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Foreign Direct Investment and Environmental Sustainability in South Asia and MENA: The Roles of Trade Flows and Institutional Quality

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Abstract: This study examines how foreign direct investment (FDI) affects environmental sustainability, considering the role of institutional quality. The study is motivated by poor environmental performance scores in South Asian countries and rising emissions of sulfur dioxide (SO_2) and carbon dioxide (CO_2) in the Middle East and North Africa (MENA) region, which threaten the United Nations sustainability agenda but have been overlooked in earlier studies. The study adopts environmental performance index scores as a measure of environmental sustainability against CO_2, and we uniquely extended the Environmental Kuznets Curve model by using the predator–prey three-dimensional nonlinear dynamic system to develop an interregional model for the analysis of the FDI–trade–environment nexus while controlling for institutions. Our System Generalised Method of Moments (SGMM) empirical results indicate that in South Asia, FDI and merchandize import trade affect environmental sustainability negatively, while merchandize export trade and institutional quality help reverse the adverse effect. The result is unique when compared to MENA countries, where the adverse effect of FDI and import trade on environmental sustainability is exacerbated by poor institutional quality, with merchandise exports as the sole remedy. Also, there is complementarity in the relationship between FDI and trade on environmental sustainability. The complementarity of FDI and trade on the environment suggests the need for countries to synchronize FDI attraction with trade policies to promote the quality of their environment. Moreover, institutional quality and income could be strengthened to realize the desired level of sustainability. These economies need to strategically improve their socio-economic conditions and institutions for inward FDI and trade to culminate in environmental quality.

Keywords: foreign direct investment, environmental sustainability, trade, institutional quality

1. Introduction

Foreign direct investment (FDI) and trade have generally been known to transform the economies of most nations worldwide. They are seen as a growth catalyst, as developing economies need their optimization to bridge the resource gap [1–3]. Hence, policymakers and scholars have widely accepted the beneficial role of FDI and trade in recipient economies. Moreover, available studies have shown that the inflow of FDI and trade results in capital formation, improved competition, technological transfer, and human capital development, thus promoting growth in recipient economies [4–11]. Despite this wide acceptance, empirical studies have shown that the impact of FDI on environmental sustainability has resulted in air pollution, energy consumption, and carbon dioxide emissions, leading to irreversible damage to natural resources and the environment [5, 12–18].

Moreover, the desire to benefit from global trade could lead to the overexploitation of natural resources (mining, fishing, and forestry activities) and cause toxic chemical processing and shipbreaking. In addition, the laxity in environmental laws and standards in developing economies might motivate multinational corporations (MNCs) to invest, hence polluting the environment [13, 19–21].

Although recent studies have refuted the claims of the pollution haven hypothesis and noted that the inflow of FDI may expedite the use of recent technologies in the production process and ensure good environmental practices, which in turn results in better knowledge transfer, skill acquisition, and energy efficiency [1, 9, 22–25]. Consequently, some scholars have argued that institutional quality is a sine qua non for attaining environmental sustainability. Based on the pollution haven hypothesis, weak environmental regulations in developing nations can pull MNCs wishing to avoid the high cost of sustainability compliance in developed economies [26–30].

In this paper, we document how FDI and trade affect environmental sustainability by considering the role of institutional quality, which extends earlier studies on the institutional quality–FDI nexus in developed and developing economies.

This paper aims to address two key questions. First, how do FDI and trade affect environmental sustainability, considering

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the role of institutions in South Asia (SA) and Middle East and North Africa (MENA) economies? Second, is there substitutability or complementarity between FDI and trade in addressing environmental sustainability? Answering these key questions is significant since FDI and trade are key determinants of the economic expansion of a nation. More so, ascertaining their impact on the environment is crucial in the attainment of the Sustainable Development Goals (SDG), especially in SA and the MENA regions, where environmental issues are significant.

This study contributes to the literature in the following ways. First, the study uses an environmental performance index (EPI) score to capture environmental sustainability, unlike previous studies that measure environmental sustainability using carbon emissions. The EPI score is sourced from the publication of the Yale Centre for Environmental Law and Policy. The EPI is an all-inclusive index that measures a country's environmental sustainability. Second, the study considers the impact of FDI on environmental sustainability and includes the impact of trade on environmental sustainability, considering the role of institutional quality as well. Third, the study examines whether a substitutive or complementary relationship exists in the FDI–trade impact on environmental sustainability. Finally, the present study also contributes to the literature by undertaking an analysis by comparing SA and MENA economies.

The findings of this study are not only relevant for SA and MENA economies but also for other economies of the world, since the inflow of FDI and trade on the environment may result in serious consequences if FDI and trade policies are not synchronized. Our empirical results showed that in SA, FDI and merchandise import trade affect environmental sustainability negatively, while merchandise export trade and institutional quality positively affect environmental sustainability. The result is quite different when compared to MENA countries, where the adverse effect of FDI and import trade on environmental sustainability is exacerbated by poor institutional quality, with merchandise exports as the sole remedy. On the interaction, the result for both regions is the same. That is, there is a complementary relationship between FDI and trade on environmental sustainability. These mixed findings command serious policy concerns as espoused under policy implications.

The remainder of this study is arranged as follows: in Section 2, we explore empirical reviews on FDI, trade, and environmental sustainability. In Section 3, we examine the nature of the data. Section 4 develops econometric models following the predator–prey approach. In Section 5, we present the results of the estimation and summarize our key findings. We conclude the study with policy implications in Section 6.

2. Literature Review

Our paper fits into various literature strands as we bring different, distinct threads from previous studies together. First, we examine the literature on FDI and environmental sustainability. Empirical findings revealed mixed results. Some scholars noted that FDI affects environmental sustainability adversely [5, 12, 15]. Their argument was based on the premise that the inflow of FDI to developing nations can result in great harm such as irreversible damage to natural resources and the environment and the emission of greenhouse gases, among others, while others claimed that FDI influences environmental sustainability positively [7, 31–34]. These authors argued that many MNCs now adopt the latest technologies and encourage innovations in achieving efficiency, and this has helped in creating a low-carbon economy, energy efficiency, and clean energy projects. Second, we examine the literature on trade and environmental sustainability. Our empirical review has mixed findings on the subject matter. For instance, while some scholars established that trade positively influences environmental sustainability [35–39], others claimed that trade adversely affects environmental sustainability [5, 7, 40]. Moreover, a further review of the literature shows that a limited number of studies examined the interactive effect of trade and governance on environmental performance, thereby ignoring the role of FDI. For instance, Yasmeen et al. [41] investigated the interactive effect of trade and governance on the environment, controlling for endogeneity and using first-difference generalized method of moments (GMM), and established that governance is a persistent instrument for resolving environmental issues among actively trading nations. Furthermore, in the work of Abaidoo and Agyapong [42], it was established that governance is a significant moderator of the trade openness and environmental sustainability nexus. Similar studies that affirmed the same position include [43–45]. Despite the unanimity of findings, these studies are limited in variable measurement, as they rely on carbon emissions as a proxy for environmental impact instead of a robust EPI. In another recent Chen et al. [46] systematically tracked the influence of trade on the environment across the globe. However, the study lacked an analytical framework as it relied on a review of earlier strands of the literature to support its submission that trade matters to environmental health.

Our study differs from previous literature in several ways. We present a first analysis of the relationship between FDI, trade, and environmental sustainability, considering the role of institutions in SA and the MENA region. Moreover, our study departs from previous literature that has used CO_2 as a measure of environmental sustainability. Rather, we use an EPI score to capture environmental sustainability, which is more inclusive. Moreover, our study also examines the FDI–trade impact on environmental sustainability as complementary or substitute.

3. Data

We developed a balanced panel dataset covering 16 developing countries from 2012 to 2020, including 10 MENA countries and 6 South Asia (SA) economies. This category of selected nations is in line with References [47–50], who assert that developing countries, especially the SA and MENA regions, are "Pollution Havens" where environmental sustainability is threatened. The list of selected countries comprising the sample is presented in Table 1.

The response variable in this study is environmental sustainability, measured as the EPI[1]. Shittu et al. [51] and Szymczyk

Table 1
List of sampled countries

South Asian countries (6)	Afghanistan, Bangladesh, Bhutan, India, Pakistan, and Sri Lanka
Middle East and North African countries (10)	Algeria, Egypt, Iran, Iraq, Jordan, Morocco, Qatar, Saudi Arabia, Tunisia, and the United Arab Emirates

[1]The environmental performance index (EPI) ranks countries on performance indicators tracked across policy categories that cover both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are to

et al. [52] indicate that the score of the EPI is more accurate, inclusive, and reliable for measuring environmental sustainability as compared to individual pollution indicators such as carbon emission or nitrous oxide emission. Thus, our study considers the EPI score of the nations as an indicator of their environmental achievement and sustainability. EPI was also adopted because it is a composite weighted average performance of a nation on child mortality (15%), CO_2 emissions per capita (6.13%), CO_2 emissions per GDP (6.13%), water quality change (8.75%), sulfur dioxide emission per capita (4.38%), sulfur emission per GDP (4.38%), marine protection (4.38%), critical habitat protection (4.38%), agricultural subsidies (3.89%), indoor air pollution (3.75%), particulate matter (3.75%), access to potable water (3.75%), and access to sanitation (3.75%). Other indicators include fishing stock overexploitation (2.92%), coastal shelf fishing pressure (2.92%), CO_2 emissions per electricity generation (2.6%), renewable electricity (2.6%), pesticide regulation (1.94%), growing stock of forest (1.94%), forest loss (1.94%), and forest cover change (1.94%). It was determined by means of principal component analysis. EPI is becoming a popular measure of environmental sustainability [53–58], however, most existing studies on FDI, trade, and environment literature have neglected it [59–63]. Trade is another predictor of environmental sustainability employed in the study. We decompose trade into merchandise imports (MIM) and exports (MX), following Sibuea et al. [64], who examined energy imports and energy exports on environmental quality with mixed but interesting findings. In line with the World Bank measurement, MIM indicates the cost, insurance, and freight value of goods received from the rest of the world, while MX includes the free-on-board value of goods supplied to the rest of the world. Some other control variables are incorporated in the analysis, with guidance and inspiration drawn from existing literatures [65–67]. These variables include institutional quality; the study included the score of the nation's corruption perception rating[2]. Kuznets Curve hypothesis, per capita GDP and its square are also included. Table 2 summarizes the definitions of variables and sources of data. Tables 3 and 4 present the descriptive statistics and correlation matrix, respectively.

Table 3 shows the descriptive statistics of the variables. The mean values are the averages for the period covered by the study. For instance, EPI average scores of 49.337 for SA and MENA were slightly below the average possible scores, which shows underperformance in environmental sustainability efforts. The standard deviation estimates of 27.975 depict a wide range of dispersion between the individual country performance indicators in EPI. Also, the mean growth in FDI is 21.207 with with a standard deviation of 1.913; the mean value of imports is 24.426

established environmental policy goals." Quoted from Chakraborty and Mukherjee (2013). EPI data are obtained from the Yale University webpage at http://epi.yale.edu/.

[2]Country Policy and Institutional Assessment (CPIA) transparency, accountability, and corruption in the public sector rating (1 = low to 6 = high). https://www.transparency.org/en/cpi/2021

Table 2
Definitions of variable

Variable	Definition	Source
EPI	Environmental performance index, composite weighted average of environmental performance (see endnote i).	Yale http://epi.yale.edu/
LFDI	Natural logarithm of FDI. Foreign direct investment refers to direct investment equity flows in the reporting economy (current US $).	World Development Indicator
LMIM	Logarithmic transformation of MIM. Merchandise imports show the *c.i.f.* value of goods received from the rest of the world valued in current US dollars.	World Development Indicator
LMX	Logarithmic expression of MX. Merchandise exports show the *f.o.b.* value of goods provided to the rest of the world, valued in current US dollars.	World Development Indicator
LPCI	Natural logarithm of GDP per capita. Data are in current US dollars.	World Development Indicator
INSTQ	Institutional quality proxy by Corruption Perception Index measures regulations and governance roles in environmental performance. The study carefully chose Corruption Perceptions Index (CPI), which encompasses direct corruption practices, governance and integrity mechanisms, institutional safeguards and transparency, administrative and business environment and oversight, media, and accountability, which have been established to have a stronger influence on environmental sustainability than the overall ISC, which included political stability, which has no direct influence on environmental sustainability.	Transparency International. https://www.transparency.org/en/cpi/2021

Table 3
Descriptive statistics

Variable	Mean	Median	Std. Dev.	Maximum	Minimum
EPI	49.337	46.578	27.975	100.000	0.000
LFDI	21.207	21.317	1.913	24.888	14.790
LMIM	24.426	24.525	1.367	26.966	20.628
LMX	24.017	24.014	1.846	26.688	19.877
LPCI	8.320	8.180	1.194	11.351	6.186
INSTQ	40.116	38.000	15.155	71.000	8.000

with a standard deviation of 1.367; exports have a mean growth rate of 24.017 with a standard deviation of 1.846 per capita GDP growth averages 8.180 with a standard deviation of 1.194; and the institutional quality index has a mean score of 40.116 with a standard deviation of 15.155. Table 4 shows that the variables have a positive correlation coefficient, with FDI and imports, and imports and exports having the highest level of relationship at 0.941 and 0.922, respectively. The variables are stationary after first differencing, as reported in Table 5.

Prior to formulating econometric models and analyzing the data, a visual presentation and examination of key variables was conducted. Figure 1 show the dot plot of environmental sustainability (EPI) against FDI and trade (MX, MIM). The visual examination reveals no evidence of a linear relationship between EPI and its predictors in MENA and SA countries. Higher FDI inflows are associated with low EPI scores, and moderate inflows of FDI are associated with high EPI scores, while low FDI inflows are associated with low EPI scores. To control for spurious correlation, we examined the stationarity property of the panel series using [68, 69], Breitung *t*-stat, and Fisher Phillips Perron (PP) and Augmented Dickey-Fuller (ADF) & statistics. All estimates reveal the absence of panel unit roots in the data series as presented in Table 5. The preliminary reports from the dot plots and unit root tests align with earlier study by Lagos and Wang [70] on the threshold effects of global economic uncertainty and FDI. However, the observed relationship between EPI and its determinants provides further evidence of heteroskedasticity, which was addressed by econometric modeling.

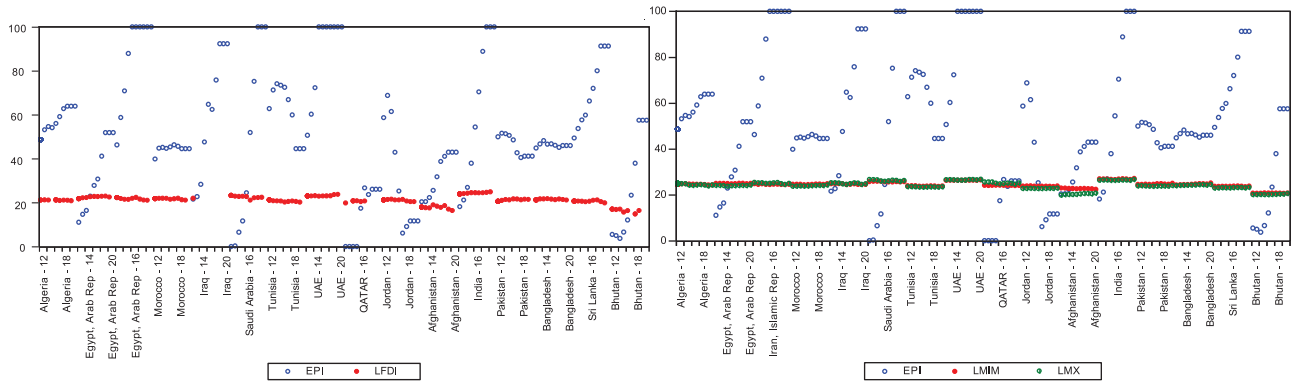
Table 4
Correlation matrix

Variable	EPI	LFDI	LMIM	LMX	LPCI	INSTQ
EPI	1.000	0.322	0.337	0.347	0.127	0.010
LFDI		1.000	0.941	0.883	0.325	0.063
LMIM			1.000	0.922	0.362	0.059
LMX				1.000	0.598	0.265
LPCI					1.000	0.758
INSTQ						1.000

Table 5
Unit root tests

Variable	Levin, Lin, Chu *t**	Breitung *t*-stat	Im, Pesaran, and Shin *W** stat	Fisher stat	Decision
EPI	–14.2103	1.48040	–0.44307	77.7069	*I*(1)
LFDI	–18.2884	–1.8274	–1.80781	65.9427	*I*(1)
LMIM	–8.76815	–1.2989	–1.51053	75.5237	*I*(1)
LMX	–20.3971	0.9616	–2.52999	47.0456	*I*(1)
LPCI	–5.57192	–0.2461	0.73300	21.8783	*I*(1)
$LPCI^2$	–9.16635	1.1994	–0.30612	49.3370	*I*(1)
INSTQ	–2.56949	1.3540	0.63473	52.2248	*I*(1)

Figure 1
Environmental sustainability, FDI, and trade relations



Note: The presentation is based on data collected from various sources, as reported in Table 3.

4. Econometric Modeling

Econometric models of interregional environmental sustainability are rare [71], although the predator–prey approach exists; econometrics that embody the behavioral dynamism that defines the components of environmental sustainability in the MENA and SA region did not exist until this study. The challenge in developing a model of this nature is the quest to establish a balance between the parsimony and explanatory capacity of the model. This is aggravated by the impossibility of identifying all the components of environmental sustainability. Hence, we designed a dynamic econometric model that included an EPI composite weighted index to measure environmental sustainability, FDI, and trade (bifurcated into merchandise imports and exports).
Quantitatively,

$$EPI = f(FDI, MIM, MX) \tag{1}$$

where EPI depicts EPI scores of the nations; FDI represents foreign direct investment inflows, and MIM and MX are merchandise imports and exports, respectively, as components of trade. Our model is based on the ideas of earlier scholars [71–73], using the predator–prey three-dimensional nonlinear dynamic system.
Let us assume that:

$$f(FDI, MIM, MX) = FDI^{\beta_1} MIM^{\beta_2} MX^{\beta_3} \tag{2}$$

where β_1, β_2, and β_3 are constants.
From Equations (1) and (2) we differentiated with respect to time (t) to obtain Equation (3).

$$\frac{1}{EPI}\frac{dEPI}{dt} = \frac{\beta_1}{FDI}\frac{dFDI}{dt} + \frac{\beta_2}{MIM}\frac{dMIM}{dt} + \frac{\beta_3}{MX}\frac{dMX}{dt} \tag{3}$$

The dynamic equations that direct the rate of variation in the variables FDI, MIM, and MX are expressed below:

$$\dot{FDI} = (a_1 e - a_2 FDI * MIM + (q_3 - c_2) FDI * MIM * MX \tag{4}$$

$$\dot{MIM} = \beta\left(\frac{b_1 FDI}{1 + b_2 l} - MIM\right) FDI * MIM \tag{5}$$

$$\dot{MX} = -c_1 MX + c_2 FDI * MIM * MX \tag{6}$$

$$\text{BUT } FDI(0) > 0, MIM(0) > 0, MX(0) > 0$$

The parameters of the model are a_1, a_2, q_3, b_1, b_2, b_3, c_1, c_2, e, β, and l is assumed to be positive definite; e represents the ecological level, with parameters a_1 *and* a_2 defining the environmental limits of FDI inflows in MENA and SA. Further, e ranges between 0 and 1; q_3 depicts FDI earnings in host regions; q_3 represents export earnings; $q_3 - c_2$ depicts the contribution of FDI to exports; c_1 represents the decline in export earnings; l is the parameter that captures the environmental cost of imports, with parameters b_1 and b_2 that determine the sustainable imports carrying capacity of the MENA and SA regions; and β is the FDI-import ratio.

With the positive definite properties of the parameters, we arrived at the following equilibrium positions:

$$\frac{dFDI}{dt} = \frac{dMIM}{dt} = \frac{dMX}{dt} = 0 \tag{7}$$

Therefore, by expanding Equation (7) we arrived at the following equilibrium conditions:

$$(a_1 e - a_2 FDI)FDI * MIM + (a_3 - c_2)FDI * MIM * MX = 0 \tag{8}$$

$$\beta\left(\frac{b_1 FDI}{1 + b_2 l} - MIM\right) FDI * MIM = 0 \tag{9}$$

$$-c_1 MX + c_2 FDI * MIM * MX = 0 \tag{10}$$

$E_0(0,0,0)$ is an equilibrium condition. To derive the empirical models, we utilized stability analysis, the persistency theorem, and the Routh-Hurwitz criterion to satisfy the final equation[3]. By extending the earlier models by Rai et al. [71] as well as Mukherjee and Chakraborty [74], we incorporated FDI and trade components (imports and exports) and introduced control variables such as institutional quality (INSTQ) and GDP per capita and its second-degree polynomials, which have been established in the literature to influence aggregate variables like exports [75–77], imports [78, 79], and FDI [80–82], to arrive at Equation (11)

$$\begin{aligned} EPI_{it} = {} & \beta_0 + \beta_1 LFDI_{it-1} + \beta_2 LMIM_{it-1} \\ & + \beta_3 LMX_{it-1} + \beta_4 LPCI_{it-1} + \beta_5 LPCI^2_{it-1} \\ & + \beta_6 INSTQ_{it-1} + \mu_{it} \end{aligned} \tag{11}$$

To determine complementarity or substitutability between FDI and trade policies for environmental benefits, we developed the next model by extending Equation (11) using Equations (8–10) to obtain Equation (12) which is the empirical model that governs the analysis of data.

$$\begin{aligned} EPI_{it} = {} & \beta_0 + \beta_1 LFDI_{it-1} + \beta_2 LMIM_{it-1} \\ & + \beta_3 LMX_{it-1} + \beta_4 FDI_{it-1} * LMIM_{it-1} * LMX_{it-1} \\ & + \beta_5 LPCI_{it-1} + \beta_6 LPCI^2_{it-1} + \beta_7 INSTQ_{it-1} + \mu_{it} \end{aligned} \tag{12}$$

where μ_{it} depicts the unobserved white noise variable.

β_0 is the model intercept, which measures the natural rate of environmental sustainability.

$\beta_1 - \beta_7$ are model coefficients of the variables described in Table 2 earlier.

5. Estimation and Results

We followed Arellano and Bover [83] as well as Blundell and Bond [84] to rationalize the use of the GMM estimation technique, as our panel data have more cross sections than time dimensions, in line with the $q - p < 0$ additional moments. Accordingly, as detailed by Nwani [85], let $\theta \in \mathbb{R} \leq R^p$ denote the vector of unknown parameters, with θ_0 being a free parameter. Let $E[f(x_i, \theta)]$ be a set of q moments and $f_n(\theta)$ be a set of

[3]The full mathematical exposition of the model is outside the scope of our study. Interested readers are encouraged to consult Rai et al. (2014).

corresponding sample moments. Let $Q_n(\theta) = f_n(\theta)^I w_n f_n(\theta)$ as the criterion equation, where w_n represents the weighting matrix, which converges to a positive definite matrix as n increases; then, the GMM estimator of $\theta_0 = \hat{\theta}$. $\hat{\theta}$ = argmin $Q_n(\theta)$ and $\theta \in \mathbb{R}$. The order condition, the rank condition, and the uniqueness condition are requisites for the identification assumption to be met at the point that the sample moments converge in expected value of $f_n(\theta_0) = \left[\frac{I}{n}\sum_{i-1}^{n} f(x_i, \theta_0)\right]$ transforms to $E[f_n(\theta_0)] = E\lfloor f(x_i\theta_0)\rfloor$ [13].

We applied both convergence assumptions and the ergodic dimensions to ascertain that the parameters of our model are estimable, with asymptotic normality of the distribution. Thus, unbiased and efficient parameters are attained as the GMM estimates asymptotically approach the lower bound of the Cramer-Rao [85].

We present the estimates of our GMM analysis for four separate models for regions and a comparative analysis of the impact of the environmental sustainability of FDI and trade variables, which are presented in Tables 6 and 7, respectively. Before the presentation and interpretation of estimates, the study probed the validity and reliability of the GMM estimation using the Arellano-Bond autocorrelation tests (AR(1) and AR(2)) and the Hansen test of overidentification and proliferation of restrictions in the model (see Table 8). To ascertain the consistency of the estimates of the GMM and to discern the validity of the slope coefficients, the serial correlation test of error AR(2), with a p-value of 0.2130, implies the acceptance of the null hypothesis of the absence of second-order autocorrelation in the dynamic panel model. At the same time, the probability value of 0.1680, which is greater than 5%, presupposes the absence of overidentification of instruments in the model based on the Hansen test.

The AR(1) test is statistically significant at the 5% level with a P-value of 0.0120, implying the presence of first-order autocorrelation in the first-differenced residuals. The estimate lends credence to the validity of the dynamic panel GMM estimation since first differencing induces a mechanical relationship in the white-noise variable; thus, the result is consistent with the expected correctly specified GMM model and therefore validates it. Moreover, the Arellano-Bond test for AR(2) with a p-value of 0.5330 implies a statistically insignificant outcome; thus, we rejected the alternative hypothesis of the presence of second-order autocorrelation and accepted the null hypothesis that the model does not suffer from second-order autocorrelation. It further supports the validity of our estimated coefficients, implying that the lagged variables are uncorrelated with the white-noise variable, validating the appropriateness of the instrument.

Also, the Hansen test of overidentification and proliferation of restrictions revealed that the GMM instruments used in this study are exogenous, and that the model is not limited by instrument invalidity, since the p-value of 0.3719 is not statistically significant. These robust findings are further complemented by the difference-in-Hansen estimated p-value of 0.6365,

Table 6
Panel results on FDI, trade, and environmental sustainability in selected MENA and SA countries

Description	Model 1	Model 2	Model 3	Model 4
Dependent variable	EPI score	EPI score	EPI score	EPI score
Independent variables				
Constant	–94.235***	–141.655***	–141.345***	33.255***
LFDI	0.174	–4.0374*	–4.014**	–2.220*
LMIM	2.185	2.657	2.621*	2.509**
LMX	3.601	7.791	7.764*	7.723**
LPCI		3.406*	3.554*	3.631*
$LPCI^2$		–1.060**	–1.060**	–1.267***
INSTQ			0.012*	0.122**
LFDI*LMIM*LMX				0.004***

Note: *, **, *** α = 0.10, 0.05, 0.01, respectively.

Table 7
Panel estimates that compare South Asia to MENA

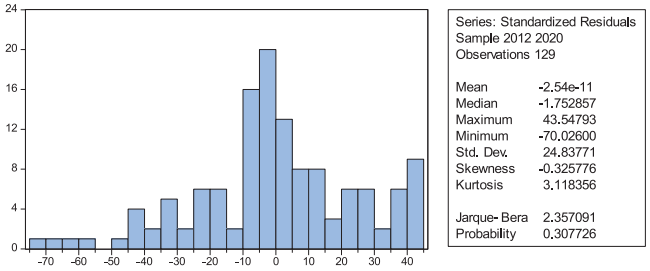
Description	South Asia model 1	South Asia model 2	MENA model 1	MENA model 2
Dependent variable	EPI score	EPI score	EPI score	EPI score
Independent variables				
Constant	1.521*	–5.694**	3.236**	–46.070***
LFDI	–0.081*	–0.055*	–0.008*	–1.156*
LMIM	–0.032*	–0.256*	–0.469*	–0.408**
LMX	0.227**	0.283***	0.651**	1.731**
LPCI	–0.376	–0.492*	–0.809	–0.818*
$LPCI^2$	6.780***	7.030***	1.901***	9.661***
INSTQ	0.010*	0.0012*	–0.0295*	0.042**
*LFDI*LMIM*LMX*	NA	0.00028**	NA	0.0019***

Note: *, **, *** α = 0.10, 0.05, 0.01, respectively.

Table 8
GMM diagnostic tests

Variable	Estimate
$C(1)$	–2.220*
$C(2)$	2.509**
$C(3)$	7.723**
$C(4)$	3.631*
$C(5)$	–1.267***
$C(6)$	0.122**
$C(7)$	0.004***
AR(1) (0.0120)	
AR(2) (0.5330)	
Hansen Test (0.3719)	
Difference-in-Hansen (H_0: 0.6365)	
Where $C(1)$ = FDI; $C(2)$ = MIM; $C(3)$ = MX; $C(4)$ = PCI; $C(5) = PCI^2$; $C(6) = INSTQ$; $C(7) = FDI*MIM*MX$.	
Estimation command:	
EPI = $C(1)$*FDI + $C(2)$*MIM + $C(3)$*MX + $C(4)$*PCI + $C(5)$*PCI^2 + $C(6)$*INSTQ + $C(7)$*FDI*MIM*MX @(D(FDI–1)) D(MIM(–1)) D(MX(–1)) D(PCI)(–1)) $D(PCI^2)$ D(FDI(–1))*MIM(–1))*MX(–1)).	

Figure 2
Test for asymptotic normal distribution of observations



implying no evidence of additional instruments, thus strengthening the validity and confidence in the model specification.

Table 6 summarizes the panel data results derived from the different model specifications of Equations (11) and (12). We noted several observations from the panel data estimates/results. First, FDI is negatively and significantly related to the EPI score in models 2, 3, and 4, indicating that inward FDI may promote environmental degradation in recipient countries in SA and the MENA region, thus confirming that inward FDI hinders the environmental sustainability drive in SA and MENA countries examined in the study. However, the benchmark model (model 1) reveals that without controlling for per capita income, the square of per capita income, and institutional quality, FDI exerted a positive impact on EPI. Expectedly, if income level and institutional quality are held constant in these regions, FDI should promote environmental sustainability, ceteris paribus!

Second, merchandise imports and exports (trade) is positively related to environmental sustainability (EPI), where the relationship is significant, implying that greater merchandise exports and imports are potentially associated with improved environmental sustainability. Third, income per capita and its second-degree polynomial have a positive and significant impact on environmental sustainability, with evidence of the substitution effect. Fourth, the results established that institutional quality influenced environmental sustainability positively, indicating that stronger regulation and less corrupt practices could improve the scores of nations' EPI.

The empirical outcomes lend credence to the contention that inward FDI and merchandise trade (imports and exports) significantly determine the environmental sustainability of SA and MENA countries subject to the quality of their institutions. Therefore, while inward FDI may lower environmental sustainability in SA and MENA countries due to a fall in EPI scores, a shift to trade in terms of merchandise imports and exports could propel environmental sustainability in these regions. These established results provide the answer to the first research question that motivated our empirical inquiry.

For region-specific policy initiatives and directions, we compared the estimated results between the SA and MENA regions as presented in Table 7. Findings from the region-specific analysis provided new insights, especially with the varying influence of trade components on environmental sustainability in each region. Emphatically, the adverse influence of FDI on the environment remains undisputed even at region-specific levels. The most notable outcome is that merchandise imports and FDI reverse environmental sustainability efforts.

The findings around the adverse effect of merchandise imports on the environment imply that the importation of merchandise into these economies influences domestic production, which promotes the emission of greenhouse gases and other pollutants, leading to higher child mortality and an overall reduction in EPI scores. Also, the role of institutional quality in FDI–trade impact on environmental sustainability varies between SA and MENA. Evidence of stronger regulatory and institutional quality is found in SA than in MENA. This is the grim reality, as only the UAE and Qatar are winning the war against corruption, while other MENA countries are failing in the fight against corruption, with an average score of 39, which makes MENA institutionally weaker than SA, with a mean score of 44 points.

FDI and trade are two important considerations in SA and MENA economies in a bid to promote growth with environmental sustainability; thus, we further examined whether there was complementarity or substitutability between FDI attraction strategies and trade policies, in line with the second research question that provided the rationale for the study. In Table 6, the interactive effect of FDI and trade on the environment is presented for countries across SA and MENA in model 4. We observed that FDI cum trade effect on environmental sustainability is positive and significant, implying complementarity in the relationship between FDI and trade on the environment. Thus, FDI attraction strategies and trade policies may not be considered in isolation in both regions; a similar result was obtained when we estimated for each region (see Table 7). In summary, our main findings remain similar for both SA and MENA countries. The reasons for the similar findings could be the trade ties and cross-border proximity with similar socio-economic characteristics as developing economies. With policy implications and conclusions imminent in the next section, Figure 2 provides evidence of asymptotic normality of the distribution with skewness and kurtosis coefficients of approximately 0 and 3, respectively. Also, the Jarque-Bera P-value >0.05 implies that the panel dataset satisfies the normality condition for estimation[4].

[4]Asymptotic normality is one of the most important conditions to avoid spurious results. Our dataset met this condition. For space constraints, we did not report other posttest estimates. This could be made available upon reasonable request.

6. Conclusions and Policy Implications

Motivated by contending positions, we explore the environmental sustainability impacts of FDI and trade, considering institutional quality in SA and MENA economies. In SA, leading economies like India, Sri Lanka, and Pakistan have poor scores in environmental performance, while the MENA region is one of the leading emitters of sulfur dioxide (SO_2) and carbon dioxide (CO_2) worldwide; unfortunately, a comparative and joint empirical study for these regions has been overlooked. To carry out this study, we use a panel of 16 countries (10 MENA and six South Asian countries) and adopt the EPI measure of environmental sustainability developed by the Yale Centre for Environmental Law & Policy. Since these regions' development strategies are outward-oriented, trade promotion through export enhancement [86], import management, and FDI attraction are essential components of their sustainability policy space for these reasons. First, to catch up with leading economic blocs and regions, SA and MENA require urgent FDI attraction and the associated technology transfer and other benefits, with the precondition of strong institutional quality. Second, the scholastic Prebisch–Singer thesis has propelled these regions to pursue favorable trade policies through the diversification from exporting primary products to merchandise exports to improve their terms of trade in the long run.

Conversely, developing economies should be aware that rising environmental compliance costs in the industrialized economies due to the income effect have led to the identification of SA and MENA countries as FDI host nations with surplus land, labor, and less stringent environmental regulations and standards. The deleterious effect of inward FDI on environmental sustainability for SA and the MENA region, as established in our study, requires a wider rationalization. Currently, FDI inflows from the developed regions toward food production and biofuel plants in several emerging economies, including SA and MENA, could be considered a decoy to the Prebisch–Singer thesis. Although recent studies [87, 88] argue that FDI increases productivity and environmental quality through technological upgrading, the study is of the opinion that it may result in natural resource overexploitation, which has environmental consequences. Our argument is buttressed by the surge in global environmental sustainability efforts in recognition of the interdependence among FDI, trade, and the environment. For instance, the most recent meetings of the Basel Convention (June 28, 2022–Lisbon, Portugal) address ocean pollution by controlling trade in plastic wastes, which is a major threat to sustainability. Others are the Montreal Protocol on combating ozone layer-depleting substances, the Rotterdam Convention, and the Stockholm Convention at the international level. Emphatically, a regional front is required to address the daunting environmental challenges squarely, as we encourage India and China to stop the blame games rather than face the reality head-on.

In addition to the regional cooperation strategies suggested, developing economies, with special attention to the regions we examine, should strengthen the quality of their institutions through the adoption and implementation of stringent country-specific environmental compliance requirements. The immediate benefits are the improvement in product quality, attraction of green FDI, and environmental protection for unborn generations. We recommend that environmental, food and drug control, and trade agencies in SA and MENA countries to closely evaluate the US's Good Agricultural Practices, the cradle-to-grave eco-labeling policies, and the EU's regulations on Registration, Evaluation, Authorisation, and Restriction of Chemical Substances (REACH), and use lessons to design a sustainable interaction among FDI attraction, trade, and the environment.

Against this backdrop, we established that the impact of FDI–trade on the environment in SA and MENA countries has some interesting policy implications. Following our earlier discussions, the positive impact of FDI on environmental sustainability (only in model 1) could be myopic since the environmental cost of FDI may be irreversible. The strategic actions are that the governments of SA and MENA countries should encourage MNCs with a moderate price premium for certification requirements through an institutionalized arrangement. Also, there is a need to avoid short-run economic considerations to attract FDI and to reach trade agreements. Further, it must be noted that green inward FDI is only obtainable through strategic actions that bypass immediate economic gains for future environmental gains, and as such, these regions should strengthen their institutions' capacity to improve on the lax environmental standards and the weak implementation of environmental regulations. Again, diversification from primary produce exports to merchandise exports is encouraged for green trade, which would reduce the overexploitation of natural resources with environmental benefits. Despite the high price and patent rights barriers to the transfer of environmentally friendly technologies to SA, MENA, and Less Developed Countries (LDCs). at large, we encourage the adoption of these technologies as a precondition for setting up local plants by Northern MNCs in the South. In conclusion, while the policy implications suggested above could be partially or collectively considered in these regions to address the remarkable impact of FDI and trade on the environment, there is a need to strengthen the institutional quality and income level if the attainment of environmental sustainability is to be a reality in these regions. LDCs need to note that trade policy and FDI attraction strategies require complementary socio-economic conditions and strong institutions to become favorable to environmental quality. The role of institutions is notable but requires more attention in MENA countries than in South Asian economies.

In the future, other studies could consider the roles of intensive land use and intensive exploitation of oil and gas when analyzing drivers of environmental performance in SA and MENA countries, respectively. Also, other studies could consider measuring institutional quality using the institutional stability scores (ISC) that encompass corruption control, regulatory quality, political stability, governance effectiveness, and rule of law.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Data are available from the corresponding author upon reasonable request.

Author Contribution Statement

Stanley Emife Nwani: Methodology, Formal analysis, Writing – original draft, Project administration. **Fredrick Ikpesu:** Software, Data curation, Validation, Resources, Data curation, Writing – original draft. **Olapeju Akorede Ikpesu:** Conceptualization, Investigation, Resources, Data curation, Writing – review & editing, Visualization, Supervision, Project administration. **Azuka Elvis Ozegbe:** Conceptualization, Resources, Data curation, Writing – original draft, Visualization. **Sunday Enebeli-Uzor:** Methodology, Validation, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Supervision, Project administration.

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