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Economic Cooperation and Environmental Sustainability in the OIC Region: A Panel Data Analysis

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ABSTRACT

Regional economic cooperation is one of the important components of trade policy. Understanding its effect on environmental sustainability is essential for eco-friendly economic cooperation. This study investigates the effects of economic cooperation on environmental sustainability in the Organisation of Islamic Cooperation (OIC) region using panel data spanning over the period of 11 years from 2010 to 2020. To understand the effects of economic cooperation on environmental sustainability, the paper employed preferential trade agreements (PTA), economic union (EU), institutional-driven integration (IDI) and pooled regional integration (REI) as indicators of economic cooperation while ecological footprint was used to capture environmental sustainability. The paper employed Tobit panel censored regression and Driscoll-Kraay standard errors regression model to document the nexus between economic cooperation and environmental sustainability in the OIC region. The results indicated that regional economic integration, preferential trade agreements, economic union, and institutional driven integration reduces ecological footprint of OIC member countries. The results also indicated that foreign direct investment net inflows can improve the environmental sustainability of OIC regional bloc members. Based on the findings, it is recommended that OIC member countries should strengthen environmental policies as they deepened regional economic cooperation.

ملخص

تعد التعاونات الاقتصادية الإقليمية من أهم مكونات السياسات التجارية، ويعد فهم أثرها على الاستدامة البيئية أمرا بالغ الأهمية لتحقيق تنمية اقتصادية صديقة للبيئة، تهدف هذه الدراسة إلى تحليل أثر التعاون الاقتصادي على الاستدامة البيئية في

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تهدف هذه الدراسة إلى تحليل أثر التعاون الاقتصادي على الاستدامة البيئية في بلدان منظمة التعاون الإسلامي (OIC) باستخدام بيانات لوحية تغطي الفترة من عام 2010 إلى 2020. اعتمدت الدراسة على مؤشرات مختلفة للتعاون الاقتصادي، شملت اتفاقيات التجارة التفضيلية، والاتحادات الاقتصادية، والتكامل المؤسسي، والتكامل الإقليمي العام، بينما تم استخدام البصمة البيئية كمؤشر للاستدامة البيئية. اعتمدت الدراسة على نماذج انحدار بانل Tobit المقطوع، بالإضافة إلى نماذجDriscoll-Kraay لتقدير العلاقة بين المتغيرات. أظهرت النتائج أن التكامل الاقتصادي الإقليمي بجميع أشكاله يسهم في تقليل البصمة البيئية في البلدان الأعضاء في منظمة التعاون الإسلامي. كما تبين أن تدفقات الاستثمار الأجنبي المباشر الصافي يمكن أن تحسن الاستدامة البيئية في المنطقة. وتوصي الدراسة الدول الأعضاء بتعزيز السياسات البيئية بالتوازي مع تعميق التعاون الاقتصادي الإقليمي لضمان تنمية شاملة ومستدامة.

RÉSUMÉ

La coopération économique régionale est l'un des principaux éléments de la politique commerciale. Il est essentiel de comprendre son impact sur la durabilité environnementale pour assurer une coopération économique respectueuse de l’environnement. Cette étude examine les effets de la coopération économique sur la durabilité environnementale dans la région de l'Organisation de la coopération islamique (OCI) à l'aide d'un panel de données couvrant une période de 11 ans, de 2010 à 2020. Pour comprendre les effets de la coopération économique sur la durabilité environnementale, le document a utilisé les accords commerciaux préférentiels (PTA), l'union économique (EU), l’intégration impulsée par les institutions (IDI) et l'intégration régionale conjointe (REI) comme indicateurs de la coopération économique, tandis que l'empreinte écologique a été utilisée pour mesurer la durabilité environnementale. L’article a utilisé le modèle de régression contrôlé par la commission Tobit et le modèle de régression par les erreurs standard de Driscoll-Kraay pour documenter la relation entre la coopération économique et la durabilité environnementale dans la région de l'OCI. Les résultats ont montré que l'intégration économique régionale, les accords commerciaux préférentiels, l'union économique et l'intégration institutionnelle réduisent l'empreinte environnementale des États membres de l'OCI. Les résultats ont également montré que les flux nets d'investissements directs étrangers peuvent améliorer la durabilité environnementale des pays de la zone régionale de l'OCI. Sur la base de ces résultats, il est recommandé aux États membres de l'OCI de renforcer leurs politiques environnementales tout en approfondissant la coopération économique régionale.

Keywords: Regional Economic Integration, Environmental Sustainability, Tobit Panel Censored, Driscoll-Kraay Standard Errors Regression, and OIC Region

JEL Classification: F1, F13, F15, Q56, and R11

1. Introduction

To stimulate economic growth, many developing countries including the Organisation of Islamic Cooperation (OIC) member countries have formed regional economic blocs with both OIC and non-OIC member countries. The establishment of regional economic integration blocs aims to strengthen intra-regional trade, foster economic cooperation and social collaboration among member countries and adopt a common tariff policy towards non-OIC member countries. Moreover, formations of regional economic blocs are often aimed at reducing tariffs and non-trade barriers (Kayadibi, 2015). Economic benefits and vested interest are the key drivers for economic cooperation in the OIC region (Hassan, 2002). Regional economic integration can also contribute to non-discriminatory treatment of foreign investments who are members of OIC countries. In the early 1980s, following the Uruguay round of General Agreements on Tariffs and Trade (GATT) members adopted to end trade barriers and domestic subsidies in agriculture, established and enforced patents, copyrights and trademarks, and remove barriers in trade in services. Eliminations of trade barriers have the potential to accelerate industrialisation and economic development among members of the regional economic blocs. Regional blocs is one of the essential components of trade policy because it expands the set of opportunities and widens market size, increasing outputs and job creation through greater economic integration and cooperation. However, it may come with much social costs such as pollution and over-crowding due to weak and divergent environmental policies (Hassan, 2002). Nevertheless, recent studies (Bretschger, 2004) have shown that regional integration may have positive spill-over effect on both income and environment through scale-effect and factor-reallocation channel. Bretschger (2004), argued that scale-effect channel increases either the long-run growth rate or the level of the balanced growth path. Few empirical studies have been conducted to document the nexus between regional economic cooperation and environmental quality in OIC Countries. From country specific experience, Zeng and Eastin (2007) investigated the link between international economic integration and environmental protection in China using statistical analysis of the variation in environmental performance from 1996 to 2004. The study indicates that increased openness to trade and foreign direct investment improved the environmental quality by acting as a transmission channel through restricted environmental standards and regulations.

The paper seeks to assess the effect of preferential trade areas (PTA), economic union (EU), institutional-driven integration and regional economic integration as indicators of economic cooperation on measure of environmental sustainability in the OIC region. The second objective of this paper is to provide trade policy recommendations that can support eco-friendly economic cooperation in the OIC region. To achieve the objectives, this paper estimates Tobit panel censored regression to account for the truncation in the environmental sustainability measured by ecological footprint index and Driscoll-Kraay standard errors regression to account for cross sectional dependency and, also a measure of robustness. In the construction of the index, the paper employed multiple correspondence analyses. By achieving the objectives, both the literature and empirical gap on eco-friendly economic cooperation in the OIC region will be filled.

The nexus between economic integration and environmental quality is yet to receive substantial empirical output. A considerable fewer study has highlighted that low tariff rates and soft conditions for free trade tend to attract polluting foreign direct investment (FDI), which, in turn, often results in higher energy consumption and impacts environmental quality negatively (Bukhari et al., 2014). Many developing countries, particularly those within the OIC, are struggling with significant challenges such as high poverty rates, high insecurity, weak and divergent environmental policies, and high levels of unemployment. In addition, poor institutional quality, inconsistent economic policies, corruption, and weak governance are relatively high. These countries have formed regional economic blocs in recent years as a strategy to address these multifaceted challenges.

While early studies largely argued that economic bloc fosters economic growth through the efficient utilisation of scarce resources, increased factor mobility, and improved knowledge sharing (Ghani, 2011; Parikh, 2006). However, a growing body of studies in recent years have also focused on the adverse effects of integration (Schneider,2017; Te Velde,2011). Most of the studies rely on the argument that economic integration can lead to the exploitation of natural resources, particularly in developing countries, due to loopholes in both economic and environmental policies that remain poorly enforced (Haque, 2013). The negative effects of regional bloc are mostly attributed to soft trade policies that are not able to push stakeholders to internalize the external costs of production and consumption. It is also argued that exploitation of natural resources exacerbates the strain on natural resources in these countries, hindering long-term environmental and economic resilience (Luo, 2024).

Cosbey (2004) posited that rapid exploitation of natural resources is one of the major factors that have caused the destruction of the environment. And since most developing countries are still struggling to accelerate their economic development there are often left with no choice but to accept polluting FDI in exchange for employment opportunities. There is always a trade-off between environmental quality and economic integration (Thalut & Kelese, 2019; Parikh, 2006). Most developing countries with soft trade policies opened their doors for short-term economic prosperity, while little attention is given to environmental sustainability.

Regional integration often aims at fostering trade flows, free movement of capital and labours by reducing trade barriers such as tariffs and non-tariffs measures have been criticised for attracting polluting FDI into developing countries because of weak environmental policies. In addition, differences in environmental policies, trade flows across the different countries and regional blocks have given rise to unequal shares of the benefits of economic integration. Liberalisation of market through reduction in trade barriers without proper environmental policies will cause polluting firms not to internalise its external costs thus generate more economic harms than goods. The environmental quality can either be alleviated or exacerbated depending on whether FDI inflows are dirty or clean. By exploring the relationship between inflows of foreign direct and CO2 emission, Deng and Song (2008), suggested that the use of modern technology and efficient production methods can reduced CO2 while heavily dependence on fossil fuels energy instead deteriorates the countries' environment. Hussain (2015) argued that economic integration can boost FDI if there are better policies coherence and coordination that guide and protect investors and their investments. Many studies have suggested that each country should assess and select only foreign direct investments which are consistent with its environmental, industrial, and sectorial needs (Hassan, 2002). By selecting only investments which are consistent with the local environment policies, the country can be sure of a clean environment.

According to Hussain et al. (2019), 24 out of 57 OIC countries are ranked as poor or vulnerable countries in terms of environmental performance. A similar study analysis the relationship between environmental performance and economic growth in the OIC countries from 2006 to 2008 was carried out by Samimi et al., (2011). By using panel least square estimation technique, the study revealed that OIC countries have not performed satisfactorily with regards to the environmental health, air quality, water resources, biodiversity and habitat, and sustainable energy usage.

One of the recent studies, Farooq et al., (2020) used system generalized method of moment (GMM) panel data estimation technique to document how globalization and foreign direct investment (FDI) affect environmental quality in OIC Member Countries. The findings show that FDI firms bring advanced and cleaner technology to host economies which decrease CO2 emissions and thus improve environmental quality in those countries. The findings are in line with the pollution halo hypothesis. The halo hypothesis simply states that, amelioration of technological progress will lead to efficiency in the method of production, and therefore reduction in green gas emissions, everything being equal, for high income OIC countries (Zarsky, 1999). Pollution heaven hypothesis was confirmed in the case of low-income countries.

The study aims to examine the effects of economic cooperation on environmental sustainability of OIC region. Most of the studies in the literature instead focus on the effect of trade liberalization on CO_2 emission whilst other studies focus on other major aspects of environmental quality. The effect of FDI inflows on CO2 emission among OIC member countries is inconclusive. Some scholars are of the opinion that the negative spillovers effect of FDI inflows deteriorates environmental quality of most member countries whilst positive spillovers effect of FDI instead reduces CO2 emission. Studies have shown foreign direct investment contributes to improving the environmental quality in high-income OIC states and it reduces environmental quality in low-income OIC countries (Farooq et al., 2020). There are substantial empirical gaps in the existing literature of economic cooperation and environmental sustainability in capturing the environmental effects of regional economic integration indicators. This study seeks to fill the gaps by firstly constructing an index for preferential trade agreements area (PTA), economic union (EU), and institutional driven integration (IDI) as indicators of economic cooperation using multiple correspondence analysis. Secondly, the study also employed the Tobit panel censored regression to account for the truncation in the dependent variable ecological footprint ignored in the existing literature and Driscoll-Kraay standard errors regression to account for cross sectional dependency and a measure of robustness. It is against these backgrounds that this study seeks to analyse the effects of economic cooperation on environmental sustainability in OIC member countries.

The rest of the paper is organised in four sections. Section two provides the relevant literature reviews. Section three presents the methodology, variables measurements and data sources. Section four reports and discusses the econometric results. The final section summarizes and concludes.

2. Literature Review

Studies in the 1990s and 2000s, focuses on atmospheric emissions such as Carbon Dioxide (CO2), Methane (CH4), Nitrous Dioxide (NO2), and Sulphur Dioxide (SO2) as proxies for environmental quality. Recent studies have diverged from the use of these traditional proxies for environmental quality to a multifaceted indicator including ecological footprint (Ahmed, Zafar, Ali, & Danish, 2020; Bulut, 2020). It has been argued that among the atmospheric emission measures, CO2 is the most used to describe environmental quality. Ulucak and Apergis (2018) claimed that the use of CO2 as a proxy for environmental quality is limited because other important resources extraction such as fishing, mining extraction and deforestation also contribute significantly to environmental quality are excluded. Recent studies adopted a multifaceted dimension of environmental quality, ecological footprint, as it is argued in most empirical literature that human are the major causes of environmental degradation (Nathaniel, et al, 2019). Most of the studies in the literature argued that ecological footprint is a better measure of environmental quality because it captures the total environmental impact of human activities, such as the consumption of natural resources and the production of waste, as well as the ecosystem's carrying capacity to generate resources and absorb the waste produced (Lenzen et al., 2007; Chavez et al., 2017). According to Wackernagel and Rees (1996), ecological footprint reflects resource usage, human consumption patterns, and waste production whilst assessing the ecosystem carrying capacity to produce and absorbed waste. In addition, ecological footprint is considered as a more comprehensive measure of environmental degradation (Ahmed, Zafar, & Mansoor, 2020; Dogan, Ulucak, & Kocak E, 2020).

Environmental quality is an important aspect of environmental sustainability. The variable ecological footprint is an index generated from six indicators which are carbon, grazing land, forest land, crop land, build up land and fishing. Each of these six indicators are used in the construction of the four components of ecological footprint; production, consumption, imports and ecological footprint embodied within exports (Ramezani et al., 2022). Empirical literature has shown that gross domestic product is one of the key significant predictors of environmental quality as it contribution to greenhouse gas emissions. The logical argument presented in most studies are that increases in gross domestic products (GDP) is driven by dirty energy consumption (Yang, Jahanger, & Khan, 2020a).

The effect of regional integration on environmental quality is complex. However, there are several channels through which regional economic integration may influence environmental quality. Firstly, it stimulates labour and capital mobility within the bloc or groupings, because of free movement of individuals and goods. This may lead to an increase in labour, capital and energy usage which will affect C02 emissions and thus deterioration of the environment. Secondly, regional integration may bring about technological innovation which may permit members of the regional bloc to internalise the external costs suffer by the third parties in the cause of production and consumption, and therefore positive effect on the environment.

Regional integration can have either positive or negative effect on the environment. Reggie (1982) posited the post-war-quid pro quo hypothesis of regional integration, which state that members of regional blocs increase social protection against non-members in exchange for an international trading regime. Most of the studies in the empirical literature on regional economic integration focuses on the impact of regional integration on trade, investment, mobility of labour and capital (Berkowitz & DeJong, 2003; Xu and Voom, 2002, 2002). According to Panagariya & Narueput (1997) claims that preferential trading improves welfare and that it depends on the level of domestic pollution charge extant and direction of trade. The study further posited that regional agreement impacts the output mix which, in turn, influences the level of pollution of member countries. The only study which examined the effect of regional integration on measure of environmental quality is that Weijun, Wang et al., (2018). The study established a positive relationship between regional economic integration and marginal cost of abatement of C02.

The race to the bottom hypothesis which state that countries which are opened to international trade and investment will adopts losses standards of environmental regulation, out of fear of the loss in international competitiveness. Openness will only have a positive effect on the environmental quality if the developing countries ratchet-up their environmental standards. According to Vogel (1995), Porter (1995) and Braithwaite and Drahos (2020) claimed that ratcheting up can be more effective for products standards than standards regarding production process and methods. Another channel through which trade openness can affect environmental quality is through technological and managerial innovation. This argument is in line with the studies of Esty and Gentry (1997) as they supported the viewed that within a given sector in most developing countries foreign firms are significant more energy efficient, that is less polluters and uses cleaner types of energy than domestic plants. It has also been documented from the literature of international trade that; the present of appropriate institutions is necessary to drive demand for higher environmental quality which will intends translate into effective regulations and desired reduction in pollution. Porter hypothesis suggests that trade openness can have a positive effect on environmental quality if trade lead to tightening of environmental regulations through technological innovation.

Berger et al. (2020) investigated the trade effects of environmental provisions in preferential trade area (PTA) agreements. The study relied on pseudo maximum likelihood (PPML) and gravity regression estimation techniques, using panel data spanning from 1984 to 2016. The findings revealed that environmental provisions in PTAs have a negative impact on trade flows, particularly for developing countries. The paper further argued that environmental provisions in PTAs restrict developing countries' access to developed countries' markets. However, recent studies have supported the inclusion of environmental provisions in PTAs (Esty, 2001; Bernauer and Nguyen, 2015), although most developing countries view them as a form of protectionism (Bastiaens and Postnikov, 2019), despite their contribution to the harmonisation of environmental policy. Berger et al. (2020) posited that environmental provisions in PTAs address a broad range of environmental concerns. Some of these issues include hazardous waste, deforestation, the protection of fish stocks, and the mitigation of greenhouse gas emissions.

According to Hzaine (1998) regional economic integration is often divided into categories such as preferential trade area, free trade zone, custom union, common market, institutional driven integration, and economic union to capture the different level of economic cooperations and commitments among members. The focus of the study is not to elaborate on the differences between the various forms of regional economic integration. Table 1 presents the different categories of regional economic integration

Table 1: Degree of groupings and Economic Integration

Degree of Groupings / **Integration**	**Preferential Trade Area**	**Free Trade Zone**	**Customs Union**	**Common Market**	**Economic Union**
Bangkok agreement, ECO, ASEAN, SAARC, PTA, UNDEAC, Since 1988	*				
CEEAC, MRU, CEAO	*	*	*		
CCA, MCA, UDEAC Before 1988	*	*	*	*	
GCC, ECOWAS, AMU	*		*		*

Source: Adopted from Hzaine (1998)

3. Data and Methodology

3.1 Variables Measurement and Data sources

Ecological footprint is the outcomes variable used to proxy for environmental quality. It is captured by four ecological footprint indicators as shown in Table 2.

Table 2: Indicators of Ecological Footprint

Construct	**Indicators**	**Units**	**Source of data**
Index of Ecological footprint	Ecological Footprint of production per capita	Global hectares	Global Footprint Network [GFN] 2023
	Ecological Footprint embodied within imports per capita	Global hectares	
	Ecological Footprint embodied within exports per capita	Global hectares	
	Ecological Footprint of consumption per capita	Global hectares	

The four indicators were subjected to principal component analysis since the indicators are continuous in nature, after which the one-dimensional index for ecologic footprint was constructed and normalised using the formula.

$$EQ_{it} = \frac{\sum_{k}^{K} \sum_{jk}^{JK} L_{jk}^{k} C_{JK}^{K}}{K} \quad (1)$$

Where; EQ$_{it}$ represents ecological footprint index for all the dimensions or domains considered**;** K is the number of indicators; the continuous variables and JK the number of loadings, C is the component extracted; L are sum of loadings (score of the first standardized axis of outcome variable Jk). The index constructed produces both negative and positive values for the index, thus pose some interpretations difficulty. Therefore, it was subject to normalised within the range of 0 to 1, though fractionalised and not binary. By so doing we get rid of the negative values of the index by adjusting the scores within the range of 0 to 1. The mathematical exposition for the normalised index for ecological footprint is as follow:

$$\tilde{EQ}_{it} = \frac{(\mathrm{EQ} - \mathrm{r(min)})}{(\mathrm{r(max)} - \mathrm{r(min)})} \quad (2)$$

Where is r(max) is the maximum value while r(min) is the minimum value of ecological footprint scores. The data was elicited from the Global Footprint Network 2023 (https://footprint.info.yorku.ca/data/).

Regional Economic Integration

The study captured four types of regional groupings: institutional-driven integration [IDI], economic union [EU], preferential trade area [PTA], and pooled regional economic integration. According to Hzaine (1998) institutional driven integration does not only aims at facilitating free movement of individuals, capital and goods but also putting in place norms and mechanism that promote industrial integration as well as equitable distribution of the gained from integration. In addition, regional integration through removal of tariff and non-tariff barriers in OIC region can open more inter regional trade channels (Hassan, 2002). Members of preferential area receive preferential access to limited segment of members market, closer cooperation and collaboration. The construction of the regional integration indices in the study was motivated by the recommendation of Hzaine (1998) on regional economic groupings as it is argued that through economic, commercial, industrial, monetary and financial integration there can be fair and equitable distribution of integration profits and losses. The regional grouping was treated as binary, that is, 1, if member of OIC countries belong to the regional grouping, 0, otherwise. The dummies for the regional groupings were used as indicators for the various indexes of economic integration. Since the indicators were binary in nature, multiple correspondence analyses (MCA) was found appropriate to construct the indexes for integration as summarised on Table 3. Multiple Correspondence Analysis (MCA) helps create an index for regional integration by analysing binary categorical of the regional groupings. MCA identifies patterns and reduces dimensionality, combining regional groupings into regional integration dimensions. These dimensions are weighed and aggregated to form an index that captured the level of integration in the different regions of OIC member countries.

The three economic integrations indexes as observed on Table 3 were preferential trade area, institutional driven integration, and economic union using multiple correspondence analysis. Selection of OIC countries into the various regional block followed the study of Hassan (2002 and Hzaine (1998). Due to availability of data, only these three integration pillars were considered in the study (See Table 3). The Association of Southeast Asian Nations excluded Burundi from the grouping due to the lack of data for environmental quality in the study.

Table 3: Measurability of Regional Economic Integration

Index of Regional Integration	**Name of Regional Groups**	**OIC Members of Regional Groupings**
Economic Union [EU]	Gulf Co-operation Council (GCC)	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and UAE
	Economic Community of West African States (ECOWAS)	Benin, Burkina Faso, Gambia, Guinea – Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo
	Arab Maghreb Union (AMU)	Algeria, Morocco, Tunisia, Libya, and Mauritania
Institutional Driven Integration [IDI]	Central Africa Customs and Economic Union (UDEAC)	Cameroon, Gabon and Chad
	Economic Community of West African States (ECOWAS)	Benin, Burkina Faso, Gambia, Guinea – Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo
Preferential Trade Area [PTA]	Gulf Co-operation Council (GCC)	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and UAE
	African Economic Community (AEC)	Algeria, Benin, Burkina Faso, Chad, CÃ´te d'Ivoire, Djibouti, Egypt, Gabon, Gambia, Guinea – Bissau, Libya, Mali, Mauritania, Mozambique, Niger, Nigeria, Senegal, Sierra Leone, Somalia, Sudan, Togo, Morocco, and Tunisia
	Council of Arab Economic Unity (CAEU)	Palestine, Libya, Mauritania, Somalia, Sudan, Egypt, Yemen, Iraq, Jordan, Kuwait, and UAE
	Mano River Union (MRU)	Guinea and Sierra Leone
	West African Economic and Monetary Union (WAEMU)	Benin, Burkina Faso, Mali, Niger, Senegal, Togo
	Arab Maghreb Union (AMU)	Algeria, Morocco, Tunisia, Libya, and Mauritania
	South Asian Association for Regional Cooperation (SAARC)	Bangladesh and Pakistan
	Central Africa Customs and Economic Union (UDEAC)	Cameroon, Gabon and Chad
	Economic Co-operation Organization (ECO)	Afghanistan, Azerbaijan, Iran, Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan, Turkiye, Turkmenistan, Uzbekistan
	Association of South East Asian Nation (ASEAN)	Indonesia and Malaysia
	Economic Community of West African States (ECOWAS)	Benin, Burkina Faso, Gambia, Guinea – Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo
Pool Regional Integration	Economic Union Integration (EU)	NA
	Institutional Driven Integration (IDI)	NA
	Preferential Trade Area (PTA)	NA

Source: Compiled by Authors, 2024

Table 4: Description of Variables

Variable Name	Symbol	Definition/Units	Expected Impact On Environment Quality	Data Source
Ecological footprint per capita	EQ	Global hectares	n/a	GFN
Regional Economic Integration	REI	Index	+/-	WDI
Economic Union Integration	EU	Index	+/-	WDI
Institutional Driven Integration	IDI	Index	+/-	WDI
Preferential Trade Area	PTA	Index	+/-	WDI
GDP per capita	RGDP	Measured in constant USD per capita	+	WDI
Trade openness	TO	Sum of exports and imports of goods and services as a percentage of GDP	+/-	WDI
Foreign Direct Investment Inflows	FDI		+/-	WDI
Domestic Health Expenditure	DHEXP		+/-	WDI
Population	Pop		+/-	WDI

Source: Compiled by Authors, 2024

3.2 Model Specifications

To document the effect of regional economic integration on environmental quality of OIC member countries, this study argued that using ecological footprint as outcome variable instead of traditional indicators such as CO_2 and biodiversity loss as a proxy for environmental sustainability will provide a more comprehensive understanding of the impact of human activities on the sustainability of the ecosystem in the OIC region. Another argument in the literature is that ecological footprint is a reliable and composite measure of environmental quality because it captures the total environmental impact of human activities, such as the consumption of natural resources and the production of waste, as well as the ecosystem's carrying capacity to generate resources and absorb the waste produced (Lenzen et al., 2007; Weijun et al.,2018; Chavez et al., 2017). This study also improved on the model on how regional integration is captured. Based on the afore argument the empirical model is specified as:

$$EQ_{it} = \theta_0 + \theta_1 \mathrm{REI}_{it} + \theta_2 \mathrm{Z}_{it} + U_t + \varepsilon_{it} \quad (3)$$
$$EQ_{it} = \theta_0 + \theta_3 \mathrm{IDI}_{it} + \theta_4 \mathrm{Z}_{it} + U_t + \varepsilon_{it} \quad (4)$$
$$EQ_{it} = \theta_0 + \theta_5 \mathrm{EU}_{it} + \theta_6 \mathrm{Z}_{it} + U_t + \varepsilon_{it} \quad (5)$$
$$EQ_{it} = \theta_0 + \theta_7 \mathrm{PTA}_{it} + \theta_8 \mathrm{Z}_{it} + U_t + \varepsilon_{it} \quad (6)$$

Where EQ is ecological footprint, REI stands for the composite index of regional economic integration of OIC countries i in period *t* respectively. Z_{it} is vector of control variables which are trade openness [TO], foreign direct investment inflows [FDI], population [POP], domestic health expenditure [DHEXP], and real gross domestic products per capita (RGDP). While U_t and ε_{it} represents the time effect and error terms. The parameters θ_is capture the magnitude and direction of the independent and control variables. The parameters were estimated using Driscoll-Kraay standard errors regression and panel Tobit Censored regression. Panel Tobit censored regression was used since the dependent variables was censored. The dependent variable in the study ecological footprint, was truncated since its distribution beyond 0.56 and 0.9 was unobserved and therefore fitting a model without accounting for the unobserved in the dependent variable will lead bias estimation. The density distribution of the ecological footprint is presented in Figure 1. To address the unobserved truncation in the dependent variable, the study adopted the Panel Tobit censoring regression approach. It is important to note that the empirical study covers 53 countries registered members of OIC countries and many other bilateral and multilateral trade agreements, so shocks in one country can easily be transmitted to the rest of countries. To account for the cross-sectional dependence and heterogeneity in the data the study make used of Driscoll-Kraay standard errors regression.

The mathematical exposition of censoring function of the ecological footprint which is used as a proxy for environmental quality is presented below.

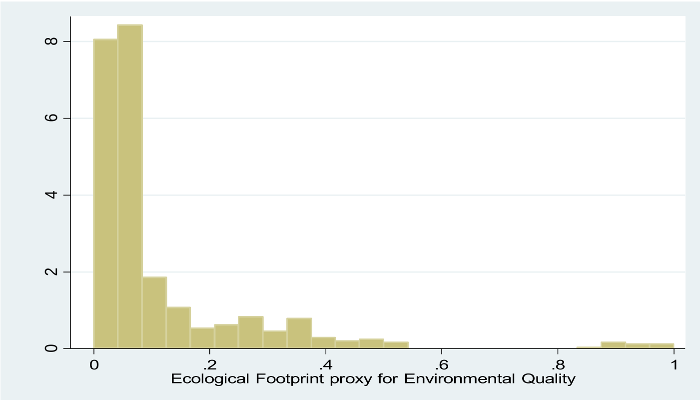
$$EQ_{it} = \begin{cases} 0, if\ EQ_{it} \leq 0 \\ EQ_{it}^{*},\ 0 \leq EQ_{it} \leq 0.56 \\ 0, EQ_{it} \geq 0.56 \end{cases} \quad (7)$$

The Driscoll-Kraay standard errors regression was used for robustness checked of the model.

3.3 Estimation Techniques

Fixed effect and random effect models are the two most used estimation techniques when dealing with panel regression (Park, 2005). However, these estimation techniques failed to account for potential endogeneity bias induced by unobserved heterogeneity in the slope and intercept especially in short panel. The fundamental differences between the fixed and random effect lies on the assumption we make about the individual specific dummy. If the dummy is considered as part of the intercept, then the model is a fixed effect model. In the random effect model the dummy part of the error term capturing the unobserved individual specific effects, which is assumed to be uncorrelated with the explanatory variables in the model (Park, 2005). The dependent variable in the study used to proxy for environmental quality is ecological footprint which is truncated since it has some threshold beyond which values are not observed (see Figure 1). The estimation of the coefficients of the model using fixed and random effect without accounting for the unobserved in ecological footprint variable will lead to inconsistent and inefficient estimate. It has been argued that generalised method of moment (GMM) can be quite accurate in producing efficient and consistent estimates when heterogeneity and simultaneity issues arise (Bun & Windmeijer, 2010). Due to the clustering of the distribution of ecological footprint used as a proxy for environmental quality, panel censored Tobit estimation technique was found appropriate in fitting the environmental quality equation. Panel Tobit regression accounts for both censoring of the dependent variable and longitudinal structure of the panel making it a better choice for the estimation of the model. In addition, Driscoll-Kraay standard errors regression was also used as robustness check of consistency for the Panel Tobit regression. Driscoll-Kraay standard error is robust to heteroscedasticity, autocorrelation, and general forms of cross-sectional dependence in the data and thus a better alternative in fitting the model. Tobit procedure have been used to explore the effects of trade among members of Arab Maghreb Union (AMU) and the members of Gulf Cooperation Council [GCC](Bakar et al., 2015; Haque, 2013). The outcome variable environmental quality was censored at zero for lower limit because ecological footprint cannot be negative, and 0.56 for upper limit as observed in Figure 1.

Figure 1: Density Distribution of the Ecological Footprint



4. Empirical Results

Table 5: Descriptive Statistics of Average Ecological Footprint by OIC Regional blocs

Variable	Countries	Average Ecological footprints	Std. Dev.
GCC	6	0.134	0.150
AEC	23	0.064	0.064
CAEU	11	0.087	0.062
ECOWAS	11	0.053	0.069
MRU	2	0.028	0.014
WAEMU	6	0.042	0.018
AMU	5	0.081	0.045
SAARC	2	0.200	0.057
UDEAC	3	0.058	0.012
ECO	10	0.166	0.161
ASEAN	2	0.635	0.303

Table 5 shows the results of the average ecological footprint among OIC regional blocs in the study. The Gulf Cooperation Council (GCC) has a moderate average ecological footprint of 0.134, and larger standard deviation of 0.150 indicates significant variation among the 6 countries within the bloc. The finding suggests unsustainable diverse overconsumption patterns that deteriorate the environment. This is because most studies in the literature attribute excessive use of natural resources and increased carbon emissions to high ecological footprint (Lenzen et al., 2007; Chavez et al. ,2017).

Similarly, the finding revealed that African Economic Community (AEC) has a low average ecological footprint of 0.064 with a standard deviation equal to the mean, implying a consistent and low ecological footprint across the 23 countries in the bloc. The implication of the finding is that there lower environmental impact perhaps due to low level of industrialisation and similar consumption patterns that has limited effect on the environmental quality.

The South Asian Association for Regional Cooperation (SAARC) shows a much higher average of 0.200 and a low standard deviation (0.057), indicating a larger ecological impact. The Economic Community of West African States (ECOWAS), with an average of 0.053 and a standard deviation of 0.069, has the lowest average ecological footprint indicating high variability in ecological impact across the 11 OIC countries in the bloc. The Central African Economic Union (CAEU) and Arab Maghreb Union (AMU) have moderate averages, 0.087 and 0.081, respectively, with relatively low standard deviations. The finding revealed some level of consistency in ecological footprints among the countries in these blocs. The West African Economic and Monetary Union (WAEMU), with an average of 0.042 and a small standard deviation of 0.018, indicates a uniformly low environmental impact across its 6 countries.

The Association of Southeast Asian Nations (ASEAN) has the highest average ecological footprint of 0.635, accompanied by a large standard deviation of 0.303, indicating significant differences in environmental impact among its countries. The Economic Co-operation Organization (ECO) also has a moderate average (0.166) but a high standard deviation (0.161), suggesting notable variation within the 10 countries in this bloc. Table 5 shows that ecological footprints vary widely across OIC regional blocs, with some having more consistent and lower impacts, while other show higher and more diverse ecological demands.

Table 6: Results of the correlation between regional blocs and environmental quality among OIC countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) env_quality	1.000											
(2) gcc	0.050	1.000										
	(0.226)											
(3) aec	-0.287*	-0.218*	1.000									
	(0.000)	(0.000)										
(4) caeu	-0.076	-0.020	0.027	1.000								
	(0.069)	(0.628)	(0.510)									
(5) ecowas	-0.204*	-0.051	0.573*	-0.146*	1.000							
	(0.000)	(0.219)	(0.000)	(0.000)								
(6) mru	-0.106*	-0.071	0.210*	-0.095*	0.366*	1.000						
	(0.011)	(0.088)	(0.000)	(0.021)	(0.000)							
(7) waemu	-0.158*	0.060	0.378*	-0.172*	0.660*	-0.071	1.000					
	(0.000)	(0.146)	(0.000)	(0.000)	(0.000)	(0.088)						
(8) amu	-0.063	-0.115*	0.212*	0.174*	-0.020	-0.064	-0.115*	1.000				
	(0.129)	(0.005)	(0.000)	(0.000)	(0.624)	(0.123)	(0.005)					
(9) saarc	0.110*	0.242*	-0.187*	-0.095*	-0.107*	-0.039	-0.071	-0.064	1.000			
	(0.008)	(0.000)	(0.000)	(0.021)	(0.010)	(0.345)	(0.088)	(0.123)				
(10) udeac	-0.085*	-0.088*	0.096*	-0.118*	-0.133*	-0.049	-0.088*	-0.079	-0.049	1.000		
	(0.041)	(0.035)	(0.021)	(0.004)	(0.001)	(0.242)	(0.035)	(0.056)	(0.242)			
(11) eco	0.164*	0.132*	-0.456*	-0.233*	-0.261*	-0.095*	-0.172*	-0.156*	0.158*	-0.118*	1.000	
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.021)	(0.000)	(0.000)	(0.000)	(0.004)		
(12) asean	0.656*	-0.071	-0.187*	-0.095*	-0.107*	-0.039	-0.071	-0.064	-0.039	-0.049	-0.095*	1.000
	(0.000)	(0.088)	(0.000)	(0.021)	(0.010)	(0.345)	(0.088)	(0.123)	(0.345)	(0.242)	(0.021)	
*** *p<0.01*, ** *p<0.05*, * *p<0.1*												

The results in Table 6 show that the regional bloc Africa Economic Community (AEC), Economic Community of West African States (ECOWAS), Mano River Union (MRU), West African Economic and

Monetary Union (WAEMU), Central Africa Customs and Economic Union (UDEAC) were found to be significant and negatively associated with ecological footprint. The negative association could be attributed to shared sustainability efforts and less ecologically intensive economic activity within these regions. Another reason may be because countries within the regional blocs are at the same level of development compared to that of other OIC member countries. The negation association between these regional blocs and ecological footprint suggests that deeper regional integration could lead to improved environmental quality. The findings also suggests that OIC Africa regional blocs can benefits more from regional integration compared to OIC Asia regional blocs.

The results in Table 6 also revealed that the regional bloc South Asian Association for Regional Cooperation (SAARC), Economic Co-operation Organization (ECO), and Association of Southeast Asian Nation (ASEAN) were found to be positively associated with ecological footprint. The finding indicates that integration in these regions has been accompanied by increased environmental degradation perhaps due to rapid economic expansion and urbanization. Council of Arab Economic Unity (CAEU) and Arab Maghreb Union (AMU) were found to be negative and non-significant while Gulf Co-operation Council (GCC) has a positive non-significant relationship with measure of environmental quality. The correlation coefficient was moderate and suggest no evidence of multicollinearity.

Table 7: Descriptive Statistics of the variables in the model

Variable	Obs	Mean	Std. Dev.	Min	Max
EQ	581	.112	.158	0	1
REI	583	1.674	.535	.644	2.829
EU	583	.467	.211	0	1
IDI	583	.688	.224	0	1
PTA	583	.519	.259	0	1
RGDP	583	7.935	.023	7.902	7.979
TO	583	16.066	.041	15.999	16.143
FDI	578	2.631	.354	-3.079	3.921
DHEXP	583	4.653	.116	4.487	4.894
POP	583	16.363	1.479	13.211	19.421

Table 7 shows that there was a strong variation across the variables. Environmental quality (EQ) has a mean of 0.112 and ranges from 0 to 1.

Regional integration (REI) has a mean of 1.674, and a significant variation in its standard deviation among countries. The binary variables, such as membership in economic unions (EU), preferential trade agreements (PTA), and institutional driven integration (IDI) were roughly evenly distributed, with means of 0.467, 0.519, and 0.688 respectively. Trade openness (TO) has a mean of 16.066 while real GDP (RGDP) has a mean of 7.935.

Foreign direct investment (FDI) shows greater variability, with a mean of 2.631 and a wide range, indicating differences in FDI inflows and outflows. Domestic health expenditure (DHEXP) has a mean of 4.653 and small variation. Population size (POP) shows substantial variation, ranging from 13.211 million to 19.421 million, reflecting diverse country sizes.

Table 8: Panel Tobit Regression Results

	(1)	(2)	(3)	(3)
VARIABLES	**env_quality**	**env_quality**	**env_quality**	**env_quality**
REI	-0.040***			
	(0.003)			
PTA		-0.214***		
		(0.007)		
EU			-0.033**	
			(0.013)	
IDI				-0.113***
				(0.007)
TO	0.017*	0.016	0.016*	0.019*
	(0.010)	(0.010)	(0.010)	(0.010)
RGDP	0.026	0.035*	0.032	0.018
	(0.021)	(0.021)	(0.021)	(0.021)
POP	0.007***	-0.001	0.002***	0.012***
	(0.002)	(0.001)	(0.001)	(0.001)
DHEXP	0.002	0.006*	0.004	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)
FDI	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.427***	-0.329***	-0.370***	-0.396***
	(0.126)	(0.125)	(0.126)	(0.126)
sigma_u	0.124***	0.122***	0.152***	0.143***
	(0.012)	(0.012)	(0.015)	(0.014)
sigma_e	0.007***	0.007***	0.007***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	576	576	576	576
LR test[Chi-Square, Prob.]	2893.77[0.000]	2872.57	2898.13	2914.67
Wald chi2(6), Prob.	253.04[0.000]	1073.71[0.000]	55.62[0.000]	362.69
Left Censored Obs.	1	1	1	1
Uncensored Obs.	564	564	564	564
Right Censored Obs	11	11	11	11
Number of cid	53	53	53	53

The results in Table 8, column 1 show that regional economic integration among OIC member countries has improved environmental quality. This finding is in line with the argument that regional economic integration lead to an improvement in the efficient use of energy, capital, and labour which will reduces $C0_2$ emissions and thus improve the environment (Bukhari et al., 2014). The negative coefficient for regional integration on environmental quality also suggests that regional integration at the general level, will lead to less dependency on fossil energy. This line of reasoning follows the findings of Deng and Song (2008), who proposed that the use of modern technology and efficient production methods are $C0_2$ reducing while heavy dependence on fossil energy deteriorates the countries' environment.

The findings in Model 2, model 3 and model 4 shows that preferential trade area, economic union, and institutional driven integration reduces ecological footprint indicating that they improve environmental quality. The findings implies that adoption of shared environmental standards, governance coordination, and legal harmonization between the OIC member countries can lead to environmental sustainability. The finding is also in line with the finding of Weijun, et al., (2017), which concluded that regional economic integration contributes to the marginal $C0_2$ abatement cost by 5%.

The significant LR test confirms the need for a panel structure with random effects, while the significant Wald chi-square confirms that the explanatory variables collectively have a meaningful impact on ecological footprint, validating the fit of the Tobit panel regression model.

Table 9: Results of the Robust Check using Driscoll-Kraay standard errors Regression

	(1)	(2)	(3)	(4)
VARIABLES	**env_quality**	**env_quality**	**env_quality**	**env_quality**
REI	-0.069***			
	(0.004)			
TO	0.024	0.0212	0.0254	0.0226
	(0.020)	(0.0198)	(0.0209)	(0.0212)
RGDP	-0.005	0.001	-0.007	-0.008
	(0.045)	(0.045)	(0.047)	(0.047)
DHEXP	-0.007	-0.00477	-0.0107	-0.0121
	(0.010)	(0.009)	(0.012)	(0.012)
POP	0.024***	0.019***	0.027***	0.024***
	(0.002)	(0.002)	(0.002)	(0.002)
FDI	-0.049*	-0.052*	-0.048	-0.055*
	(0.026)	(0.027)	(0.029)	(0.030)
PTA		-0.177***		
		(0.006)		
EU			-0.115***	
			(0.012)	
IDI				-0.068***
				(0.008)
Constant	-0.374**	-0.310**	-0.459***	-0.342**
	(0.119)	(0.139)	(0.130)	(0.124)
Observations	576	576	576	576
R-squared	0.132	0.159	0.100	0.087
Number of groups	53	53	53	53

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results in Table 9 shows strong evidence robustness of the findings in Table 8. The differences categories of regional economic integration was still negatively associated with ecological footprint as the indicate by the Panel Tobit regression results in Table 8. There is significant evidence of consistency in the findings.

5. Conclusions

This study examines the relationship between regional economic integration and environmental quality in OIC member countries. The results indicate that regional integration improves environmental quality, suggesting that deeper regional integration is good for the sustainability of OIC member countries. Improvement of environmental quality of the OIC member countries can be attributed to economic cooperation and shared sustainability, social and political policy among members of OIC regional blocs. The study also revealed that African OIC members regional blocs may benefits more from regional economic integration than OIC Asian member regional blocs. The reason is because of rapid industrialisation and soft trade conditions. Based on the finding, OIC member countries should strengthen environmental policies and promote green foreign direct investment as they deepened into regional economic integration as it has the tendency to mitigate the negative impact of environmental quality

Conflict of Interest Statement

The authors declare no conflict of interest

Data Availability

The data and do file are available from the corresponding author upon reasonable request.

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