Economic Development Indicators and Their Impact on the Environmental Footprint in Arab Countries

An Econometric Study of 13 Arab Nations

مؤشرات التنمية الاقتصادية وأثرها على البصمة البيئية في الدول العربية

دراسة قياسية اقتصادية لـ ١٣ دولة عربية

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Abstract:

This study primarily aims to examine the impact of economic development indicators, represented by economic growth, energy consumption, population growth, natural resource rents, and foreign trade on the Environmental Footprint (EF) in Arab countries, Algeria, Egypt, Iraq, Jordan, Lebanon, Libya, Mauritania, Morocco, Syria, Tunisia, Oman, Qatar, and Saudi Arabia. To achieve this goal, the Panel Data Model was utilized for the period from 2019 to 2022, considering both the short- and long-term effects. The analysis was based on cross-sectional data (CSD), unit root tests, cointegration tests, and the dynamic generalized method of moments (GMM).

The results indicate that all variables increase the Environmental Footprint (EF) in both the short and long term. Additionally, there is an equilibrium relationship and cointegration in both timeframes. The study confirmed the validity of the Environmental Kuznets Curve (EKC) hypothesis for the Arab countries under investigation. The paper suggests effectively linking economic policies to environmental objectives by adopting strategies to reduce unsustainable environmental practices in Arab countries.

Keywords: Economic Development, Environmental Footprint (EF), Environmental Kuznets Curve (EKC), Arab Countries, Econometric Study.

المستخلص:

تهدف هذه الدراسة في المقام الأول إلى دراسة تأثير مؤشرات التنمية الاقتصادية المتمثلة في النمو الاقتصادي واستهلاك الطاقة والنمو السكاني وإيجارات الموارد الطبيعية والتجارة الخارجية على البصمة البيئية في الدول العربية الجزائر ومصر والعراق والأردن ولبنان وليبيا وموريتانيا والمغرب وسوريا وتونس وعمان وقطر والمملكة العربية السعودية. ولتحقيق هذا الهدف، تم استخدام نموذج البيانات اللوحيّة للفترة من ٢٠١٩ إلى ٢٠٢٢، مع الأخذ في

الاعتبار التأثيرات قصيرة وطويلة الأجل. واستند التحليل إلى البيانات المقطعية (CSD) واختبارات الجذر الوحدوي واختبارات التكامل المشترك وطريقة العزوم الديناميكية المعممة.(GMM)

وتشير النتائج إلى أن جميع المتغيرات تزيد من البصمة البيئية (EF) في كل من الأمدين القصير والطويل. بالإضافة إلى ذلك، هناك علاقة توازن وتكامل مشترك في كلا الإطارين الزمنيين. وأكدت الدراسة صحة فرضية منحنى كوزنتس البيئي (EKC) للدول العربية قيد البحث. تقترح الورقة ربط السياسات الاقتصادية بالأهداف البيئية بشكل فعال من خلال تبني استراتيجيات للحد من الممارسات البيئية غير المستدامة في الدول العربية.

الكلمات المفتاحية: التنمية الاقتصادية، البصمة البيئية، منحنى كوزنتس البيئي، الدول العربية، دراسة قياسية اقتصادية.

1- Introduction:

The global environment, particularly in the Arab region, has witnessed escalating environmental risks over the past few decades due to the increasing demand for energy to support economic development and urbanization. These risks are exacerbated by intensified human activity, which depletes natural resources in the Arab region. Therefore, analyzing the factors influencing the Environmental Footprint (EF)—including variables such as economic growth, energy consumption, population growth, natural resource depletion, and foreign trade—has become essential for achieving sustainable development. Urbanization, as a driver of economic growth, necessitates utilizing natural resources and energy, which in turn increases the EF.

Despite the critical environmental and economic implications of the factors influencing the EF, studies in this field remain scarce, especially in Arab countries, often yielding contradictory results. Economic development is one of the primary objectives pursued by Arab countries to ensure the well-being of their populations and improve living standards. However, such development often comes at a high environmental cost, increasing the EF due to the intensive use of natural resources and pollution. The Arab region is characterized by significant economic and environmental diversity, highlighting the need to study the relationship between economic development and the EF to understand the challenges and opportunities these nations face in their pursuit of sustainable development.

Environmental issues have received substantial attention in recent decades, particularly from the late 20th century into the early 21st century. Balancing economic growth with environmental welfare has become a core agenda of global development strategies (Ulucak, 2020a; Ali, 2020; Nathaniel & Khan, 2020). In this context, Arab countries are no exception. These nations are experiencing rapid growth, with significant economic expansion anticipated. Such expansion, however, is expected to lead to increased environmental degradation (Abouzeid, 2024). Consequently, it is essential for Arab countries to align their economic growth policies with environmental welfare objectives. Identifying the factors responsible for environmental degradation is therefore critical, given the varying levels of development across the region.

The **research problem**: The world today is witnessing a significant increase in awareness of environmental issues and the impact of economic activities on climate change and environmental degradation. In this context, the relationship between economic development and environmental impact in Arab countries becomes a key issue for understanding the dynamics of growth and sustainable development. Arab countries exhibit considerable variations in economic growth rates and their ability to affect the environment, due to structural differences in their economies (such as oil and gas, agriculture, and industry), as well as the unique environmental challenges they face.

The main problem of this research is to understand how various economic development indicators (such as GDP, population, foreign trade, and urbanization) affect the environmental footprint (such as carbon emissions, energy consumption, and natural resource management) in 13 Arab countries. Through an econometric study, the research aims to identify the factors that contribute to either improving or deteriorating the environmental situation in the region, thus contributing to the adoption of sustainable development policies that balance economic growth with environmental preservation.

The **research hypotheses** a positive correlation between the level of economic development and the increase in the Environmental Footprint (EF) in Arab countries. Economic development is represented by variables such as population size (POP), energy consumption (ENERG), foreign trade (TRAD), natural resource rents (RENT), and per capita GDP.

This research contributes to economic studies, as most previous studies on Arab countries have used carbon dioxide (CO_2) emissions as an indicator of environmental degradation (Elshimy, 2020; Mehrjo, A., et al., 2023; Nathaniel, S. P., et al., 2021). However, the CO_2 emissions indicator fails to comprehensively capture the multidimensional aspects of environmental quality (Altıntas and Kassouri, 2020; Ansari et al., 2020; Baz et al., 2020). To address this limitation, Wackernagel and Rees (1998) introduced the concept of the Environmental Footprint (EF) to measure environmental impacts.

The EF considers the area and quality of biologically productive land required to meet human needs and absorb the waste generated by production and consumption processes (Wackernagel and Rees, 1998; Wackernagel et al., 2004). By employing EF as a comprehensive indicator, this study aims to provide a deeper understanding of the negative environmental impacts associated with economic development in the Arab regio.

This **research aims** to explore the relationship between economic development and environmental degradation, represented by the EF, by analyzing economic and environmental data. It also seeks to provide policy recommendations that can contribute to achieving a balance between economic growth and environmental conservation. Over the past few decades, the Arab region has experienced heightened environmental risks due to the increasing demand for energy to support economic development and urbanization. These risks are further compounded by intensified human activities that deplete natural resources.

The **Methodology:** This study adopts an econometric methodology to analyze the impact of economic development indicators on the environmental footprint in 13 Arab countries. The study employs an econometric approach using a dynamic panel data model, which allows for examining the relationships between economic development indicators and environmental outcomes over time, while accounting for both temporal and cross-sectional variations across countries.

The **significance** of this paper lies in estimating the results at the country level for each of the 13 nations, which can assist policymakers in aligning their policies with the distinct characteristics of these countries. Additionally, the paper discusses policy directions in line with the Sustainable Development Goals (SDGs), aiming to provide an ideal framework for the Arab countries under study to meet their SDG commitments. It evaluates the determinants of environmental degradation in these nations.

The paper addresses the following questions:

a) What are the environmental impacts of energy consumption and trade on Arab countries?
b) Does economic development have a significant impact on the Environmental Footprint in these countries?
c) Does the Environmental Kuznets Curve (EKC) hypothesis apply to development in these nations?

The research is structured as follows:

a. A literature review exploring the relationship between the Environmental Footprint and economic development.
b. The concept of the Environmental Footprint and the ecological deficit in the 13 Arab countries.

c. A theoretical analysis of the relationship between economic development indicators and the Environmental Footprint in the 13 Arab countries.
d. An econometric study of the relationship between economic development and the Environmental Footprint in the 13 Arab countries.
e. Results and general policy recommendations for countries.

2- Literature review:

Numerous studies have analyzed the relationship between various development indicators and environmental changes globally or across different geographical regions, including Arab countries, the Middle East, and Africa. Below, we review some of these studies according to the region under investigation:

2/1- Studies covering many countries of the world:

Nathaniel, S. P., Murshed, M., & Bassim, M. (2021), Mishra, A. K., & Dash, A. K. (2022), KUMAR, P. (2023), Zhang, S., Xu, G., Shu, Y., & Zhu, J. (2024), and Hossain, M. A., Eleais, M. D., Urbee, A. J., Hasan, M. A., & Tahrim, F. (2024) conducted studies on the relationship between economic development indicators and their environmental impact across different global regions.

Nathaniel, S. P., Murshed, M., & Bassim, M. (2021) analyzed the effects of energy consumption and trade on the environment while testing the validity of the Environmental Kuznets Curve (EKC) hypothesis in the context of 11 countries globally, using unit root tests. Their findings revealed that non-renewable energy consumption, international trade (e.g., exporting high carbon-emission goods), and weak enforcement of environmental laws increase the Environmental Footprint. They recommended strengthening environmental legislation to achieve a balance between economic growth and environmental protection.

Mishra, A. K., & Dash, A. K. (2022) explored the relationship between carbon Environmental Footprint, economic globalization, population density, and financial sector development in five South Asian countries over a span of 49 years. Using unit root tests and the ARDL model, they found that population density, economic growth, and economic globalization positively impact the carbon Environmental Footprint. They recommended formulating environmental policies focusing on emission efficiency rather than energy efficiency.

KUMAR, P. (2023) analyzed the relationship between the Environmental Footprint, air pollutants, economic growth, urbanization, foreign direct investment inflows, and energy consumption within the framework of the EKC hypothesis. Using fixed and random effects models for a sample of 56 countries across various income groups (high, middle, and low) from 1990 to 2019, the study demonstrated an N-shaped relationship between economic growth and the Environmental Footprint in high- and middle-income countries. The findings emphasized the importance of sustainable practices and policies to balance economic growth with environmental conservation.

Hossain, M. A., Eleais, M. D., Urbee, A. J., Hasan, M. A., & Tahrim, F. (2024) examined the relationship between environmental degradation and various factors, such as economic growth, industrial development, and energy consumption, in the G7 and five selected countries in the Middle East and North Africa (MENA) region during 1997–2018. Using panel data analysis, including homogeneity regression tests (SH), cross-sectional dependence (CSD) tests, unit root tests, cointegration tests, feasible generalized least squares (FGLS), and dynamic generalized method of moments (GMM), the study found that increases in GDP, fossil fuel consumption, manufacturing, and electricity generation significantly contribute to higher CO_2 emissions. Specifically, a 1% increase in GDP leads to a 79.8% rise in CO_2 emissions, while renewable energy consumption reduces emissions by 6.56%. The study concluded that as economies grow, environmental pollution tends to rise, emphasizing the need for policymakers to implement strategies that promote sustainable growth while protecting the environment.

2/2- Studies of some Arab countries and the Middle East:

Several studies have analyzed the causality between the environment and economic development in Arab countries and the Middle East using a comparative quantitative approach, including those by Elshimy, M., & El-Aasar, K. M. (2020), Nathaniel,& Adedoyin, F. F. (2021), Ramezani & Athars (2022), Ragmoun, W. (2023), Satari, S., & Athras (2023), Fawzi, W. & Shaimaa (2022).

Elshimy et al. (2020) analyzed the relationship between carbon footprint, real income, energy by source, and livestock in Arab countries from 1980 to 2014. Their findings revealed a quadratic relationship between carbon footprint and real income, supporting the Environmental Kuznets Curve (EKC) hypothesis. The study highlighted that renewable energy mitigates carbon footprints and emphasized that renewable energy and sustainable production and consumption patterns could play a crucial role in reducing carbon footprints in Arab countries.

Nathaniel, S. P., et al. (2021) investigated the effects of natural resource abundance and renewable energy on the environmental footprint in Middle Eastern and North African (MENA) countries using Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) methods. The study found that urbanization exacerbates environmental degradation in all countries except Algeria, Bahrain, Tunisia, and Morocco. Furthermore, natural resource rents increase the environmental footprint in the UAE, Oman, and Lebanon. The study identified causal relationships between urbanization, economic growth, and economic efficiency.

Aminzadeh, M. (2022) explored factors affecting the environmental footprint in 18 MENA countries from 2000 to 2016. The study revealed that neighboring countries' behaviors significantly influence a country's environmental footprint, emphasizing the interconnection of environmental issues in the MENA region and the importance of collaborative policymaking efforts to enhance environmental sustainability.

Ramezani et al. (2022) also used a spatial approach to analyze the interactions between natural resource rents, industrial production, and environmental footprints across 17 MENA countries between 2000 and 2018. The findings indicated that increased industrial production could lead to further environmental degradation, influenced by development levels and resource management. The study demonstrated positive spatial correlations in environmental footprint levels, suggesting that one country's environmental impact can affect its neighbors.

Mehrjo, A., et al. (2020) evaluated CO_2 emissions in the region by creating a renewable energy index and applying the Cross-sectional Autoregressive Distributed Lag (CS-ARDL) technique to data from 18 MENA countries spanning 1990 to 2019. The study found that the significance of explanatory variables varied across regional country groups. Economic growth had a substantial long-term positive effect on CO_2 emissions, refuting the EKC hypothesis. The study highlighted the importance of energy efficiency in enhancing environmental quality in both the short and long term. It found that renewable energy reduces CO_2 emissions, whereas urbanization and fossil fuel consumption do not improve environmental quality in the MENA region. The study recommended promoting energy efficiency and transitioning from fossil fuels to renewable energy sources.

Fawzi, W. & Shaimaa (2022) analyzed the relationship and estimated the impact of certain determinants on the environmental footprint in selected North African countries (Egypt, Algeria, Tunisia, and Morocco) from 1973 to 2017. Using panel data methodologies and dynamic longitudinal models, the study found that economic growth variables—represented by per capita GDP, final energy consumption, natural resource rents, and trade openness—negatively affected environmental quality by increasing per capita environmental footprint. However, higher population growth rates reduced per capita environmental footprint consumption.

Studies such as those by Ansari, M. A., Ahmad, M. R., Siddique, S., & Mansoor, K. (2020), Farooq, U., Tabash, M. I., Anagreh, S., Al-Rdaydeh, M., & Habib, S. (2022), and ElMassah, S., & Hassanein, E. A. (2023) have analyzed the impact of various development indicators on the environmental footprint in the Gulf Cooperation Council (GCC) countries. Using comparative quantitative analysis across countries over periods spanning from 1975 to 2022, these studies consistently confirmed the validity of the Environmental Kuznets Curve (EKC) hypothesis for the six GCC countries. They found that economic growth leads to environmental degradation after surpassing a certain income level. Additionally, energy consumption has a significant positive effect on the environmental footprint.

The studies concluded that the GCC region continues to face substantial pressures on its ecosystem due to its reliance on fossil fuels and unsustainable consumption patterns. However, the findings on the impact of globalization on the environmental footprint in these countries varied. All studies emphasized the urgent need to reduce dependence on fossil fuels, transition to alternative energy sources, and implement incentivized policies to lower CO_2 emissions and reduce the environmental footprint.

Other studies focused on the reciprocal relationship between development and the environment by examining single-country cases. For instance, Aldegheishem, A. (2024) investigated the effects of urbanization, energy consumption, natural resources, economic growth, and technological innovation on the environmental footprint in Saudi Arabia. Using the Autoregressive Distributed Lag (ARDL) model for the period 1990–2022, the study assessed both short- and long-term effects. It found that urbanization, natural resources, and technological innovation reduce the environmental footprint (EF), whereas energy consumption and economic growth increase it. The study underscored the need to align economic policies with environmental goals by electrifying the economy, replacing carbon-based energy sources with renewables, re-evaluating energy pricing systems, increasing taxes on carbon-based energy, and revising current energy laws and regulations.

The above findings reveal the variability in results from studies conducted on Middle Eastern and North African (MENA) countries, particularly regarding the relationships between economic growth, foreign trade, population size, average energy consumption, natural resource rents, and the environmental footprint (EF). However, these relationships have not been comprehensively studied across Arab countries with varying levels of economic development. This paper aims to address this gap by investigating these relationships in the context of Arab countries.

3- The Concept of E F and Estimation of ED in the Study Countries:

The Ecological Footprint (EF) is one of the most prominent indicators used to assess the sustainability of human activities by measuring the amount of natural resources required to support various economic and social activities. It is measured in Global Hectares (GHA) and encompasses the consumption of food, energy, water, and land use, compared to the Earth's biocapacity to regenerate these resources (Global Footprint Network, 2021). The Ecological Deficit (ED) is defined as the difference between the ecological footprint and local biocapacity. It occurs when the ecological footprint exceeds the ecosystem's capacity to regenerate, reflecting significant pressure on natural resources (Wackernagel et al., 2019).

The ecological footprint represents the demand side, while biocapacity, a related concept, represents the supply side. Biocapacity refers to "the capacity of an ecosystem to produce useful biological materials and absorb waste generated by human activities at present." Both measures are expressed in Global Hectares (GHA), a standardized unit globally adjusted for biological productivity. The ecological footprint of a city or country can be compared to its biocapacity. When the ecological footprint of a population in a specific region exceeds the biocapacity of that area, an ecological deficit occurs, and vice versa. In the case of an ecological deficit, demand is met through imports, depletion of local environmental assets, and/or overloading the atmosphere with carbon dioxide emissions (Global Footprint Network, 2024).

In the Arab context, studies have shown a significant increase in ecological deficit rates due to the heavy reliance on fossil fuels and unsustainable consumption patterns. This underscores the need for effective environmental policies to balance economic development with the preservation of natural resources (Nathaniel & Adedoyin, 2021). Additionally, studies indicate that rapid urbanization and population growth in Arab countries exert further pressure on natural resources, posing additional challenges for these nations to adopt sustainable development strategies and reduce carbon emissions (ElMassah & Hassanein, 2023).

Understanding the importance of using ecological footprint (EF) levels to ascertain the extent of environmental degradation in Arab countries is vital, given that all these nations currently face an ecological deficit. This means their environmental demands exceed their biocapacity to meet such needs. Consequently, ecological deficits in these countries reflect their deteriorating environmental conditions, which form the impetus for conducting this study.

Table (1) illustrates the levels of per capita ecological footprint (EF), biocapacity (BIO), and ecological deficit (ED) in the study countries and globally between 1990 and 2022. The data reveals that the ecological deficit (ED) in all Arab countries under study exceeds the global average ecological deficit. This indicates that Arab countries face significant challenges in their ecosystems' ability to produce useful biological materials and absorb the waste generated by urbanization-driven human activities.

Table (١)

Trends in ecological footprint and environmental deficit in the study countries from 1990 to 2022

yeer	1990			2000			2010			2020			2022		
country	EF	Bio	ED	EF	Bio	ED	EF	Bio	ED	EF	Bio	ED	EF	Bio	ED
Algeria	3.638579	1.712045	1.926534	3.638579	1.712045	1.926534	3.638579	1.712045	1.926534	3.638579	1.712045	1.926534	3.638579	1.712045	1.926534
Egypt	1.269677	0.332445	0.937233	1.463639	0.377418	1.086221	1.773453	0.342674	1.430779	1.470956	0.31735	1.153606	1.453028	0.313084	1.139944
Iraq	1.605972	0.449579	1.156393	1.351667	0.225156	1.126511	1.536729	0.308623	1.228106	1.563783	0.326928	1.236855	1.726746	0.314222	1.412524
Jordan	2.783558	0.321919	2.46164	2.014999	0.270253	1.744747	1.931395	0.284018	1.647378	1.366535	0.22032	1.146215	1.303853	0.214335	1.089518
Lebanon	2.329602	0.407921	1.92168	3.07257	0.364861	2.707709	3.475168	0.319921	3.155247	2.750883	0.310997	2.439887	3.145596	0.318992	2.826604
Mauritania	2.36908	8.487134	-6.11805	2.384185	6.375561	-3.99138	2.518408	4.953944	-2.43554	2.328863	3.844893	-1.51603	2.256408	3.653577	-1.39717
Morocco	1.176191	0.879846	0.296345	1.288789	0.594746	0.694043	1.659726	0.794298	0.865428	1.555481	0.576527	0.978955	1.545268	0.565398	0.97987
Syrian	1.494208	0.673889	0.820319	1.640461	0.70824	0.932222	1.819749	0.523933	1.295816	1.067065	0.636648	0.430417	0.997263	0.599875	0.397388
Tunisia	1.745258	1.008898	0.73636	1.446185	0.777909	0.668276	1.912112	0.821495	1.090617	1.368003	0.726978	0.641026	1.361352	0.716018	0.645334
Oman	2.331701	3.222851	-0.89115	3.233935	2.623529	0.610406	5.815386	2.239342	3.576045	6.617538	1.793019	4.824519	7.281467	1.801255	5.480212
Qatar	7.336538	5.57974	1.756798	9.840203	3.911449	5.928754	14.20007	1.510061	12.69001	11.3619	1.010664	10.35123	13.12633	1.038996	12.08734
Saudi	2.402493	1.316883	1.085609	4.110788	0.954245	3.156543	5.44275	0.761978	4.680772	5.512841	0.704258	4.808583	5.74548	0.697532	5.047947
World	2.615136	2.080728	0.534408	2.604019	1.852448	0.751571	2.759843	1.677376	1.082467	2.466229	1.534777	0.931452	2.58164	1.510215	1.071424

ED, Bio, EF refer to Ecological Footprint, Biocapacity and Ecological Deficit respectively; ED was calculated by subtracting Bio from EF by the researcher.

All figures are in terms of global land per capita.

Source: Global Ecological Footprint Network. https://www.footprintnet

4- Theoretical Analysis:

The relationship between economic development and the ecological footprint can be explained within the theoretical framework of the Environmental Kuznets Curve (EKC) hypothesis. According to this hypothesis, it is initially assumed that economic growth leads to environmental degradation. During this growth phase, there is a trade-off between higher economic growth and declining environmental quality (Murshed, M., 2021). However, once the economy exceeds a certain threshold of growth, it is believed that the effects of growth will revert the environment to a more sustainable state, where the ecological footprint (EF) is expected to decrease. As a result, the initial trade-off between economic growth and environmental degradation is gradually eliminated beyond the growth threshold. Therefore, under these conditions, the EKC hypothesis is supported if there is statistical evidence of an inverted U-shaped relationship between economic growth and the ecological footprint (EF) (Kongbuamai, N., Bui, Q., Yousaf, H. M. A. U., & Liu, Y., 2020).

In contrast, the EKC hypothesis is contradicted by evidence suggesting that strict environmental regulations (which countries may implement after surpassing the growth threshold) could improve environmental quality and reduce the trade-off between economic growth and environmental degradation that occurs during the earlier stages of growth. As a result, the application of stringent environmental rules is expected to reduce this trade-off. Thus, it is more likely to reduce the ecological footprint (EF) relative to a scenario in which no such regulations are enforced. In the absence of these regulations, production and consumption processes within the economy are likely to be environmentally unfriendly, which, in turn, is likely to increase the ecological footprint (EF) (Wang, H., & Wei, W., 2020). Furthermore, a weaker growth rate could also attract "dirty" foreign direct investment (FDI), which is expected to exacerbate the ecological footprint (EF) further. In contrast, the application of strict environmental regulations would reverse these scenarios by requiring investors to focus on green projects and motivating consumers to adopt sustainable consumption practices. These regulations would also obligate producers to reduce their use of non-renewable energy resources and gradually replace them with relatively cleaner alternatives (Ulucak, R., Kassouri, Y., İlkay, S. Ç., Altıntaş, H., & Garang, A. P. M., 2020).

Moreover, the implementation of stringent environmental policies could prevent harmful foreign direct investment flows, aligning with the Pollution Haven Hypothesis, which argues that economic recovery acts as a mechanism to shift "dirty" FDI from countries with strict environmental regulations to those with poor environmental policies (Doytch, N., 2020). Therefore, enforcing strict environmental rules is expected to reduce environmental imbalances and mitigate the trade-off between economic growth and environmental degradation.

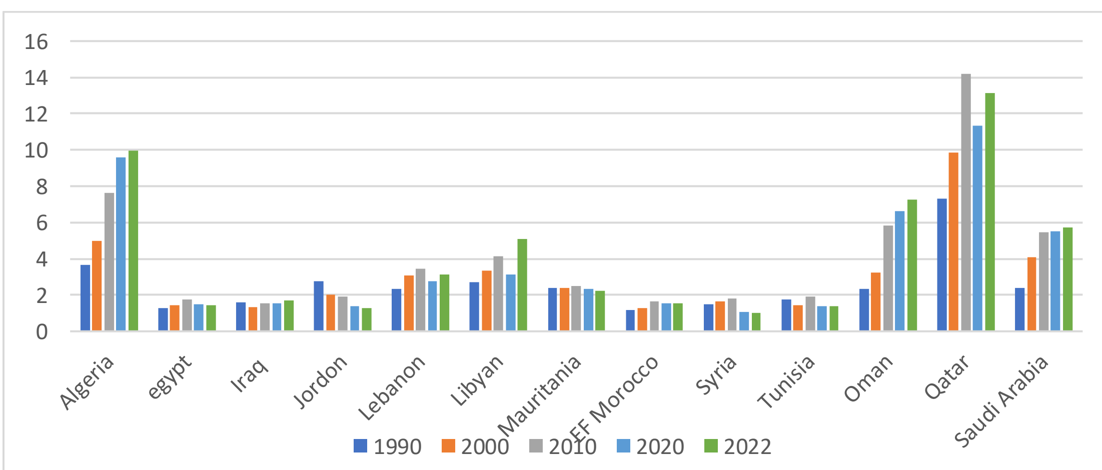
Hence, it is crucial to understand the development of the ecological footprint (EF) and analyze the trends in the relationship between the ecological footprint and various economic indicators in the 13 study countries to verify whether these environmental hypotheses hold true for these nations.

4/1 – The Environmental Footprint (EF) in the 13 Countries:

Most Arab countries lie within the world's desert belt, making them face the challenges of accelerating climate change, water scarcity, and rising temperatures. These factors have impacted agricultural production and biodiversity (Shahid, S. A., & Behnassi, M., 2014). Rising temperatures contribute to increased groundwater evaporation and reduced rainfall, disrupting the hydrological cycle, exacerbating the risk of desertification, and causing changes in crop patterns in these countries (Al Saifi, S. A., 2015).

The Arab region is endowed with significant oil wealth, leading to an increasing reliance on fossil fuels as the primary energy source for driving development. Moreover, the Arab countries have the highest population growth rates globally. These changes have significantly influenced the environmental footprint, which has shown an upward trend since the beginning of the 21st century. The following figure illustrates the development of the environmental footprint in the 13 Arab countries from 1990 to 2022.

Figure (1): EF Cons Per Cap for study countries



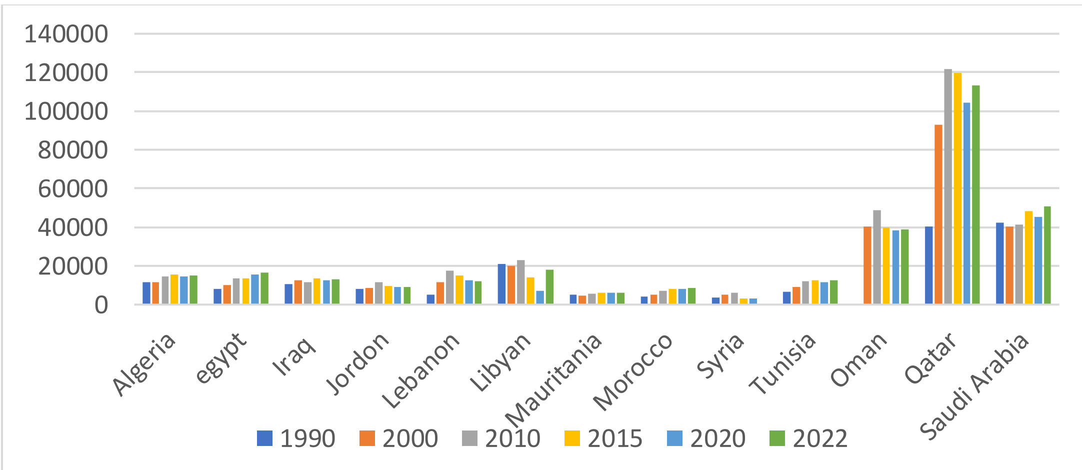
Source: Made by the researcher, citing environmental footprint data. https://www.footprintnetwork.org/

Figure (1) clearly demonstrates an upward trend in the environmental footprint across all the studied countries. Moreover, high-income countries (Qatar, Algeria, Oman, and Saudi Arabia) exhibit a significantly higher environmental footprint compared to the other countries.

4/2 - Evolution of Per Capita GDP in 13 Countries:

To measure the economic growth variable, per capita GDP was used for the countries under study. The following figure illustrates the evolution of per capita GDP in the 13 countries during the period from 1990 to 2022.

Figure (2) :per capita GDP(1990- 2022)



Source: Made by the researcher, the World Bank database. https://data.albankaldawli.org/

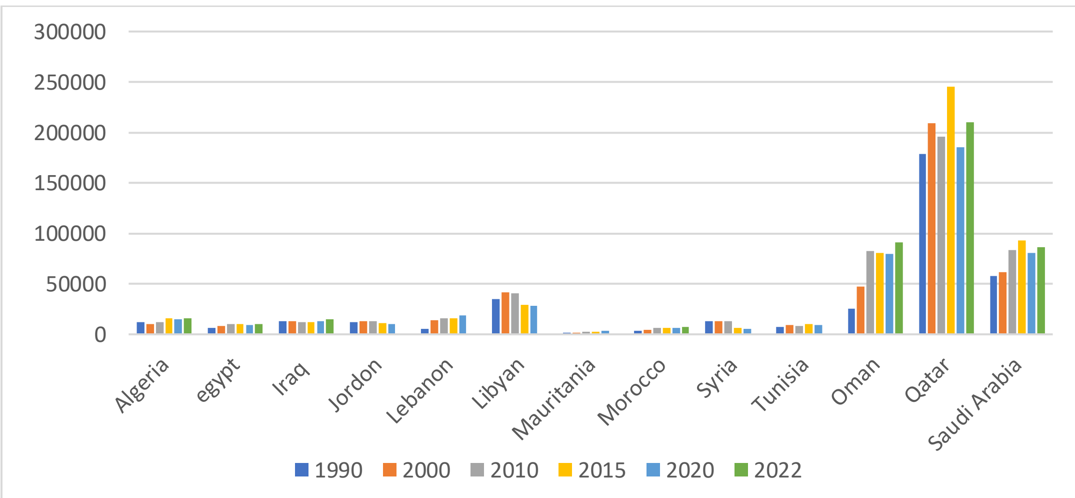
By examining Figure (2) and Figure (1), it is evident that countries with higher per capita GDP tend to have a larger environmental footprint (EF) compared to countries with medium and low-income levels. Notably, Qatar, the country with the highest per capita GDP, also ranks first in EF. This observation supports the hypothesis of a positive correlation between GDP and EF, aligning with the Environmental Kuznets Curve hypothesis.

4/3 - Energy Consumption in the 13 Countries:

Energy consumption is a key indicator of urbanization, as it drives economic growth but often leads to environmental degradation (Udemba, E. N., & Agha, C. O., 2020). Numerous studies have shown that reliance on conventional energy sources increases the environmental footprint (EF), prompting European countries to transition towards renewable energy for consumption and production. Renewable energy consumption has been shown to reduce EF (Destek, M. A., & Sinha, A., 2020). Increasing reliance on renewable energy and transitioning to clean energy sources reduce environmental pollution and lower EF in many high- and middle-income countries (Usman, M., Makhdum, M. S. A., & Kousar, R., 2021; Baris-Tuzemen, O., Uzuner, G., Ozturk, I., & Sinha, A., 2020).

In contrast, non-renewable energy consumption contributes to environmental degradation. Therefore, the energy sector is expected to play a crucial role in promoting the adoption of renewable energy. Despite variations in development levels, Arab countries primarily rely on conventional energy as the main source for electricity generation and consumption. The following figure illustrates the trends in energy consumption among the 13 studied countries during the period from 1990 to 2022.

Figure (3): Primary energy consumption in Arab countries (190-2022)



Source: Made by the researcher, the World Bank database. https://data.albankaldawli.org/

We observe a significant increase in **primary energy consumption** in high-income oil-producing and exporting countries, with Qatar ranking first, followed by Saudi Arabia, Oman, and Libya. In contrast, energy consumption remains relatively low in middle- and low-income countries. Notably, the top four energy-consuming countries also rank highest among the studied countries in terms of environmental footprint (EF), indicating a positive correlation between energy consumption and EF. This supports the hypothesis that energy consumption contributes to environmental degradation, particularly in the early stages of economic growth

4/4 - Foreign Trade in the 13 Countries:

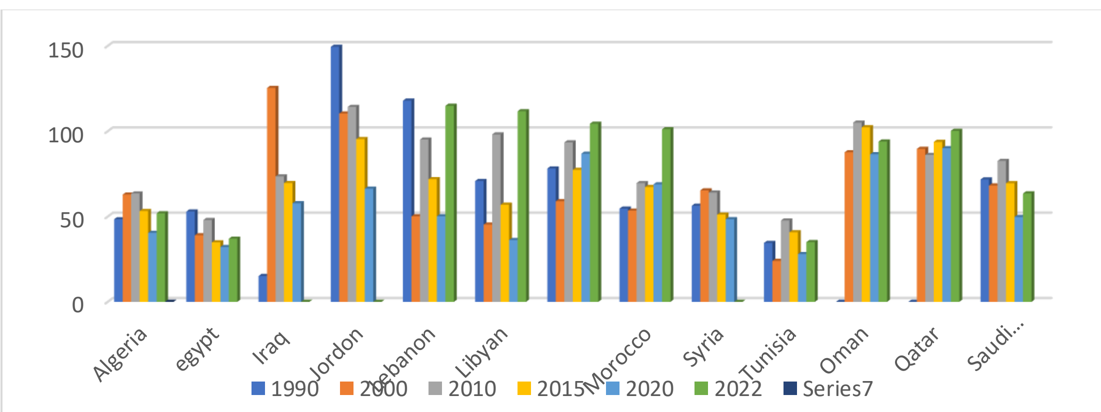
Foreign trade serves as a means of achieving economic growth. However, such trade policies can have adverse environmental outcomes for trade partners. Erdoğan, S., Çakar, N. D., Ulucak, R., Danish, & Kassouri, Y. (2021) emphasized that high openness to international trade is associated with increased CO_2 emissions. For instance, the international tourism industry was identified as a key contributor to the environmental issues linked to trade in Greece. Similarly, Zhang, Z., Xi, L., Bin, S., Yuhuan, Z., Song, W., Ya, L., ... & Guang, S. (2019) demonstrated that BRICS countries' participation in international trade tends to increase the production of "dirty" goods, which can lead to greater environmental pollution across these nations.

In contrast, China, specializing in relatively cleaner goods, has seen better environmental outcomes from international trade. Additionally, greater trade openness has been shown to improve environmental quality in the top 15 economies by reducing CO_2 emissions (Usman, M., Makhdum, M. S. A., & Kousar, R., et al., 2021). On the other hand, Uddin, G. A., Salahuddin, M., Alam, K., & Gow, J. (2017), in a study of 27 countries with the highest CO_2 emissions, found that international trade was not effective in explaining shifts in EF levels.

These conflicting environmental outcomes of international trade highlight the need to enforce environmental commitments to preserve environmental quality. Therefore, these studies suggest that the impact of international trade on the environmental footprint remains unclear.

To verify these hypotheses for the 13 countries under study, we can examine the trends and developments in foreign trade from 1990 to 2022, as illustrated in the following figure.

Figure (4): Net foreign trade (% of GDP)



Source: Made by the researcher, the World Bank database. https://data.albankaldawli.org/

It is evident that countries with stable levels of net foreign trade as a percentage of GDP since the beginning of the 21st century, such as Saudi Arabia, Qatar, and Oman, rank highest in terms of environmental footprint (EF). In contrast, other countries with fluctuating foreign trade volumes from year to year tend to have relatively lower environmental footprints. This supports the hypothesis that foreign trade has a positive correlation with the environmental footprint in Arab countries.

4/5- Population in 13 Countries:

The relationship between environmental footprint and population in Arab countries is complex, influenced by rapid urbanization, economic development, and governance. As population growth continues, pressure on natural resources increases, with environmental consequences becoming increasingly evident. The rapid population growth in Arab countries has led to higher carbon emissions and environmental footprints, primarily driven by urbanization and industrialization (Hussein, 2016; Abou-Ali et al., 2016).

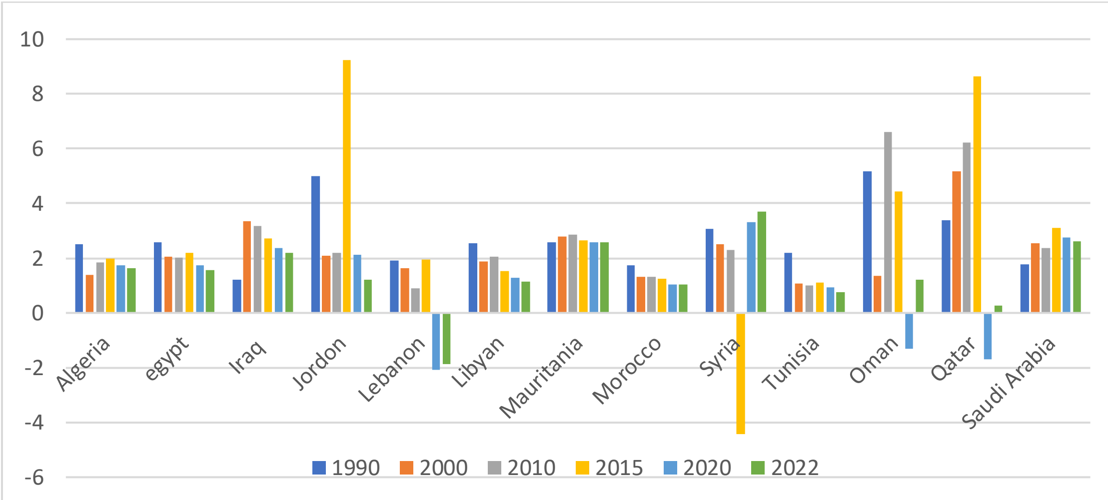
The STIRPAT II[1] model indicates that population dynamics significantly impact CO2 emissions, underscoring the need for effective governance to mitigate these effects (Abou-Ali et al., 2016). The Arab region is characterized by rapid urban growth, with more than 50% of the Arab population now residing in urban areas, and urbanization exceeding 90% in some countries (Hussein et al., 2016). The consequences of this transformation include:

- Increased water pollution and biodiversity loss due to urban expansion (Hussein et al., 2016).
- Heightened pressure on renewable water resources, particularly in poorer countries (Kulczycki & Saxena, 1998).

Although population growth presents significant environmental challenges, it can also drive innovation and sustainable practices if managed effectively and efficiently. Figure 5 illustrates the population growth rate across 13 countries during the period from 1990 to 2022.

[1] The STIRPAT model is a refinement and enhancement of the classical IPAT model, which serves as a framework for studying the factors influencing environmental impact. STIRPAT aims to provide a more flexible and statistically analyzable approach to examining the relationship between human activity and the environment. The acronym STIRPAT stands for Stochastic Impacts by Regression on Population, Affluence, and Technology, representing a probabilistic method that employs regression analysis to evaluate the effects of population, affluence, and technology on environmental outcomes.

Figure (5): Population growth



Source: Made by the researcher, the World Bank database. https://data.albankaldawli.org/

In general, there is population growth across the 13 countries, although the rate tends to decline in highly populated countries like Egypt, while it is significantly increasing in Gulf countries, where economies are characterized by high average income levels. Comparing population growth rates with the Environmental Footprint (EF) of these countries, as shown in Figure 1, reveals a positive relationship between population growth rates and EF. Qatar, for instance, exhibits the highest rates of population and urban growth, as illustrated in Figure 5, and also has the highest EF. This supports the hypothesis of a positive causal relationship between population growth and environmental footprint.

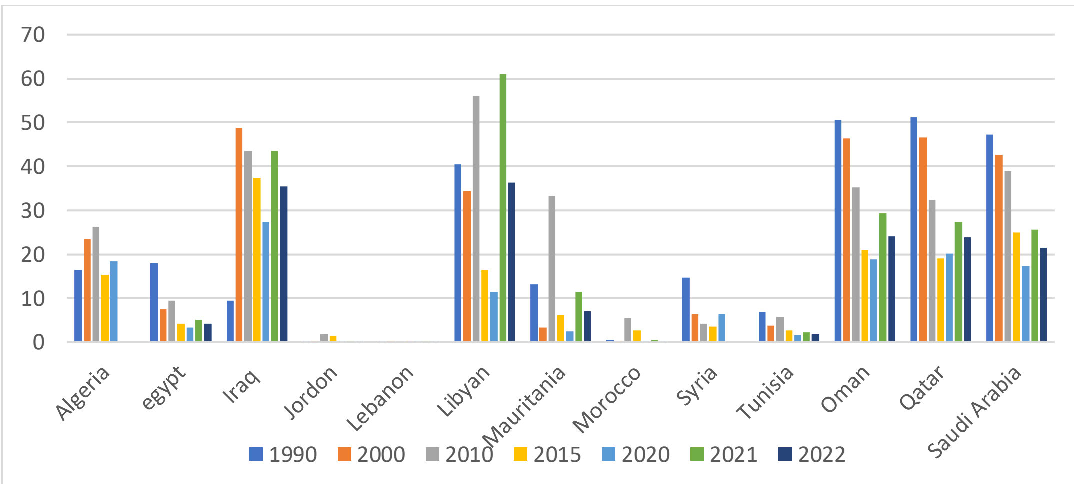
4/6- Natural Resource Rents in the 13 Countries:

The economies of most Arab countries are primarily tied to natural resources as a key source of income and wealth. The relationship between natural resources and the environmental footprint (EF) in Arab countries is characterized by significant interactions among resource utilization, economic growth, and environmental degradation. Some studies suggest that while natural resources can drive economic development, they often contribute to increasing environmental footprints, particularly in the context of non-renewable energy consumption and urbanization. This hypothesis is evident in countries like Oman and Lebanon (Nathaniel et al., 2021).

Excessive exploitation of resources exacerbates environmental degradation, as demonstrated by the high levels of EF in the Middle East and North Africa (Ramezani et al., 2022). The resource curse hypothesis posits that resource-rich countries may experience greater environmental harm due to unsustainable practices (Onifade et al., 2023). Economic growth driven by industrialization and urbanization tends to escalate environmental degradation (Ragmoun, 2023; Aldegheishem, 2024). There is a notable link between urbanization and increasing EF, though some countries, such as Algeria and Morocco, present exceptions to this trend (Nathaniel et al., 2021).

The alignment of the resource curse hypothesis can be examined in the following figure, which illustrates the evolution of natural resource rents in the 13 countries during the period from 1990 to 2022.

Figure (6): Total natural resources rents (% of GDP)



Source: Made by the researcher, the World Bank database. https://data.albankaldawli.org/

As observed, the resource curse hypothesis aligns with the situation in Arab countries. Nations with high revenue from natural resources—such as Qatar, Oman, Saudi Arabia, Libya, Iraq, and Algeria, which are among the largest producers of oil and gas—also exhibit the highest Environmental Footprint (EF).

From the above, it is evident that there is a positive relationship between the EF index and economic development indicators, represented by GDP, net foreign trade (TRAD), energy consumption (ENERG), population growth rate (POP), and natural resource rents (RENT). To validate these findings, an econometric analysis is conducted to confirm or refute these hypotheses.

5- Econometric Model and Data:

The current study estimates the impact of certain variables on the Environmental Footprint (EF) using panel data, which includes 13 entities (Algeria, Egypt, Iraq, Jordan, Lebanon, Libya, Mauritania, Morocco, Syria, Tunisia, Oman, Qatar, and Saudi Arabia) over the period 1990–2022.

The determinants of the Environmental Footprint include:

- GDP Per Capita: Average GDP per capita.
- POP: Population size.
- RENT: Total natural resource rents as a percentage of GDP.
- TRAD: Balance of goods and services as a percentage of GDP.
- ENERD: Average per capita energy consumption.

This relationship can be expressed through the following econometric model:

5/1- Model Specification:

$$\ln \_y_{it} = \ln \_\alpha_i + \sum_{j=1}^{k} \gamma_i \ln\_x_{j(it)} + \varepsilon_{it}$$

where:

- **ln_yit: is the dependent variable at segment i or at time t**
- **ln_$x(it)$: It is the set of independent variables**
- **αi: is the constant term**
- **γi is the regression coefficient.**
- **αi is the random error.**
- **i={1,…………,13)**

Where

- J={1,2,3,4,5}

Table (2) : Model countries

I	Country	i	Country
1	Algeria	٨	Morocco
2	Egypt	٩	Syria
3	Iraq	١٠	Tunisia
4	Jordan	١١	Oman
5	Lebanon	١٢	Qatar
6	Libyan Arab Jamahiriya	١٣	Saudi Arabia
7	Mauritania		

Source: Prepared by the researcher

The model equation is

$$\textbf{Ln EF}_{it} = \alpha + \beta_1 \textbf{ Ln GDP}_{it} + \beta_2 \textbf{ Ln POP}_{it} + \beta_3 \textbf{ Ln RENT}_{it} + \beta_4 \textbf{ Ln TRAd}_{it} + \beta_5 \textbf{ Ln ENERG}_{it}$$

The following table defines the variables of the model used in the analysis.

Table No. (3) Definition of model variables

variables	Definition	Unit of measure	Source
Y(Ef)	EF Cons Per Cap	Hectare	https://www.footprintnetwork.org/
X_1(GDP)	GDP per capita		https://data.albankaldawli.org/
X_2(POP)	Pop, total	Number	https://data.albankaldawli.org/
X_3(RENT)	Total natural resources rents	(% of GDP)	https://data.albankaldawli.org/
X_4 (TRAd)	Net barter terms of trade index (2015 = 100)	$	https://data.albankaldawli.org/
X_5 (ENERG)	Primary energy consumption per capita	(kWh/person)	Data source: U.S. Energy Information Administration (2023); Energy Institute - Statistical Review of World Energy (2024); Population based on various sources (2023)
LN	Logarithm of a natural number E		https://data.albankaldawli.org/

Source: Prepared by the researcher

The econometric analysis approach requires an in-depth understanding of the nature of the dataset. Therefore, a preliminary examination is essential to guide the selection of the appropriate technique(s).

In this regard, **Panel Data**, as described by Baltagi, B. H. (2008), also known as longitudinal or cross-sectional time-series data, combines both a temporal dimension and a cross-sectional dimension. Panel Data consist of multiple observations for the same individuals, firms, countries, or other units over different time periods. This structure allows researchers to study changes over time as well as differences across cross-sectional units, providing a comprehensive analysis of economic and social phenomena.

The analysis of Panel Data requires several assumptions, with the most notable being:

1. **Homoscedasticity**: This implies that the variance of the random error term for any observation is not influenced by the error term of another observation.
2. **Stationarity**: This requires that the mean and variance remain constant over time.

According to Fawzi and Shaimaa (2022), ensuring stationarity in Panel Data is a critical prerequisite for accurately estimating econometric models. Non-stationary data can lead to the issue of **Spurious Regression**, where the estimated coefficients and statistical tests become misleading. Economic data often exhibit upward trends over time, as highlighted by Wooldridge, J. M. (2013). This makes testing and addressing stationarity an integral step in Panel Data analysis to ensure reliable and valid results.

5/2 - Examining the Stationarity of Model Variables: Unit Root Test

Unit root tests are a primary tool for assessing the stationarity of time series and are widely used in econometric modeling. Various unit root tests for panel data were employed in this analysis, including **PP - Fisher Chi-square**, **Im, Pesaran and Shin W-stat**, **ADF - Fisher Chi-square**, **Breitung t-stat**, and **Levin, Lin & Chu t** tests.

The results, as presented in Tables (4 to 15), indicate that the variables—**Environmental Footprint (EF)**, **Gross Domestic Product (GDP)**, **Population (POP)**, **Energy Consumption (ENERG)**, **Natural Resource Rent (RENT)**, and **Trade Openness (TRAD)**—are non-stationary in their original form at levels I(0). However, after taking the first difference, I(1), these variables become stationary, meaning they are first-order integrated variables.

5/2/1 - Unit Root Test for the Environmental Footprint Variable (Ln EF):

The **unit root test** was conducted for the logarithmic transformation of the environmental footprint variable (**Ln EF**) to determine its stationarity. Multiple panel unit root tests were applied, including: **Levin, Lin & Chu t-test**, **Im, Pesaran and Shin W-stat**, **ADF - Fisher Chi-square**, **PP - Fisher Chi-square**, **Breitung t-stat**.

- At the **level form I(0)I(0)**, the test results indicate that **Ln EF** is non-stationary across all tests.
- After taking the **first difference I(1)I(1)**, the results confirm that **Ln EF** becomes stationary, indicating it is a first-order integrated variable.

These findings suggest that the logarithmic transformation of the environmental footprint requires differencing to achieve stationarity, ensuring robust and reliable econometric analysis.

Table No (4) : Panel unit root test at level: Summary Series: Ln (EF)

Panel unit root test: Summary
Series: LN Y
Date: 10/25/24 Time: 20:36
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections
Null: Unit root (assumes common unit root process)			
Levin, Lin & Chu t*	0.38010	0.6481	13
Breitung t-stat	0.05068	0.5202	13
Null: Unit root (assumes individual unit root process)			
Im, Pesaran and Shin W-stat	1.00961	0.8437	13
ADF - Fisher Chi-square	20.7841	0.7530	13
PP - Fisher Chi-square	46.8533	0.0073	13

Table No(5) Panel unit root test at D: Summary Series: Ln(EF)

Panel unit root test: Summary
Series: D(LN Y)
Date: 10/25/24 Time: 20:40
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-7.11668	0.0000	13	390
Breitung t-stat	-7.70259	0.0000	13	377
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-11.2313	0.0000	13	390
ADF - Fisher Chi-square	155.545	0.0000	13	390
PP - Fisher Chi-square	700.583	0.0000	13	403

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ .World Development Indicators & https://www.footprintnetwork.org

5/2/2 - Unit Root Test for the Per Capita GDP Variable (Ln GDP)

The **unit root test** was conducted for the logarithmic transformation of the per capita GDP variable (**Ln GDP**) to assess its stationarity. The following panel unit root tests were applied: **Levin, Lin & Chu t-test**, **Im, Pesaran and Shin W-stat**, **ADF - Fisher Chi-square**, **PP - Fisher Chi-square**,**Breitung t-stat**.

- At the **level form I(0)I(0)**, the test results show that **Ln GDP** is non-stationary across all tests.
- After taking the **first difference I(1)I(1)**, the results confirm that **Ln GDP** becomes stationary, indicating that it is a first-order integrated variable.

These findings indicate that the per capita GDP variable, when expressed in its logarithmic form, requires differencing to achieve stationarity. This step is crucial for avoiding spurious regression and ensuring the validity of the econometric analysis.

Table No (6): Panel unit root test at level: Summary Series at level: ln (GDP)

Panel unit root test: Summary
Series: LN X1
Date: 10/25/24 Time: 20:57
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.21844	0.8885	13	403
Breitung t-stat	-0.77010	0.2206	13	390
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.11594	0.8678	13	403
ADF - Fisher Chi-square	22.5301	0.6594	13	403
PP - Fisher Chi-square	47.4134	0.0063	13	416

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table No (7): Panel unit root test at D: Summary Series at level: ln(GDP)

Panel unit root test: Summary
Series: D(LN X1)
Date: 10/25/24 Time: 21:02
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.32946	0.0918	13	390
Breitung t-stat	-3.11107	0.0009	13	377
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-7.80665	0.0000	13	390
ADF - Fisher Chi-square	109.355	0.0000	13	390
PP - Fisher Chi-square	721.154	0.0000	13	403

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

5/2/3 - Unit Root Test for the Population Variable (Ln POP)

The **unit root test** was conducted for the logarithmic transformation of the population variable (**Ln POP**) to evaluate its stationarity. The following panel unit root tests were applied: **Levin, Lin & Chu t-test**, **Im, Pesaran and Shin W-stat**, **ADF - Fisher Chi-square**, **PP - Fisher Chi-square**, **Breitung t-stat**.

- At the **level form I(0)I(0)**, the test results indicate that **Ln POP** is non-stationary.
- After taking the **first difference I(1)I(1)**, the results confirm that **Ln POP** becomes stationary, implying it is a first-order integrated variable.

These results highlight that the logarithmic form of the population variable requires differencing to achieve stationarity, ensuring the reliability and robustness of the econometric analysis.

Table No (8): Panel unit root test at level: Summary Series: LN_ (POP)

nel unit root test: Summary
ries: LN X2
te: 10/25/24 Time: 21:10
mple: 1990 2022
ogenous variables: Individual effects, individual linear trends
er-specified lags: 1
wey-West automatic bandwidth selection and Bartlett kernel
lanced observations for each test

thod	Statistic	Prob.**	Cross-sections	Obs
ll: Unit root (assumes common unit root process)				
vin, Lin & Chu t*	-7.07784	0.0000	13	403
eitung t-stat	3.98244	1.0000	13	390
ll: Unit root (assumes individual unit root process)				
Pesaran and Shin W-stat	-5.31820	0.0000	13	403
F - Fisher Chi-square	110.285	0.0000	13	403
- Fisher Chi-square	22.9902	0.6335	13	416

Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table No (9): Panel unit root test at D: Summary Series: LN (POP)

Panel unit root test: Summary
Series: D(LN X2)
Date: 10/25/24 Time: 21:14
Sample: 1990 2022
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Ob
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-5.01391	0.0000	13	39
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.94142	0.0000	13	39
ADF - Fisher Chi-square	104.995	0.0000	13	39
PP - Fisher Chi-square	38.9725	0.0491	13	40

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

5/2/4 - Unit Root Test for the Natural Resource Rent Variable (Ln RENT):

The **unit root test** was conducted for the logarithmic transformation of the natural resource rent variable (**Ln RENT**) to assess its stationarity. The following panel unit root tests were employed: **Levin, Lin & Chu t-test**, **Im, Pesaran and Shin W-stat**, **ADF - Fisher Chi-square**, **PP - Fisher Chi-square**, **Breitung t-stat**.

- At the **level form I(0)I(0)**, the test results show that **Ln RENT** is non-stationary across all applied tests.
- After taking the **first difference I(1)I(1)**, the results indicate that **Ln RENT** becomes stationary, suggesting it is a first-order integrated variable.

These findings confirm that the natural resource rent variable in its logarithmic form requires differencing to attain stationarity. This adjustment is critical to avoid issues such as spurious regression and to ensure the validity of the econometric analysis.

Table No(10): Panel unit root test at level: Summary Series: LN (RENT)

Panel unit root test: Summary
Series: LN X3
Date: 10/25/24 Time: 21:17
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.02068	0.8463	13	403
Breitung t-stat	-2.02847	0.0213	13	390
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.41427	0.6607	13	403
ADF - Fisher Chi-square	21.5420	0.7135	13	403
PP - Fisher Chi-square	42.7536	0.0205	13	416

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table No (11): Panel unit root test at D: Summary Series: LN(RENT)

Panel unit root test: Summary
Series: LN X3
Date: 10/25/24 Time: 21:21
Sample: 1990 2022
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.74053	0.0001	13	415
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.45297	0.0000	13	415
ADF - Fisher Chi-square	71.2127	0.0000	13	415
PP - Fisher Chi-square	68.8946	0.0000	13	416

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

5/2/4 - Unit Root Test for the Natural Resource Rent Variable (Ln RENT):

To examine the stationarity of the logarithmic transformation of the natural resource rent variable (**Ln RENT**), a series of panel unit root tests were applied, including: **Levin, Lin & Chu t-test**, **Im, Pesaran and Shin W-stat**, **ADF - Fisher Chi-square**, **PP - Fisher Chi-square**, **Breitung t-stat**.

- At the **level form I(0)I(0)**, the test results indicate that **Ln RENT** is non-stationary across all tests.
- After applying the **first difference I(1)I(1)**, the results confirm that **Ln RENT** becomes stationary, indicating it is a first-order integrated variable.

This outcome demonstrates the necessity of differencing the natural resource rent variable to ensure stationarity, which is a crucial step for robust and accurate econometric analysis.

Table No (10): Panel unit root test at level: Summary Series: LN (RENT)

Panel unit root test: Summary
Series: LN X3
Date: 10/25/24 Time: 21:17
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.02068	0.8463	13	403
Breitung t-stat	-2.02847	0.0213	13	390
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.41427	0.6607	13	403
ADF - Fisher Chi-square	21.5420	0.7135	13	403
PP - Fisher Chi-square	42.7536	0.0205	13	416

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table No (11): Panel unit root test at D: Summary Series: LN(RENT)

Panel unit root test: Summary
Series: LN X3
Date: 10/25/24 Time: 21:21
Sample: 1990 2022
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.74053	0.0001	13	415
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.45297	0.0000	13	415
ADF - Fisher Chi-square	71.2127	0.0000	13	415
PP - Fisher Chi-square	68.8946	0.0000	13	416

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

5/2/5 - Unit Root Test for the Net Trade Openness Variable (Ln TRAD)

The **unit root test** was conducted for the logarithmic transformation of the net trade openness variable (**Ln TRAD**) to assess its stationarity. The following panel unit root tests were employed: **Levin, Lin & Chu t-test**, **Im, Pesaran and Shin W-stat**, **ADF - Fisher Chi-square**, **PP - Fisher Chi-square**, **Breitung t-stat**.

- At the **level form I(0)I(0)**, the test results show that **Ln TRAD** is non-stationary across all tests.
- After taking the **first difference I(1)I(1)**, the results confirm that **Ln TRAD** becomes stationary, indicating it is a first-order integrated variable.

These findings highlight the need to difference the net trade openness variable in its logarithmic form to achieve stationarity, a necessary step for reliable and valid econometric modeling.

Table No (12) Panel unit root test at level: Summary Series: LN(TRED)

Panel unit root test: Summary
Series: LN X4
Date: 10/25/24 Time: 21:28
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.70531	0.0441	13	403
Breitung t-stat	-1.01403	0.1553	13	390
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.85874	0.1952	13	403
ADF - Fisher Chi-square	33.4288	0.1500	13	403
PP - Fisher Chi-square	41.7440	0.0261	13	416

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table No (13) :Panel unit root test at level: Summary Series: LN (TRED)

Panel unit root test: Summary
Series: LN X4
Date: 10/25/24 Time: 21:36
Sample: 1990 2022
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.98018	0.0238	13	413
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.26155	0.1036	13	413
ADF - Fisher Chi-square	46.1310	0.0088	13	413
PP - Fisher Chi-square	41.1762	0.0298	13	416

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

5/2/6 - Unit Root Test for the Energy Consumption Variable (Ln ENERG)

The **unit root test** was performed for the logarithmic transformation of the energy consumption variable (**Ln ENERG**) to evaluate its stationarity. The following panel unit root tests were applied: **Levin, Lin & Chu t-test**, **Im, Pesaran and Shin W-stat**, **ADF - Fisher Chi-square**, **PP - Fisher Chi-square**, **Breitung t-stat**.

- At the **level form I(0)I(0)**, the test results indicate that **Ln ENERG** is non-stationary across all applied tests.
- After taking the **first difference I(1)I(1)**, the results confirm that **Ln ENERG** becomes stationary, demonstrating that it is a first-order integrated variable.

These results underscore the necessity of differencing the energy consumption variable to ensure stationarity, which is essential for conducting robust and accurate econometric analyses.

Table No (14): Panel unit root test at level: Summary Series: LN (ENERG)

Panel unit root test: Summary
Series: LN X5
Date: 10/25/24 Time: 21:38
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.65274	0.0492	13	403
Breitung t-stat	-1.14285	0.1266	13	390
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.39821	0.0810	13	403
ADF - Fisher Chi-square	35.7146	0.0970	13	403
PP - Fisher Chi-square	26.1242	0.4563	13	416

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table No (15): Panel unit root test at level: Summary Series: LN (ENERG)

Panel unit root test: Summary
Series: D(LN X5)
Date: 10/25/24 Time: 21:41
Sample: 1990 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-13.0093	0.0000	13	397
Breitung t-stat	-5.51630	0.0000	13	384
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-13.3451	0.0000	13	397
ADF - Fisher Chi-square	184.544	0.0000	13	397
PP - Fisher Chi-square	310.549	0.0000	13	403

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

5/3 - Panel Cointegration Test:

The **panel cointegration test** was conducted to examine whether a long-term equilibrium relationship exists between the variables in the model. This step is crucial in panel data analysis, especially when dealing with non-stationary variables, as it ensures that the relationships among the variables are not spurious.

The following panel cointegration tests were employed:

- **Pedroni Cointegration Test**,
- **Kao Residual Cointegration Test**,
- **Johansen-Fisher Panel Cointegration Test**.

The Results: The tests reveal significant evidence of cointegration among the variables. This implies that despite the non-stationarity of the variables at their levels, they move together in the long term, maintaining a stable relationship.

The existence of cointegration allows for the estimation of long-term relationships using models such as the Fully Modified Ordinary Least Squares (FMOLS) or Dynamic

Ordinary Least Squares (DOLS), which account for the non-stationary nature of the data and potential endogeneity issues.

Table No(16): Using cointegration Pedroni Residual Cointegration Test

Pedroni Residual Cointegration Test
Series: LN Y LN X1 LN X2 LN X3 LN X4 LN X5
Date: 10/25/24 Time: 21:52
Sample: 1990 2022
Included observations: 429
Cross-sections included: 13
Null Hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Automatic lag length selection based on SIC with a max lag of 6
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-2.129494	0.9834	-2.169078	0.9850
Panel rho-Statistic	0.464794	0.6790	1.195611	0.8841
Panel PP-Statistic	-7.358868	0.0000	-5.234905	0.0000
Panel ADF-Statistic	-8.680235	0.0000	-6.462172	0.0000

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	2.186070	0.9856
Group PP-Statistic	-4.607132	0.0000
Group ADF-Statistic	-6.669064	0.0000

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

The results of Pedroni Residual Cointegration Test: The null hypothesis assumes no cointegration among the variables (No Cointegration).

Within-Dimension (Panel Statistics): Panel v-Statistic: Value: **-2.129494**, Probability: **0.9834.** Interpretation: Indicates failure to reject the null hypothesis, suggesting no evidence of cointegration based on this statistic.

Panel rho-Statistic: Value: **0.464794**, Probability: **0.6790**. Interpretation: Also fails to reject the null hypothesis, implying no cointegration according to this measure.

Panel PP-Statistic: Value: **-7.358868**, Probability: **0.0000.** Interpretation: Strongly rejects the null hypothesis, indicating the presence of cointegration among the variables.

The **Panel PP-Statistic** provides evidence supporting the existence of a long-term cointegration relationship between the variables.

Given the presence of cointegration among the variables, as demonstrated by the results of the **Pedroni Residual Cointegration Test**, the **PANEL ARDL (Auto-Regressive Distributed Lag)** model is an appropriate choice for analyzing the dynamic relationship between the variables in both the short and long term.

5/4- Dynamic Panel Model (PMG/ARDL)

5/4/1- Description of the model

Estimation Equation:
=========================
D(LN_Y) = [CX=SR,ESTSMPL="1994 2022"]

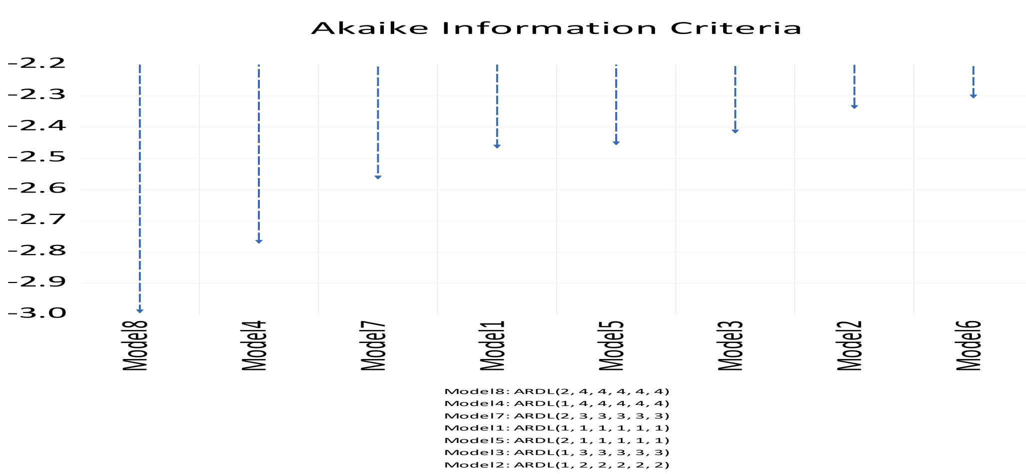
Forecasting Equation:
=========================
D(LN_Y) = [CX=SR,ESTSMPL="1994 2022"]

Substituted Coefficients:
=========================
D(LN_Y) = [CX=SR,ESTSMPL="1994 2022"]

5/4/2-Testing the optimal deceleration periods:

This figure typically refers to a test or criterion used to determine the optimal number of lags in a model, such as a panel ARDL or time series model. The optimal lag length is important because selecting the correct number of lags helps improve the model's performance and ensures reliable results. Common methods for determining optimal lag length include the **Akaike Information Criterion (AIC)**, **Bayesian Information Criterion (BIC)**, and other statistical tests.

Figure (7): Optimal Lag Length Test



Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

From Figure (7), we can observe that the optimal lag length for the variables is the one that provides the lowest value of Akaike (2,4,4,4,4,4) ARDL.

5/4/4 - Estimating Long-Run Parameters

Estimating the long-run parameters in the **PANEL ARDL** model involves determining the stable relationship between the variables over the long term, i.e., identifying the effects that persist over time. These parameters are estimated using the **Pooled Mean Group (PMG)** method, which assumes that long-run parameters are identical across cross-sectional units (such as countries or firms) while short-run parameters can vary.

Table (17): Long-Run Model

Dependent Variable: D(LN_Y)
Method: ARDL
Date: 10/25/24 Time: 19:11
Sample: 1994 2022
Included observations: 377
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LN_X1 LN_X2 LN_X3 LN_X4 LN_X5
Fixed regressors: C
Number of models evalulated: 8
Selected Model: ARDL(2, 4, 4, 4, 4, 4)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
	Long Run Equation			
LN_X1	-0.579154	0.106621	-5.431874	0.0000
LN_X2	0.616685	0.034374	17.94049	0.0000
LN_X3	0.051240	0.014565	3.518126	0.0006
LN_X4	0.937123	0.072240	12.97239	0.0000
LN_X5	0.297577	0.060406	4.926289	0.0000

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

From Table (17), the following key results can be extracted:

1. **Independent Variables** (variables in the long-run equation):
   - **LN_X1(GDP):** The coefficient (-0.579154) with a standard error (0.106621) and t-statistic (t = -5.431874), with a probability value (Prob = 0.0000), indicates a significant negative relationship between LN_X1 and LN_Y in the long run.
   - **LN_X2 (POP):** The coefficient (0.616685) with a standard error (0.034374) and t-statistic (t = 17.9409), with a probability value (Prob = 0.0000), indicates a significant positive relationship between LN_X2 and LN_Y in the long run.

- **LN_X3 (RENT)**: The coefficient (0.051240) with a standard error (0.014565) and t-statistic (t = 3.518126), with a probability value (Prob = 0.0000), indicates a significant positive relationship between LN_X3 and LN_Y in the long run.
- **LN_X4 (ENERG)**: The coefficient (0.937123) with a standard error (0.072240) and t-statistic (t = 12.9739), with a probability value (Prob = 0.0000), indicates a significant positive relationship between LN_X4 and LN_Y in the long run.
- **LN_X5 (TRAD)**: The coefficient (0.297577) with a standard error (0.060406) and t-statistic (t = 4.926289), with a probability value (Prob = 0.0000), indicates a significant positive relationship between LN_X5 and LN_Y in the long run.

2. **Model Selection**:
   - The **ARDL (2, 4, 4, 4, 4)** model was selected based on the Akaike Information Criterion (AIC).
   - A total of 377 observations were used in the model.
3. **Statistical Significance**:
   - All independent variables show strong statistical significance, as the probability values for all coefficients are below 0.05.

Based on these results, it can be concluded that all independent variables significantly affect the dependent variable LNYLN_Y in the long run.

5/4/5 - Estimation of Short-Run Parameters and Error Correction Term

In this section, the estimation of short-run parameters and the error correction term (ECT) is discussed. The short-run parameters capture the immediate, or short-term, impact of changes in independent variables on the dependent variable, while the error correction term indicates how quickly the system adjusts to long-run equilibrium.

Table No. (18): Error correction model ECM Regression

Dependent Variable: D(LN_Y)
Method: ARDL
Date: 10/25/24 Time: 19:11
Sample: 1994 2022
Included observations: 377
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LN_X1 LN_X2 LN_X3 LN_X4 LN_X5

Fixed regressors: C
Number of models evalulated: 8
Selected Model: ARDL(2, 4, 4, 4, 4, 4)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
	Short Run Equation			
COINTEQ01	-0.491711	0.228023	-2.156412	0.0330
D(LN_Y(-1))	-0.108933	0.138694	-0.785415	0.4337
D(LN_X1)	0.883859	0.382679	2.309658	0.0225
D(LN_X1(-1))	0.051140	0.325711	0.157012	0.8755
D(LN_X1(-2))	-0.240319	0.191663	-1.253862	0.2122
D(LN_X1(-3))	-0.452514	0.353651	-1.279551	0.2031
D(LN_X2)	-1.441667	11.16888	-0.129079	0.8975
D(LN_X2(-1))	6.562547	16.90549	0.388190	0.6985
D(LN_X2(-2))	2.651058	10.03005	0.264312	0.7920
D(LN_X2(-3))	-5.886027	10.88661	-0.540667	0.5897
D(LN_X3)	0.008697	0.031262	0.278206	0.7813
D(LN_X3(-1))	0.123402	0.056350	2.189909	0.0304
D(LN_X3(-2))	0.071276	0.048571	1.467468	0.1448
D(LN_X3(-3))	0.056106	0.055686	1.007540	0.3156
D(LN_X4)	-0.088857	0.261616	-0.339647	0.7347
D(LN_X4(-1))	0.211448	0.145581	1.452443	0.1489
D(LN_X4(-2))	0.252349	0.103120	2.447131	0.0158
D(LN_X4(-3))	0.188560	0.242367	0.777992	0.4380
D(LN_X5)	-0.221343	0.121057	-1.828422	0.0699
D(LN_X5(-1))	-0.284150	0.122037	-2.328394	0.0215
D(LN_X5(-2))	-0.110301	0.170655	-0.646338	0.5192
D(LN_X5(-3))	0.045094	0.126850	0.355494	0.7228
C	-6.778231	3.385531	-2.002118	0.0474

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

Key Results from the Short-Run Estimation (ARDL Model):

1. **Error Correction Term (COINTEQ01)**: Coefficient: **-0.491711,** Standard Error: **0.228023,** t-Statistic: **-2.156412**, Probability (Prob): **0.0330**

This indicates a significant negative relationship in the error correction term, which means the system is adjusting toward long-run equilibrium at a rate of **49.17%** per period. This is a statistically significant result.

2. **Short-Run Dynamics of Independent Variables**:

   - **D(LN_X1) GDP**: Coefficient: **0.883859**, Standard Error: **0.382679**, t-Statistic: **2.309658**, Probability (Prob): **0.0225**. There is a significant positive relationship between **LN_X1** and **LN_Y** in the short run. A 1% increase in **LN_X1** results in a **0.88%** increase in **LN_Y**.

- **D(LN_X2) POP**: Coefficient: **-1.441667,** Standard Error: **11.16888**, t-Statistic: **-0.129079**, Probability (Prob): **0.8975**. This variable does not show any significant relationship with **LN_Y** in the short run.
- **D(LN_X3) RENT**: Coefficient: **0.008697**, Standard Error: **0.031262**, t-Statistic: **0.278206**, Probability (Prob): **0.7813**. **LN_X3** does not have a statistically significant effect on **LN_Y** in the short run.
- **D(LN_X4) ENERG**: Coefficient: **-0.088857**, Standard Error: **0.261616**, t-Statistic: **-0.339647**, Probability (Prob): **0.7347**. **LN_X4** also shows no significant short-run effect on **LN_Y**.
- **D(LN_X5) TRAD**: Coefficient: **-0.221343**, Standard Error: **0.121057**, t-Statistic: **-1.828422**, Probability (Prob): **0.0699**. This coefficient is marginally significant, suggesting a slight negative short-run effect of **LN_X5** on **LN_Y**. The probability value is close to 0.05, which indicates that this result is at the border of statistical significance.

3. **Other Variables**: The other lagged variables for **LN_X1**, **LN_X2**, **LN_X3**, **LN_X4**, and **LN_X5** show varying degrees of significance, but none of them appear consistently significant across different lags.
4. **Constant (C)**: Coefficient: **-6.778231**, Standard Error: **3.385531**, t-Statistic: **-2.002118**, Probability (Prob): **0.0474**. The constant term is statistically significant at the 5% level, suggesting that the baseline level of **LN_Y** is significantly different from zero.

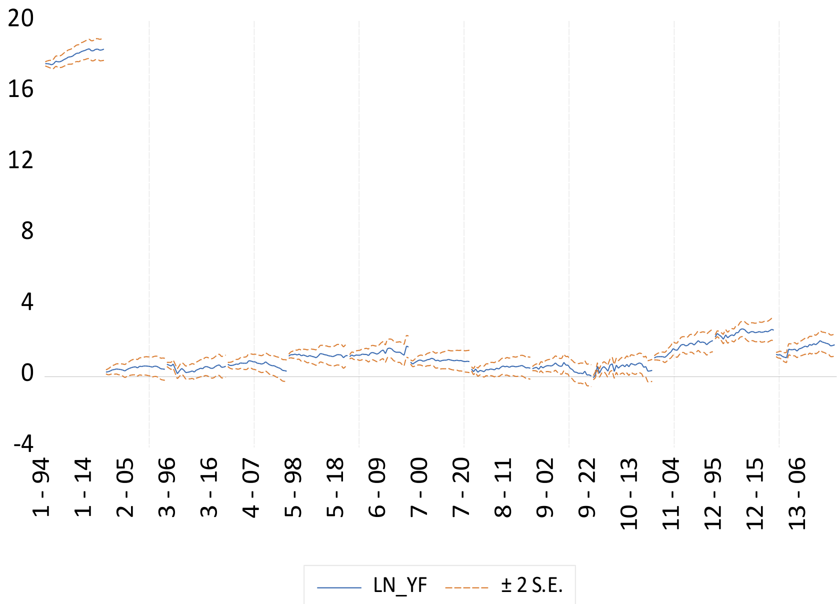
The model shows that certain variables, particularly **D(LN_X1)** and **D(LN_X5)**, have a significant effect on **LN_Y** in the short run. The **error correction term (COINTEQ01)** is also significant, indicating that the model adjusts towards long-run equilibrium. The overall fit of the model appears reasonable, with some variables showing significance and others not.

5/5 - Model Predictive Power Test:

The predictive power test is used to assess the accuracy of the model in forecasting future values of the dependent variable based on the past values of the independent variables.

The predictive power test is an important tool for measuring the effectiveness of the model in forecasting future variables. It can help guide policy or economic decisions based on the model's reliability in providing accurate predictions.

Table No. (1٩) Model Predictive Power Test



Forecast: LN_YF	
Actual: LN_Y	
Forecast sample: 1990 2022	
Adjusted sample: 1994 2022	
Included observations: 377	
Root Mean Squared Error	0.056473
Mean Absolute Error	0.034500
Mean Abs. Percent Error	3.643058
Theil Inequality Coef.	0.005500
Bias Proportion	0.023620
Variance Proportion	0.001112
Covariance Proportion	0.975268
Theil U2 Coefficient	0.081002
Symmetric MAPE	3.598924

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

From the attached table, the main results can be summarized as follows:

1. **Forecasted vs. Actual Values**:
   - The figure shows the predictions for the variable LN_YF\text{LN_YF} compared to the actual values of LN_Y\text{LN_Y}.
   - The forecasted values exhibit a stable linear trend with some minor fluctuations.
2. **Accompanying Statistics**:
   - **Root Mean Squared Error (RMSE)**: 0.054473, indicating the model's high accuracy in forecasting values.
   - **Mean Absolute Error (MAE)**: 0.039500, which is low, reflecting accurate predictions.
   - **Mean Absolute Percent Error (MAPE)**: 3.64058%, showing a low level of relative error in predictions.
   - **Theil Inequality Coefficient**: 0.006500, indicating high prediction accuracy.

- **Variance Proportion**: 0.975268, suggesting that most of the variance in the data is explained by the model.
- **Bias Proportion**: 0.026320, which is small, meaning the predictions are not significantly biased.
- **Theil U2 Coefficient**: 0.081020, a good indicator of prediction accuracy in the model.

3. **Symmetric MAPE**: 3.589824, reflecting the accuracy of the model's forecast with the symmetric MAPE metric.

   Based on these values, it can be concluded that the model provides accurate and reliable predictions.

4. From the attached tables, it is observed that all the models in the short run for the panels (13 countries) exhibit cointegration, with negative and significant error correction coefficients. This indicates that the short-run equilibrium for each model leads to long-run equilibrium.

5/6- Key Results of the Model:

1. **High Accuracy of the Model:**
   - The model demonstrates strong forecasting ability for future values of the dependent variable, with most statistics indicating high accuracy.
   - The Root Mean Squared Error (RMSE) is low at 0.054473, indicating accurate predictions.
   - The Mean Absolute Error (MAE) is low at 0.039500, reflecting good performance in forecasting.
   - The Mean Absolute Percentage Error (MAPE) is 3.64058%, showing a relatively small error percentage in predictions.
   - The Theil Inequality Coefficient is 0.006500, indicating high model accuracy.
2. **Good Data Interpretation:**
   - The Variance Proportion is 0.975268, indicating that the model explains most of the variance in the data.

- The Bias Proportion is 0.026320, which is low, meaning the model is not significantly biased.

3. **High Predictive Ability:**
   - The Theil U2 Index is 0.081020, indicating that the predictions are highly accurate.
   - The Symmetric MAPE is 3.589824, reflecting the prediction accuracy on a proportional basis.

It is evident from the model that all independent variables have a significant impact on the environmental footprint as the dependent variable in the long run. There is a cointegrating relationship and an equilibrium connection between the short run and the long run, with any shock being absorbed within two years.

6- Conclusion and Recommendations

This study examined the various dimensions of economic development and their impact on environmental quality in Arab countries, using a sample of 13 countries to represent varying levels of development across the region during the period 1990–2022. The Environmental Footprint (EF) was employed as a measure of environmental degradation in these countries. Econometric tools were applied to address cointegration issues in the data and verify relationships among variables.

In addition to confirming the existence of the Environmental Kuznets Curve (EKC) hypothesis for the 13 Arab countries, the long-term elasticity estimates indicate that patterns of energy consumption, international trade, rising growth rates, population increases, and resource depletion contribute to environmental degradation.

Several important policy recommendations are proposed to improve environmental quality in Arab countries:

1. Enforcing Strict Environmental Regulations: Arab policymakers should implement stringent environmental legislations or rigorously enforce existing ones. Proper enforcement of current regulatory requirements is essential to mitigate the adverse environmental impacts of various economic activities.
2. Aligning Economic Growth with Environmental Sustainability: Arab countries must adopt policies that accelerate economic growth, especially in low-income economies, while ensuring alignment with environmental sustainability objectives. This approach is expected to reduce the trade-off between economic growth and

environmental degradation before reaching the economic growth threshold where growth can coexist with environmental well-being, ensuring welfare is achieved in tandem.

3. Shifting Away from Fossil Fuel Dependence: Arab countries need to gradually reduce their reliance on fossil fuels for electricity generation to enhance overall environmental quality. Economies should work toward increasing the share of renewable energy in their energy systems. Furthermore, the share of renewable electricity outputs in these countries must be significantly enhanced to mitigate environmental degradation effectively.
4. Promoting Sustainable Trade Practices: Arab countries should actively engage in sustainable trade activities. High-carbon-emission products and environmentally harmful goods should be reduced through sustainable production and consumption practices within these nations.
5. Controlling Population Growth and Reducing Harmful Consumption: Arab countries, regardless of their level of development, should aim to lower population growth rates and adopt consumption policies that minimize environmentally harmful practices.
6. Adopting Environmentally Compatible Production Methods: Improving environmental quality requires Arab countries to adopt production methods that align with the environment’s absorptive capacity for waste generated from production and consumption activities.

By implementing these recommendations, Arab countries can effectively balance economic growth with environmental sustainability, contributing to long-term ecological and economic welfare.

Attachments

Co-integration results of variables (items)

Attached (1) Algeria

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-0.344789	0.005370	-64.20518	0.0000
D(LN Y(-1))	-0.003734	0.032922	-0.113416	0.9169
D(LN X1)	-0.812038	0.465139	-1.745799	0.1792
D(LN X1(-1))	0.039217	0.237432	0.165173	0.8793
D(LN X1(-2))	-1.413715	0.249263	-5.671586	0.0109
D(LN X1(-3))	0.425256	0.258835	1.642961	0.1989
D(LN X2)	-38.26898	252.0379	-0.151838	0.8890
D(LN X2(-1))	46.64148	739.8393	0.063043	0.9537
D(LN X2(-2))	-25.26771	1435.758	-0.017599	0.9871
D(LN X2(-3))	-6.351864	563.9919	-0.011262	0.9917
D(LN X3)	-0.014603	0.006385	-2.287297	0.1062
D(LN X3(-1))	0.094987	0.009468	10.03249	0.0021
D(LN X3(-2))	-0.148986	0.019560	-7.616818	0.0047
D(LN X3(-3))	-0.256703	0.007435	-34.52679	0.0001
D(LN X4)	1.329990	0.152021	8.748749	0.0031
D(LN X4(-1))	0.642422	0.143271	4.483955	0.0207
D(LN X4(-2))	0.969953	0.109748	8.838016	0.0031
D(LN X4(-3))	-0.409313	0.086513	-4.731222	0.0179
D(LN X5)	-0.106744	0.048233	-2.213075	0.1138
D(LN X5(-1))	-0.778480	0.044960	-17.31501	0.0004
D(LN X5(-2))	-0.100761	0.063481	-1.587262	0.2107
D(LN X5(-3))	0.097275	0.035205	2.763099	0.0700
C	1.324615	0.080019	16.55373	0.0005

Attached (2)Egypt

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-0.783085	0.030681	-25.52377	0.0001
D(LN Y(-1))	0.328490	0.020497	16.02661	0.0005
D(LN X1)	0.746453	0.269031	2.774601	0.0693
D(LN X1(-1))	-0.701389	0.310945	-2.255669	0.1094
D(LN X1(-2))	-0.385388	0.444086	-0.867823	0.4493
D(LN X1(-3))	-0.976976	0.287828	-3.394312	0.0426
D(LN X2)	-107.6533	693.7581	-0.155174	0.8865
D(LN X2(-1))	86.46718	1008.098	0.085773	0.9371
D(LN X2(-2))	-0.363094	699.7099	-0.000519	0.9996
D(LN X2(-3))	28.65081	208.1917	0.137617	0.8993
D(LN X3)	0.094760	0.000704	134.6560	0.0000
D(LN X3(-1))	-0.025873	0.001335	-19.37586	0.0003
D(LN X3(-2))	0.108800	0.001141	95.34646	0.0000
D(LN X3(-3))	-0.013293	0.001078	-12.32927	0.0011
D(LN X4)	-0.575557	0.059254	-9.713409	0.0023
D(LN X4(-1))	0.959908	0.115075	8.341614	0.0036
D(LN X4(-2))	0.531069	0.115761	4.587621	0.0195
D(LN X4(-3))	2.600614	0.253677	10.25169	0.0020
D(LN X5)	-0.319777	0.006042	-52.92296	0.0000
D(LN X5(-1))	-0.514528	0.008146	-63.15941	0.0000
D(LN X5(-2))	-0.608383	0.016649	-36.54245	0.0000
D(LN X5(-3))	-0.096432	0.004451	-21.66547	0.0002
C	-12.08579	8.400683	-1.438667	0.2458

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

Attachments

Co-integration results of variables (items)

Attached (3) Iraq

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-0.030359	0.000177	-171.4812	0.0000
D(LN_Y(-1))	-0.706380	0.009213	-76.67334	0.0000
D(LN_X1)	0.133020	0.001596	83.36840	0.0000
D(LN_X1(-1))	0.250464	0.001618	154.7573	0.0000
D(LN_X1(-2))	0.166342	0.000878	189.5595	0.0000
D(LN_X1(-3))	0.014914	0.000541	27.54163	0.0001
D(LN_X2)	-1.579417	0.322548	-4.896691	0.0163
D(LN_X2(-1))	3.973123	0.478899	8.296377	0.0037
D(LN_X2(-2))	-4.287783	0.366911	-11.68615	0.0013
D(LN_X2(-3))	-0.211823	0.179392	-1.180781	0.3228
D(LN_X3)	0.099686	0.000315	316.4673	0.0000
D(LN_X3(-1))	0.140720	0.000357	394.3401	0.0000
D(LN_X3(-2))	0.068704	0.000426	161.1284	0.0000
D(LN_X3(-3))	-0.095094	0.000189	-504.2542	0.0000
D(LN_X4)	0.487307	0.002409	202.2721	0.0000
D(LN_X4(-1))	0.322746	0.007555	42.71765	0.0000
D(LN_X4(-2))	-0.037042	0.001316	-28.14581	0.0001
D(LN_X4(-3))	-0.016396	0.001229	-13.34112	0.0009
D(LN_X5)	-0.004641	1.57E-05	-296.5725	0.0000
D(LN_X5(-1))	-0.039075	1.13E-05	-3459.184	0.0000
D(LN_X5(-2))	-0.029091	2.71E-05	-1075.241	0.0000
D(LN_X5(-3))	-0.024949	1.98E-05	-1263.092	0.0000
C	-0.391916	0.041586	-9.424304	0.0025

Attached (4) Jordan

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	0.037536	0.002697	13.91717	0.0008
D(LN_Y(-1))	-0.487664	0.012827	-38.01898	0.0000
D(LN_X1)	1.235988	0.287950	4.292367	0.0232
D(LN_X1(-1))	-2.711905	0.225827	-12.00875	0.0012
D(LN_X1(-2))	-1.208500	0.063192	-19.12433	0.0003
D(LN_X1(-3))	-0.353410	0.073855	-4.785195	0.0174
D(LN_X2)	-0.917027	0.284084	-3.228012	0.0483
D(LN_X2(-1))	-0.263554	0.303322	-0.868893	0.4488
D(LN_X2(-2))	-2.806070	0.285328	-9.834540	0.0022
D(LN_X2(-3))	-1.069635	0.221054	-4.838789	0.0168
D(LN_X3)	0.027526	6.15E-05	447.9094	0.0000
D(LN_X3(-1))	0.055487	6.53E-05	850.1743	0.0000
D(LN_X3(-2))	0.032269	9.28E-05	347.5343	0.0000
D(LN_X3(-3))	0.019804	3.89E-05	508.9789	0.0000
D(LN_X4)	0.396304	0.012784	30.99914	0.0001
D(LN_X4(-1))	0.717185	0.013981	51.29593	0.0000
D(LN_X4(-2))	0.299767	0.020428	14.67419	0.0007
D(LN_X4(-3))	-0.616410	0.023503	-26.22664	0.0001
D(LN_X5)	-0.199212	0.008815	-22.59984	0.0002
D(LN_X5(-1))	0.164982	0.012238	13.48142	0.0009
D(LN_X5(-2))	0.317146	0.008907	35.60499	0.0000
D(LN_X5(-3))	0.115375	0.005935	19.44036	0.0003
C	0.724387	0.529872	1.367099	0.2650

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

Attached (5) Lebanon

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-0.339317	0.002100	-161.5693	0.0000
D(LN_Y(-1))	-0.490117	0.016750	-29.26045	0.0001
D(LN_X1)	0.603092	0.008630	69.88437	0.0000
D(LN_X1(-1))	-0.136015	0.014230	-9.558351	0.0024
D(LN_X1(-2))	-0.007246	0.017385	-0.416781	0.7049
D(LN_X1(-3))	-0.186160	0.003313	-56.18723	0.0000
D(LN_X2)	0.268786	0.043829	6.132557	0.0087
D(LN_X2(-1))	0.930086	0.107272	8.670313	0.0032
D(LN_X2(-2))	-0.838967	0.114667	-7.316541	0.0053
D(LN_X2(-3))	0.468195	0.039863	11.74507	0.0013
D(LN_X3)	-0.076240	8.56E-05	-890.5702	0.0000
D(LN_X3(-1))	-0.094437	8.52E-05	-1108.577	0.0000
D(LN_X3(-2))	-0.083354	6.69E-05	-1245.769	0.0000
D(LN_X3(-3))	-0.054843	3.70E-05	-1483.075	0.0000
D(LN_X4)	0.598935	0.007378	81.17894	0.0000
D(LN_X4(-1))	0.435239	0.007182	60.59782	0.0000
D(LN_X4(-2))	0.320007	0.002452	130.5154	0.0000
D(LN_X4(-3))	0.058124	0.001395	41.67402	0.0000
D(LN_X5)	0.010843	0.000914	11.86764	0.0013
D(LN_X5(-1))	0.153715	0.000961	159.9334	0.0000
D(LN_X5(-2))	0.186624	0.001024	182.1899	0.0000
D(LN_X5(-3))	0.279785	0.001625	172.1752	0.0000
C	-4.401602	0.343041	-12.83113	0.0010

Attached (6) Libyan

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	0.466981	0.040699	11.47390	0.0014
D(LN_Y(-1))	-0.447831	0.037912	-11.81236	0.0013
D(LN_X1)	0.181328	0.019337	9.377328	0.0026
D(LN_X1(-1))	-0.476710	0.008209	-58.07088	0.0000
D(LN_X1(-2))	-0.390528	0.007313	-53.39877	0.0000
D(LN_X1(-3))	0.453744	0.011069	40.99208	0.0000
D(LN_X2)	-3.346049	3.528189	-0.948376	0.4129
D(LN_X2(-1))	3.718443	4.022404	0.924433	0.4234
D(LN_X2(-2))	-5.636761	3.392415	-1.661578	0.1952
D(LN_X2(-3))	5.564038	2.484907	2.239133	0.1111
D(LN_X3)	-0.026310	0.005341	-4.926159	0.0160
D(LN_X3(-1))	-0.155256	0.011162	-13.90950	0.0008
D(LN_X3(-2))	-0.105285	0.011583	-9.089339	0.0028
D(LN_X3(-3))	0.057337	0.003103	18.47995	0.0003
D(LN_X4)	0.844306	0.067447	12.51806	0.0011
D(LN_X4(-1))	0.157668	0.028430	5.545888	0.0116
D(LN_X4(-2))	-0.254667	0.058779	-4.332597	0.0227
D(LN_X4(-3))	-0.982192	0.032645	-30.08743	0.0001
D(LN_X5)	0.022630	0.022702	0.996837	0.3923
D(LN_X5(-1))	0.482065	0.025391	18.98546	0.0003
D(LN_X5(-2))	0.496450	0.016127	30.78331	0.0001
D(LN_X5(-3))	0.142002	0.017472	8.127540	0.0039
C	6.501293	7.858087	0.827338	0.4687

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

Attachments

Co-integration results of variables (items)

Attached (7) Mauritania

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	0.048826	0.000514	95.04677	0.0000
D(LN Y(-1))	0.406855	0.051008	7.976363	0.0041
D(LN X1)	-0.766386	0.033408	-22.94027	0.0002
D(LN X1(-1))	0.447061	0.055826	8.008057	0.0041
D(LN X1(-2))	-0.575006	0.015370	-37.41157	0.0000
D(LN X1(-3))	0.660737	0.254750	2.593668	0.0808
D(LN X2)	14.80250	53.97035	0.274271	0.8017
D(LN X2(-1))	-9.160010	88.76461	-0.103194	0.9243
D(LN X2(-2))	-8.040416	76.16879	-0.105561	0.9226
D(LN X2(-3))	15.57027	7.441332	2.092403	0.1275
D(LN X3)	0.011235	0.000228	49.21391	0.0000
D(LN X3(-1))	0.008841	0.000196	45.15607	0.0000
D(LN X3(-2))	-0.016027	0.000324	-49.47299	0.0000
D(LN X3(-3))	-0.004549	0.000266	-17.11335	0.0004
D(LN X4)	0.065977	0.001087	60.71103	0.0000
D(LN X4(-1))	-0.058559	0.002741	-21.36172	0.0002
D(LN X4(-2))	-0.028277	0.000722	-39.16944	0.0000
D(LN X4(-3))	-0.035046	0.001523	-23.01236	0.0002
D(LN X5)	0.248764	0.018734	13.27893	0.0009
D(LN X5(-1))	-0.048660	0.003134	-15.52419	0.0006
D(LN X5(-2))	0.152142	0.004006	37.97685	0.0000
D(LN X5(-3))	-0.033486	0.005564	-6.018209	0.0092
C	0.251502	0.085647	2.936506	0.0607

Attached (8) Morocco

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-0.303774	0.009172	-33.12013	0.0001
D(LN Y(-1))	-0.642077	0.007038	-91.23347	0.0000
D(LN X1)	2.809739	0.120389	23.33880	0.0002
D(LN X1(-1))	0.669270	0.184125	3.634870	0.0359
D(LN X1(-2))	-0.046754	0.060520	-0.772541	0.4961
D(LN X1(-3))	0.856695	0.043918	19.50675	0.0003
D(LN X2)	24.60296	439.7036	0.055954	0.9589
D(LN X2(-1))	-134.0347	1484.348	-0.090299	0.9337
D(LN X2(-2))	95.72614	1605.074	0.059640	0.9562
D(LN X2(-3))	36.85693	679.3591	0.054252	0.9601
D(LN X3)	0.002638	7.65E-05	34.49179	0.0001
D(LN X3(-1))	-0.002912	7.57E-05	-38.47755	0.0000
D(LN X3(-2))	-0.010337	0.000137	-75.49399	0.0000
D(LN X3(-3))	-0.002911	0.000140	-20.83014	0.0002
D(LN X4)	-0.579161	0.022784	-25.41935	0.0001
D(LN X4(-1))	0.586286	0.046612	12.57801	0.0011
D(LN X4(-2))	-0.047938	0.046072	-1.040519	0.3746
D(LN X4(-3))	-0.408579	0.039362	-10.37996	0.0019
D(LN X5)	0.106218	0.009083	11.69430	0.0013
D(LN X5(-1))	-0.021729	0.012418	-1.749760	0.1785
D(LN X5(-2))	0.413602	0.011362	36.40341	0.0000
D(LN X5(-3))	0.275435	0.016223	16.97820	0.0004
C	-4.801559	2.270395	-2.114856	0.1248

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

Attached (9) Syria

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-2.403799	0.078430	-30.64880	0.0001
D(LN Y(-1))	0.676818	0.032155	21.04865	0.0002
D(LN X1)	2.523162	0.073950	34.11978	0.0001
D(LN X1(-1))	1.540823	0.092059	16.73733	0.0005
D(LN X1(-2))	1.373631	0.065687	20.91169	0.0002
D(LN X1(-3))	-0.180517	0.029204	-6.181237	0.0085
D(LN X2)	-3.629541	2.069390	-1.753918	0.1777
D(LN X2(-1))	-10.51002	3.590102	-2.927498	0.0611
D(LN X2(-2))	-0.046832	3.688236	-0.012698	0.9907
D(LN X2(-3))	-1.607954	1.580947	-1.017083	0.3840
D(LN X3)	-0.021546	0.001626	-13.25225	0.0009
D(LN X3(-1))	0.153413	0.001109	138.2921	0.0000
D(LN X3(-2))	0.234517	0.001022	229.3903	0.0000
D(LN X3(-3))	0.130847	0.000812	161.2072	0.0000
D(LN X4)	-2.038160	0.119561	-17.04705	0.0004
D(LN X4(-1))	-0.434845	0.072075	-6.033223	0.0091
D(LN X4(-2))	0.546560	0.047518	11.50219	0.0014
D(LN X4(-3))	0.639476	0.024016	26.62666	0.0001
D(LN X5)	-0.523764	0.018729	-27.96496	0.0001
D(LN X5(-1))	-0.469098	0.016907	-27.74518	0.0001
D(LN X5(-2))	-0.462673	0.014512	-31.88135	0.0001
D(LN X5(-3))	-0.303276	0.010053	-30.16761	0.0001
C	-35.78848	17.48833	-2.046421	0.1332

Attached (10) Tunisia

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-1.753208	0.016406	-106.8628	0.0000
D(LN Y(-1))	0.298086	0.006760	44.09495	0.0000
D(LN X1)	2.930632	0.339296	8.637392	0.0033
D(LN X1(-1))	1.344611	0.294495	4.565816	0.0197
D(LN X1(-2))	-0.255773	0.505941	-0.505539	0.6480
D(LN X1(-3))	-4.160343	1.042457	-3.990902	0.0282
D(LN X2)	65.07814	1572.268	0.041391	0.9696
D(LN X2(-1))	125.1641	3288.526	0.038061	0.9720
D(LN X2(-2))	-55.42046	2115.208	-0.026201	0.9807
D(LN X2(-3))	-123.2695	522.7091	-0.235828	0.8287
D(LN X3)	-0.078512	0.006878	-11.41487	0.0014
D(LN X3(-1))	0.150162	0.006813	22.04200	0.0002
D(LN X3(-2))	0.050951	0.006046	8.427716	0.0035
D(LN X3(-3))	0.381779	0.005283	72.26142	0.0000
D(LN X4)	-1.471477	0.051657	-28.48566	0.0001
D(LN X4(-1))	-0.812924	0.049851	-16.30724	0.0005
D(LN X4(-2))	0.678175	0.055963	12.11821	0.0012
D(LN X4(-3))	0.389181	0.025254	15.41046	0.0006
D(LN X5)	-1.038630	0.030078	-34.53161	0.0001
D(LN X5(-1))	-0.726540	0.022205	-32.71993	0.0001
D(LN X5(-2))	-0.747182	0.019864	-37.61451	0.0000
D(LN X5(-3))	-0.490482	0.023722	-20.67646	0.0002
C	-24.17111	3.234540	-7.472811	0.0050

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

Attachments

Co-integration results of variables (items)

Attached (11) Oman

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-0.059152	0.007175	-8.244252	0.0037
D(LN_Y(-1))	-0.154708	0.026249	-5.893752	0.0098
D(LN_X1)	-0.362879	0.618310	-0.586888	0.5985
D(LN_X1(-1))	1.615508	0.615566	2.624427	0.0787
D(LN_X1(-2))	-0.615891	0.387865	-1.587899	0.2105
D(LN_X1(-3))	-1.024249	0.340529	-3.007813	0.0573
D(LN_X2)	-2.420191	3.399651	-0.711894	0.5279
D(LN_X2(-1))	6.340338	7.955251	0.797000	0.4837
D(LN_X2(-2))	-5.914542	6.365284	-0.929188	0.4213
D(LN_X2(-3))	3.092213	3.026153	1.021830	0.3821
D(LN_X3)	0.014732	0.022853	0.644638	0.5651
D(LN_X3(-1))	0.569696	0.015762	36.14454	0.0000
D(LN_X3(-2))	0.224438	0.007296	30.76277	0.0001
D(LN_X3(-3))	0.357668	0.007917	45.17800	0.0000
D(LN_X4)	-0.251701	0.049165	-5.119512	0.0144
D(LN_X4(-1))	-0.041455	0.048210	-0.859870	0.4531
D(LN_X4(-2))	-0.113820	0.054728	-2.079740	0.1290
D(LN_X4(-3))	0.330927	0.023086	14.33425	0.0007
D(LN_X5)	-0.399842	0.049842	-8.022183	0.0040
D(LN_X5(-1))	-0.460494	0.123877	-3.717348	0.0339
D(LN_X5(-2))	0.954471	0.070546	13.52970	0.0009
D(LN_X5(-3))	0.969348	0.115424	8.398137	0.0035
C	-0.766800	1.279519	-0.599287	0.5912

Attached (12) Qatar

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	0.170682	0.011564	14.75979	0.0007
D(LN_Y(-1))	-0.689449	0.071334	-9.665022	0.0024
D(LN_X1)	-0.226428	0.265177	-0.853874	0.4559
D(LN_X1(-1))	-0.255872	0.252899	-1.011754	0.3862
D(LN_X1(-2))	0.145884	0.277699	0.525331	0.6357
D(LN_X1(-3))	-0.467743	0.063531	-7.362385	0.0052
D(LN_X2)	-2.219485	1.151236	-1.927915	0.1495
D(LN_X2(-1))	5.596647	3.803960	1.471269	0.2376
D(LN_X2(-2))	-4.884505	4.902376	-0.996355	0.3925
D(LN_X2(-3))	0.952252	1.611283	0.590990	0.5961
D(LN_X3)	0.281606	0.023453	12.00706	0.0012
D(LN_X3(-1))	0.406547	0.024433	16.63900	0.0005
D(LN_X3(-2))	0.056381	0.016460	3.425444	0.0417
D(LN_X3(-3))	0.359742	0.014678	24.50946	0.0001
D(LN_X4)	0.514172	0.057488	8.943929	0.0029
D(LN_X4(-1))	0.629441	0.103722	6.068549	0.0090
D(LN_X4(-2))	0.476546	0.042909	11.10589	0.0016
D(LN_X4(-3))	0.677414	0.055321	12.24514	0.0012
D(LN_X5)	-1.028122	0.332141	-3.095437	0.0535
D(LN_X5(-1))	-0.383836	0.219483	-1.748820	0.1786
D(LN_X5(-2))	-1.158458	0.158211	-7.322240	0.0053
D(LN_X5(-3))	-0.878237	0.123098	-7.134444	0.0057
C	2.260645	1.884546	1.199570	0.3164

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

Attached (13) Saudi Arabia

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	-1.098780	0.037295	-29.46214	0.0001
D(LN_Y(-1))	0.495588	0.033541	14.77575	0.0007
D(LN_X1)	2.494483	0.487091	5.121184	0.0144
D(LN_X1(-1))	-0.960237	0.748998	-1.282029	0.2899
D(LN_X1(-2))	0.088797	0.426634	0.208134	0.8485
D(LN_X1(-3))	-0.944626	0.314865	-3.000094	0.0577
D(LN_X2)	36.53996	263.4193	0.138714	0.8985
D(LN_X2(-1))	-39.55000	582.6443	-0.067880	0.9502
D(LN_X2(-2))	52.24475	817.9819	0.063870	0.9531
D(LN_X2(-3))	-35.16233	293.6039	-0.119761	0.9122
D(LN_X3)	-0.201907	0.027691	-7.291464	0.0053
D(LN_X3(-1))	0.302854	0.057301	5.285328	0.0132
D(LN_X3(-2))	0.514513	0.176149	2.920898	0.0615
D(LN_X3(-3))	-0.150406	0.020437	-7.359660	0.0052
D(LN_X4)	-0.476075	0.779672	-0.610610	0.5846
D(LN_X4(-1))	-0.354286	0.771045	-0.459489	0.6771
D(LN_X4(-2))	-0.059799	0.402434	-0.148594	0.8913
D(LN_X4(-3))	0.223476	0.768182	0.290915	0.7901
D(LN_X5)	0.354821	0.162100	2.188902	0.1164
D(LN_X5(-1))	-1.052269	0.444036	-2.369781	0.0985
D(LN_X5(-2))	-0.847797	0.721281	-1.175405	0.3246
D(LN_X5(-3))	0.533870	0.414807	1.287032	0.2884
C	-16.77220	8.478925	-1.978104	0.1423

Source: EVIEWS program outputs based on https://wdi.worldbank.org/ World Development Indicators & https://www.footprintnetwork.org

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