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WHAT SUSTAINS THE SUSTAINABLE? AN EMPIRICAL ANALYSIS OF ECONOMIC, SOCIAL AND ENVIRONMENTAL FACTORS IN OECD COUNTRIES

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Abstract
This study investigates the determinants of economic, social and environmental sustainability in OECD countries using panel data from 38 member nations over the period 2000–2023. The study has analyzed economic sustainability through GDP growth, social sustainability via secondary school enrollment and environmental sustainability through CO_2 emissions using a robust methodology of Cross-Sectionally Augmented ARDL (CS-ARDL) model. The findings reveal that gross fixed capital formation, labor force participation, trade openness, financial development, and foreign direct investment significantly enhance economic sustainability while population density and CO_2 emissions negatively impact it. Social sustainability is positively influenced by GDP growth, urbanization, and population density whereas inflation and unemployment exert negative effects. Environmental sustainability increases with GDP, foreign direct investment, urbanization and population growth though the squared GDP term reflects a potential turning point in the Environmental Kuznets Curve. Based on these results, the study proposes targeted policy recommendations for promoting sustainability. The study contributes to the empirical literature on sustainability by providing comprehensive, policy-relevant insights grounded in the OECD context.
***Keywords**: Sustainability, Economic Growth, CO_2 Emissions, Social Development, OECD, CS-ARDL*

INTRODUCTION

In recent decades, sustainability has become a core focus of global development agendas, with growing recognition that the long-term well-being of nations depends on balancing economic growth, social eq4uity, and environmental protection. (Sharma, 2010). This concept of sustainable development, as defined by the Brundtland Commission in 1987, emphasizes the need to meet the present needs without compromising the ability of future generations to meet their own needs. Sustainability is traditionally viewed through three key dimensions: economic sustainability, social sustainability, and environmental sustainability. Each of these dimensions has unique determinants and challenges, especially in developed countries like those in the Organization for Economic Co-operation and Development (OECD) (Omri et al., (2019)
The OECD countries, comprising 38 advanced economies, represent a diverse group in terms of development, economic structures, and policy priorities. However, these nations share common goals of fostering high levels of living standards, social welfare, and environmental responsibility. (Koirala and Pradhan, 2019). Despite being at the forefront of economic development, these countries face significant challenges in maintaining the balance between economic growth, social inclusion, and environmental preservation. Addressing these challenges requires a thorough understanding of the various determinants that influence each of these sustainability dimensions (Cheben et al., 2019; Audi & Audi, 2016)
Economic sustainability in OECD countries is often evaluated by indicators such as GDP growth, investment rates, labor market participation, and fiscal health. A growing concern is how to sustain economic growth while reducing disparities in wealth and opportunities, ensuring that growth benefits all sections of society (Maitah et al., 2020; Ali et al., 2021). Social sustainability, on the other hand, focuses on the equitable distribution of resources and opportunities, aiming to ensure long-term social stability and quality of life. Indicators such as secondary school enrollment, income inequality, unemployment, and social mobility are commonly used to measure social sustainability. Environmental sustainability in these countries is increasingly linked to reducing carbon emissions, improving energy efficiency, and adopting green technologies. Carbon dioxide emissions, energy consumption, and waste generation are key indicators of environmental performance (Paniagua et al., 2019; Ali et al., 2021; Marc & Ali, 2023).
Over the past few decades, OECD countries have increasingly adopted policies aimed at fostering sustainability in all three dimensions. However, the complex relationships among the economic, social, and environmental aspects of sustainability remain underexplored. The challenge lies in understanding how changes in one dimension, such as economic growth, impact the other dimensions, such as social equity and environmental quality. This interplay is critical for policymakers seeking to create integrated strategies that promote overall sustainability (Niu et al., 2020).
The challenge of achieving sustainability is especially prominent in OECD countries, where economic growth often leads to increased environmental pressures and social inequalities. Despite significant progress in economic development and technological innovation, these nations are still grappling with issues related to environmental degradation, income inequality, and social exclusion (Silva et al., 2022). For instance, rapid urbanization and industrialization in these countries have led to increased carbon emissions, even as efforts to transition to a low-carbon economy are being made. At the

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same time, income inequality has been rising in many OECD nations, exacerbating social tensions and undermining the inclusivity of economic growth. These issues underscore the need for a deeper understanding of the determinants of economic, social, and environmental sustainability (Yin Ip et al., 2022; Audi et al., 2025; Ito & Zhang, 2025).

The importance of this study lies in its potential to contribute to the development of more effective policies for achieving sustainable development in OECD countries. Policymakers in these countries face the difficult task of balancing competing goals—fostering economic growth, reducing inequality, and protecting the environment. A better understanding of the interdependencies between these dimensions of sustainability is essential for designing integrated policies that promote long-term well-being for all citizens (Barro, 2003).

Moreover, this study addresses the need for empirical evidence on the specific factors that drive sustainability in OECD countries. Given the unique challenges these countries face in maintaining high levels of development while addressing social and environmental concerns, the findings from this research can help inform policy decisions at both the national and international levels (Mbulawa, 2015). By focusing on key determinants such as GDP growth, foreign direct investment, urbanization, and income inequality, the study aims to provide actionable recommendations for improving sustainability outcomes (Sezer and Abasiz, 2016; Lopez & Peters, 2025).

The study's general objective is to examine the determinants of economic, social and environmental sustainability in OECD countries. This study holds significant value for several reasons. First, there is a limited body of literature that specifically addresses the determinants of economic, social, and environmental sustainability within the context of OECD countries. While the importance of sustainability in OECD nations has been acknowledged, detailed empirical studies that explore these factors across these countries are still scarce. This gap in the literature highlights the need for further investigation into the underlying drivers of sustainability in this specific group of nations. Second, previous studies on this topic predominantly rely on first-generation econometric techniques, which fail to account for cross-sectional dependence among countries. This limitation is crucial because the economic, social, and environmental dynamics of OECD countries are often interconnected, and ignoring such dependencies could lead to biased results. In contrast, this study uses the more advanced second-generation CS-ARDL (Cross-sectional Autoregressive Distributed Lag) model, which effectively captures the problem of cross-sectional dependence. By employing this sophisticated methodology, the study provides more accurate and robust estimates, allowing for a deeper understanding of the complex relationships between the variables under consideration.

The study is organized into five sections. Section 2 reviews relevant literature. In section 3, data, model specifications and methodology are explained. Section 4 explores results and discussions by using the CS-ARDL method. Finally, section 5 summarizes the study's findings and offers policy recommendations.

REVIEW OF LITERATURE

This section reviews key studies on environmental, social and economic sustainability. It highlights major findings, methodologies and regional focuses as summarized in Table 1. The review aims to find common trends and gaps in the existing literature to guide future research.

Table 1: Summary of Determinants of Environmental Social and Economic Sustainability

Dimension	Authors	Countries/Regions	Methods	Findings Summary
Environmental	Sharma (2010), Dogan & Seker (2016), Omri et al. (2019), Khalid et al. (2020), Joshua & Bekun (2020), Nguyen et al. (2023), etc.	69 countries, OECD, China, SAARC, South Africa, ASEAN, BRICS, etc.	GMM, ARDL, DOLS, FMOLS, OLS, DEA	Mixed results: mostly (+ve), several (-ve), EKC pattern often tested
Social	Ahmadvand et al. (2010), Galina et al. (2013), Amrutha & Geetha (2019), Niu et al. (2020), Pang et al. (2023), Lawal et al. (2024), etc.	Iran, Brazil, India, China, Ghana, Nigeria, Europe	OLS, SEM, ANN, PLS, NVivo, CFA	Mostly positive impacts; few mixed or negative outcomes
Economic	Barro (2003), Mbulawa (2015), Ajide (2014), Zahid et al. (2021), Bazaluk et al. (2024), Ahmed & Shaikh (2024), etc.	Nigeria, Pakistan, OECD, China, South Asia, EU	GMM, ARDL, FMOLS, OLS, SEM, Bayesian	Largely mixed findings (+ve/−ve); depends on country and model

The reviewed literature demonstrates a growing body of empirical research exploring the determinants of environmental, social and economic sustainability across various countries and regions. Most environmental studies apply econometric models such as ARDL, GMM, and FMOLS to examine the Environmental Kuznets Curve (EKC) hypothesis and yield mixed results. Social sustainability studies employ structural equation modeling, regression techniques reflecting positive social outcomes from sustainable practices. Economic sustainability research utilizes advanced panel data techniques and regression-based models which show varied impacts of sustainability related variables depending on country context and methodological approach

MODEL SPECIFICATION, DATA AND METHODOLOGY

This section describes the impact of determinants of economic sustainability social sustainability and environmental sustainability in OECD countries. Based on our results we have three objectives in this study. The first model describes the determinants of economic sustainability in OECD The second model provides the determinants of social sustainability. Moreover, the third model indicates the determinants of environmental sustainability in OECD countries

Model 1: Economic Sustainability and GDPG

$$GDPG = f(PD, LFPR, GFCF, FDI, Trade, FD) \quad (1)$$

The construction of the econometric model is as follows:

$$GDPG_{it} = (\beta_0 + \beta_1 PD_{it} + \beta_2 LFPR_{it} + \beta_3 GFCF_{it} + \beta_4 FDI_{it} + \beta_5 Trade_{it} + \beta_6 FD_{it} + \varepsilon_{it}) \quad (2)$$

Model 2: Social Sustainability and Secondary School Enrollment

$$SSE = f(GINI, URBAN, PD, INF, UN, POPG) \quad (3)$$

The econometric model of the functional form is as follows

$$SSE_{it} = \beta_o + \beta_1 GINI_{it} + \beta_2 URBAN_{it} + \beta_3 PD_{it} + \beta_4 INF_{it} + \beta_5 UN_{it} + \beta_6 POPG_{it} + \varepsilon_{it} \quad (4)$$

Model 3: Environmental Sustainability and CO2

$$CO2it = f(URBAN, FDI, POPG) \quad (5)$$

and the econometric model that is constructed in this functional form is

$$CO2_{it} = (\beta_o + \beta_1 URBAN_{it} + \beta 2FDI_{it} + \beta_3 POPG_{it} + \varepsilon_{it}) \quad (6)$$

Table 2 presents a description of the variables used in the study along with their measurement units and data sources. These variables cover environmental, economic and demographic dimensions relevant to the analysis.

Table 2: Variables Description, Measurement Units and Data Sources

Variables	Description	Measurement Units	Data Sources
CO2	Carbon Dioxide	(CO2) emissions excluding LULUCF per capita (CO2e/capita)	WDI
GDPG	GDP Growth	(annual %)	
SSC	Secondary School Enrollment	(% gross)	
GINI	GINI	Gini index	
URBAN	Urbanization	(annual %)	
PD	Population Density	(people per sq. km of land area)	
INF	Inflation	(annual %)	
UN	Unemployment	(% of total labor force)	
LFPR	Labor Force Participation Rate	total (%)	
GFCP	Gross Fixed Capital Formation	(annual % growth)	
FDI	Foreign Direct Investment	(% of GDP)	
Trade	Trade	(% of GDP)	
FD	Financial Development	(% of GDP)	
PG	Population Growth	(annual %)	

CS-ARDL METHODOLOGY

An advanced econometric method called the Cointegrated Structural Autoregressive Distributed Lag (CS-ARDL) model is used to examine the dynamic relationship between variables that are both cointegrated and susceptible to structural breaks over time. Building on the standard ARDL approach, which models both short-term and long-term relationships between dependent and independent variables. The first-generation panel ARDL does not provide the best estimates due to the existence of cross-sectional dependency (CD). This empirical study avoided the issue of cross-sectional dependency by using CS-ARDL (Uddin et al, 2023). The CS-ARDL explicitly accounts for cointegration, a property where non-stationary variables share a stable, long-term equilibrium. When time series data show changes because of outside influences like shifting policies, economic events, or structural modifications to the underlying process, this approach is especially helpful. The CS-ARDL not only identifies these long-term relationships but also incorporates adjustments to short-term deviations from the equilibrium, using an Error Correction Mechanism (ECM). By incorporating structural breaks of the model.

RESULTS AND DISCUSSIONS

SUMMARY STATISTICS AND CORRELATION ANALYSIS

Upper part of Table 3 presents the summary statistics for the variables used in the analysis. The mean GDP growth rate is 2.41%, indicating modest economic expansion on average. Secondary school enrollment shows a high average of 107.93%, reflecting a strong commitment to education although values above 100% may include under or over aged students. CO_2 emissions per capita average 8.62 metric tons which highlight significant environmental stress. The GINI index averages 32.25 that points to moderate income inequality. Variables such as population density and inflation show wide ranges with population density from 2.88 to 531.1 people per square kilometer and inflation ranging from -5.12% to 28.97%, signaling significant variation in demographic and economic conditions across regions.

The skewness and kurtosis values suggest that many variables deviate from a normal distribution. For example, inflation and foreign direct investment are highly positively skewed while variables GFCF and GDP growth show substantial dispersion. High kurtosis in variables such as FDI and inflation indicates the presence of heavy tails and extreme outliers. The Jarque-Bera test confirms non-normality for most variables except urbanization.

The lower part of Table 3 shows the correlation analysis. GDP growth is positively associated with investment suggesting that higher capital formation leads to economic expansion. It also shows mild positive links with urbanization, population growth and inflation. On the other hand, it has a negative association with unemployment and financial development indicating that growth may reduce joblessness, it does not always correspond with financial sector improvement.

Secondary school enrollment is negatively related to income inequality and population density indicating that education contributes to social equity and is often higher in less densely populated areas. It is positively linked with labor force participation and reflecting its role in workforce readiness. Its negative association with CO_2 emissions suggests that education promotes environmentally responsible behavior.

CO_2 emissions tend to decrease with greater trade openness and lower unemployment showing that economic activity and employment may drive emissions. These are positively associated with labor force participation and financial development and reflect industrial expansion. A negative link with education implies that greater schooling helps mitigate environmental degradation.

CROSS-SECTIONAL DEPENDENCE TEST

Table 4 provides the results of cross-sectional dependence test. The cross-sectional dependence test results indicate that most variables exhibit significant cross-sectional dependence, as evidenced by the high CD-test values and corresponding p-values of 0.000. This implies that these variables are strongly influenced by common factors or shocks across the cross-sectional units in the sample. Specifically, GDP growth (GDPG), social sector expenditure (SSE), carbon emissions (CO2), urban population growth (URBAN), population density (PD), inflation (INF), unemployment (UN), labor force participation rate (LFPR), gross fixed capital formation (GFCF), foreign direct investment (FDI), trade openness (TRADE), financial development (FD), and population growth (POPG) all show significant dependence across countries.

Table 4: Cross-Sectional Dependence Test

Variable	CD-test	P-value
GDPG	66.584	0.000
SSE	24.750	0.000
CO2	49.199	0.000
GINI	-0.646	0.518
URBAN	4.310	0.000
PD	39.800	0.000
INF	39.738	0.000
UN	19.944	0.000
LFPR	16.309	0.000
GFCF	37.203	0.000
FDI	12.483	0.000
TRADE	44.184	0.000
FD	32.273	0.000
POPG	5.650	0.000

In contrast, the Gini coefficient (GINI) does not display significant cross-sectional dependence, as indicated by its non-significant p-value, suggesting that inequality might vary independently across the cross-sectional units without being substantially affected by common external factors.

SLOPE HOMOGENEITY TEST

The slope homogeneity test results shown in Table 5 based on the Pesaran and Yamagata (2008) method indicate significant slope heterogeneity in all three models, as the delta test statistics are high and the p-values are 0.000, leading to the rejection of the null hypothesis of slope homogeneity. This implies that the relationship between the variables varies across different cross-sectional units.

The HAC robust adjusted delta test results, following the Blomquist and Westerlund (2013) approach, present mixed findings. For Model 1, the null hypothesis of slope homogeneity is rejected at the 5% significance level, indicating slope heterogeneity. Model 2 also shows significant heterogeneity, as indicated by a p-value below 0.05. However, for Model 3, the p-value is slightly above the 5% threshold, meaning the null hypothesis of slope homogeneity cannot be rejected, implying relatively homogeneous slopes in this model.

PANEL UNIT ROOT TEST

Table 6 shows the results of the second-generation panel unit root tests using the Cross-Section-Dependence based Im-Pesaran-Shin (CSDIPS) method. It reveals mixed stationarity outcomes across the variables, both without and with a trend. For GDPG, INF, GFCF, and FDI, the Zt statistics are significantly negative, and the p-values are below 0.05 in both specifications, indicating that these variables are stationary. SSE and URBAN are found to be stationary only in the "without trend" specification, as their p-values are below 0.05, but they become non-stationary when a trend is included. Conversely, PD is stationary only in the "with trend" specification, as the p-value becomes significant in that case.

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Table 3: Summary Statistics and Correlation Analysis

	GDPG	SSE	CO2	GINI	URBAN	PD	INF	UN	LFPR	GFCF	FDI	TRADE	FD	POPG
Mean	2.4	107.9	8.6	32.3	1.0	147.3	2.9	5.9	51.7	3.1	5.0	87.4	87.0	0.8
Median	2.5	102.2	8.8	30.6	1.0	132.0	2.1	5.4	54.8	3.6	3.2	79.9	75.4	0.7
Maximum	11.4	155.6	19.9	52.8	2.7	531.1	29.0	13.7	83.0	30.2	106.5	168.4	233.0	2.5
Minimum	-10.4	86.9	3.4	23.8	-1.6	2.9	-5.1	2.0	23.2	-47.5	-40.1	23.1	37.8	-1.8
Std. Dev.	2.9	13.6	3.5	6.2	0.6	143.3	3.5	2.5	15.3	7.6	11.7	34.3	35.6	0.6
Skewness	-0.9	1.2	0.8	1.0	0.1	1.1	3.2	1.0	-0.3	-1.2	4.2	0.7	1.2	0.2
Kurtosis	6.0	3.8	3.3	3.2	3.5	3.4	20.1	3.6	2.1	12.5	35.0	2.9	4.0	3.8
Jarque-Bera	108.6	55.9	24.5	33.2	2.6	41.8	28.9	34.8	8.6	831.0	98.9	16.4	61.8	7.3
Probability	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	GDPG	SSE	CO2	GINI	URBAN	PD	INF	UN	LFPR	GFCF	FDI	TRADE	FD	POPG
GDPG	1.000													
SSE	-0.056	1.000												
CO2	0.073	-0.186	1.000											
GINI	0.153	-0.424	-0.011	1.000										
URBAN	0.105	0.000	-0.041	0.433	1.000									
PD	0.072	-0.352	0.022	0.264	0.008	1.000								
INF	0.060	0.004	-0.095	0.204	0.153	-0.244	1.000							
UN	-0.087	-0.064	-0.258	0.411	0.165	-0.069	0.231	1.000						
LFPR	-0.006	0.324	0.163	-0.102	0.405	-0.293	-0.059	-0.201	1.000					
GFCF	0.656	0.042	0.038	-0.013	0.029	-0.037	-0.072	-0.205	0.082	1.000				
FDI	-0.035	-0.113	-0.109	-0.033	-0.092	-0.065	0.086	-0.058	-0.120	-0.054	1.000			
TRADE	-0.028	-0.050	-0.320	-0.516	-0.506	-0.067	-0.040	-0.008	-0.410	-0.002	0.239	1.000		
FD	-0.103	-0.258	0.141	0.249	-0.013	0.524	-0.218	-0.189	0.104	-0.117	-0.057	-0.233	1.000	
POPG	0.128	-0.050	0.047	0.441	0.952	0.103	0.034	0.105	0.438	0.044	-0.132	-0.516	0.072	1.000

Table 5: Slope Homogeneity Test

Models	(Pesaran and Yamagata, 2008)		(Blomquist and Westerlund, 2013)	
	Delta Test	P-Value	HAC Robust Adjusted Delta Test	P-Value
1	16.573	0.000	-2.509	0.012
2	6.183	0.000	0.826	0.009
3	3.861	0.000	-0.676	0.097

Table 6: Panel Unit Root Tests

Cross-Section-Dependence based Im-Pesaran-Shin (CSDIPS) Unit Root Test						
Variables	Without Trend			With Trend		
	Lags	Zt Statistics	P-Value	Lags	Zt Statistics	P-Value
GDPG	0	-8.048	0.000	0	-6.862	0.000
SSE	0	-1.996	0.023	0	-0.670	0.252
CO2	0	0.217	0.586	0	-0.091	0.464
GINI	1	0.652	0.865	0	0.568	0.245
URBAN	1	-1.655	0.049	1	-0.136	0.446
PD	1	0.073	0.529	1	4.211	0.000
INF	0	-10.321	0.000	0	-9.169	0.000
UN	1	-3.035	0.001	1	-1.308	0.095
LFPR	0	0.453	0.675	0	1.060	0.855
GFCF	0	-10.576	0.000	0	-8.313	0.000
FDI	0	-7.626	0.000	0	-6.372	0.000
TRADE	0	0.854	0.803	0	0.031	0.512
FD	0	-1.347	0.089	0	-1.767	0.039
POPG	1	-1.307	0.096	1	0.003	0.501

Non-stationarity is observed for CO2, GINI, LFPR, and TRADE, as their p-values remain above 0.05 in both specifications, meaning they contain unit roots and are non-stationary. The results for UN, FD, and POPG are mixed, with some evidence of stationarity depending on the inclusion of a trend and lag order.

PANEL COINTEGRATION ANALYSIS

The results of Table 7 summarize the panel cointegration tests for three models using the Westerlund, Kao, and Pedroni approaches.

Table 7: Panel Cointegration Tests

Models	Westerlund Test	Gt	Ga		Pt	Pa
1		-2.809 (0.000)	-5.941 (0.004)		-11.860 (0.000)	-6.629 (0.000)
2		-1.383 (0.098)	-1.580 (0.013)		-5.649 (0.000)	-5.553 (0.000)
3		-1.625 (0.000)	-2.074 (0.000)		1.804 (0.000)	0.014 (0.074)
	Kao Test	Modified Dickey-Fuller	Dickey-Fuller	Augmented Dickey-Fuller	Unadjusted Modified Dickey	Unadjusted Dickey-Fuller
1		-9.948 (0.000)	12.382 (0.000)	-7.229 (0.000)	27.156 (0.000)	17.179 (0.000)
2		-2.910 (0.001)	-1.783 (0.037)	-3.204 (0.000)	-2.249 (0.012)	-1.457 (0.072)
3		3.887 (0.000)	4.449 (0.000)	2.518 (0.005)	4.950 (0.000)	6.897 (0.000)
	Pedroni Test	Modified Phillips-Perron		Phillips-Perron	Augmented Dickey-Fuller	
1		-7.256 (0.000)		19.482 (0.000)	17.910 (0.000)	
2		1.273 (0.101)		-0.702 (0.241)	-1.553 (0.060)	
3		5.463 (0.000)		6.403 (0.000)	8.377 (0.000)	

In the Westerlund test, Model 1 confirms strong cointegration, as all statistics are significant with very low p-values. Model 2 shows mixed results, with some statistics (Pt and Pa) indicating significant cointegration, while others (Gt and

Ga) are either weakly significant or insignificant. Model 3 presents contradictory results, where some statistics suggest cointegration, but the overall evidence is inconsistent.
For the Kao test, Model 1 demonstrates robust cointegration with significant p-values across all statistics. Model 2 also provides strong evidence of cointegration, though the p-value for the unadjusted Dickey-Fuller statistic is marginally insignificant. In contrast, Model 3 exhibits no cointegration, as indicated by positive statistics and high p-values.
In the Pedroni test, Model 1 consistently shows significant cointegration across all statistics, confirming a stable long-run relationship. Model 2 yields inconclusive results, as only one statistic (Augmented Dickey-Fuller) approaches significance, while the others are insignificant. Model 3, however, strongly supports cointegration, with all statistics being highly significant. Model 1 provides the most robust and consistent evidence of cointegration across all tests, while Model 2 shows partial evidence. Model 3 exhibits cointegration according to the Pedroni and Westerlund tests but fails to show consistent evidence in the Kao test.
CS-ARDL ESTIMATES
Table 8 presents the results of the CS-ARDL estimators. In the first model, GDP growth (GDPG) is used as the dependent variable, serving as a proxy for economic sustainability. The independent variables include carbon emissions, population density, labor force participation rate, gross fixed capital formation, foreign direct investment, trade openness, and financial development. In the second model, secondary school enrollment is the dependent variable, acting as a proxy for social sustainability. The independent variables in this model are GDP growth, the Gini index, urbanization, population density, inflation, and unemployment. In the third model, CO2 emissions are the dependent variable, used as a proxy for environmental sustainability. The independent variables in this model include GDP growth, the squared and cubed terms of GDP growth, urbanization, foreign direct investment, and population growth.
In the short run, the first model's error correction term (ECT) is -1.612 and statistically significant at the 1% level, indicating a convergence period of approximately 7 months and 13 days. For the second model, the ECT is -2.797, which is also significant at the 1% level, reflecting a strong adjustment towards equilibrium with a convergence time of about 4 months and 6 days. The third model has an ECT of -0.202, which demonstrates a significant and robust adjustment towards equilibrium, converging within approximately 4 months and 12 days to 11 months.
In the first model, the long-run results indicate that CO2 has a negative impact on GDP growth, and this effect is highly statistically significant in OECD countries. The negative impact of CO2 on GDP growth in OECD countries can be attributed to several factors. One reason is that high levels of CO2 emissions contribute to environmental degradation, including climate change and air pollution. These negative environmental effects can disrupt economic activities, reduce productivity, and increase healthcare costs, all of which ultimately hinder GDP growth (Borhan et al., 2012). Another reason is that many OECD countries have adopted increasingly stringent environmental regulations aimed at reducing CO2 emissions. While these regulations are essential for long-term sustainability, they can impose short-term costs on businesses and industries as they adjust to new technologies and compliance standards, leading to slower economic growth (Appiah et al., 2017). The study is inline with the following studies (Borhan et al., 2012; Appiah et al., 2017).
Population density has a negative impact on GDP growth in OECD countries, with the result being highly statistically significant. Higher population density can result in increased competition for resources such as land, housing, and infrastructure, especially in urban areas. As more people live in a concentrated area, the demand for essential services like transportation, education, healthcare, and housing increases. If these services are not adequately expanded to meet the growing demand, congestion, overcrowding, and a strain on public infrastructure can occur. This may result in reduced productivity and efficiency, as businesses and individuals face higher operational costs, longer commutes, and limited access to essential services, which can ultimately stifle economic growth (Nzunda and Midtgaard, 2017).
Furthermore, densely populated areas often experience higher levels of pollution, including air, water, and noise pollution, due to the concentration of industrial activities, vehicles, and waste. Pollution has been linked to a range of negative health outcomes, such as respiratory problems, cardiovascular diseases, and reduced life expectancy. Poor health outcomes can reduce labor productivity, increase healthcare costs, and lower overall well-being, which in turn affects the economic performance of a country. Environmental degradation can also lead to long-term economic challenges, such as the depletion of natural resources, reduced agricultural yields, and the loss of biodiversity, all of which can have significant negative effects on GDP growth in OECD countries (Han and Siau, 2021). The study is consistent with the following studies ((Nzunda and Midtgaard, 2017; Han and Siau, 2021; Wang & Zaman, 2025; Marc, 2025).
Labor force participation rate has a positive impact on economic sustainability which is highly statistically significant in OECD countries. A higher labor force participation rate increases the availability of skilled and unskilled labor, which directly contributes to higher production and economic output. As more individuals enter the workforce, businesses have access to a larger pool of talent, enhancing productivity and driving economic growth (Cung and Hung, 2020). In addition, a growing workforce stimulates demand for goods and services, creating a positive cycle of consumption and investment. Increased consumer spending encourages businesses to invest in expansion, leading to job creation and sustained GDP growth (Zhang et al., 2022; Roussel & Audi, 2024).
Finally, greater labor force participation strengthens the government's fiscal position by broadening the tax base. With more taxpayers, governments can increase public investment in key sectors such as infrastructure, health, and education, which supports long-term economic development and sustainability (Pandey et al., 2024). The results are matched with the following studies (Cung and Hung, 2020; Zhang et al., 2022; Pandey et al., 2024; Farhadi & Zhao, 2024).

Gross fixed capital formation has a positive impact on economic sustainability which is highly statistically significant in OECD countries. Gross fixed capital formation positively impacts economic sustainability by enhancing the economy's productive capacity. Investment in physical assets such as infrastructure, machinery, and technology improves overall efficiency, productivity, and output. This leads to sustained long-term growth, enabling economies to better cope with external shocks and maintain stability (Chirwa and Odhiambo, 2016; Mehdi et al., 2025).

Furthermore, capital formation drives innovation and technological progress. As businesses invest in modern equipment and research, they adopt advanced production methods, improving product quality and lowering costs. This fosters competitiveness in global markets and contributes to steady economic expansion (Mose, 2021). Lastly, increased investment stimulates employment and income growth. As businesses expand through capital formation, they create jobs across various sectors, leading to higher disposable income and consumption. This rise in demand further encourages investment, supporting a sustainable economic growth trajectory (Batrancea et al., 2022). The findings of the study is consistent with the following studies (Chirwa and Odhiambo, 2016; Mose, 2021; Batrancea et al., 2022).

Economic sustainability is positively impacted by foreign direct investment which is highly statistically significant in OECD countries. Foreign direct investment (FDI) has a positive effect on economic sustainability by providing financial resources for capital-intensive projects, such as infrastructure development and industrial expansion. This increases the productive capacity of the economy and enhances long-term economic stability. FDI also introduces advanced technologies and expertise, leading to greater innovation and competitiveness in local industries (Muhammad et al., 2021). FDI promotes employment generation by creating new job opportunities in various sectors. The increase in employment leads to higher household incomes, which stimulates consumption and further drives economic growth. This ripple effect strengthens the overall economy and supports sustainable development (Wei et al., 2022). Additionally, FDI fosters integration into the global economy by linking domestic industries with international markets. This improves trade opportunities and enhances the country's export potential, which, in turn, helps balance the current account and ensures economic resilience against external shocks (Shaheen, 2024). The findings of the study is matched with the following studies (Muhammad et al., 2021; Wei et al., 2022; Shaheen, 2024; Batool et al., 2025).

Trade openness has a positive impact on economic sustainability which is highly statistically significant in OECD countries. Trade openness positively impacts economic sustainability by fostering access to a wider range of goods, services, and markets. When countries engage in open trade, they can focus on producing goods in which they have a comparative advantage, leading to more efficient resource allocation and higher productivity. This enhances economic output and long-term growth potential (Kleemann and Abdulai, 2013; Naeem et al., 2025).

Open trade encourages competition, which drives innovation and improves the quality of goods and services. Firms exposed to international competition are incentivized to adopt advanced technologies and efficient production methods, contributing to sustainable economic performance over time (Chen et al., 2022). Additionally, trade openness attracts foreign investment by offering investors access to larger, interconnected markets. This inflow of capital boosts infrastructure development, industrial capacity, and employment opportunities, reinforcing economic growth and stability (Irwin, 2024). The result is consistent with the following studies (Kleemann and Abdulai, 2013; Chen et al., 2022; Irwin, 2024; Ali et al., 2025).

Financial development which is measured by broad money has a positive impact on economic sustainability which is highly statistically significant in OCED countries. Financial development, as measured by broad money, positively impacts economic sustainability because it enhances the capacity of businesses to access credit. This increased access to financial resources allows firms to expand and invest in long-term projects that support economic growth, leading to more sustainable and diversified economies (Jalil and Feridun, 2011). Secondly, financial development improves the efficiency of resource allocation within an economy. A well-developed financial system ensures that savings are directed towards productive investments, supporting innovation and technological advancement. This helps in fostering sustainable economic development by ensuring capital is used efficiently to improve productivity across sectors (Wang et al., 2021). Lastly, broad money growth can contribute to economic stability by strengthening the financial sector. With a more robust financial system, economies are better equipped to withstand external shocks and economic downturns. By offering financial products that enhance savings and investments, financial development ensures greater resilience and long-term economic sustainability (Sarwar et al., 2021; Longston et al., 2025). The findings are consistent with the following studies (Jalil and Feridun, 2011; Wang et al., 2021; Sarwar et al., 2021).

In the second model, long run results indicate that economic sustainability has a positive impact on social sustainability measured by secondary school enrollment which is highly statistically significant in OECD countries. Economic sustainability positively impacts social sustainability, measured by secondary school enrollment, for several reasons. First, a stable and growing economy provides the necessary resources for governments to invest in education, ensuring wider access to secondary schooling. Economic prosperity often leads to higher government revenues, which can be allocated to improving educational infrastructure and increasing funding for schools (Hanushek and Woessmann, 2010).

Second, economic stability creates better job opportunities, motivating families to prioritize education, as they see it as a means to secure better futures for their children. As people experience economic growth, the value placed on education increases, leading to higher enrollment rates in secondary schools (Benos and Zotou, 2014). Lastly, economic growth often results in improved living standards, reducing poverty and social inequality. When families experience improved financial stability, they are more likely to send their children to school, particularly at the secondary level, as education becomes more accessible and less of a financial burden (Ven Le and Tran, 2024). The findings of the study is matched with the following studies (Hanushek and Woessmann, 2010; Benos and Zotou, 2014; Ven Le and Tran, 2024).

Table 8: CS-ARDL Estimates of Sustainability

Variables	1(GDPG)	2(SSE)	3(CO_2)
	Short-Run		
Δ ECT (-1)	-1.612*** (0.609)	-2.797*** (0.655)	-0.202*** (0.0757)
Δ GDPG		-0.128 (0.169)	0.0831* (0.0459)
Δ $GDPG^2$			0.139** (0.0575)
Δ $GDPG^3$			0.0496 (0.0420)
Δ SSE			
Δ CO_2	0.291*** (0.0120)		
Δ GINI		0.00908 (0.00778)	
Δ URBAN		-0.00590 (0.00429)	-0.0376 (0.0402)
Δ PD	-0.00159 (0.00297)	0.0147*** (0.00462)	
Δ INF		0.000668 (0.00562)	
Δ UN		0.0278** (0.0142)	
Δ LFPR	0.313*** (0.0132)		
Δ GFCF	-0.0198** (0.00846)		
Δ FDI	-0.00252 (0.00301)		-0.00628 (0.0393)
Δ TRADE	0.00421 (0.00532)		
Δ FD	0.00179 (0.00525)		
Δ POPG			-0.0672 (0.0434)
	Long-Run		
GDPG		0.533*** (0.206)	0.302*** (0.0117)
$GDPG^2$			-0.670** (0.292)
$GDPG^3$			0.330*** (0.0183)
SSE			
CO_2	-0.319*** (0.0147)		
GINI		-0.387*** (0.130)	
URBAN		0.419*** (0.126)	0.104** (0.0500)
PD	-0.297*** (0.0116)	0.604** (0.286)	
INF		-0.470*** (0.149)	
UN		-0.0113***	

		(0.00358)	
LFPR	0.0166***		
	(0.00377)		
GFCF	0.0116*		
	(0.00666)		
FDI	0.0167**		0.121***
	(0.00827)		(0.0373)
TRADE	0.00886**		
	(0.00383)		
FD	0.302***		
	(0.0118)		
POPG			0.108**
			(0.0503)
Constant	1.161***	1.688***	2.287***
	(0.280)	(0.280)	(0.292)

Income inequality measured by the GINI coefficient has a negative impact on social sustainability which is highly statistically significant in OECD countries. Income inequality, as measured by the Gini coefficient, negatively impacts social sustainability, particularly secondary school enrollment, for several reasons. First, when income distribution is highly unequal, access to education becomes more limited for lower-income households. Families with lower incomes often face financial barriers to sending their children to school, which can result in lower enrollment rates, especially at the secondary level, as education becomes a luxury they cannot afford (Rodríguez-Pose and Tselios, 2009).

Second, higher income inequality typically leads to social tensions and unequal opportunities, which can undermine the effectiveness of social programs. In societies with significant income inequality, educational systems may be less effective in addressing the needs of disadvantaged communities, further exacerbating disparities in secondary school enrollment. The gap between rich and poor in terms of access to quality education widens, contributing to lower enrollment rates among children from lower-income backgrounds (Hassan et al., 2022; Ali et al., 2025).

Lastly, income inequality can lead to lower social mobility, where children from poorer families are less likely to continue their education beyond primary school. With fewer financial resources, lower-income families may prioritize immediate income-generating activities over secondary education, which negatively impacts enrollment rates. Consequently, income inequality creates barriers to equitable educational opportunities, hindering social sustainability (Li et al., 2024). This outcome is in line with the following studies (Rodríguez-Pose and Tselios, 2009; Hassan et al., 2022; Li et al., 2024).

Urbanization has a positive impact on social sustainability which is highly statistically significant on OECD countries. Urbanization positively impacts social sustainability, as measured by secondary school enrollment, for several reasons. First, urban areas typically have better access to educational infrastructure and resources. The concentration of schools, educational institutions, and other learning opportunities in cities makes it easier for students, especially those from disadvantaged backgrounds, to attend secondary school. Urbanization often leads to improved facilities, better-trained teachers, and more educational programs, all of which contribute to higher enrollment rates (Oure, 2014).

Second, urbanization is usually associated with higher levels of income and economic development, which can improve access to education. In urban settings, families tend to have more stable incomes and may be better able to afford the costs of education, including transportation and school supplies. This financial stability allows more children to attend secondary school, fostering greater educational attainment and social sustainability (Konuk et al., 2016).

Lastly, as urbanization promotes greater societal awareness and cultural change, it can lead to shifts in social attitudes toward the importance of education. In urban areas, education is often seen as a key to social mobility, and there is greater emphasis on the need for both boys and girls to receive an education. As a result, urbanization can lead to more inclusive educational systems and higher secondary school enrollment rates, contributing to social sustainability (Momna Bibi, 2021). The outcome is consistent with the following studies (Oure, 2014; Konuk et al., 2016; Momna Bibi, 2021).

Population density has a positive impact on social sustainability which is highly statistically significant in OECD countries. Population density can positively impact social sustainability, as measured by education, for several reasons. First, higher population density often leads to a concentration of resources and educational infrastructure. In densely populated areas, there is usually greater investment in public services, including schools and educational institutions. The proximity of these institutions makes it easier for people to access education, thereby increasing enrollment rates and improving the overall educational environment (Başkan et al., 2017; Ali et al., 2025).

Second, population density fosters greater diversity and social interaction, which can enhance the quality of education. As more people gather in one area, there are more opportunities for cross-cultural exchange and the sharing of ideas, which can enrich the educational experience. The higher population may lead to the establishment of specialized schools or programs that cater to different learning needs, promoting educational equity and inclusiveness (Zhang and Roselle, 2022). Lastly, in densely populated regions, there is often a stronger demand for education due to competition for resources and opportunities. People living in high-density areas may be more motivated to invest in education as a means of securing better economic and social prospects. This collective push for educational attainment can drive up enrollment rates, leading to improved social sustainability by fostering a more educated population (Telaumbanua et al., 2024). This outcome is matched with the following studies (Başkan et al., 2017; Zhang and Roselle, 2022; Telaumbanua et al., 2024)

Inflation has a negative impact on social sustainability which is highly statistically significant in OECD countries. Inflation can negatively impact social sustainability, measured by secondary school enrollment, for several reasons. First, inflation erodes the purchasing power of households, making it more difficult for families to afford education-related expenses such as school fees, uniforms, and books. As the cost of living rises due to inflation, parents may prioritize basic needs over education, leading to reduced enrollment rates in secondary schools (Nordin et al., 2019).

Second, inflation can negatively affect government spending on education. As inflation increases, the real value of government revenues may decrease, limiting the resources available for public services, including education. Governments facing inflationary pressures might cut funding for schools or reduce subsidies for education programs, which could result in lower quality of education or less access to educational opportunities, further hindering secondary school enrollment (Obiakor, 2021). Lastly, inflation can lead to economic instability, which affects employment opportunities and overall income levels. In an inflationary environment, individuals may experience job insecurity or wage stagnation, reducing their ability to invest in education for their children. This economic uncertainty discourages families from committing to long-term educational investments, resulting in lower enrollment rates in secondary education, and consequently, a negative impact on social sustainability (Ukozor et al., 2024). This finding is in line with the following studies (Nordin et al., 2019; Obiakor, 2021; Ukozor et al., 2024).

Unemployment has a negative impact on social sustainability which is highly statistically significant in OECD countries. Unemployment negatively impacts social sustainability, measured by secondary school enrollment, for several reasons. First, when unemployment rates are high, household incomes decrease, reducing the financial capacity of families to afford education for their children. Parents facing prolonged periods of joblessness may prioritize meeting basic survival needs over educational expenses, resulting in lower secondary school enrollment (Ashenfelter and Ham, 1979).

Second, high unemployment creates an environment of economic uncertainty, discouraging long-term investments in education. Families may perceive fewer future job opportunities for educated individuals, leading them to withdraw children from school and push them toward informal work or other income-generating activities to support the household (Lavrinovicha et al., 2015). Lastly, high unemployment often leads to reduced government revenues due to a shrinking tax base. This limits public spending on education infrastructure, teacher salaries, and scholarship programs. With fewer resources available, schools may deteriorate in quality or become less accessible, further discouraging secondary school enrollment and undermining social sustainability (Levchenko et al., 2017). This finding is consistent with the following studies (Ashenfelter and Ham, 1979; Lavrinovicha et al., 2015; Levchenko et al., 2017).

In the third model, the long-run results indicate that GDP growth and the cubic term of GDP growth have a negative impact on environmental sustainability, as they lead to increased CO2 emissions. Conversely, the squared term of GDP growth positively influences environmental sustainability by reducing CO2 emissions. All these relationships are highly statistically significant in OECD countries. At the early stages of economic growth, the focus tends to be on industrialization and expansion, which heavily relies on energy from fossil fuels, leading to higher CO2 emissions. As economies grow rapidly, environmental concerns often take a back seat to economic priorities, causing GDP growth and its cubic term to have a negative impact on environmental sustainability (Mikayilov et al., 2018; Shouwu, et al., 2024). However, as economies develop further, they tend to experience structural changes. With higher income levels, investment in cleaner technologies increases, and stricter environmental regulations are implemented. This shift explains why the squared term of GDP growth positively influences environmental sustainability by helping to reduce CO2 emissions over time (Zeraibi et al., 2024). This study confirms the N-shaped Environmetal Kuznet Curve (EKC). This result is matched with the following studies (Mikayilov et al., 2018; Shouwu, et al., 2024; Zeraibi et al., 2024).

Urbanization has a negative impact on environmental sustainability as it leads to an increase the CO2 emissions which is highly statistically significant in OECD countries. Urbanization negatively impacts environmental sustainability because it drives higher energy consumption, particularly in transportation, residential, and industrial sectors, resulting in increased CO2 emissions. As cities expand, the demand for energy-intensive infrastructure and services, such as electricity, heating, and transportation, rises, contributing to greater fossil fuel consumption (Zhai and Kong, 2024).

Additionally, urbanization often leads to deforestation and the loss of green spaces, which reduces the natural ability to absorb CO2. The concentration of human activities in urban areas further exacerbates air pollution and greenhouse gas emissions, undermining environmental sustainability (Abro et al., 2024). This results is consistent with the following studies (Zhai and Kong, 2024; Abro et al., 2024).

Foreign direct investment has a negative impact on environmental sustainability as it contributes more CO2 emission which is highly statistically significant. Foreign direct investment (FDI) can negatively impact environmental sustainability by contributing to higher CO2 emissions for several reasons. Firstly, FDI often flows into energy-intensive industries such as manufacturing, mining, and construction. These industries typically rely on fossil fuels, leading to increased greenhouse gas emissions (Blanco et al., 2013).

Secondly, in pursuit of economic growth, many developing countries with less stringent environmental regulations attract foreign investors. This regulatory gap allows foreign firms to engage in environmentally harmful practices, resulting in higher CO2 emissions and environmental degradation (Pazienza, 2019). Thirdly, infrastructure development driven by FDI, including transportation networks and industrial facilities, can significantly increase carbon emissions. The construction and operation of these infrastructures demand large amounts of energy, further contributing to the carbon footprint of host countries (Eriandani et al., 2020). This study confirm the theory of the pollution heaven hypothesis. The results is matched with the following studies (Blanco et al., 2013; Pazienza, 2019; Eriandani et al., 2020).

Lastly, population growth has an adverse impact on environmental sustainability as it contributes more CO2 emission which is highly statistically significant in OECD countries. Population growth adversely impacts environmental sustainability by contributing to higher CO2 emissions for several reasons. Firstly, a growing population increases energy demand for residential, industrial, and transportation purposes. This heightened demand often leads to greater reliance on fossil fuels, which are major sources of CO2 emissions (Martínez-Zarzoso et al., 2007).

Secondly, as population density rises, urbanization accelerates, leading to the expansion of cities and infrastructure. This expansion results in deforestation, loss of green spaces, and increased vehicle usage, all of which contribute to higher carbon emissions and environmental degradation (Cao and Liu, 2024). Lastly, higher population growth strains existing resources, including water, food, and energy. To meet these rising needs, countries may prioritize rapid industrial growth over environmental conservation, further exacerbating CO2 emissions and negatively affecting sustainability efforts (Pea-Assounga et al., 2025). This result is in line with the following studies (Martínez-Zarzoso et al., 2007; Cao and Liu, 2024; Pea-Assounga et al., 2025).

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

This study aims to assess the determinants of economic, social, and environmental sustainability in OECD countries. The three primary objectives focus on: economic sustainability, measured by GDP growth (GDPG); social sustainability, represented by secondary school enrollment (SSE); and environmental sustainability, measured by carbon dioxide emissions (CO2). The study is structured into three models: the first model evaluates the determinants of economic sustainability, the second investigates the factors affecting social sustainability, and the third explores the determinants of environmental sustainability. Using a comprehensive methodological framework, the study applies panel data from 38 OECD countries spanning from 2000 to 2023. The CS-ARDL econometric model is used to estimate both long-run and short-run relationships. In the first model, GDPG is the dependent variable, with population density (PD), labor force participation rate (LFPR), gross fixed capital formation (GFCF), foreign direct investment (FDI), trade (TRADE), and financial development (FD) as independent variables. In the second model, secondary school enrollment (SSE) is the dependent variable, and income inequality (GINI), urbanization (URBAN), population density (PD), inflation (INF), and unemployment (UN) are the independent variables. In the final model, CO2 emissions (CO2) serve as the dependent variable, with urbanization (URBAN), foreign direct investment (FDI), and population growth (POPG) as the independent variables. The study examines the factors influencing economic, social, and environmental sustainability in OECD countries.

POLICY RECOMMENDATIONS

POLICIES FOR ECONOMIC SUSTAINABILITY

Based on the results of the study, we recommend the following policies:

- The variable environmental sustainability, measured by CO2 emissions, negatively impacts economic sustainability, represented by GDP growth. It is recommended that governments develop and enforce policies aimed at reducing CO2 emissions or improving environmental quality to enhance economic sustainability in OECD countries.
- Population growth negatively impacts economic growth. It is recommended that governments implement policies, such as family planning programs, to control population growth and foster economic sustainability.
- The labor force participation rate positively impacts economic growth. To foster sustained economic development, governments should implement policies aimed at improving participation rates, such as increasing access to education, reducing employment barriers, and promoting inclusive labor market opportunities.
- The variable gross fixed capital formation also positively impacts economic sustainability. It is suggested that policymakers should design and implement strategies that encourage increased capital formation to enhance economic sustainability,
- Foreign direct investment has a positive impact on economic sustainability. Policymakers should implement strategies that attract and enhance foreign investment to foster long-term economic sustainability.
- Trade openness has a positive impact on economic sustainability. Policymakers should implement policies that encourage trade openness, such as reducing tariffs, removing trade barriers, and fostering international partnerships to support long-term economic growth.
- Financial development has a positive impact on economic sustainability. Governments should focus on policies that strengthen the financial sector, improve access to credit, and promote financial inclusion to boost long-term economic sustainability.

POLICIES FOR SOCIAL SUSTAINABILITY

Based on the results of the study, we recommend the following policies:

- Economic sustainability, measured by GDP growth, has a positive impact on social sustainability, measured by secondary school enrollment. Governments should implement policies that promote economic growth to enhance both economic and social sustainability.
- Income inequality has a negative impact on social sustainability by hindering equal access to opportunities and creating social tensions. Policymakers should implement policies that reduce income inequality to enhance social sustainability.

- Urbanization has a positive impact on social sustainability. Planners should implement policies that encourage sustainable urban growth to foster social sustainability.
- Population density has a positive impact on social sustainability. Governments should encourage population density through urban planning policies that focus on sustainable, high-density development and efficient use of resources to enhance social sustainability.
- Inflation has a negative impact on social sustainability by reducing purchasing power. Planners should implement fiscal and monetary policies aimed at controlling inflation, such as tightening monetary policy, controlling public spending, and ensuring stable prices, to improve social sustainability.
- The variable unemployment has a negative impact on social sustainability by increasing poverty and social instability. Policymakers should implement strategies that reduce unemployment, such as promoting job creation, providing vocational training, and improving access to education, to enhance social sustainability.

POLICIES FOR ENVIRONMENTAL SUSTAINABILITY

Based on the results of the study, we recommend the following policies:

- GDP positively impacts environmental sustainability, measured by CO2 emissions, while the squared GDP term has a negative impact and the cube of GDP has a positive impact on CO2. Policymakers should promote GDP growth up to a certain threshold, beyond which focus should shift to green technologies and sustainability to reduce CO2 emissions.
- Urbanization, or an increase in urban population, has a positive impact on CO2 emissions. Planners should implement policies that encourage urban population growth while promoting efficient use of resources, improving public transportation, and reducing emissions through better infrastructure and green spaces to enhance environmental sustainability.
- Foreign direct investment has a positive impact on CO2 emissions. Planners should implement policies that attract foreign investment by promoting clean technologies, green energy initiatives, and sustainable practices, to ensure that FDI contributes to environmental sustainability while fostering economic growth.
- Population growth has a positive impact on CO2 emissions. Planners should implement policies that aim to reduce population growth to enhance environmental sustainability by reducing pressure on resources and lowering emissions.

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