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Assessing the Impact of Green Energy, Taxation, and Financial Flows on Sustainable Development

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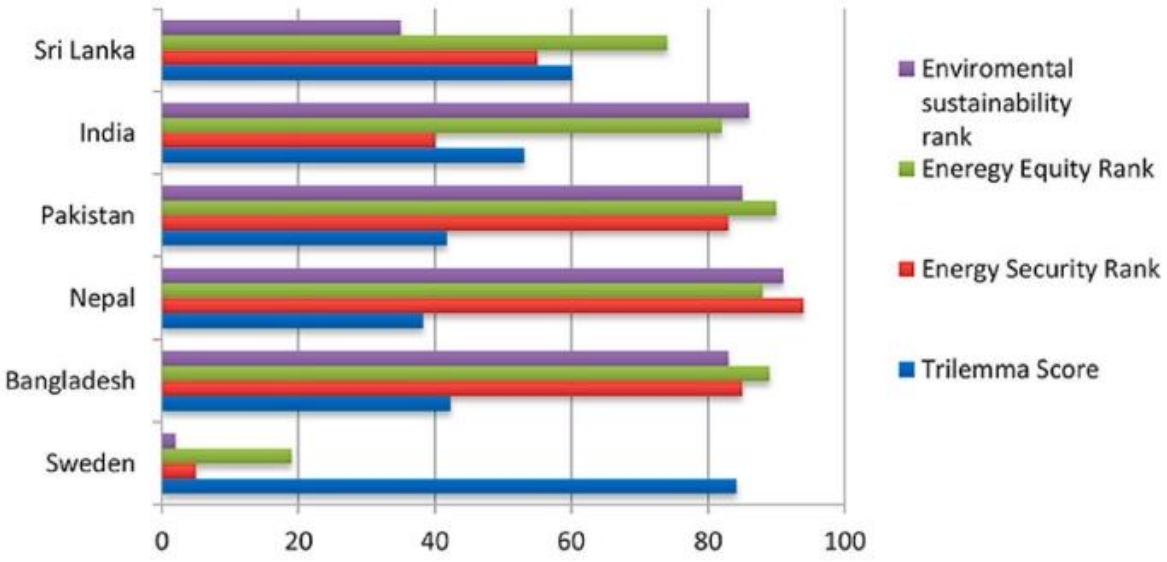
Sustainable development can facilitate reversing the impacts of climate change and environmental degradation. This study investigates the effects of green energy consumption, taxation, and remittance inflow on sustainable development using a panel data set 45 countries over the period 2000 to 2020 and the data was sourced from World Development Indicators (WDI). This paper employs, among others, CS-ARDL dynamic panel estimation methods to form an informed opinion on the mediating effect of economic growth on the association between green energy, taxation, remittances and exports with sustainable development. The findings of this research indicate that green energy and, to a certain extent, exports are important contributors to sustainable development through economic growth. Tax reforms are claimed to support growth but seem to constrain sustainable development while remittances have varied effects as they are known to have positive effects on poverty reduction and financial development yet can have negative impacts on environmental sustainability with the pollution from increased consumption which many economists see as detrimental. The findings of the research for economic development with the slightest negative effect on the atmosphere involve capital flow, tax variation, and the adaptation of green energy regulations. This contributes to the global political debate and yields lessons for governments and institutions all over the world in their efforts to reach the UN sustainable development goals.

1. Introduction

In the course of the past decades, ecologically oriented development has become a prime focus of international policy debate and academic research in view of the rise of environmental challenges, climate change, and claims for social and economic growth. The United Nations established the 2030 Agenda for Sustainable Development in the year 2015. It is a call to action with 17 SDGs that support social welfare, environmental protection, and balanced economic growth.

Given such goals, it stresses that an integrated approach is highly needed for economic growth to be pursued, with environmental sustainability at stake. We can only meet those targets with sustainability in the trade system, consumption and lifestyle structures like medication use, taxes and policy's structure, and financial flows such as remittances. The relation between environmental quality and sustainable development is bi-directional and thus progressive environmental sustainability not only leads to less pollution but fosters the overall economic development. A comparison between South Asian countries and developed nations is illustrated in Fig. 1 below.

Figure No1: A comparison of the developed economy and South Asian countries



Source: (Ali et al., 2022)

South Asian economies face higher risks related to energy security and environmental sustainability compared to wealthy economies. Also, natural resources in South Asian economies significantly impact sustainable development because they signal industrial and economic activity. Their exhaustion has a significant impact on growth (Zhou et al., 2022). Several factors aid in sustainable development, including exports, remittances, clean energy, and taxes. Exports in countries that focus on the environment lead to new tech ideas and less carbon pollution. This is

because firms are trying to comply with global environmental regulations. It is further supported by the fact that export-oriented companies have to stay abreast of global It is further bolstered by the necessity for export-oriented companies to keep pace with ecological developments across the globe. Export-oriented businesses have no option other than to apply sustainable production methods in a bid to remain competitive at the destinations. In addition, exports contribute to the attainment of the SDGs through renewable energy innovations across national borders and encouraging sustainable behaviors in international trade. Remittances are the other vital channel in so far as sustainable development is concerned. Whereas remittances are widely regarded as an important tool for poverty reduction and economic development, new studies suggest that they may impact negatively on the environment. Particularly, higher energy use occasioned by increased remittance incomes contributes to environmental degradation by stimulating demand for energy-intensive commodities.

Remittances, on the other hand, may improve educational opportunities, augment environmental awareness, and align expenditure more closely with environmentally aware patterns to reduce contamination (Zafar et al., 2022). In most countries, the potential of remittances for contributing to environmental sustainability is less documented. Another imperative dimension of sustainability is green energy. Solar, wind, and geothermal energies are increasingly adopted to replace GHG-emitting energy sources in order to contribute to containing climate change problems. A number of studies were conducted regarding the contribution of green energy to both environmental protection and economic development.

Cerqueira et al. (2021) looked at how waste management, power from renewable sources, and economic expansion affect sustainable development made possible by the economy of recycling. To support environmentally conscious growth, more research is required to understand how the usage of renewable sources of energy intersects with other economic factors like taxes and remittances. One strategy that is regarded as the main way to finance the SDGs is the creation of funds. In addition to providing the government with funds, a well-designed tax system helps achieve the dual objectives of prudent spending and effective income distribution. In this sense, taxes help safeguard local businesses, encourage eco-friendly practices, and reduce income inequality particularly in emerging nations.

Although many studies have reviewed the impact of taxes on economic growth, few have explored how tax policies are influencing environmental outcomes and sustainable development across countries with varied economies. In contradiction of such a setting, the existing research has revisited the nexus between exports, remittances, green energy, taxation, and their interactions in determining sustainable development. Drawing on a large dataset for 45 countries, this research attempts to seal the lacuna in earlier work by providing a cross-national perspective on how the aforementioned variables interact in shaping sustainable development outcomes.

The research shall utilize dynamic panel data techniques to capture the complex relationships of these variables and provide insight into how societies might balance economic prosperity with environmental sustainability. The present study is relevant to academics and policy thinkers alike,

as this adds to the continuing debate on sustainable development and presents correct representations of the contributions of exports, remittances, green energy, and taxes to the SDGs. In light of these factors, the paper tries to extend practical policy recommendations that could help nations create more functional schemes for reaching their sustainable development objectives within a wider global framework. Finally, it strives to advance our understanding of how countries could successfully navigate such demanding routes toward sustainability and promote economic expansion without compromising environmental integrity.

2. Literature Review

Climate change threatens ecosystems and human livelihoods at many levels (Kumar et al., 2021). Several academics and policymakers from throughout the world have addressed this problem, among which several researchers found that exports can promote technological innovation and mitigate climate change as global business becomes more competitive and environmentally conscious. Exporters gain a greater understanding of climate change mitigation strategies (Xie & Li, 2018). Through technical innovation, exporting can boost enterprises' green total factor productivity while reducing CO2 emissions. Exporting enterprises must adapt to climate change to compete with global firms and achieve sustainable growth. According to the UN, international trade is the means of implementation of sustainable development goals (The 2030 Agenda for Sustainable Development, 2015); hence, the exports have a vigorous significance in the achievement of sustainable development goals across the globe. (Teame Ghirmay & Sharma, 2001)used a vector error correction model (VECM) to study how exports affected economic growth in 19 developing nations. They find that in twelve of the developing nations under investigation, trade openness and economic growth have a long-term link. They point out that the growth processes in East Asia and Southeast Asia differ. Similarly, (Mamun et al, 2005) examines the connection between Bangladesh's exports and economic expansion. They document the existence of a long-term, unidirectional causal relationship between exports and Bangladesh's economic expansion.

Remittances contribute to the Sustainable Development Goals (SDGs) notably by fostering economic growth, gender equality, and poverty reduction. According to research, a ten percent spike in per capita remittances results in a 3.5% decrease in the population's proportion of the poor. (IFAD, 2017). Previous studies have examined the relationship between external sector variables like foreign direct investment and the environment of the recipient country, but the role of remittance in environmental pollution has just come to light. The few studies on the topic can be explained by the indirect ways in which remittances affect the environment. Explanations for the few studies on the topic can be found in indirect ways through which remittances impact the environment. A rise in remittances via the first channel raises personal and discretionary income. On the one hand, rising personal income raises energy-related demand, which exacerbates environmental deterioration. Meanwhile, a rise in personal income boosts productivity and generates additional employment (Zafar et al., 2022). A complicated transmission mechanism considering environmental and remittance-related variables was proposed by (Manzoor Ahmad

Zahoor Ul Haq & Khan, 2019) and (Khan et al., 2020).These advantages can be utilized by higher remittance earners to further their education (Arif et al., 2019, Askarov & Doucouliagos, 2020) which in turn enhances environmental consciousness and reduces activities that lead to pollution (Zafar et al., 2022). For example, RAHMAN et al. 2023 examined the indirect effects of the environment on remittances for six Asian economies. Another study also established a positive nexus between remittances and sustainable development (Dastidar & Apergis, n.d.). Remittances are a crucial source of foreign earnings that contributes positively to people's growth and well-being, Kaiser & Welters 2019. However, while it has adverse impacts on the environment, environmental stability is requisite for development and poverty reduction.

Remittances increase the level of income, thereby enhancing spending to raise living standards. The greenhouse gas emissions of the economy also increase with increased energy consumption. Remittances increase the level of savings and hence living standards (Rahim et al., 2022), which promotes financial development but also pollution (Manzoor Ahmad Zahoor Ul Haq & Khan, 2019). Due to savings and consumption, remittances, or personal income, increase CO2 emissions. Saving increases industrial output, while consumption enhances financial development. Both lead to higher environmental damage (Huang et al., 2023).Remittances are therefore a significant source of finance for sustainable development, but it is impossible to overlook their detrimental effects on the environment.

Recycling and renewable energy are considered important in bolstering sustainability and offering solutions to climate change. During the industrialization era, green energy is becoming progressively more prominent. The natural environment worldwide suffers disruption, while natural resources are destroyed by pollution-heavy developments, especially in the US, China, and India. The utilization of solar energy, biomass conversions, and geothermal energy have been deliberated upon in various research in recent years, and literature highlighted a number of energy transition strategies towards mitigating the impacts of greenhouse gas emissions. In relation to this, the authors Cerqueira et al. (2021) analyzed data gathered from 28 OECD nations between 2000 and 2016 to detect the paradigm of the circular economy, or the phenomenon of circular interconnectedness that occurs between economic development, recycling, and renewable energy. On the one hand, Hsu et al. (2021) investigates the short- and long-term relationships between green energy and its impact on China's sustainable environment through the quantile ARDL approach.

They note that using green energy, which directly aims to achieve technical sustainability in the environment, requires consideration of financial concerns. Globalization, renewable energy, ecological innovation, and environmental taxation are the key determinants of this study. The results show that renewable energy, ecological innovation, and environmental taxation all have a negative effect on CO2 emissions; nevertheless, over time, these same factors also contribute to a decrease in pollution rates. Furthermore, it is determined that the rate of CO2 emissions is greatly impacted by globalization. (Noussan et al., 2021) assert that developing nations' financial situations are too immature to handle the costs of renewable energy projects or green energy

transitions, while (Dong et al., 2021) investigate how energy poverty increases China's use of CO2 emissions as the country's population grows. However, according to (Kahia et al., 2021), Saudi Arabia is expected to generate energy base alternatives to achieve electricity sustainability by 2030 because it is a stable economy with capacity for energy production. Even though (Ben Jebli et al., 2020) show that green energy is essential for all kinds of businesses, regardless of whether they are industrial, service-based, or play any other significant role in the energy industry. Green energy solutions must therefore be incorporated into these industries in order to increase GDP and organizational productivity. (Rehman Khan et al., 2018) carried out research in 43 nations to investigate the connection between the demand for green energy, green logistics, economic expansion, and a sustainable environment. Previous literature also focuses on green logistic operations. Logistic operations use non-green fossil fuel energy, which is bad for the environment and slows down economic expansion. The results show that utilizing green energy lessens the logistic operation's detrimental effects. In short, recently developed methods (such as solar, wind, geothermal, biomass, and non-renewable renewable resources) significantly meet the need for green energy and are very consistent with the development of an environmentally pleasant environment (Sharma et al., 2022).

Effective taxation as a strategy for mobilizing domestic resources for the goal of sustainable development generates revenue and aids in financing the Sustainable Development Goals (Griffiths, 2018). According to (Ajeigbe et al., 2023), apart from raising money, taxes can also be used for income redistribution, sustainable spending, safeguarding domestic businesses or investors, implementing budgetary plans, achieving sustainable financial development, and dropping revenue discrepancy. Overhead altogether, tax income may be rummage-sale to money and accomplish the SDGs for minimal poverty, zero starvation, incredibly low redundancy, zero dissimilarity, including gender disparity, zero environmental damage, sustainable financial development, and expansion. (Richards, 2021) analyzed the role of taxes as a source of financing for nations' developmental goals and as a way to achieve the SDGs show that financial limitations impede the achievement of developmental goals and suggested that private sector cooperation across national boundaries is necessary to mobilize private funds that can support the SDGs, like taxes. According to (Mardan & Stimmelmayr, 2020) analysis of tax competitiveness between established and developing nations, tax income both explains and contributes to a nation's degree of development and progress. Additionally, (Galperova et al., 2021) proposed a methodical way to change the current tax structure in accordance with sustainable development concepts. They also discussed the concept of taxation, which can play a role in realizing the SDGs. However, there is a contrasting view on that; a study conducted by (Omojolaibi et al., 2016) employed the fixed effect estimation method to study how fiscal policy affected investments for the five different West African nations for the sustainable development. Research indicates that government spending and revenue can reduce investment in sustainable development. (Mengistu, 2022) investigated the relationship, during a 35-year period, between Ethiopia's economic development and fiscal policy initiatives and found that non-distortionary taxes and wasteful spending are unrelated to sustainable development, according to time series study. While development is generated by

productive spending, distortionary taxation hinders attaining sustainable development. In closing, efficient taxation allows mobilization toward the SDGs. Taxes create revenue, finance redistribution, and drive long-term economic growth. At the same time, smart fiscal action is required because of international cooperation and financial constraints. Distortionary taxes hinder development while productive spending generates it. Thus, a judicious blend of taxation and fiscal policy is critical to achieve sustainable development.

The United Nations' sustainable development goals (SDGs) encourage global economies to take proactive actions to promote socioeconomic well-being and safeguard the environment, regardless of their economic growth condition (Ahmed et al., 2022, Sinha et al., 2020, Zhao et al., 2022). The UN has set 17 targets for the facilitation of economic progress (Zahoor et al., 2022), social well-being (Ashurov et al., 2020), and environmental development (Tillaguango et al., 2021). To materialize it, sustainable growth and expansion is being given prime importance by all nations' economies globally with the aim to protect the environment and maintain its quality over time. Thus, a number of countries have established goals to achieve the development in a sustainable way. According to "The Welding Institute," the United Nations describes sustainability as a mix between the conservation of the environment and the advancement of the social and economic features. In simple three words, they are profits, people, and the earth (Y. Khan et al., 2023).

This is because, according to Zafar et al. (2022), the extent to which economic growth through higher production affects the environment differs depending on the stage of economic development. While linear modeling shows that GDP growth causes an increase in environmental degradation (Kirikkaleli et al., 2023), Grossman & Krueger, 1992 found out that developing countries with more productivity use more fossil fuels and hence cause environmental degradation due to the scale effect. In sum, though the UN SDGs try to balance economic growth, social well-being, and the environment, the effect of economic growth on the environment varies with the level of development. In developing countries, increased productivity often leads to increased fossil fuel use and degradation of the environment. Thus, customized approaches addressing the issues and advancing general well-being are what will deliver sustainable development.

Therefore, there is a significant research gap in sustainable development studies due to the lack of extensive investigation across a broader number of countries. There are only a few cross-national comparisons in the existing literature, which often focuses on either industrialized or developing countries. Few studies analyze the collective impacts of exports, remittances, and green energy within a single research framework; most studies have focused on the individual impacts of each. Taxation, despite being recognized as one of the most important instruments for sustainable development, has not been studied much regarding how different tax laws affect economic and environmental outcomes in countries at varying levels of development. The study aims to close this gap by examining the dynamic linkages between exports, remittances, green energy, taxes, and sustainable development in 45 countries.

3. Methods and Data

3.1 Variables

3.1.1 Dependent Variable

Various scholars measure sustainable development using different indicators. Some have indeed used composite indicators that combine economic, social, and environmental factors; others have utilized GDP growth, environmental quality measures, and human development indices (see, respectively, Anas Ali Al-Qudah & Alqudah, 2022, Wang & Razzaq, 2022, and Ozili, 2022). Sustainable development has been proxied in this study using adjusted net savings, excluding particulate emission damage as a percent of GNI, taken from Ahmad et al. (2023a). This measure, derived from the World Development Indicators, presents a comprehensive view of sustainable development because it captures both economic and environmental dimensions.

3.1.2 Independent Variables

The literature has used various measures to capture the impact of economic activities on sustainable development. Table 1 depicts the variables used to understand their influence on sustainable development in this study. The value of exports of goods and services is measured in current USD, the same methodology used by Anda et al. (2023), while remittances are measured as personal remittances received as a percentage of GDP, being a proxy employed by Y. Khan et al. (2023), Barkat et al. (2024), and Huang et al. (2023). Green energy is expressed as the percentage of renewable energy consumption of total final energy consumption, hence reflecting the focus on sustainable and clean sources (Annor et al., 2024). Tax revenue is measured as a percentage of GDP, per previous studies indicating the role of government revenue in sustainable development (Samour et al., 2022)).

3.1.3 Mediating Variable

Economic growth is a common mediating variable that has been adopted while investigating sustainable development. Quite often, it can be measured by using GDP per capita or annual GDP growth rates (N. Ahmad et al., 2023, Bilal & Shaheen, 2024, Belloumi & Alshehry, 2020). This study considers per capita GDP as the mediating variable, which clearly explains how economic growth per individual contributes to overall sustainable development.

3.1.4 Control Variables

The control variables in this research are technology adoption and technological innovation, which are considered very crucial drivers of sustainable development. While technology adoption is measured by mobile cellular subscriptions per 100 people, technological innovation is proxied by the number of patent applications. These measures are chosen because they provide a clear indication of the level of technological progress and innovation within a country, both of which are crucial for sustainable development.

The data of all the variables is taken from the World Development Indicators (WDI). The data availability restricted study to the forty-five countries in the world and from years 2000–2021. Log of each variable is taken for statistical analysis.

Table No 1: Variable Description

Variables	Notion	Proxy	Data Source
Dependent Variable			
Sustainable Development	SD	Total Number of patent applications Adjusted net savings, excluding particulate emission damage (% of GNI)	WDI
Independent Variables			
Exports of goods and services	EXP	Exports of goods and services (current USD)	WDI
Remittance	REM	Personal remittances received (% of GDP)	WDI
Green energy	GE	Renewable energy consumption (% of total final energy consumption)	WDI
Tax revenue	TR	Tax Revenue (as % of GDP)	WDI
Mediating Variable			
Economic Growth	EG	Per capita GDP	WDI
Moderating Variable			
Education Level	EDU	School enrollment, Primary (%gross)	WDI
Control Variable			
Technology adaptation	TECHAD	Mobile cellular subscriptions Per 100 People	WDI
Technological Innovation	TI	Number of patent applications	WDI

4. Analysis and Results

4.1 Descriptive Statistics

Table No 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
lnSD	990	23.179	2.308	0	28.714
lnEXP	990	24.712	1.653	20.144	28.899
lnREM	990	.104	1.617	-10.452	3.483
lnGE	990	2.903	.958	-.163	4.514
lnTR	990	2.82	.352	1.889	3.883
lnEG	990	9.037	1.452	5.41	11.803
lnTECHAD	990	4.227	1.131	-3.179	5.176
lnTI	990	5.935	2.427	0	14.171

Table 2 presents a summary of descriptive statistics for each of our variables. The average for lnSD is 23.179, which has a standard deviation of 2.308, indicating great variation around the mean. However, the export levels (lnEXP) have a mean of 24.712 and a relatively small standard deviation of 1.653, meaning that the export levels are consistent across data. Remittances, lnREM, are close to zero with a mean of 0.104 and a high standard deviation of 1.617, indicating high dispersion with negative values. Green energy, lnGE, averages 2.903 with a moderate standard deviation of 0.958, reflecting consistency in green energy consumption across observations. Tax revenue, lnTR, averages 2.82, with a very small standard deviation of 0.352, which implies very minimal variation.

4.2 Correlation and VIF

Table No 3: VIF and correlation Matrix

Variables	VIF	lnSD	lnEXP	lnREM	lnGE	lnTR	lnEG
lnEXP	1.018	0.643	1.000				
lnREM	1.446	-0.272	-0.491	1.000			
lnGE	1.191	-0.128	-0.376	0.133	1.000		
lnTR	1.581	0.038	0.231	-0.304	-0.193	1.000	
lnEG	2.485	0.387	0.625	-0.491	-0.276	0.572	1.000

Variance Inflation Factor (VIF) values and correlation matrix for the variables pertinent to our analysis are illustrated in Table 3. The VIF values of all variables are significantly lower than the generally accepted threshold of 10, indicating that multicollinearity is not a major concern in our model. The VIF for lnEXP is 1.018; lnREM is 1.446; lnGE is 1.191; lnTR is 1.581; and lnEG is 2.485. These low VIF values demonstrate that every independent variable is not strongly associated with the others, which improves the trustworthiness of our regression results.

The strength and direction of the linear relationship between two variables are presented in the correlation matrix. Higher exports are associated with higher levels of sustainable development, as indicated by the significant positive relationship that exists between the variables lnEXP and lnSD, at 0.643. On the contrary, there is a negative relationship, -0.272 between lnREM and lnSD, which indicates that higher remittance levels are associated with lower levels of sustainable development. While lnTR has only extremely minor positive relationships, 0.038, hence has very minimal direct relationships with sustainable development, the variable lnGE has a small negative relationship, -0.128 with lnSD.

Also, lnEG has a positive relation with lnSD at a medium level of 0.387, which means economic growth influences sustainable development noticeably. Then again, there is also a strong positive relationship, 0.625, between lnEXP and lnEG, which means exports are helpful for economic growth. At the same time, the value of the correlation between lnREM and lnEG shows a strong negative relation, -0.491, which means that higher remittances probably lead to worse economic growth.

Overall, the correlation matrix has shown different levels of interlinkages of the variables, where economic growth and exports are found to have stronger positive associations with sustainable development. The relatively low VIF has indicated low multicollinearity, hence allowing for more precise and reliable parameter estimation.

4.3 Average correlation coefficients & Pesaran (2004) CD test

Table No 4: Average Correlation Coefficients & Pesaran (2004) CD test

Variable	CD-test	p-value	Corr	abs(corr)
lnSD	74.560	0.000	0.734	0.734
lnEXP	99.960	0.000	0.984	0.984
lnREM	90.460	0.000	0.891	0.891
lnGE	93.810	0.000	0.924	0.924
lnTR	89.220	0.000	0.878	0.878
lnEG	99.850	0.000	0.983	0.983

Table 4 presents the results of the Average Correlation Coefficients and the Pesaran, 2004, Cross-Sectional Dependence test for the variables under study. On the whole, the results of the Pesaran CD test are highly significant and show that there is a high level of cross-sectional dependence in panel data. Exports and Economic Growth have the most significant average coefficients, indicating integrated global trade and economic growth tendencies. Other factors, like remittances, green energy, and tax revenue, are also very highly correlated on average. These findings really underscore the importance of cross-sectional dependence in econometric modelling.

4.4 Heteroskedasticity (Breusch-Pagan Test)

Table No 5: Heteroskedasticity (Breusch-Pagan Test) Serial correlation

Variable	Var	sd = sqrt(Var)
lnSD	5.350125	2.313034
E	2.961482	1.720896
U	0	0

The Breusch-Pagan test findings for heteroskedasticity are shown in the table above. The dependent variable, lnSD, has a variance (Var) of 5.350125 and a standard deviation (SD) of 2.313034. The residuals' (E) variance is 2.961482, with a standard deviation of 1.720896. These results exhibit that the overall variability of the error component (U) is zero, illustrating no obvious heteroskedasticity. Furthermore, the zero variance for the error component (U) indicates the absence of a serial correlation, which improves the dependability of our model's estimates.

4.5 Testing for Slope Heterogeneity

Table No 6: Testing for slope heterogeneity
(Blomquist, Westerlund. 2013. Economic Letters)

	Delta	p-value
	-2.993	0.003
Adj	-3.216	0.001

Table 6 shows the results of the slope heterogeneity test. The delta statistic stands at -2.993, with a p-value of 0.003, while the adjusted (Adj) statistic is -3.216, with a p-value of 0.001. Both statistics have significance at the 1% level. This points to strong proof of slope heterogeneity across the panel data. It means the link between the variables changes a lot across the units in the sample. This underscores why it's crucial to factor in heterogeneous slopes when we specify our model.

4.6 2nd Generation Unit Root Test

Table No 7: 2nd Generation Unit Root Test

	CIPS		CADF	
	LEVEL 1(0)	**1st Difference 1(1)**	**LEVEL 1(0)**	**1st Difference 1(1)**
lnSD	-5.974	/	-5.974	/
lnEXP	-5.269	/	-5.269	/
lnREM	-6.023	/	-6.023	/
lnGE	-5.804	/	-5.804	/
lnTR	-6.166	/	-6.166	
lnEG	-5.227	/	-5.227	/

The 2nd generation unit root test outcomes, which include CIPS and CADF, were performed to examine the series stationarity at their levels and first differences and are presented in Table 7. The statistics reveal that all variables are significant at their levels, with values ranging from -5.227 to -6.166. Also, the absence of the first difference indicates that all variables are at their level, as all the values of both of the tests exceed the critical values for rejecting the null hypothesis of a unit root, suggesting that the variables do not require differencing to achieve stability.

4.7 Random, fixed effect & GMM model

Table No 8: Estimation Results for lnSD Using Random Effects, Fixed Effects, and GMM Models

	(1)	(2)	(3)	(4)
VARIABLES	**Random Effects**	**Fixed Effects**	**GMM**	**lnSD**
lnEXP	0.908***	0.985***	1.084***	1.084***
	(0.0582)	(0.0682)	(0.00993)	(0.00993)
lnREM	0.0863**	0.108**	0.129***	0.129***
	(0.0411)	(0.0431)	(0.0156)	(0.0156)

lnGE	0.304***	0.350***	0.388***	0.388***
	(0.0625)	(0.0651)	(0.0136)	(0.0136)
lnTR	-0.585***	-0.600***	-0.545***	-0.545***
	(0.166)	(0.167)	(0.0396)	(0.0396)
L.lnSD			0.0721***	0.0721***
			(0.00856)	(0.00856)
Constant	0.865	-0.963	-4.887***	-4.887***
	(1.399)	(1.635)	(0.185)	(0.185)
Observations	990	990	968	968
R-squared		0.435		
Number of YEARS	22	22	22	22
Sargan Test				0.0900
AR(1) p-value				0
AR(2) p-value				0.260

Table 8 presents the regression results for the impact of the explanatory variables used in this study on sustainable development (lnSD) using Random Effects, Fixed Effects, and Generalized Method of Moments (GMM) estimators, which reveal that all the explanatory variables have a significant impact on sustainable development. All the explanatory variables except lnTR have significant positive impact on lnSD, while lnTR shows significant negative impact on lnSD, suggesting that higher tax revenue may be associated with lower sustainable development outcomes, possibly due to inefficient tax systems or economic burdens. In the GMM model, the lag dependent variable, L.lnSD, is significant with a coefficient of 0.0721, reflecting a moderate persistence effect of sustainable development across time. The results for control factors are omitted from the above table in order to focus on the main variables of interest. The Sargan test p-value obtained is 0.0900, which supports the adoption of the GMM estimator as the over-identifying limitations are legitimate. Additionally, the Arellano-Bond test for AR(1) in first differences is significant (p-value = 0), while AR(2) is not significant (p-value = 0.260), confirming that there is no second-order serial correlation in the differenced errors, validating the GMM model's assumptions. Overall, the results demonstrate strong and consistent relationships across different estimation techniques, with exports, remittances, and green energy positively influencing sustainable development, while tax revenue has a negative effect.

4.8 Hausman Test

Table No 9: Hausman (1978) specification test

	Coef.
Chi-square test value	20.876
P-value	.001

The Hausman test is presented in Table 9, and its results indicate that the fixed effect model is more appropriate for the data as the value of chi square is 20.876 with a p-value of 0.001.

4.9 Prais-Winsten regression

Table No 10: Prais-Winsten regression, correlated panels corrected standard errors (PCSEs)

lnSD	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	S
lnEXP	.723	.154	4.70	0	.421	1.025	*
lnREM	.175	.091	1.93	.054	-.003	.352	
lnGE	.303	.132	2.29	.022	.044	.562	
lnTR	-1.091	.42	-2.60	.009	-1.914	-.268	*
lnEG	.305	.136	2.25	.025	.039	.571	
lnTI	.187	.09	2.08	.037	.011	.363	
Constant	3.63	3.273	1.11	.267	-2.785	10.045	

Mean dependent var	23.180	SD dependent var	2.313
R-squared	0.503	Number of obs	986
Chi-square	163.005	Prob > chi2	0.000

Table 10 reports the results of the Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) to account for potential autocorrelation and heteroskedasticity across the panels, which reveals that all the variables have a significant impact on sustainable development. Except for tax income, which has a substantial negative association with the dependent variable, all the factors have a strong positive link with sustainable development. The model explains 50.3% of the variation in sustainable development, with a Chi-square statistic of 163.005 and a p-value of 0.000. The constant term suggests a positive baseline level of sustainable development when all independent variables are at zero.

4.10 Westerlund ECM panel cointegration tests

Table No 11 Westerlund ECM panel cointegration tests

Statistic	Value	Z-value	P-value
Gt	-3.385	-4.616	0.000
Ga	-20.650	-4.710	0.000
Pt	-15.220	-4.748	0.000
Pa	-16.549	-4.481	0.000

Table 11 presents the Westerlund ECM panel cointegration tests, indicating a long-run

equilibrium relationship between variables. The results are significantly negative, implying a stable long-term equilibrium dynamic in sustainable development. These results indicate that the variables, though experiencing temporary changes, end up moving together, hence rejecting the null hypothesis of no co-integration.

4.11 Structural Equation Model Estimation

Table No 12: Structural Equation Model Estimation Result

	Coef.	Std.Err.	Z	P>z	[95%Conf.	Interval]
Structural						
lnSD						
lnEXP	0.962	0.047	20.360	0.000	0.869	1.054
lnREM	0.080	0.041	1.960	0.050	0.000	0.160
lnGE	0.299	0.062	4.790	0.000	0.177	0.421
lnTR	-0.881	0.195	-4.510	0.000	-1.264	-0.498
lnEG	0.151	0.059	2.550	0.011	0.035	0.268
_cons	-0.345	1.224	-0.280	0.778	-2.744	2.055
var(e.lnSD)	2.961		0.133	2.711	3.233	

The SEM analysis finds that all the variables, such as exports, remittances, green energy consumption, tax revenue, and economic growth, are significantly related. In addition, the findings indicate that remittances have a marginal positive effect while exports have a significant positive effect on sustainable development. It is also found that the use of renewable energy enhances sustainable development. Economic growth positively influences sustainable development, but tax revenue negatively influences it. The model contains unexplained variation because the constant term is insignificant.

4.12 Conditional Short run Autoregressive Distributed Lag

Table No 13: CS-ARDL Model Estimation Results

lnSD	**Coef.**	**Std.Err.**	**z**	**P>z**	**[95%Conf.**	**Interval]**
Short Run Est.						
Mean Group:						
L.lnSD	0.058	0.012	4.850	0.000	0.034	0.081
lnEXP	0.893	0.253	3.540	0.000	0.398	1.389
lnREM	0.293	0.172	1.700	0.089	-0.045	0.631
lnGE	-0.733	0.250	-2.930	0.003	-1.223	-0.243
lnTR	0.850	0.391	2.170	0.030	0.083	1.616
lnEG	1.412	0.216	6.540	0.000	0.989	1.834
Adjust. Term						
Mean Group:						
lr_lnSD	-0.942	0.012	-79.380	0.000	-0.966	-0.919
Long Run Est.						

Mean Group:						
lr_lnEG	1.528	0.236	6.470	0.000	1.065	1.991
lr_lnEXP	0.919	0.253	3.630	0.000	0.422	1.415
lr_lnGE	-0.734	0.245	-3.000	0.003	-1.214	-0.255
lr_lnREM	0.288	0.168	1.720	0.086	-0.041	0.617
lr_lnTR	0.968	0.415	2.330	0.020	0.155	1.780

The CS-ARDL model estimates shed more light on both the short-run and long-run variations between the variables. The coefficient for exports (lnEXP) is positive and significant in the short run, indicating that an increase in exports is associated with improved sustainable development outcomes. Remittances (lnREM) exhibit a positive effect, though marginally significant, indicating a weak short-term consequence of such flows on sustainable development. Green energy consumption is negatively and significantly related, implying that an increase in it may reduce sustainable development in the short term due to possibly transitional costs or adjustment dynamics. Tax revenue and economic growth both have positive and significant coefficients, showing that higher tax revenues and economic growth contribute positively to sustainable development in the short run. Also, the control variable results are not shown in the table above to put more emphasis on the main variables.

The adjustment term, lr_lnSD, is negative and highly significant, confirming a strong error correction mechanism that exists to push the system toward its equilibrium following a shock. The research evaluates the impacts of taxes, green energy, exports, and remittances upon sustainable development in 45 countries. Attainment of the United Nations SDGs is pursued-issues related to social well-being, environmental sustainability, and economic progress. Exports and remittances are basic to sustainable development; they enable gender equality, healthcare, education, and poverty reduction. However, they can cause detrimental environmental impacts by increasing the emission of greenhouse gases. Green energy will start the transition toward a sustainable economy. Biomass, geothermal, solar, and wind are some of the renewable resources for generating energy, which are not used fully due to economic constraints. Removing these economic barriers is required to determine the long-term goals of sustainability. Taxes are one of the most significant sources of finance for sustainable development, but their structure needs to be revised to be sustainable. The final factor contributing to sustainable development is a non-biased approach toward the social, environmental, as well as economic issues. The remittances improve health and education, exports result in technical development, while green energy decreases the dependence on fossil fuels.

These drivers can be properly used to overcome budgetary restrictions, energy destitution, and economic gaps. If an equitable and sustainable global economy is to be created, then policymakers have to give priority to integrated efforts, international partnership, technological transfer, financial support, and tax reform. For providing an environmentally sound future for all, mechanisms have to be instituted to ensure that revenue growth and remittances are not happening at the cost of damage to the environment.

5. Conclusion & Recommendation

Trade subsidies, tax breaks for research and development, and other incentives by governments can be given for encouraging the merchants to use the green technologies in achieving breakthrough innovations through exports. Because of international trade agreements, exports can follow global environmental goals. Through certain monetary programs, education campaigns, and financial incentives for remittances used for the renewable energy initiatives, remittances can be utilized to support sustainable development. Public-private partnerships and international loans or grants may guarantee funding for renewable energy installation. Programs for education and training would make it easier to create local green energy systems, particularly in developing nations where energy poverty still exists. Businesses and people who engage in renewable energy solutions can take advantage of tax incentives, subsidies, and low-interest loans. Tax system reform, international collaboration on tax policy, and maximum taxation for environmentally friendly development should be the main ideas. Developing countries could also be offered new sources of finance, such as green bonds, climate funds, and concessional loans. They can reduce financial burdens and accelerate their transition toward renewable energy. Sustainable logistics operations are achieved by public-private partnerships and green logistics incentives. Encouraging Global Collaboration for the SDGs: From an SDG perspective, international collaboration enables countries to fulfill the SDGs by setting global standards for exports, renewable energy, taxation, and remittance use. Environmental Awareness and Education Environmental awareness and education can be indirectly fostered through public-private partnerships and education-related interventions. Strategies for Sustainable Development Adapted to Local Conditions Plans for customized sustainable development need to consider local economic conditions, energy poverty, and regional technological capabilities. Governments will then be in a better position to adjust their strategies in order to achieve the pertinent sustainability goals through regular monitoring and assessment of achievement.

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