asia and Latin America but a considerable majority in Northern Africa and the Middle East (MENA) region, subsidise fossil energy resources considerably for social-political purposes. Consequently, the need for these fuels has promptly risen, leading to significant economically and environmentally liabilities for these nations (Aryanpur et al., 2022; Ibrahiem, 2015). According to World Bank data, Arab countries, called the United Arab Emirates, Saudi Arabia, Qatar, Libya, Kuwait, Iraq, Egypt, Bahrain and Algeria, located in the MENA region recorded more than 60% of total emissions in this region.

Moreover, many emerging countries have initiated fossil fuel subsidies to improve justice and social welfare systems, improve energy supply security and economic development, encourage local production and employment, and manage volatility. They may have negative consequences by encouraging wasteful energy usage, which diminishes the motivation to invest in energy-saving and green energy technology, among other things. According to IEA 2021, many developing countries, particularly Arab countries, continue to modify their subsidy programs, but following declining fossil fuel costs in 2020, which reached a low of around USD 180 billion, down 40% from 2019 levels, subsidies surged again in 2021 to USD 440 billion, and the same level as in 2018. Arab countries located in the MENA region, named the United Arab Emirates, Saudi Arabia, Qatar, Libya, Kuwait, Iraq, Egypt, Bahrain and Algeria,, are among the top countries that provide the largest subsidies in their energy sector especially oil and gas which remain the most subsidised fuel [International Energy Agency (n.d.)].

Saudi Arabia ranked the largest Arab countries in providing energy subsidy recorded more than 2,500 Exajoule (Ej). Followed by Egypt, Algeria which provide more than 1,500 Ej while Qatar is considered the lowest one in Arab countries. This matched with (EIA) reports that showed fossil energies, notably petroleum and natural gas, still provide more than 95% of the country's primary energy in Egypt (US EIA, 2018). In addition, with roughly 20% of global output, Iraq, Kuwait and Saudi Arabia have the greatest rates of fossil fuel production (Al-Naffakh et al., 2021).

Furthermore, environmental issues are pressured by energy consumption especially related to fossil energies usage. Developing countries strive for higher economic rates, which necessitates more usage of common energy reserves, such as oil and natural gas, which pollutes and destroys the environment, making renewable energy the best option. It is well recognised that if renewables are employed effectively, it can secure twice the current pace of global energy consumption (Esily et al., 2022a; Nurgazina et al., 2021).

Also, environmental threats may be boosted by trade openness depending on the channel via which it arrives. Because of poor environmental restrictions that attract pollution-intensive businesses, the detrimental impact in emerging countries is significant. International relations between governments and multinational firms have permitted some diffusion of technological advancements into developing countries, which has helped to promote a cleaner environment in some ways (Dauda et al., 2021).

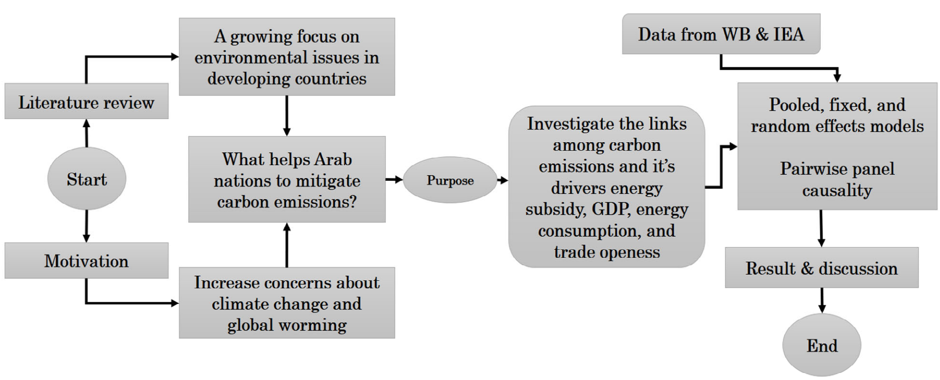
It is important to mention that improving the understanding of driver factors of environmental deterioration is not only relevant for achieving sustainable development but is also important for catalysing the global transition to low-carbon age, environmentally friendly energy processes. So, our study focuses on analysing energy subsidy on the environment as well as economic progress, energy usage, and trade openness during the period from 2010 to 2019 for Arab countries, named the United Arab Emirates, Saudi Arabia, Qatar, Libya, Kuwait, Iraq, Egypt, Bahrain and Algeria, which are considered the leading fossil fuel energy subsidy providers and CO_2 emitters using pooled, fixed, and random-effects models.

Based on the aforementioned debate, empirical investigation into the drivers of environmental threat in Arab countries, is critical with a view to developing a set of policy actions aimed at accelerating the phasing out of energy subsidy on fossil fuels. The following are the significant contributions of this work; there are three primary aspects: firstly, the current study assesses the influences of energy subsidy on CO_2 emissions in leader energy subsidy Arab countries; this study would assist in better understanding the relative impact of energy subsidy on environmental issues. Secondly, in these Arab selected countries, no empirical research has yet focused on these indicators for the elimination of CO_2 emissions. Thirdly, based on the results, various recommendations can be suggested to help in the transition to low carbon energy era.

The findings reveal that energy subsides, economic progress, and energy usage are all significantly and positively connected with environmental deterioration except trade openness has a negative influence. The pairwise panel causality results indicate that both carbon dioxide and economic progress cause trade openness.

Figure 1 shows the diagram of the paper's structure. After this introduction, Section 2 will focus on the literature review. The research technique and data descriptions are presented and discussed in Section 3. Section 4 presents empirical findings, which are followed by a discussion of the empirical findings in Section 5. The study's main conclusions and policy implications are addressed in Section 6.

Figure 1 Roadmap of this paper



2 Literature review

Poor environmental quality, as evidenced by high air pollution in general and an increasing rate of carbon dioxide emissions in particular, have negative consequences for health, civilisation, and the ecosystem, resulting in substantial economic costs. As a result, many academics are paying close attention to empirically investigating the causes of environmental degradation. The literature review will be divided into four strands depending on the factors that cause environmental pollution and are important to our empirical investigation. In the first strand, the environmental quality-energy subsidy link will be discussed; in the second strand, the economic growth-environmental qualities link will be examined; in the third and fourth strands, the energy consumption-environmental quality link and trade openness-environmental quality link will be summarised respectively.

2.1 The energy subsidies and environmental quality

The first strand looked into the relationship between environmental quality and energy subsidies. Energy subsidies are policies that maintain customer prices lower than market rates, raise supplier prices over market rates, or lower customer and supplier costs. As a result, for universal future sustainable growth, a detailed overview of the links between energy subsidies and CO_2 emissions is needed. As a result, the link between energy subsidies and CO_2 emissions has long been a source of debate in the field of pollution control. So, many scholars studied this relationship and the final conclusions of this research were mixed. Some researchers have claimed that the accelerating rate of environmental deterioration is considered a negative aspect of (fossil) energy subsidies and that this may have negative consequences by encouraging wasteful energy usage, lowering motivation to invest in energy-saving and green energy technology, and thus confirming the importance of phasing out energy subsidies through reforms initiatives, and among these scholars are (Jewell et al., 2018; Monasterolo and Raberto, 2019).

Other scholars, on the other hand, confirm that (green) energy subsidies improve environmental quality, which may reflect improvements in energy efficiency measures and diversification of the energy mix by increasing reliance on clean energy sources through government-provided green loan subsidies or via foreign aids and subsides as mentioned in Mahalik et al. (2021), Wu and Qu (2021) respectively. Also, even though several developing countries, especially Arab countries, have implemented numerous energy subsidy reforms, these measures are insufficient and do not modify the Arab nations' environmental compact as mentioned in (Al-Saidi, 2022; Gelan, 2018).

2.2 The economic progress and environmental quality

The second strand explored the correlation between environmental qualities and economic growth, with mixed results. Some academics concluded that economic growth is seen as a necessary goal for achieving sustainable development, and as a result, economic success is seen as a stimulant that accelerates environmental damage, particularly in the early stages of growth, when countries rely on fossil fuels as Saint Akadiri et al. (2019) for Italy, Ibrahiem (2020) for Egypt, Namahoro et al. (2021) for African countries, and Ibrahim and Alola (2020) for MENA countries.

Other authors, on the other hand, agree that economic growth improves environmental quality, which could be due to increased energy-efficient technologies, the sharing of information of environmental knowledge and training, encouraging energy new ideas and technologies, and the expansion of the energy mix by increasing reliance on renewable generation as Danish and Wang (2018) for BIRCS countries, and Solarin et al. (2021) for Nigeria in the long run. Furthermore, there were mixed results in terms of causality. It was discovered that there is a two-way causal link between economic progress and environmental quality (Rahman et al., 2021). Furthermore, no causation was detected (Richmond and Kaufmann, 2006).

2.3 The energy consumption and environmental quality

The third strand focused on research into the energy consumption-environmental deterioration link were with various studies concluding that energy subsidy and economic progress are not the only fundamental variables affecting the environment, but energy consumption is one of the significant elements that influence environmental quality. Energy consumption is a mirror of the manufacturing of goods, which fuels economic expansion, and more things equal more growth. As a result, energy and how it is used are key components of human society's long-term growth and substantial challenges (Nawaz et al., 2021).

So, many academics study this link and conducted mixed results; some studies have clearly highlighted the serious risk that the forms of traditional energy consumption (fossil energies) pose to the environment's pollution and deterioration as conducted in Nathaniel and Adeleye (2021) for selected African countries and Arshad et al. (2020) for Asian economies. These validated findings have led to numerous studies on clean/green energy consumption (renewable energies), which is widely regarded as the best alternative for reducing CO_2 emissions and thereby improving environmental quality such as Sohail et al. (2021) for Pakistan and Sherif et al. (2022) for N11 countries.

2.4 The trade openness and environmental quality

Lastly, the final strand of our literature review concentrated upon the interaction between trade openness and environmental quality. The sum of commodities and services exported and imported as a percentage of GDP is known as trade openness (Salik and Aras, 2022). Many researchers have concluded that more openness leads to increased economic activity via greater transportation services, manufacturing, and usage of products, all of which have significant environmental costs for example: Nurgazina et al. (2021) for Malaysia, and Yu et al. (2019) for CIS countries.

Other authors showed that the expansion of ecologically friendly and energy-saving production methods among countries can lead to lower pollution, thereby trade openness is good for the environment such as Khan et al. (2021a) for 176 countries of the world, (Park et al., 2018) for panel data. Furthermore, there were mixed results in terms of developed and developing countries, depending on the pollution, the nation, and the GDP per capita, trade openness had a different influence on environmental quality as conducted in Iqbal et al. (2021), and Khan et al. (2021b).

As mentioned in the literature review, previous research examining the link between environmental quality, energy subsidies, economic progress, energy consumption, and trade openness have provided conflicting results, and only just few studies have looked into the influence of energy subsidies on the environment in the world's top energy subsidy payers in general and Arab countries in particular. As a result, our research will look into the linkages between environmental quality, energy subsidies, economic progress, energy consumption, and trade openness in Arab nations in order to close the gap in prior research.

3 Methodology

3.1 Econometric model and data

The present study's objective is to examine specific factors on CO_2 emissions in certain Arab countries over the period 2010–2019. Relying on the theoretical framework of variables affecting environmental quality which is pointed out in previous literature review, the following equation is formulated as follows:

$$LCO_{2_{it}} = f\left(LENERGSUB_{it}, LGDP_{it}, ENERGCON_{it}, TRAD_{it}\right) \quad (1)$$

$$LCO_{2_{it}} = \alpha + \beta_1 LENERGSUB_{it} + \beta_2 LGDP_{it} + \beta_3 ENERGCON_{it} + \beta_4 TRAD_{it} + \varepsilon_{it} \quad (2)$$

According to the determined equation, the symbols t, i, β, α, and ε denote time period, cross sections, partial slope coefficients, intercept term, and stochastic error term respectively.

Regarding variables concerned, CO_2 emissions from fuel combustion ($MtCO_2$) represent the endogenous variable. While energy subsidy (ENERGSUB Real 2019 million USD), GDP per capita (constant 2015 US$), Energy Consumption [ENERGCON Exajoule (Ej)], and trade openness [TRAD (% of GDP)] are used as exogenous variables. The data of these variables are obtained from two main sources namely World Bank and International Energy Agency. Moreover, the main outcomes regarding descriptive statistics of variables show that the mean of LENERGSUB and ENERGCON is 9.04 and 1.64 respectively over the whole countries concerned. Moreover, Saudi Arabia has the maximum value of LENERGSUB and ENERGCON (11.17 and 6.40 respectively), while Bahrain recorded the minimum value of both (6.03 and 0.21 respectively). Also, Saudi Arabia is considered as the highest emitter of CO_2 emissions in our sample with a maximum value estimated with 6.27, while Bahrain was the lowest one with a minimum of 3.23.

It is worth noting from a statistical perspective to observe distribution of the variables. Only LCO_2, LENERGSUB, and TRAD are normally distributed at 10% significance level.

The correlation matrix findings concluded that there is high association amongst LCO_2, LENERGSUB and ENERGCON. While the correlation among LCO_2 and TRAD is moderate.

3.2 Empirical procedures

3.2.1 Panel unit root tests

Many economic time series have high potential to be non-stationary. Additionally, the estimation of econometric model using such series leads to what is referred to as spurious regression, which means inaccurate regression results (Granger and Newbold, 1974).

Hence, unit root tests are employed to ensure stationarity of data series. In this regard there are two categories of panel unit root tests. The first category are tests with common unit root process (LLC and Breitung tests), while the second one are tests with individual unit root tests (IPS, Fisher-ADF, Fisher-PP, and Hadri tests) (Hlouskova and Wagner, 2006).

This study employs Levin, Lin and Chu (LLC) and Fisher-PP tests. In both the aforementioned tests, the null hypothesis states that the panel series has unit root (non-stationary). However, in LLC test the alternative hypothesis is identified as no unit root exists for all cross sections, but the alternative hypothesis in PP test is set as inexistence of a unit root in some cross sections (Levin et al., 2002; Maddala and Wu, 1999).

3.2.2 Panel co-integration test

The next step to tackle the non-stationarity property of variables is to test the presence of co-integration relationship amongst the concerned variables. Among different panel co-integration tests, two tests are chosen to be performed namely, Pedroni residual co-integration and Kao residual co-integration tests. Both tests evolved on the base of Engle-Granger two-step co-integration tests. The null hypothesis of both tests implies that there is no co-integration relationship between the variables (Kao, 1999; Pedroni, 2004).

3.2.3 Static panel data models

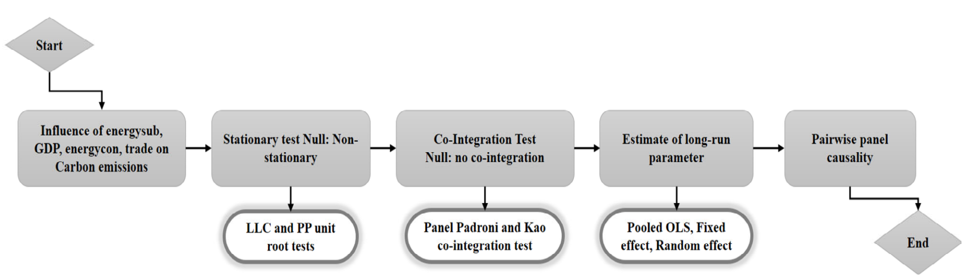
In static panel data models, three estimation techniques were developed which are pooled OLS, fixed effects, and random effects.

The pooled OLS method neglects the heterogeneity effects assuming the restriction of similarity of coefficients across cross-section and time. While, fixed effects method allows each observation to have its fixed intercept and/or coefficient value. Finally, the random effects estimation method assumes that the individual constant terms are randomly distributed across cross-sectional units (Greene, 2012; Gujarati, 2011).

3.2.4 Causality test of panel data

The causality test has the advantage of clearing the whole picture of the direction of impact among the different factors in model. This study uses stacked test and as a required condition the optimal lag length is determined by applying vector autoregressive model (Dumitrescu and Hurlin, 2012). All the steps employed in the empirical procedures are depicted in Figure 2.

Figure 2 Studying procedure for evaluating the Influence of ENERGSUB, GDP, ENERGCON, TRADE on CO_2



4 Empirical outcomes

The findings of panel unit root tests are depicted in Tables 1 and 2. Briefly, the variables LCO_2, LGDP, and TRAD are stationary at levels (I(0)), while, the variables LENERGSUB, ENERGCON become stationary after the conversion to first difference (I(1)).

Table 1 LLC panel unit root test

	At level		*1st difference*	
	Intercept	*Intercept and trend*	*Intercept*	*Intercept and trend*
LCO_2	–3.42926***	–6.59370***	5.62511***	–3.89380***
LGDP	–3.74142***	–2.76035***	–5.74388***	–8.05631***
ENERGCONS	–2.56709***	–4.77054***	–6.82140***	–7.87541***
LENERGSUB	–0.30872	–5.87368***	–5.39364***	–5.88649***
TRAD	–2.15457**	–6.33679***	–7.88487***	–6.92244***

Note: ***, and **signify 1% and 5%, significance level, respectively.

Table 2 Fisher-PP panel unit root

	At level		*1st difference*	
	Intercept	*Intercept and trend*	*Intercept*	*Intercept and trend*
LCO_2	52.0292***	26.5408*	39.2510***	38.1530***
LGDP	38.6073***	43.6454***	55.4677***	60.3566***
ENERGCONS	18.5554	26.1968*	59.0282***	52.5165***
LENERGSUB	6.84042	13.6768	29.9786**	29.7794**
TRAD	28.0197**	27.5915*	53.2592***	43.3755***

Note: ***, **and *signify 1%, 5% and 10%, significance level, respectively.

Pedroni residual co-integration test is conducted. Its results provide seven statistics, three out of these statistics reject the null hypothesis of co-integration. On the other side, the outcome of Kao residual co-integration test indicates the rejection of the null hypothesis. So, it can be concluded that there is a co-integration relationship between the CO_2, ENERGSUB, GDP, ENERGCON, and TRAD factors.

To determine the most accurate estimation technique, three tests were performed, which are likelihood ratio, Lagrange multiplier and Hausman tests (Wooldridge, 2010). This process is conducted through three steps.

The first step is to compare between pooled OLS and fixed effects through employing Likelihood ratio test. Its null hypothesis states that pooled OLS (restricted model) is the appropriate method of estimation. It is obvious from the outcomes that the null hypothesis is rejected.

In the second step, Lagrange multiplier test is applied to determine which pooled OLS or random effects is the best method to follow. The results figure out that random effects method is more appropriate to use.

Hausman test is conducted in the last step. It implies that random effects are uncorrelated with regressors which is the main assumption required for random effects method to obtain consistent and efficient estimates. The results of employing Hausman test points out that fixed effects method is the best efficient method to estimate the model.

Table 3 Fixed effects model estimation results

Variable	*Coefficient*	*t-statistic*	*Prob.*
LENERGSUB	0.253847***	5.271345	0.0000
LGDP	0.109104***	2.929352	0.0044
ENERGCON	0.278824***	9.116961	0.0000
TRAD	–0.004406***	–4.898859	0.0000
C	1.307021**	2.169862	0.0328

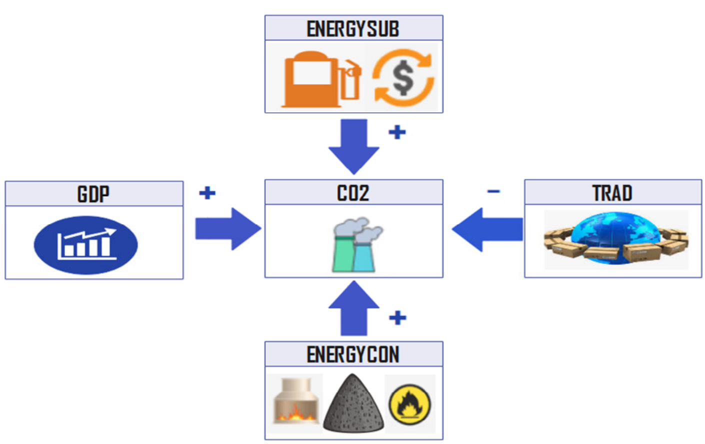
Note: *** and ** signify 1% and 5% significance level, respectively.

Table 4 Pairwise Granger causality test

Regrassand	*Regressors F-statistics (p-values)*				
	LCO_2	*LENERGSUB*	*LGDP*	*ENERGCON*	*TRAD*
LCO_2	-	2.12372 (0.1075)	0.31002 (0.8180)	0.98309 (0.4074)	0.63958 (0.5927)
LENERGSUB	0.96227 (0.4170)	-	1.68701 (0.1802)	0.54114 (0.6561)	1.34901 (0.2678)
LGDP	1.95641 (0.1310)	0.19963 (0.8962)	-	0.36019 (0.7820)	2.10520 (0.1098)
ENERGCON	0.30128 (0.8243)	0.39286 (0.7586)	0.01872 (0.9965)	-	0.01184 (0.9982)
TRAD	2.66931* (0.0563)	1.31534 (0.2785)	7.14864*** (0.0004)	0.14415 (0.9330)	-

Note: ***and *signify 1% and 10%, significance level, respectively.

Figure 3 Fixed effect model findings representation for the study variables (see online version for colours)



Two main features of fixed effects model results showed in Table 3 and Figure 3. First, there is a positive and significant impact of ENEGSUB, GDP and ENERGCON on CO_2 emissions at 1% level of significance. Second, TRAD factor negatively and significantly affects CO_2 emissions at 1% level of significance. Moreover, CO_2 and GDP cause TRAD as depicted in Table 4.

5 Discussion

The findings reveal that LCO_2 is positively affected by LENERGSUB, LGDP and ENERGCON, while it is negatively affected by TRAD. The positive sign of LENERGSUB on LCO_2 is affirmed by Jewell et al. (2018), Monasterolo and Raberto (2019) as by applying subsidies on non-renewable energy resources this will encourage various economic sectors, especially the industrial sector, to consume more of these non-renewable resources instead of the usage of appropriate technology targeting energy efficiency and also will slow down the transition process towards the use of renewable energy. Recently, gradual abolishing subsidies is one of prominent strategy adopted by the selected Arab nations as reducing fossil fuel subsidies can contribute to mitigating the effects of climate change. and can help rationalise consumption and pave the way for the entry of renewable energies, whose prices are still high when compared to energy produced from petroleum and so selling fossil fuels at their real price will generate a breakthrough in reducing carbon dioxide emissions in oil and gas-exporting regions including Arab nations in the future.

The positive sign of LGDP is consistent with the expected sign of the coefficient of economic progress in several developing countries and similar to the findings (Al Araby et al., 2019; Esily et al., 2023, 2022c; Farag et al., 2021; Sherif et al., 2022). High population density, increasing industrial and urban cities, and the spread of random housing units in some Arab countries, are reflected in resource depletion which leads to degradation in environmental conditions in various Arab nations making for example Saudi Arabia one of the most CO_2 emitters around the globe.

LENERCON is positively linked with LCO_2 and this can be obvious in the selected countries being the top countries in energy production and characterised by huge energy consumption where Saudi Arabia is among the top energy consumption countries around the globe. This can be justified by stating that these nations mainly depend on non-renewable resources where non-renewable energy resources' consumption constitute more than 95% from total energy consumption and so can be reflected in degradation in environmental conditions. This positive association between LENERGSUB and LCO_2 is affirmed by Rahman et al. (2021) where they stated that the excessive consumption of non-renewable resources produces LCO_2 and as a result the surface temperature of the earth increases dramatically and the increase is enough to disturb ecosystems. This implies the pressing need for these selected Arab countries to dedicate their resources towards enhancing renewable energy resources.

The negative impact of TRAD on LCO_2 is similar to the findings of Hacatrjan et al. (2022) where trade openness means more increased income and technology transfer that allow for better treatment and protection of the environment. Thus, Arab nations while striving to comply with international environmental standards to enhance trade openness, environmental conditions are being improved.

6 Conclusions and recommendations

This paper explores the effects of energy subsidies, energy consumption, economic growth, and trade openness on CO_2 emissions in the top energy subsidy providers in the Arab world: The United Arab Emirates, Saudi Arabia, Qatar, Libya, Kuwait, Iraq, Egypt, Bahrain and Algeria, from 2010 to 2019. The findings reveal that energy subsidies, economic progress, and energy consumption are all strongly and positively linked to environmental degradation, with the exception of trade openness, which has a negative impact.

Although many Arab countries do many energy subsidies reforms, these reforms enacted so far aren't complete, and they don't change the social compact of Arab nations. As evidenced by country experiences with energy subsidy reforms which mentioned in IMF reports, energy subsidies must include a basic set of elements represented in developing a comprehensive plan according to international experiences that includes clear long-term goals:

First, analysing the impact of reforms, and consulting with the concerned parties, increasing transparency by publishing information on the volume of subsidies, and recording subsidies in the budget.

Second, increasing energy efficiency through stimulating innovation and investing in the human aspect by teaching workers on new technology, all while gradually increasing energy prices in proportion to energy products, automatic pricing systems as an example are being implemented as part of institutional reforms to price energy goods and shifting subsidies to cleaner and more economical renewable energies. Moreover, policymakers in charge of Arab countries' national energy strategies should concentrate on global hydrogen energy insights, international experience, and natural gas-sourced blue hydrogen as a step toward renewables-sourced green hydrogen, particularly in areas where the sun shines abundantly (Esily et al., 2022b).

Third, the findings of this study aided us in reaching an accord with supporters of Arab countries diversifying their energy consumption. This can be accomplished by pursuing renewable energy sources more aggressively, which would help these countries maintain both economic progress and environmental quality. So, investing in and using green energy sources could help to alleviate the negative effects of the growing environment. The development and implementation of efficient policies to govern activities in the energy and industrial sectors of Arab countries will contribute to the country's long-term progress. CO_2 emission limitations imposed by the government on manufacturing enterprises and industries will help to minimise CO_2 emissions in the country.

Fourth, several academics have also suggested that technology such as Clean Coal Technology be implemented in coal-fired power plants to boost efficiency and minimise GHG emissions. As a result, increasing research and development activities will be crucial in the introduction and deployment of new coal-consuming technologies as a means to reduce CO_2 emissions and achieve green growth and sustainable development.

Fifth, various industries with ecologically friendly production processes must be sought as a means to counteract the negative implications of trade openness in developing nations, as this will boost knowledge dissemination from clean technology into various sectors of economic activity. Host governments have to improve their dynamic capabilities systems to ensure a successful and effective know-how transfer process.

The current study adds to the already-existing literature review as follows:

- It assesses the influences of energy subsidy on CO_2 emissions in leader energy subsidy Arab countries; this would assist in better understanding the relative impact of energy subsidy on environmental issues.
- In these Arab selected countries, no empirical research has yet focused on these indicators for the elimination of CO_2 emissions.
- Various recommendations based on the results, can be suggested to help in the transition to low carbon energy era.

There are some limitations to this paper that can be addressed through future investigations, first, other indicators can be used as proxies for environmental quality as carbon footprint and ecological footprint. Second, disaggregation of energy subsidies can be taken into consideration as natural gas energy subsidy and oil subsidy.

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