The relationships between political stability, arms imports, oil exports, and GHG emissions: a CS-DL approach for eight Gulf countries

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Abstract: We study the relationships between arms imports, political stability, oil exports, gross domestic product, and greenhouse gas emissions by considering a panel of eight oil-exporting countries of the Gulf region and yearly data between 2000 and 2023. Since there is cross-sectional dependence between our considered variables, second-generation panel unit root and cointegration tests are used. In addition, we use the cross-sectional distributed lag (CS-DL) methodology to estimate our long-run coefficients. Several new and interesting results are deduced. Arms imports increase political stability and economic growth. Political stability increases oil exports and reduces greenhouse gas emissions. Oil exports reduce arms imports. Oil-exporting Gulf countries are advised to continue importing and plan the production of high-tech weapons to strengthen their political stability. This latter enables them to elaborate and realize energy efficiency and renewable energy strategies, transforming them into producing and exporting renewable energy countries.

Keywords: Arms imports; political stability; oil exports; greenhouse gas emissions; cross-sectional distributed lag; Gulf countries.

Jel classification: C33; H56; O53 ; Q37 ; Q54.

1. Introduction

The Gulf region is one of the most oil-producing and exporting of oil in the world. It is also characterized by important imports of arms and by periodic threats of armed conflicts. This research tries to understand the relationships between arms imports, oil exports, and political stability in this region by considering a panel data analysis comprising eight countries: Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE).

According to the Organization of the Petroleum Exporting Countries (OPEC, 2024), in 2023, total crude oil exports for OPEC countries are 17207 (in 1000 barrels per day), and the world total exports are 43829, meaning a proportion of 39.3%. These exports are detailed as follows: Bahrain (148), Iran (1323), Iraq (3467), Kuwait (1568), Oman (919), Qatar (472), Saudi Arabia (6659), and the United Arab Emirates (2651). Petroleum exports generated too much money for these countries (in million US $): Iran (41129), Iraq (102574), Kuwait (78061), Saudi Arabia (248376), and the United Arab Emirates (78161).

The World's proven crude oil reserves located in OPEC member countries are evaluated at 1241.33 billion barrels, representing 79.1% of the total World reserves. The Middle East proportion is 67.3% of the OPEC total, distributed among the main countries as follows: Iraq (11.7%), Iran (16.8%), Kuwait (8.2%), Saudi Arabia (21.5%), and the United Arab Emirates (9.1%). International oil demand continues to grow. In 2023, global oil demand increased by 2.6 million barrels of oil a day (mb/d), reaching an average of 102.2 mb/d. This growth impacts almost every region, with non-OECD (Organisation for Economic Co-operation and Development) countries like China leading the way.

According to George et al. (2025), during the period 2020-24, the five largest international arms exporters were the USA, France, Russia, China, and Germany. The USA's share of global arms exports was 43%. The five largest arms importers during this period were Ukraine, India, Qatar, Saudi Arabia, and Pakistan, which received 35% of global arms imports. The Middle East accounts for 27% of global arms imports. Four of the World's top 10 arms importers in 2020–24 were in the Middle East: Qatar, Saudi Arabia, Egypt, and Kuwait. The USA provides more than half of Middle Eastern arms imports (52%).

The share in % of total international arms imports of our considered countries during this period is: Bahrain (1.1), Kuwait (2.9), Qatar (6.8), Saudi Arabia (6.8), and the United Arab Emirates (2.6). Qatar was the third largest arms importer in 2020–24, registering an increase of 127% compared to the period 2015-19, and an increase of 1312% compared to the 2010-14 period. Its main supplier in 2020–24 was the USA with 48% of its total arms imports. Saudi Arabia decreased its arms imports by 41% between 2015–19 and 2020–24 and declassified from being the World's largest arms importer to the fourth largest. Its main provider in 2020–24 was the USA with a 74% share. This decrease in arms imports by Saudi Arabia in 2020–24 is mainly attributed to the cyclical nature of arms procurement.

Alsayegh (2023) recalls that because of its strategic geographic location and rich hydrocarbon resources, the Gulf region has played an important international rôle during the past decades. It has experienced several political tensions and armed conflicts, which have led to disruptions in energy provisions and sometimes international economic crises. Examples: the 1973 Arab oil embargo, and the 1990 shock of oil prices caused by the Kuwait invasion by Iraq. For several decades, the USA and Europe relied on fossil energy, particularly oil, provided by these countries, in exchange for providing these countries with sophisticated arms to assure their stability and security, meanwhile securing their provision of energy. This relationship is also beneficial for Gulf economies heavily relying on the exports of fossil energy, particularly oil, and can be summarized as "oil for security''.

Akkas and Altiparmak (2021) show that while the military and security dependence of the Gulf Cooperation Council (GCC) countries on the United States remains relatively intact, the dependence of the United States on the natural resources of the GCC region has decreased, transforming this relationship into a unilateral dependence with GCC countries' natural resources mainly directed to Asian countries. This relationship change is due to two major reasons: *i)* The USA (when democrats were in power) and Europe are encouraging energy transition in favor of renewable energy; *ii)* The early 2010s USA shale revolution that transformed it into a net exporter of oil. In addition to this, China's Belt and Road Initiative (BRI) would increase its presence in this region, leading to increased tensions with, particularly, the USA. That's why the present precautionary strategy of Gulf oil exporters can be resumed as "protect economic interests and strengthen national security".

The relationship between oil exports, arms imports, and political stability is evident for the considered countries of the Gulf region. This region plays and will play an important geopolitical role during the following decades, and it is important to better understand the interplay between the above-mentioned variables. Our research contributions are: *i)* To the best of our knowledge, no empirical study has been devoted to the relationship between oil exports, arms imports, and political stability, and this study will try to fill this gap; *ii)* We will use the cross-sectional distributed lag (CS-DL) panel approach proposed by Chudik et al. (2016) which has not been sufficiently exploited by the literature, despite the interesting results it can provide when the time dimension is not very long. We will consider a panel study about the eight important countries of the Gulf region and annual data between 2000 and 2023. Included variables are arms imports, political stability, oil exports, gross domestic product, and greenhouse gas emissions. Our empirical study begins with some descriptive statistics to prove the existence of cross-section dependence between variables, and second-generation panel unit-root and cointegration tests. Finally, we estimate the long-run coefficients through the cross-sectional distributed lag methodology.

This paper has the following structure. Section 2 is devoted to the literature review, Section 3 is for econometric methodology, Section 4 discusses the econometric results, and Section 5 concludes with policy recommendations.

2. Literature review

Several studies have been concerned with the empirical analysis of the trade of oil or arms, or with geopolitical risk or political stability. We divide our literature review into two subsections.

2.1. Trade of arms or oil

Snider's (1984) temporal series early study on five Western arms exporting countries (the United States of America, France, the United Kingdom, Germany, and Italy) shows that oil imports harm the trade balance of these countries but have a positive impact on unemployment. Bove et al. (2018) use gravity models and data from 149 countries to show that the volume of arms transferred to a given country is influenced by the degree of dependence on its oil supply. Moreover, global oil dependence justifies arms exports to oil-rich countries, even in the absence of direct bilateral oil-for-arms trade. Vézina (2021) shows that for developing countries, arms imports increase by an average of 30% after an important gas or oil discovery.

Ben Youssef (2023a) uses annual data for the United States, the autoregressive distributed lag (ARDL) approach, and the vector error correction model (VECM) to show that arms exports have a positive long-run effect on renewable energy consumption and net energy imports. Military spending has a positive long-run effect on renewable energy consumption, but it has a negative long-run effect on net energy imports and carbon dioxide (CO_2) emissions. Ben Youssef (2023b) uses the ARDL and the non-linear ARDL approaches, with annual data about China ranging from 1989 to 2016, to show that oil imports have a non-linear and asymmetric impact on military spending both in the short- and long-run and that renewable energy consumption reduces oil imports. Adedeji et al. (2024) use a panel threshold model for eleven selected OPEC countries and conclude that a variation in the price of oil reduces arms imports as these countries may be interested in allocating more oil revenue for economic development.

Yakovlev (2007) studies a balanced panel of 28 countries from 1965–2000 and shows that military expenditures and net arms exports taken separately reduce economic growth, but military expenditures are less harmful to economic growth when a country is a net exporter of arms. Aminu and Abu Bakar's (2016) study on Nigeria shows that defense expenditures and arms imports reduce gross domestic product (GDP) in the long-run. Chary (2024) examines a balanced panel of twenty-five of the World's top arms importers from 2000 to 2021 and finds that arms imports and military expenditures negatively impact per capita GDP in the short-run.

Khan et al. (2021) consider data about India between 1975 and 2020 and the non-linear autoregressive distributed lag (NARDL) approach. Arms import positive and negative shocks increase carbon emissions in the long-run. In the short-run, arms import positive and negative shocks increase and decrease carbon emissions, respectively.

2.2. Geopolitical risk and political stability

Noguera-Santaella (2016) uses time series monthly data since 1859 to analyze the impact of 32 different geopolitical events on the real prices of oil. Geopolitical events affect positively affected oil prices before the year 2000, but they have had a weak effect afterward. Bove and Böhmelt (2021) highlight a systematic increase in arms imports in the neighborhood of states under an embargo and in conflict. He and Mei (2024) examine the impact of arms imports from the USA on internal conflicts in 135 non-OECD countries. Their study reveals that US arms imports have a significant negative impact on the occurrence of civil war. Fukutomi (2024) points out that the Middle East has been facing a geopolitical crisis in recent years because the United States can obtain oil elsewhere, but the Middle East is essential for the United States to export its weapons. Dizaji and Murshed (2024) consider a sample of 48 developing countries and annual data between 1990 to 2017 and apply panel vector autoregressive methods. They find that decreasing arms imports has a positive effect on the political system, democracy, and education and health expenditures. However, the impact is negative on military expenditures, and these arms import reductions can stimulate internal conflicts and ethnic tensions. Fagbemi and Fajingbesi (2024) show that oil rents reduce political stability in Nigeria as oil wealth could give incentives for more civil and political conflicts. Aldabagh et al. (2025) study a panel of OPEC countries with annual data ranging from 2001 to 2020 and show that political stability has a positive impact on economic growth.

Syed et al. (2022) use annual data from 1990 to 2015, second-generation panel data methods, augmented mean group (AMG) and common correlated effects mean group (CCEMG) estimators, and panel quantile regression model to a panel of BRICST (Brazil, China, India, Russia, South Africa, and Turkey) countries. They show that economic policy uncertainty and geopolitical risk have a heterogeneous impact on carbon emissions across different quantiles. Ulussever et al. (2023) consider five GCC countries, monthly data from 2000/1 to 2021/12, and quantile-based techniques to show that political risk index, geopolitical risk, and crude oil price have mixed effects on environmental degradation.

Kirikkaleli and Osmanlı (2023) consider data about Turkey covering the period 1990 to 2019 and conclude that political stability reduces CO_2 emissions. Han et al. (2024) consider a panel of Asian countries (China, India, Pakistan, Kazakhstan) and data between 2001 and 2021 to show that political stability reduces CO_2 emissions. Al-Zubairi et al. (2024) consider a panel of Arab countries and annual data from 2000 to 2020, the fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS), and feasible generalized least squares (FGLS) methods to conclude that political stability is correlated positively with carbon emissions, this correlation being moderated by the interaction between political stability and financial development. Nazir et al. (2024) consider a panel of the South Asian Association for Regional Cooperation region to show that political stability increases carbon emissions. They explain this result by the presence of rent-seeking behavior and the pollution haven hypothesis.

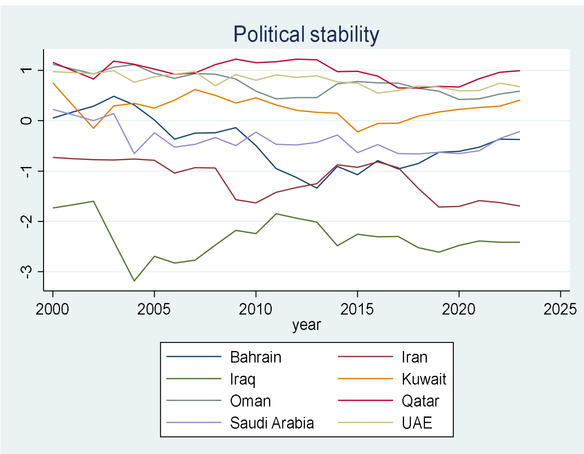
Alsagr and van Hemmen (2021) apply a two-step system generalized method of moments (GMM) to a panel of emerging markets with annual data ranging from 1996 to 2015. They find a significant positive impact of geopolitical risk on renewable energy consumption. Dutta and Dutta (2022) use a two-state Markov regime-switching model and show that an increase in the geopolitical risk (GPR) index increases (reduces) the likelihood of being in the low (high) volatility regime of renewable energy exchange-traded funds (ETFs). Matallah et al. (2023) use the ARDL model and annual data about Egypt, Tunisia, and Turkey over the period 1990–2020. Their major finding is that geopolitical risks have an important role in boosting renewable energy use in these oil-importing countries both in the short and long-run.

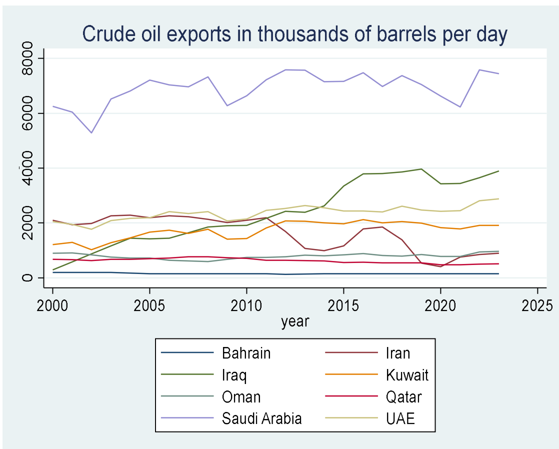
3. Econometric methodology

3.1. Data

Our empirical analysis considers eight oil-exporting countries of the Gulf region, which are Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. We use annual data from 2000 to 2023. Therefore, our empirical study uses a total of 192 observations. We consider five variables: *i)* Political stability and absence of violence/terrorism (PS): measures the likelihood that a government could be destabilized or overthrown by violent or unconstitutional methods such as politically motivated violence and terrorism. This index varies approximately between -2.5 and 2.5; *ii)* Crude oil exports (OE) are in thousands of barrels per day (Th.b/d); *iii)* Arms imports (AI) are in trend-indicator value (TIV), which is a common unit measuring the volume of international transfers of major conventional arms; *iv)* Total greenhouse gas (GHG) emissions excluding LULUCF are in metric tons of carbon dioxide equivalent (Mt CO2e). Greenhouse gases caused by land use change land use and forestry (LULUCF) are excluded because of their higher uncertainties; *v)* Gross domestic products (GDP, Y) are in constant 2015 US$.

All the variables' data are obtained from the World Bank (2025) World Development Indicators, except data about arms imports are obtained from Stockholm International Peace Research Institute (SIPRI, 2025). For each variable, we should have 192 observations. However, some data are missing: a total of 8, 15, and 4 observations are missing for the variables PS, AI, and OE, respectively. To correct this, when there is a missing observation between two available ones, we take their average. When there is more than one successive missing observation between two available ones, we take the linear adjustment made by these two available observations. All computations are done with Stata 17 software. We applied the logarithmic transformation to our variables, except the PS variable, before the econometric computations. These transformed variables are denoted by lai, lghg, loe, and ly.





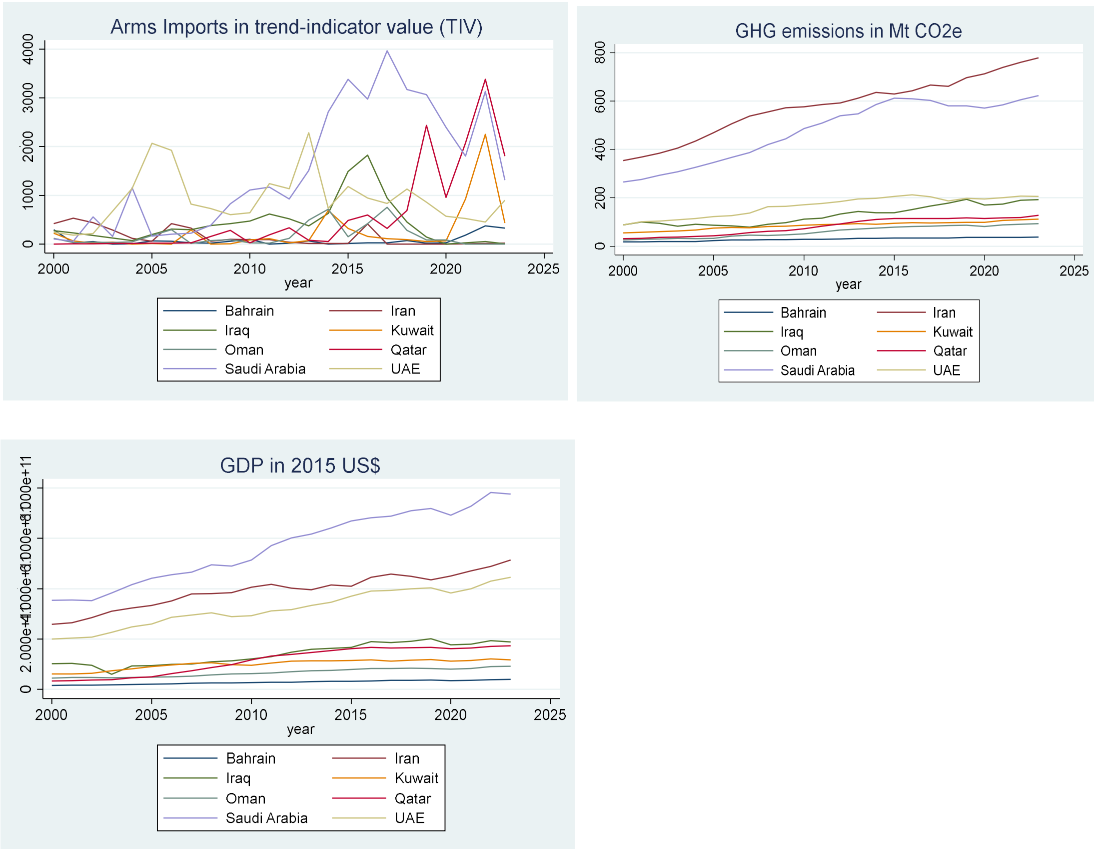


Fig. 1. Plots of the considered variables

Looking at the plots of the considered variables in Fig. 1, we can see that political stability, crude oil exports, arms imports, and gross domestic product are nearly stationary for all countries. However, greenhouse gas emissions are not. Table 1 gives some descriptive statistics. Political stability is almost stationary for all countries. The minimum level of -3,180 was attained by Iraq in 2004 due to its war against the USA coalition, and the maximum level of 1.224 was attained by Qatar in 2012. Crude oil exports are almost stationary with a minimum level of 130 Th.b/d reached by Bahrain in 2012 and a maximum level of 7580 Th.b/d reached by Saudi Arabia in 2012. Arms imports are also globally stationary with a minimum level of 1 TIV reached by Bahrain in 2003 and 2004 and a maximum level of 3968 TIV reached by Saudi Arabia in 2017. Greenhouse gas emissions seem to be non-stationary because mainly Saudi Arabia and Iran have realized a net increasing tendency during this period. Iran is the most polluter with a maximum level of 778.802 Mt CO2e realized in 2023. The three countries, Saudi Arabia, Iran, and the United Arab Emirates, have had an important and continuous increase in GDP during the considered period. Saudi Arabia has the highest GDP, with a maximum of 782 billion constant 2015 US$ reached in 2022.

Table 1. Some descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
ps	192	-0.190	1.106	-3.180	1.224
oe	192	2071.667	2050.642	130	7580
ai	192	511.963	776.301	1	3968
ghg	192	201.078	205.905	17.771	778.802
y	192	2.17e+11	1.90e+11	1.62e+10	7.82e+11

3.2. Cross-section dependence tests

Our empirical study begins by looking for possible cross-sectional dependence (CD) between our considered variables. Indeed, when there is a CD between the variables, panel first-generation unit root tests are no longer valid because estimates may be biased and inconsistent. In this case, we must use second-generation unit root tests.

Pesaran (2015) tests the hypothesis that errors in a panel data model are weakly cross-sectionally dependent, using the exponent of cross-sectional dependence α, introduced by Bailey et al. (2016). In the case of large N panels, Pesaran (2015) shows that the null hypothesis of weak dependence is more appropriate than the null hypothesis of independence, as the latter could be quite restrictive. The developed CD test has good results for either static or dynamic panels, irrespective of whether the panel contains lagged values of the dependent variable, while supposing no major asymmetries in the error distributions.

The exponent of cross-sectional dependence α can take any value between 0 and 1. The values of α belonging to $[0, 1/2)$, treated by Pesaran (2015), relate to different weak cross-sectional dependence degrees, and the values of α belonging to $(1/2, 1]$, treated by Bailey et al. (2016), relate to different strong cross-sectional dependence degrees. The absence of cross-sectional dependence corresponds to $\alpha = 0$.

Table 2. CD tests of Bailey et al. (2016) and Pesaran (2015).

	Strong CD test				Weak CD test			
Variables	Alpha	Std. Err.	[95% Conf. Interval]		CD	P-value	N_g	T
lai	0. 489	0.091	0.310	0.667	-0.094	0.925	8	24
lghg	1.010	0.082	0.850	1.171	24.519	0.000	8	24
loe	0.658	0.075	0.510	0.805	-0.976	0.329	8	24
ps	0.804	0.102	0.603	1.005	8.692	0.000	8	24
ly	1.010	0.065	0.883	1.137	24.283	0.000	8	24

0.5<=Alpha<1 implies a strong CD. For the weak CD test, H0: errors are weakly CD.

Table 2 shows that the Alpha's Bailey et al. (2016) exponent of cross-sectional dependence is higher than 0.5 for all variables except for the lai variable, Alpha is slightly lower than 0.5 (Alpha=0.49). This test shows the existence of strong cross-sectional dependence for all variables. The Pesaran (2015) CD test rejects the null hypothesis of weak cross-sectional dependence for variables lghg, ps, and ly. Considering both tests, we can conclude that there is strong cross-sectional dependence for all considered variables.

3.3. Second-generation stationary test

Pesaran et al. (2013) extend the cross-sectionally augmented panel unit root test (CIPS) developed by Pesaran (2007) by considering a multifactor error structure. This second-generation panel unit root test is valid in the presence of cross-sectional dependence generated by stationary common factors. The main idea is to use, in addition to the considered series, the information concerning the m unobserved factors shared by k observed time series. CIPS test is obtained from the average of t-ratios Augmented Dickey-Fuller (ADF, 1979) régressions, which are augmented by the cross-section averages of the dependent variable and k other regressors with similar common factor characteristics. Monte Carlo experiments suggest that the proposed test has good small-sample properties for all cross-section (N) and time series (T) combinations considered. Its power rises with N and T. The CIPS test uses critical values depending on N, T, k, and the lag order p. In Table 3, we perform the CIPS second-generation panel unit root test with a constant. We find that all variables are stationary at level, i.e., are integrated of order 0, or are I(0), except le logarithm of greenhouse gas emissions, which is stationary after first-difference, i.e., is integrated of order 1, or is I(1).

Table 3. CIPS unit root test

Variables	lai	lghg	dlghg	loe	ps	ly
Maximum lag	4	4	4	4	4	4
Bglag	4	4	4	4	4	4
Pesaran-CIPS	- 2.526***	-1.597	-4.027***	-2.263**	-2.600***	-2.150*

The CIPS test is performed with a constant. Bglag is the number of lags used in the model to adjust for autocorrelation. Statistical significance levels at 10%, 5%, and 1% are denoted respectively by *, **, and ***. Critical values at level: 1%: -2.51; 5%: -2.25; 10%: -2.12. Critical values for first differences: 1%: -2.44; 5%: -2.22; 10%: -2.1.

3.4. Second-generation cointegration test

Since there is cross-sectional dependence between variables, second-generation cointegration tests should be used. Westerlund (2007) develops a bias-adjusted (BA) estimator to use in panel régressions with errors that are cross-sectionally correlated. Cross-sectional dependence transforms the commonly used ordinary least squares estimators, such as Kao and Chiang (2001), into inefficient and biased estimators, making them inconvenient inference tools. Compared to the second-generation fully modified (FM) cointegration test of Bai and Kao (2006), the Westerlund (2007) test supposes that the number of common factors responsible for the cross-sectional dependence is unknown and is estimated from the data by using newly proposed information criteria. Monte Carlo simulations in small samples are made, and the asymptotic distributions are examined, suggesting that the BA estimator performs well compared to existing ones. More precisely, the BA estimator is as efficient as the FM estimator but is more convenient computationally.

Table 4. Westerlund's (2007) second-generation panel cointegration test

	Statistic	p-value
Variance ratio	2.335	0.010

The included panel means and time trends are considered. lghg is the dependent variable, and lai, loe, ps, and ly are the independent variables. H0: no cointegration, Ha: all panels are cointegrated.

Table 4 contains the result of Westerlund's (2007) test, which is conducted with included panel means and time trends, lghg being the dependent variable, while lai, loe, ps, and ly are the independent variables. The H0 hypothesis is no cointegration, and the alternative hypothesis Ha is that all panels are cointegrated. H0 can be rejected at the 1% statistical significance risk, signifying that there is a long-run cointegration between our considered variables: arms imports, oil exports, political stability, greenhouse gas emissions, and gross domestic product for our considered panel of eight oil-exporting Gulf countries.

3.5. Cross-sectionally distributed lag estimates

To better understand the interplay between our variables, arms imports, political stability, oil exports, gross domestic product, and greenhouse gas emissions, we will estimate five models where at each time one variable is taken as dependent:

$$lai=f_1(lghg, loe, ps, ly) \quad (1)$$

$$lghg=f_2(lai, loe, ps) \quad (2)$$

$$loe=f_3(lai, lghg, ps, ly) \quad (3)$$

$$ps=f_4(lai, lghg, loe, ly) \quad (4)$$

$$ly=f_5(lai, lghg, loe, ps) \quad (5)$$

Since there is cross-sectional dependence between our variables, which are mixed integrated of orders 0 and 1, we choose to use the cross-sectionally distributed lag (CS-DL) methodology developed by Chudik et al. (2016). This methodology is shown to give better performances than the alternative panel ARDL estimates, such as the cross-sectionally autoregressive distributed lag (CS-ARDL) approach developed by Chudik and Pesaran (2015), when the time series dimension, as in our study, is lower than 50.

Conventional literature on panel long-run estimates such as the pooled mean group (PMG) approach of Pesaran et al. (1999), the dynamic ordinary least squares (DOLS) approach of Mark and Sul (2003), and the fully modified ordinary least squares (FMOLS) approach of Pedroni (2001), while they permit for lagged-dependent variables and short-run dynamics to be heterogeneous, they do not permit for cross-sectional dependence of errors.

In the case of panel data models without lagged-dependent variables, the problem of cross-sectionally dependent errors has been treated by the common correlated effects (CCE) methodology of Pesaran (2006). To permit weakly exogenous regressors, including lagged-dependent variables, Chudik and Pesaran (2015) extend the CCE approach to consider the CS-ARDL approach. These two approaches consider ARDL specifications augmented by cross-sectional averages to filter out the unobserved effects of common factors. The main drawback of the CS-ARDL methodology is the need for a large time dimension.

The CS-DL approach developed by Chudik et al. (2016) is based on an ARDL representation augmented by cross-sectional averages but does not include lags of the dependent variable, and allows for cross-sectionally dependent errors. Its main advantages are the following: *i)* Unlike the ARDL-type estimators, it is robust to misspecification of dynamics and serial error correlation; *ii)* It gives better small sample performances than the CS-ARDL methodology when the time dimension is moderately large (T<50); *iii)* Long-run coefficients are directly estimated.

Since we don't have a sufficiently long series (T=24), we will use the CS-DL approach. Following Chudik et al. (2016), we use the following auxiliary régressions:

$$y_{it} = c_i + \alpha_i^{'} x_{it} + \sum_{s=0}^{p-1} \lambda_{is}^{'} \Delta x_{i,t-s} + \sum_{s=0}^{p_{\bar{y}}} \theta_{y,is} \overline{y_{t-s}} + \sum_{s=0}^{p_{\bar{x}}} \theta_{x,is}^{'} \overline{x_{t-s}} + \varepsilon_{it} \quad (6)$$

α_i is the *1xk* vector coefficients of independent variables, i.e. individual long-run estimates, and the average CS-DL mean group estimator of the long-run coefficients is given by $\bar{\hat{\alpha}} = N^{-1} \sum_{i=1}^{N} \hat{\alpha}_i$; Δ is the first-difference operator and ε_{it} is the residual term; $\overline{y_t} = N^{-1} \sum_{i=1}^{N} y_{it}$, $\overline{x_t} = N^{-1} \sum_{i=1}^{N} x_{it}$ are the cross-section averages of the dependent and independent variables; $p_{\bar{x}}$ is set equal to the integer part of $T^{1/3}$, i.e. equal to 2; $p = p_{\bar{x}} = 2$, and $p_{\bar{y}}$ is set equal to 0.

Therefore, our estimated equation includes one lag of the differenced independent variables, the cross-sectional average of the dependent variable, and two lags of the cross-sectional averages of the regressors for models 1 and 4. Thus, for these models, our cross-sectionally augmented distributed lag equation to estimate is:

$$y_{it} = c_i + \alpha_i^{'} x_{it} + \sum_{s=0}^{1} \lambda_{is}^{'} \Delta x_{i,t-s} + \theta_{y,i} \overline{y_t} + \sum_{s=0}^{2} \theta_{x,is}^{'} \overline{x_{t-s}} + \varepsilon_{it} \quad (7)$$

We didn't obtain satisfactory results with the above lags recommended by Chudik et al. (2016) for the other models. That's why we have sometimes used lag two for the differenced independent variables, and lag one for the cross-sectional averages of the regressors. Only the cross-sectional average of the dependent variable is used for all models. Estimate details are given in Table 5. Models' fit was assessed using the mean group (MG) R-squared, reflecting the average fit across the cross-sectional units, consistent with the mean group estimation approach. All R-squared (MG) values are sufficiently high, reflecting the statistical significance of our models.

Table 5: Long-run estimates

Exogenous variables						R-squared (MG)
Model/Endogenous variables	lai	lghg	loe	ps	ly	
Model 1: lai [1;2]	-	3.054 (0.422)	-8.226 (0.083)*	-	17.189 (0.094)*	0.71
Model 2: lghg [2;2]	0.064 (0.035)**	-	-0.126 (0.748)	-0.271 (0.046)**	-	0.98
Model 3: loe [2;1]	0.009 (0.778)	-0.344 (0.609)	-	0.188 (0.029)**	2.744 (0.038)**	0.94
Model 4: ps [1;2]	0.065 (0.059)*	2.712 (0.074)*	1.336 (0.291)	-	-2.661 (0.568)	0.89
Model 5: ly [1;1]	0.010 (0.067)*	0.069 (0.616)	0.239 (0.094)*	0.003 (0.962)	-	0.99

Statistical significance levels at 10% and 5% are denoted by * and **, respectively. Between brackets, we have indicated the lags of the differenced independent variables and their cross-sectional averages, respectively. R-squared (MG) is the mean group R-squared.

4. Results discussion

All coefficients reported in Table 5 can be considered as elasticities except those concerned with political stability because we didn't make the logarithmic transformation to this variable, as some of its values are negative. For each considered equation, most of the long-run estimated coefficients are statistically significant at the 5% or 10% levels.

A 1% increase in oil exports importantly reduces arms imports by 8% in the long-run. This is an unexpected result, as one may expect that more disposal oil revenues enable these countries to buy more arms. An increase in oil exports generally happens when there are no political or arms conflicts in this Gulf region and thus no need to buy more arms. This result is similar to that of Adedeji et al.'s (2024) study on eleven selected OPEC countries, concluding that a variation in the price of oil reduces arms imports by these countries. A 1% increase in gross domestic product importantly increases arms imports by 17%. Thus, more money generated by economic growth pushes these countries to import more arms for their security. This constitutes a new and interesting result.

An increase of 1% in arms imports has a weak positive impact on greenhouse gas emissions by 0.06% due to the fossil energy used by these arms, like tanks or fighter jets. This result is similar to that of Khan et al.'s (2021) study on India, showing that arms imports increase carbon emissions. Interestingly, political stability reduces greenhouse gas emissions as it enables governments to plan and realize long-run strategies for energy efficiency and renewable energy use. This result follows that of the Han et al. (2024) study on a panel comprised of China, India, Pakistan, and Kazakhstan and that of Kirikkaleli and Osmanlı (2023) study on Turkey. However, our result is in opposition to that of Nazir et al. (2024) panel study about the South Asian Association for Regional Cooperation region.

Political stability enhances oil exports because political stability in this region is closely related to political and economic perturbations in other regions of the world. In addition, political stability makes Gulf oil shipping lanes more secure and favorable for more oil exports. Political stability also enables governments to better negotiate and plan contracts and projects for the production and export of oil. This result is similar to Sama et al. (2025), showing that, in the long-run, political stability has a positive impact on crude oil production in Cameroon. In our study, a 1% increase in GDP importantly increases oil exports by 2.7%, confirming the strong correlation between economic growth and oil exports in this Gulf region.

Interestingly, an increase in arms imports increases political stability. Possession of weapons, especially sophisticated ones, reduces the intentions of other countries to interfere in their internal affairs or to have intentions of destabilization, or colonization driven by the presence of oil wealth. It also provides arms importers with certain protection and support from their arms suppliers, who do not want to see their arms contracts compromised. Terrorist groups will also think twice. Our result is in line with that of He and Mei (2024) study on 135 non-OECD countries showing that US arms imports have a significant negative impact on the occurrence of civil war and with that of Dizaji and Murshed (2024) study on a panel of 48 developing countries showing that arms import reductions can stimulate internal conflicts and ethnic tensions.

A 1% increase in arms imports increases gross domestic product by only 0.01%. This may be explained by the internal and external security that these imports procure and by the consolidated military, political, and economic relations with arms-exporting countries. Our result differs from those of Chary (2024), examining a balanced panel of twenty-five of the World's top arms importers and showing that arms imports negatively impact per capita GDP in the short-run, and Aminu and Bakar's (2016) study on Nigeria, showing that arms imports reduce GDP in the long-run.

A 1% increase in oil exports increases gross domestic product by 0.24%. This expected result is due to the significant share of oil exports in the gross domestic product of the majority of the Gulf countries considered. Indeed, according to OPEC (2024), the share of petroleum exports as a percentage of GDP in Saudi Arabia in 2023 is 23.26%. Our findings are consistent with those of Aziz and Waheed's (2023) study on Saudi Arabia.

5. Conclusion and policy implications

This paper is a research on the interaction between our main variables, which are arms imports, oil exports, and political stability. A panel of eight Gulf oil-exporting countries (Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) is considered. To the best of our knowledge, there is no temporal series study or panel study about our considered countries evaluating the relationship between our main variables because we think, the lack of sufficiently long data concerning especially oil exports and political stability. Another contribution of our study is the use of the cross-sectional distributed lag approach developed by Chudik et al. (2016), which has not been sufficiently used in the literature, despite the good results it can provide when the time dimension is not very long. Cross-sectional dependence tests prompt us to use second-generation unit-root and cointegration tests, and we opt for the CS-DL approach to estimate our long-run coefficients because our time series are not sufficiently long.

Oil exports importantly reduce arms imports in the long-run. What explains this result is that oil exports grow in general when there are no political or arms conflicts in this Gulf region, preventing the need for buying more arms. In the long run, gross domestic product positively and importantly impacts arms imports induced by the available means to increase its security. These constitute new and interesting results not reached before by the literature, either for the case of a Gulf country or not.

In the long-run, political stability reduces greenhouse gas emissions in these countries because it enables governments to plan and realize long-run strategies for renewable energy use and energy efficiency. Political stability increases oil exports because it enables governments to better negotiate and plan contracts and projects for the production and export of oil, while making Gulf oil shipping lanes more secure and favorable for more oil exports. Arms imports are beneficial for political stability because weapons reduce the intentions of destabilization or colonization by other countries, procure some protection and support from arms providers countries, and terrorist groups will think twice about it. Arms imports positively impact gross domestic product because they consolidate military, political, and economic relations with arms-providing countries. These are new results for the case of Gulf countries.

Based on the above econometric results, oil-exporting Gulf countries are advised to continue importing weapons, especially more sophisticated ones, as these weapons are crucial for their political stability in this highly turbulent and conflict-ridden region. The presence of high-tech weapons in sufficient quantities acts as a deterrent and prevents armed conflicts. They are a vector for economic growth, and these countries should consider and plan the production of their sophisticated weapons. Political stability, in turn, stimulates oil exports and thus economic growth. This political stability proves beneficial for the environment, as it allows these countries to plan and realize energy efficiency and renewable energy strategies. These countries are also potentially rich in renewable energy resources, particularly solar energy. The World is moving towards increased use of renewable energy; the Gulf countries must prepare for this and develop strategies to transition from being exclusively fossil fuel producers and exporters to also producing and exporting renewable energy.

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