3 EMPOWERING SUSTAINABLE HUMAN DEVELOPMENT AND ECONOMIC GROWTH: EVIDENCE FROM DEVELOPING WORLD

Xin GUO[1]
Haoran LIU[2]*
Sardar Fawad SALEEM[3]
Radu Alexandru BUDU[4]

Abstract

Promoting human development and economic growth in tandem with sustainable practices progress towards long-term sustainable development. This study examines the refined interactions that affect human development (HD) and economic progress (GDP) in developing nations. The study uses panel data from 30 developing countries from 2001 to 2022 to examine how energy availability, climate change, governance, ICT, clean fuels and technology access, green innovation, health and education expenditures, and renewable energy use affect HD and GDP. The findings show relationships, including the negative influence of governance on HD and GDP, the positive effect of governance interacting with energy efficiency on both HD and GDP, and the varied impacts of factors like energy availability, clean technologies, and GDP. Notably, green innovation technologies exhibit a particulary profound positive impact on both HD and GDP. The evidence indicates that public spending on health and education has a positive, yet moderate, impact both on HD and GDP. Policy implications highlight the critical need to bolster governance for improved human development and economic growth in the developing world, alongside fiscal expenditure and investments in clean energy and innovation to drive sustainable progress.

Keywords**:** Human development; economic growth; sustainable development; developing nations; energy availability; green innovation.

JEL Classification: Q01, Q43, I38

1. Introduction

The Sustainable Development Goals (SDGs) have garnered significant attention from decision-makers (Khurshid et al., 2023a; Ma et al., 2023). Since their announcement, researchers and governments have worked together to attain them (Khurshid et al., 2022). Furthermore, to fight the climate change menace, endeavors like the Paris Agreement and the Sendai Framework for Disaster Risk Reduction highlighted the need for worldwide coordination (Li et al., 2023).

[1] *Business School of Anyang Institute of Technology, Anyang, 455000, P.R. China. aygxygx@163.com*
[2]* *School of Dornsife arts and sciences, University of Southern California, California 90007, United State of America. maple2905795957@163.com*
[3] *Department of Economics, Abbottabad University of Science and Technology, Abbottabad, Pakistan. sardarfwad@yahoo.com*
[4] *Bucharest Academy of Economic Studies, buduradu@gmail.com*

Furthermore, the Green Economy and Circular Economy models emphasizing resource efficiency and renewable energy use have also gained popularity. In this regard, researchers and decision-makers continue to identify the most critical determinants of sustainable development. For this, they explored the interconnectedness of healthcare, environmental conservation, poverty alleviation, and inclusive economic growth (Khurshid et al., 2024b). These continuing endeavors are also directed to provide evidence-based policy interventions and strategies to attain green growth (Saleem et al., 2024). Moreover, the target is to address environmental degradation issues and social injustice while promoting well-being.

The relationship between access to improved energy options and economic advancement has been extensively studied in recent years. Economic advancement with HD necessitates sophisticated energy services in order to address basic human requirements (Chen et al., 2023). Energies have a significant influence on output, health, education, access to clean drinking water, and communication. In addition, enhanced health, access to knowledge, and increased agricultural production require the availability of electricity, natural gas, contemporary cooking fuel, and mechanical power (Gaye, 2007). Similarly, the production, distribution, and use of energy have an impact on the local, regional, and global environments, which in turn has an impact on human development and a variety of livelihood options (Khurshid et al., 2023b). The presence of clean fuels, technology, and renewable energy has a significant impact on both the progress of human society and economic growth. Through efficient management and optimal utilization of energy resources, we can guide the path of growth toward sustainability (Khurshid et al., 2024c).

Governance provides stability, transparency, and accountability, boosting human and economic development (Aziz & Sarwar, 2023). Rule of law, property rights, and investment are promoted by good governance. Fair and inclusive governance procedures decrease corruption and bureaucracy and level the playing field, boosting innovation and productivity. Institutions with strong governance promote social cohesiveness, empower underprivileged populations, and safeguard human rights, fostering sustainable development (Okolie & Ikenga, 2024; Khurshid et al., 2020). Governance also shapes regulatory frameworks, budgetary policies, and infrastructure investments, which affect economic development. Furthermore, good governance boosts macroeconomic stability, international investment, and capital market access (Chen et al., 2023). Transparency and accountability boost investor trust, minimize corporate risks, and boost long-term economic growth. Effective government also prioritizes social welfare, equitable resource allocation, and inclusive development, minimizing poverty and social unrest. Therefore, it accelerates human and economic growth toward sustainable and inclusive prosperity (Kwilinski et al., 2023).

Green innovation creates technological advances that reduce environmental consequences and promote sustainable growth, boosting human and economic development (Chen et al., 2023). Society can reduce pollution and fight climate change by investing in clean technology (Wang et al., 2022). Green innovation creates jobs, boosts economic competitiveness, and expands the renewable energy and sustainable practices sectors. Moreover, it promotes resource efficiency, decreases manufacturing costs, and increases productivity, making the economy more resilient, profitable, and clean. However, sustainable human and economic development requires adequate greenhouse gas (GHG) emission management (Khurshid et al., 2024a). Reducing GHG emissions can help countries mitigate climate change while also protecting public health and ecosystems. Additionally, reducing GHG emissions can stimulate investment in renewable energy, labor, and the green economy. Addressing GHG emissions fosters global collaboration, international partnerships, peace, and stability by mitigating the harmful effects of climate change on vulnerable groups (Khurshid et al., 2023b). Therefore, GHG emissions control is critical to a successful and resilient future.

Energy generation and utilization are crucial to SDGs 1 and 7. In emerging countries, clean, contemporary, and economical energy technologies are essential for human, social, and economic development (Khurshid et al., 2024b). Developing nations will play a pivotal role in the energy transition since they have the option to shift towards renewable energy consumption, which is predicted to surge in the near future. These economies' size and energy systems can make significant reforms faster and easier than in developed nations (Qiang et al., 2019). Additionally, developing nations require such studies for several reasons. First, limited resources, infrastructure, and sensitivity to exogenous shocks like climate change make sustainable growth challenging for these nations. The World Bank reports that 70% of the poor live in developing nations, highlighting the need for targeted poverty and inequality solutions (Al Kez et al., 2024). Second, developing countries generally lack HD and GDP data and relevant empirical studies. This makes it harder to create evidence-based economic and human development initiatives (Chen et al., 2023). The UNDP observes that many poor nations have data gaps and inconsistencies in measuring SDG progress.

The primary objective of the current study is to examine the factors influencing sustainable HD and GDP in developing countries. Through empirical modeling, we aim to analyze the influence of key factors such as energy availability, governance, climate change, education and health expenditure, ICT, access to clean fuels and technology (CFT), green innovation, and renewable energy use on HD and GDP. Additionally, we seek to evaluate the impact of two interactive terms, specifically governance interacting with energy efficiency and education interacting with health spending on HD and GDP outcomes. By doing so, we aim to guide the policymakers with novel and correct policy interventions to promote sustainable HD and economic growth in the developing world. Moreover, the significance of this study also lies in its potential to inform policymakers about the importance of investing in clean use of energy, energy access, efficiency, and governance to promote sustainable economic growth and human development in developing countries.

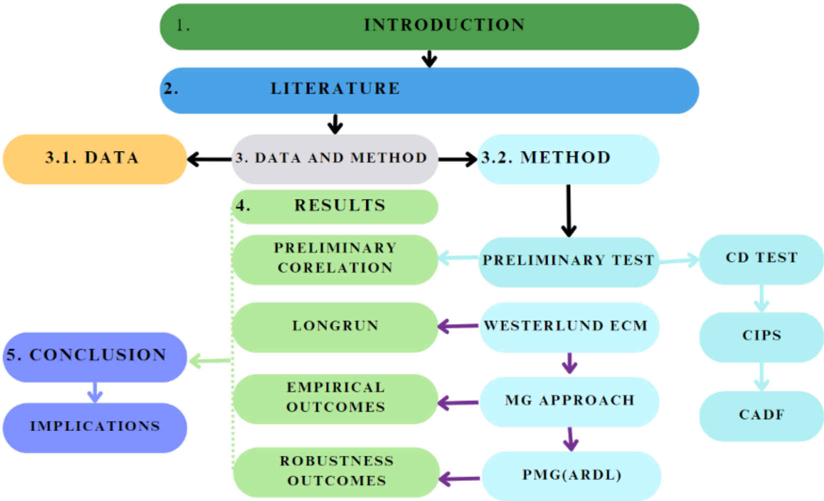
The formulation of research questions can be expressed as follows:

1. How do energy availability, climate change, national income, and ICT influence human development in developing countries?
2. What is the relationship of governance, CFT, green innovation, age dependency, population, and GFCF with human development in developing nations?
3. How do energy availability, climate change, GFCF, population dynamics, and renewable energy use influence economic growth as measured by GDP in the developing world?
4. How do factors like governance, access to CFT, ICT, and green innovation contribute to the economic growth of developing countries?
5. Do interactive terms such as governance interacting with energy efficiency and education with health spending significantly and more profoundly affect both human development and GDP in the developing world, and if so, how?

The current study makes significant theoretical and practical contributions. It provides recent empirical information on energy-related, innovation, and governance aspects and development results in developing nations and considers their interactions. This work can help developing-world energy policymakers understand their effects on economic development. This study shows that energy availability, green innovation, efficiency, and governance are interdependent for sustainable development. It also examines the potential trade-offs and interactions between development and energy-related issues in emerging nations by examining their effects on HD and GDP growth, with interactive implications. It assists developing world decision-makers in creating renewable energy policies. Similarly, the study introduced two interaction terms and examined their impact on HD and GDP. These interactive term estimations attempt to reveal fresh insight into the requirements of good governance with energy efficiency improvements. It also empirically substantiates the idea that education and health may boost human and economic advancement in these regions

Figure 1 presents the organization of the study in visual form. The details regarding the methodology and tests employed in the current study are also visible in this figure.

Figure 1. Research flowchart



2. Literature review

This section of the literature review includes theoretical literature regarding the human development index, which is taken as HDI. The theoretical base is also added regarding the significance of energy access, green technology innovation, and governance in human and economic development. Furthermore, the empirical literature presents studies that consider sustainable factors influencing human and economic development one by one.

2.1. Theoretical literature

The models presented in this article are built on a foundation of economic theories that have developed over the years. The Human Development Index (HDI), which is employed as the dependent variable presenting HD, is a well-established concept in economic theory. It is called a yardstick of well-being in the theoretical literature of economics (Khurshid et al., 2024b). It measures HD based on a healthy life, knowledge, and fair living standard. This concept of HD was first given by Mahbub in 1990. Subsequently, it has been extensively employed as a metric for assessing human development (World Bank, 1990). Moreover, HD is often linked with sustainable development because it provides a composite measure of well-being and sustainable development (Korsakienė et al., 2011). The countries with higher HDI scores tend to have greater progress towards sustainable development goals (Khurshid et al., 2024f).

Moreover, energy availability and energy efficiency are two important independent variables included in the models of the current study. Economists have documented energy as a main component of economic growth for a long time. In this regard, the neoclassical growth theory suggests that economic growth is achieved by the accrual of physical and human capital along with technological progress. Energy is a crucial input in the production process and is considered a factor of production (Solow, 1956). Therefore, energy availability and energy efficiency are important determinants of economic growth and prosperity. Moreover, switching towards energy efficiency is the primary goal of most energy plans (Khan et al., 2024). Moreover, According to SDG 7, CFT is crucial to HD because it can lower the poverty level and promote prosperity (Khurshid et al., 2024c).

Furthermore, governance is another independent variable included in the current work models. Good governance is essential for economic development because it creates a conducive scenario for economic growth. It also ensures that resources are allocated efficiently and that the economy is stable. The literature usually shows that good governance is positively related to economic growth (Chen et al., 2023). Additionally, green innovation technologies rectify HD and economic growth models to achieve sustainable development. Green innovation focuses on environmental stewardship and green growth. This ensures economic growth, creates new industries, and enhances living standards without damaging the environment (Duan et al., 2024). By integrating measures of green innovation into HD and economic growth models, policymakers gain a more comprehensive understanding of sustainable development. This enables them to formulate strategies that promote inclusive economic growth, environmental protection, and social well-being (Khurshid et al., 2024b).

2.2. *Empirical Literature*

2.2.1. Sustainable factors influencing human development

In this section, the literature is gathered, which discusses the traditional and novel sustainable factors affecting HD. Improved and modern energy is a prerequisite for sustainable development as it reduces poverty and income inequality (Wang et al., 2022). Also, Khurshid et al. (2024b) in 26 nations found that consumption of electricity positively influenced HD and economic growth. Similarly, Adekoya et al. (2021) found that renewable energy use contributes to HD. Furthermore, Acheampong et al. (2021) regarded access to energy as the heart of human development. They examined access to clean energy impact on HD in seventy-nine countries for the period 1990–2018. They found that access to clean energy improved HD in the studied area. Results also demonstrated that economic growth, trade openness, FDI, and urbanization enhanced human development. Similarly, Khurshid et al. (2024c) demonstrated that the CFT was essential to achieving sustainable development. They studied the relationship between CFT-based energy poverty and carbon emissions. The results indicated that energy poverty increases carbon emissions in emerging Asia. He and Yang (2024), using the HDI as a yardstick, studied how polluting versus clean energy sources affect household economic growth, ignorng energy poverty’s health risks. The Indian Human Development Survey between 2005 and 2012 indicated that families who converted to renewable energy developed 12.2% more. Families continue to utilize polluting power sources despite the growing popularity of greener energy, which is detrimental to sustainable growth. To address the growing energy waste, they suggested conducting more research.

Moreover, many other factors are explored in the literature to measure their impact on HD. In a few studies, advancement in HD is considered the accomplishment of sustainable development. Chen et al. (2023) used a panel linear regression model to examine governance and sustainable development in 185 countries from 2005 to 2020. HDI measured sustainable development. They found that governance improves sustainable development (HDI). Nam and Ryu (2023) examined the effect of FDI on HD in Southeast Asian nations. They showed that governance, ODA, and national competitiveness moderate FDI-HD relationships. They found that governance, ODI, and national competitiveness positively moderate this association. Yanto et al. (2024) examined Indonesia’s sustainable development factors. The feasibility of attaining sustainable development was assessed in the study using two variables: the HDI and economic growth. They also examined the moderating effect of the good governance variable. The outcomes showed that HDI and economic growth had a significant impact on achieving the sustainable development goal. Furthermore, they found that good governance helped achieve this goal.

2.2.2. Sustainable factors influencing economic growth

Previously, energy access was examined to achieve the target of economic growth and development. Khurshid et al. (2024b) found that affordable modern energy carriers are necessary but insufficient to reduce poverty and grow local economies—even villages with physical access struggle to switch to electricity and other fuels due to cost and reliability. Connectivity, conversion technologies, and the necessary equipment may be out of reach for consumers purchasing upgraded energy carriers. In low-income and fragmented rural markets, the economic returns to energy suppliers may be minimal in the absence of income-generating energy applications. Therefore, scaling up from pilot and demonstration initiatives to market development and population needs is neglected. However, in the recent literature, the focus was diverted to sustainable development from conventional development with reference to energy access. Khurshid et al. (2023c) addressed that many SDGs require adequate, dependable, and clean energy services. Energy access has become one of the most significant development concerns, symbolizing the need to end poverty and achieve human development.

Murshed (2020) examined how ICT affects renewable energy transition, energy use efficiency, and CO2 in selected South Asian economies. The economic analysis showed that ICT trade directly boosted renewable energy consumption, cleaner cooking fuel use, and CO2 emissions. Ahmed et al. (2022) examined how cleaner energy, green innovation, and green commerce affect South Asian green economic growth. The study found that clean energy, green innovation, and green commerce boosted regional green economic growth. Furthermore, Khurshid et al. (2023a) examined how green technology innovation (INV) affected economic growth in the economically top ten countries between 1995 and 2018. Research suggests INV boosts economic growth. Chen et al. (2024) examined how efficient energy practices affect clean growth in ten countries from 1990 to 2019. Data demonstrated that energy use and access harmed the environment but were found to accelerate economic progress.

Mahran (2023) examined how governance (GOV) affects economic growth in spatially dependent countries. The study used spatial regression models to evaluate how GOV affected economic growth in 116 nations in 2017. GOV appears to influence economic growth positively. The function of GOV in sustainable economic growth in Saudi Arabia was examined by Aziz and Sarwar (2023) using the ARDL econometric method. Contrary to the literature, actual estimates show that government effectiveness hurts economic growth. In addition, Ullah et al. (2024) used advanced panel estimate techniques to study how climate change affected economic growth in 47 Asian economies from 2010 to 2020. The research concluded that good policies should balance government effectiveness for greater environmental regulation implementation and economic prosperity to meet society's requirements and ensure ecological sustainability.

The models presented in this article build upon previous literature and theories to explore the influence of many factors on HD and GDP. The models include several independent variables that have been suggested to be important determinants of economic growth and HD. The article covers a literature gap by investigating the relationship between energy, technology, governance, and climate change in promoting HD and economic growth in the developing world. The models proposed in the current work are built upon relevant economic theories and previous empirical studies. Specifically, the models include a comprehensive set of independent variables, including energy availability, energy efficiency, renewable energy consumption, GDP/income, population, government expenditure on education and health, ICT goods imports, R&D, gross fixed capital formation, governance, age dependency ratio, and climate change, to investigate their impact on HD and GDP. Furthermore, the inclusion of interactive terms in the models highlights the importance of studying the interrelationships between these variables.

3. Data detail with methodology

3.1. Data detail

This study used 2001–2021 panel data from 30 developing nations. The research timeframe and countries depend exclusively on balanced data. The main data sources include the World Bank (WB), IEA, and UNDP. The variable of age dependency (AD) "*Age dependency ratio is the ratio of dependents--people younger than 15 or older than 64--to the working-age population--those ages 15-64. Data are shown as the proportion of dependents per 100 working-age population*" on human and economic growth. Whereas INV is the sum of patents registered each year (by local and foreign residents). The detailed description of other variables is summarized in Table 1, whereas Table A summarizes the list of countries in the Appendix.

Table1. Variables detail description

Symbol	Variable	Symbol	Variable
HD	Human Development (HDI Index –UNDP)	HHPC	Energy availability (Electricity consumption (kWh per capita - WB)
GVEE	Governance*Energy efficiency (Interaction Term)	CC	Climate change (GHG- Tonnes of CO_2 equivalent, Million
GDPC	Per capita, National Income	ICT	Mean ICT - (Mean value – WB)
GOV	Governance (Index-WB)	CFT	Access to clean fuels & technology for cooking (million-WB)
REA	Renewable energy consumption (Tonnes of oil equivalent, Millions) (IEA)	INV	Green innovation technologies (Patents + Trademarks) WB
GFCF	Gross fixed capital formation (Annual growth –WB)	POP	Population (Number million- WB)
EEHE	Education*Health spending (Interaction Term)	AD	Age dependency (working-age population –WB)

Note: The data in percentages are changed into numbers and taken log before final testing. For example, access to clean fuels & technology for cooking is available to a percentage of the total population. The authors changed it using the following formula for CFT: CFT (million pop) = $(\frac{CFT}{100} * pop * \frac{1}{10^6})$.

3.2. Empirical models

This section describes the empirical models that meet the study's goals. The independent variables are chosen based on their potential effect on the dependent variables, which is important for sustainable development.

$$HD_{it} = \rho_0 + \alpha_1 HHPC_{it} + \alpha_2 GVEE_{it} + \alpha_3 CC_{it} + \alpha_4 EEHE_{it} + \alpha_5 GDPC_{it} + \alpha_6 ICT_{it} + \varphi_{it} \quad (1)$$
$$HD_{it} = \rho_0 + \alpha_1 GOV_{it} + \alpha_2 CFT_{it} + \alpha_3 INV_{it} + \alpha_4 AD_{it} + \alpha_5 POP_{it} + \alpha_6 GFCF_{it} + \varphi_{it} \quad (2)$$
$$GDP_{it} = \rho_0 + \alpha_1 HHPC_{it} + \alpha_2 GVEE_{it} + \alpha_3 CC_{it} + \alpha_4 GFCF_{it} + \alpha_5 POP_{it} + \alpha_6 REA_{it} + \varphi_{it} \quad (3)$$
$$GDP_{it} = \rho_0 + \alpha_1 GOV_{it} + \alpha_2 CFT_{it} + \alpha_3 ICT_{it} + \alpha_4 INV_{it} + \alpha_5 EEHE_{it} + \varphi_{it} \quad (4)$$

In each empirical model, ρ0 serves as the intercept term. Similarly, α1, α2, α3, α4, α5, and α6 quantify the coefficient value with the independent variables. Φi represents the error term, encapsulating random variations affecting the dependent variable not accounted for by the model. The introduction, literature review, and Table 1 address the factors and study theme.

3.3. Estimation strategy

This section describes the study's methodology. This research blends environmental, energy, and growth theory concepts into a complete theoretical framework. This is meant to lay the groundwork for understanding how essential elements affect human and economic growth for sustainable development. Descriptive statistics are calculated first. This helps explain data dynamics by providing a complete data overview. Additionally, descriptive statistics simplify variable comparison at first glance (Khurshid et al., 2024d).

As a next step, we check the cross-section dependency. It affects prevalent shocks with panel data outcomes, making it necessary (Wang et al., 2022). The first-generation stationary tests cannot check stationarity after CRD confirmation. Therefore, we address the issues of heterogeneity and cross-sectional dependency using CIPS and CADF tests.

The CADF test statistic is as follows:

$$\Delta\delta_{it} = \alpha_{it} + \beta_{it}\delta_{i,t-1} + \gamma_i\bar{\delta}_{t-1} + \rho_i\Delta\bar{\delta}_t + \mu_{it} \tag{5}$$

Equation (5), i shows the cross sections and *t* depicts the time. The null hypothesis is $\beta_i = 0$ in the CADF, whereas the alternative hypothesis is $\beta_i < 0$. The CIPS test statistic is as follows:

$$CIPS = N^{-1}\sum_{i=1}^{N} CADF_i \tag{6}$$

Equation (6) *CADF* shows the CADF for the *ith* cross-sectional unit of panel data.

Following Ma *et al.* (2023), the current work uses the Westerlund panel co-integration technique based on error correction procedures (2015). The results of the said technique are based on panel statistics (Pt, Pa) and group statistics (Gt, Ga). The Westerlund (2015) error-correction-based tests are formed on the Engle and Granger theorem (1987). That states that the two variables cointegrate if there is an error correction representation for either or both of the variables. In the mixed integration settings, Khurshid et al. (2022) note that this strategy reduces estimation bias.

The Mean Group (MG) estimator is applied for parameter estimation. It estimates dynamic panel data models with different slope coefficients using computational empirical methods. This technique allows distinct variety in cross-sectional unit short-term dynamics and long-term relationships. The MG estimator estimates correlations for each cross-sectional unit and averages the coefficients. The MG estimator's strength is heterogenescence. It allows different slope coefficients across cross-sectional units. The main equation of MG approach is as follows.

$$y_{it} = \emptyset_i + \sum_{j=1}^{p} \gamma_{ij}\,\Delta y_{i,t-j} + \sum_{k=1}^{q} \partial_{ij}\,\Delta x_{i,t-k} + u_{it} \tag{7}$$

Where, the unit-specific intercept is denoted by $\emptyset_i$, y_{it} *is* the dependent variable, the lagged dependent variables' coefficient is γ_{ij}, the explanatory variable vector is Δx_{it}, the lagged independent variables' coefficients are ∂_{ij}, and the error term is u_{it}.

Following Khan et al. (2022), robustness outcomes are estimated through the Pooled MG approach PMG (ARDL) method. This method ensures accurate estimations (Pesaran *et al.,* 1999). Moreover, this method presented by Pesaran & Shin (1995) is appropriate when the variables are mixed and correlated. The PMG (ARDL) method can estimate reliable coefficients in the presence of endogeneity. This is done by including the reaction slacks and descriptive features of the data (Pesaran *et al.,* 1999). Figure 2 shows the research flow estimation approach.

Figure 2

Estimation Strategy

4. Results and discussion

Table 2 shows variable descriptive statistics. The variable with the highest mean is HHPC at 733.0, and the variable with the lowest mean is GOV at -0.681. This implies that, on average, the countries in the study have relatively high levels of energy availability but lower average levels of governance. Moreover, HHPC also has the highest standard deviation, indicating more significant variability among the considered countries. The variable with the lowest standard deviation is HD, suggesting more consistent levels of human development across the studied countries.

Table 2. The descriptive statistics outcomes

Stats	GOV	GDP	HHP	CFT	REA	HD	GHG	GFC	INV	ICT
Mean	-	2.206	733.0	41.8	43.1	0.575	4.72	12.61	0.38	3.77
Sd.	0.531	4.123	784.1	35.0	35.0	0.113	0.67	62.09	0.49	5.75
Variance	0.282	17.00	6148	1228	1226	0.013	0.46	3855	0.24	33.1
Skewnes	-	-	1.715	0.47	0.39	-	0.18	9.018	3.15	4.74
Kurtosis	3.324	9.127	5.691	1.73	1.74	3.517	2.66	101.4	15.0	28.2
Max.	0.695	19.93	3662	99.9	100.	0.789	6.53	983.7	3.14	46.7
Min.	-	-	23.91	0.60	0.00	0.000	3.32	-	0.00	0.22
Mean	-	2.206	733.0	41.8	43.1	0.575	4.72	12.61	0.38	3.77

Source: Authors' calculations

The CRD test is carried out as the subsequent procedure. According to Table 3, outcomes accept the alternative hypothesis for all the variables at a 1% significance level. These results confirm that CRD exists among all the data from the studied developing countries due to their interdependence. Unit root check is an important step in empirical estimation (Khan et al., 2023). Table 3 also shows unit root outcomes of CIPS and CADF and displays that most of the variables are stationary at the level. However, the variables that are not stationary at the level become stationary at first difference.

Table 3. Unit-root and CRD outcomes

	CADF outcomes		CIPS outcomes		
	level	1st diff	level	1st diff	CRD
GOV	-1.497	-3.022***	-1.771	-4.627***	69.58***
GDPC	-2.259***	-3.927***	-3.009***	-5.207***	32.99***
HHPC	-2.87***	-3.369***	-3.019***	-4.286***	70.93***
AE	-2.18**	-1.580	-3.214***	-5.352***	93.83***
CFT	-2.856***	-1.580	-0.648	-2.29**	77.40***

	CADF outcomes		CIPS outcomes		
	level	**1st diff**	**level**	**1st diff**	**CRD**
REA	-2.089*	-3.426***	-2.145*	-4.236***	41.98***
HD	-2.652***	-2.661***	-2.333**	-3.501***	117.1***
GHG	-2.195**	-2.741***	-2.21**	-4.225***	86.33***
POP	-2.110*	-1.352	-2.828***	-1.002	119.1***
GFCF	-2.624***	-3.983***	-3.646***	-5.488***	13.69***
EEHE	-2.412***	-3.278***	-2.261**	-4.063***	17.87***
AD	-1.645	-3.185***	-2.801***	-1.816	38.19***
INV	-1.691	-2.553***	-1.870	-3.667***	16.41***
ICT	-2.230**	-3.380***	-2.598***	-4.629***	8.26***

***** p<0.01, ** p<0.05, * p<0.1**

Table 4 displays the error correction model values for all four empirical models. The results indicate the long-run equilibrium among variables, therefore suggesting co-integration.

Table 4. Co-integration outcomes

	Stats	Value	Z-	P-	Robust		Value	Z-	P-	Robust
Model 1	Gt	-3.717	-12.85	0.00	0.02	Model 2	-5.517	2.634	0.02	0.04
	Ga	-6.263	2.874	0.00	0.03		-7.648	1.521	0.00	0.02
	Pt	-8.059	0.44	0.00	0.01		-5.759	2.194	0.06	0.00
	Pa	-7.108	3.283	0.00	0.03		-1.155	3.234	1.00	0.10
Model 3	Gt	-3.532	1.137	0.08	0.05	Model 4	-6.444	2.65	0.00	0.02
	Ga	-1.728	6.386	1.00	0.80		-5.038	0.942	0.03	0.04
	Pt	-24.48	-12.09	0.00	0.04		-18.91	9.608	0.00	0.03
	Pa	-9.234	-5.154	0.00	0.04		-7.882	1.202	0.00	0.04

Source: Authors' calculations.

4.1. MG outcomes

This section presents the findings from the MG estimation, examining the impact of various lagged independent variables on HD and GDP. These methods will estimate all four models, indicating consistent directional influences of the variables. Moreover, the analysis examines the impact of lagged variables on HD and GDP. The coefficients for the error correction terms are significant at the 1% level in all four models, indicating a strong and significant negative adjustment of HD and GDP towards their long-run equilibrium levels. This consistency ensures that the results are reliable. Table 5 summarizes the empirical results.

The findings show a negative association between GOV and HD in both the long and short run. Khurshid et al. (2024b) also found the same in their study. Moreover, the same negative influence of GOV on GDP is also evident in both the long and short run, which is supported in the recent study of Chen et al. (2023). A 1% increase in GOV corresponds to a 5.2% and 9.12% decline in HD in the long and short run, respectively—similarly, it causes a 31.5% and 26.2% decrease in the GDP in the long and short run, respectively. The negative correlation between GOV, HD, and GDP highlights the crucial role of governance structures in shaping socio-economic progress in developing nations. Weak governance hinders investments, undermines economic stability, and requires reforms for a sustainable future.

In contrast, the outcomes show that when governance interacts with energy efficiency (GVEE), it demonstrates a positive impact on both HD and GDP in the long run. Yanto et al. (2024) observed a similar relationship in their study. A 1 percent increase in GVEE leads to a 0.54% rise in HD in the long run. Similarly, a 2.8% increase in GDP was observed in the long run. These findings suggest that policies promoting energy efficiency in the presence of good governance can lead to enhanced living standards and economic growth. Energy efficiency regulations and good governance can foster inclusive development and prosperity in developing countries, raising living standards. They also boost economic growth, lessen resource scarcity, slow environmental deterioration, and attract investment in sustainable energy infrastructure. Moreover, HHPC exhibits a positive influence on HD. Acheampong et al. (2021) and Khurshid et al. (2024c) found similar relationships. Results show that a 1% rise in HHPC causes a 9.8% and 0.15% increase in HD in long and short-run, respectively. In comparison, it causes a 19.1% and 3.9% loss in GDP in long and short-run, respectively. The results suggest that energy is essential for developing countries' socio-economic success, but pricing, infrastructure, and resource distribution affect GDP. HHPC raises living standards, yet GDP difficulties demand energy-efficient technology, infrastructure improvements, and resource optimization for sustainable growth.

The results further revealed that access to CFT, ICT, the interactive term of education and health spending (EEHE), INV, and GFCF all demonstrate a progressive influence on both HD and GDP. Similar findings can be found in the studies regarding HD, Chen et al. (2023), and regarding economic growth, Khurshid et al. (2023b) and Ullah et al. (2024). These findings suggest that developing countries should prioritize investments in CFT, ICT, EEHE, and INV. Such investments collectively enhance both HD and GDP. Strategic investments in CFT, ICT expansion, EEHE, green innovation, and infrastructure development can lead to sustainable and inclusive growth in developing countries, promoting public health, economic opportunities, and resilience against climate change.

In contrast, CC and POP both demonstrate a detrimental effect on HD in long and short-run. However, shows a progressive impact on GDP in both long and short-run outcomes. A similar association was depicted by Opoku et al. (2022) in case of CC and Zhang et al. (2023) in the case of POP. The impact of climate change and population on GDP and health in emerging countries is complex, with the latter relying heavily on conventional fossil fuels, highlighting the need for green production practices and integrated population policies for sustainable growth. Moreover, Age dependency (AD) shows that it has a detrimental effect on HD in the long-run. On the other hand, HD is positively impacted by GDP per capita in both the long and short-run. Rahmawati and Intan (2020) endorse this result. Finally, REA exhibits a positive effect on GDP in the long-run. The findings are the same as shown by Awan et al. (2023). This finding implies that transitioning towards renewable energy sources is good for environmental sustainability. The adoption of renewable energy technologies can enhance clean productivity, which ultimately fosters long-term economic prosperity.

Table 5. Empirical outcome using MG approach

	(1)		(2)		(3)		(4)
	HD				***GDP***		
_ec	-0.047***		-1.324***		-0.864**		-0.868***
	(0.007)		(0.350)		(0.351)		(0.052)
L.HD	-0.047***	L.GOV	-0.052***	L.GDP	0.336**	L.GOV	- 0.315***
	(0.017)		(0.0024)		(0.123)		(0.055)
L.HHPC	0.098**	L.CFT	0.0781*	L.HHPC	0.191**	L.CFT	0.045***
	(0.0075)		(0.0107)		(0.090)		(0.024)
L.GVEE	0.0054***	L.INV	0.0824**	L.GVEE	0.028***	L.ICT	0.136*
	(0.0004)		(0.039)		(0.008)		(0.077)
L.CC	-0. 419***	L.AD	-0.011**	L.CC	1.534***	L.INV	0.231**
	(0.0343)		(0.0062)		(0.518)		(0.101)
L.EEHE	0.018***	L.POP	-0.432***	L.GFCF	0.022***	L.EEHE	0.063***
	(0.0012)		(0.011)		(0.0022)		(0.014)
L.GDPC	0.023***	L.GFCF	0.016***	L.POP	1.283***		
	(0.012)		(0.003)		(0.484)		
L.ICT	0.0057***			L.REA	0.093**		
	(0.0015)				(0.034)		
SR							
D.HHPC	0.0015*	D.GOV	-0.0912*	D.HHPC	0.039*	D.GOV	- 0.262***
	(0.0007)		(0.0241)		(0.012)		(0.052)
D.GVEE	0.0017	D.CFT	0.0230**	D.GVEE	0.002	D.CFT	0.792*
	(0.032)		(0.0019)		(0.099)		(0.355)
D.CC	-0.156***	D.INV	0.0911*	D.CC	0.579**	D.ICT	0.052*
	(0.094)		(0.041)		(0.113)		(0. 023)
D.EEHE	0.0095*	D.AD	-0.0308	D.GFCF	0.081*	D.INV	1.931**
	(0.0018)		(0.0235)		(0.0038)		(0.729)
D.GDPC	0.0079**	D.POP	-0.378*	D.POP	1.198**	D.EEHE	0.175**
	(0.028)		(0.173)		(0.489)		(0.076)
D.ICT	0.0014***	D.GFCF	0.0052**	D.REA	0.273		
	(0.0007)		(0.0013)		(0.327)		
Constant	0.0310***		-0.834*		95.62***		7.417***
	(0.0036)		(0.372)		(5.409)		(0.504)
Groups	30		30		30	.	30
Observ.	630		630		630		630

**Note:* p<0.01, ** p<0.05, * p<0.1*

Source: Authors' calculations

4.2. PMG (ARDL) outcomes

This work uses PMG (ARDL) as a secondary measure to assess all four empirical models. The outcomes in Table B (See Appendix) show that the direction and significance of the link between the variables in all four empirical models are consistent with the findings of the MG approach. The utilization of three different methodologies to estimate the results, all of which yielded similar outcomes, enhanced the reliability of the results. Consequently, the derived policy implications are more reliable.

5. Conclusion and Policy Suggestions

This study examines the relationships underlying economic growth and HD in developing countries. This research employed panel data from 30 developing nations from 2001 to 2022 to explore how energy availability, climate change, governance, ICT, clean fuels and technologies access, green innovation, age dependency, population, GFCF, and renewable energy consumption affect HD and economic progress. The main purpose of the current work is to explore the factors influencing sustainable HD and economic growth in developing countries.

The empirical outcomes are achieved using Westerlund (2015) for co-integration, MG for long/short-term relationship analysis, and PMG (ARDL) for regression analysis. Findings reveal a significant negative association between governance (GOV) in developing countries and HD. Additionally, the FE test indicates a negative association between GOV and GDP. In contrast, when GOV interacts with GVEE, it demonstrates a positive influence on both HD and GDP. Besides, HHPC exhibits a positive influence on HD. CFT, ICT, EEHE, INV, and GFCF all demonstrate a positive influence on both HD and GDP. Notably, green innovation technologies exhibit a particularly profound positive impact on both HD and GDP. In contrast, CC and POP exhibited mixed results. CC demonstrates a detrimental effect on HD while showing a progressive impact on GDP. Moreover, AD has a detrimental effect on HD. In contrast, an increase in GDP has a beneficial effect on human development. The utilization of renewable energy sources has been determined to have a positive impact on the GDP.

The following policy implications can be derived from the findings:

1. Governance changes are necessary in developing countries to improve accountability, openness, and effectiveness, as there is a negative correlation between GOV and HD.
2. The negative correlation between GOV and GDP highlights the need for better oversight to foster investment and economic productivity in developing nations.
3. Integrating governance changes with sustainable energy policies can bring benefits, emphasizing the need for regulatory frameworks that encourage energy-efficient activities and investments.
4. The favorable impact of energy availability on HD highlights the need for affordable energy sources to be spread. Especially in rural and underprivileged communities, to boost education, healthcare, and well-being in developing countries.
5. CFT, ICT, education, health spending, green innovation, and GFCF positively impact HD and GDP, emphasizing the importance of investing in infrastructure, education, healthcare, and innovation for equitable and sustainable growth.
6. Comprehensive climate adaptation and mitigation plans are needed to prevent negative impacts on human development and capitalize on economic growth prospects in developing nations due to mixed results on CC.

7. Addressing the requirements of aging people, such as healthcare, social protection, and work prospects, is crucial for inclusive development results because of the detrimental impact of age reliance on HD.
8. The positive impact of GDP per capita on HD emphasizes the need for economic growth and income distribution to improve human development outcomes in developing countries.
9. REA's positive impact on GDP highlights the advantages of investing in renewable energy for economic growth and environmental sustainability in emerging nations.

The study has some limitations. Firstly, we have not included all the relevant variables that could impact HDI and GDP in developing countries. Lastly, our study does not consider the unique characteristics of each country, which may limit the generalizability of our findings.

References

Acheampong, A.O., Erdiaw-Kwasie, M.O. and Abunyewah, M., 2021. Does energy accessibility improve human development? Evidence from energy-poor regions. *Energy Economics*, *96*, p.105165. https://doi.org/10.1016/j.eneco.2021.105165

Adekoya, O.B., Olabode, J.K. and Rafi, S.K., 2021. Renewable energy consumption, carbon emissions and human development: Empirical comparison of the trajectories of world regions. *Renewable energy*, *179*, pp.1836-1848. https://doi.org/10.1016/j.renene.2021.08.019

Ahmed, F., Kousar, S., Pervaiz, A., Trinidad-Segovia, J.E., del Pilar Casado-Belmonte, M. and Ahmed, W., 2022. Role of green innovation, trade and energy to promote green economic growth: a case of South Asian Nations. *Environmental Science and Pollution Research*, *29*(5), pp.6871-6885. https://doi.org/10.1007/s11356-021-15881-4

Al Kez, D., Foley, A., Lowans, C. and Del Rio, D.F., 2024. Energy poverty assessment: Indicators and implications for developing and developed countries. *Energy Conversion and Management*, *307*, p.118324. https://doi.org/10.1016/j.enconman.2024.118324

Awan, A.M., Saleem, S.F. and Khan, S., 2024. Navigating sustainable development: exploring the environmental Kuznets curve in the SAARC region with global stochastic trends. *Environment, Development and Sustainability*, pp.1-22. https://doi.org/10.1007/s10668-024-04505-9

Aziz, G. and Sarwar, S., 2023. Revisit the role of governance indicators to achieve sustainable economic growth of Saudi Arabia–pre and post implementation of 2030 Vision. *Structural Change and Economic Dynamics*, *66*, pp.213-227. https://doi.org/10.1016/j.strueco.2023.04.008

Chen, W., Alharthi, M., Zhang, J. and Khan, I., 2024. The need for energy efficiency and economic prosperity in a sustainable environment. *Gondwana Research*, *127*, pp.22-35. https://doi.org/10.1016/j.gr.2023.03.025

Chen, Y., Khurshid, A., Rauf, A., Yang, H. and Calin, AC, 2023. Natural resource endowment and human development: Contemporary role of governance. *Resources Policy*, *81*, p.103334. https://doi.org/10.1016/j.resourpol.2023.103334

Duan, W., Khurshid, A., Khan, K. and Calin, AC, 2024. Transforming industry: Investigating 4.0 technologies for sustainable product evolution in china through a novel fuzzy three-way decision-making process. *Technological Forecasting and Social Change*, *200*, p.123125. https://doi.org/10.1016/j.techfore.2023.123125

Engle, R.F. and Granger, C.W., 1987. Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, pp.251-276. https://doi.org/10.2307/1913236

Garba, I. and Bellingham, R., 2021. Energy poverty: Estimating the impact of solid cooking fuels on GDP per capita in developing countries-Case of sub-Saharan Africa. *Energy*, *221*, p.119770. https://doi.org/10.1016/j.energy.2021.119770

Gaye, A., 2007. Access to energy and human development. *Human development report*, *2008*, p.2007. Available at: <http://rrojasdatabank.info/gaye_amie.pdf>

He, M. and Yang, S., 2024. Public–private partnerships for energy transition: studying role of economic change and energy restructuring over the time. *Economic Change and Restructuring*, *57*(2), p.81. https://doi.org/10.1007/s10644-024-09606-z

Khan, M.A., Khan, Z. and Saleem, S.F., 2023. Monetary policy effectiveness in Asian developing economies: the moderating role of financial sector development. *Journal of Financial Economic Policy*, *15*(3), pp.226-247. https://doi.org/10.1108/JFEP-01-2023-0021

Khan, S., Azam, M., Ozturk, I. and Saleem, S.F., 2022. Analysing association in environmental pollution, tourism and economic growth: empirical evidence from the commonwealth of independent states. *Journal of Asian and African Studies*, *57*(8), pp.1544-1561. https://doi.org/10.1177/00219096211058881

Khan, K., Khurshid, A. and Cifuentes-Faura, J., 2024. Impact of Defence Expenditure on Total Factor Productivity: New Insights from Panel Bootstrap Granger Causality. Defence and Peace Economics, pp.1-16. https://doi.org/10.1080/10242694.2024.2367410

Khurshid, A., Huang, Y., Cifuentes-Faura, J. and Khan, K., 2024a. Beyond borders: assessing the transboundary effects of environmental regulation on technological development in Europe. *Technological Forecasting and Social Change*, *200*, p.123212. https://doi.org/10.1016/j.techfore.2024.123212

Khurshid, A., Huang, Y., Khan, K. and Cifuentes-Faura, J., 2024b. Innovation, institutions, and sustainability: Evaluating drivers of household green technology adoption and environmental sustainability of Africa. *Gondwana Research*, *132*, pp.88-102. https://doi.org/10.1016/j.gr.2024.03.012

Khurshid, A., Kedong, Y., Calin, A.C., Zeldea, C.G., Qiang, S. and Wenqi, D., 2020. Is the relationship between remittances and economic growth influenced by the governance and development of the financial sector? New evidence from the developing countries. *Romanian Journal of Economic Forecasting*, 23(1), pp.37-56.

Khurshid, A., Khan, K. and Cifuentes-Faura, J., 2023b. 2030 Agenda of sustainable transport: Can current progress lead towards carbon neutrality?. *Transportation Research Part D: Transport and Environment*, *122*, p.103869. https://doi.org/10.1016/j.trd.2023.103869

Khurshid, A., Khan, K., Chen, Y. and Cifuentes-Faura, J., 2023c. Do green transport and mitigation technologies drive OECD countries to sustainable path?. *Transportation Research Part D: Transport and Environment*, *118*, p.103669. https://doi.org/10.1016/j.trd.2023.103669

Khurshid, A., Khan, K., Cifuentes-Faura, J. and Chen, Y., 2024c. Asymmetric multifractality: Comparative efficiency analysis of global technological and renewable energy prices using MFDFA and A-MFDFA approaches. *Energy*, *289*, p.130106. https://doi.org/10.1016/j.energy.2023.130106

Khurshid, A., Khan, K., Rauf, A. and Cifuentes-Faura, J., 2024d. Effect of geopolitical risk on resources prices in the global and Russian-Ukrainian context: A novel Bayesian structural model. *Resources Policy*, *88*, p.104536. https://doi.org/10.1016/j.resourpol.2023.104536

Khurshid, A., Khan, K., Saleem, S.F., Cifuentes-Faura, J. and Calin, A.C., 2023a. Driving towards a sustainable future: Transport sector innovation, climate change and social welfare. *Journal of Cleaner Production*, *427*, p.139250. https://doi.org/10.1016/j.jclepro.2023.139250

Khurshid, A., Khan, K., Khan, S. and Cifuentes-Faura, J., 2024f. Tackling sustainable development challenges: A fuzzy set examination of textile industry 4.0 and green supply chain barriers. Sustainable Development. https://doi.org/10.1002/sd.3061

Korsakienė, R., Breivytė, I. and Wamboye, E., 2011. Sustainable development and human development index. https://etalpykla.vilniustech.lt/handle/123456789/132612

Kwilinski, A., Lyulyov, O. and Pimonenko, T., 2023. Inclusive economic growth: Relationship between energy and governance efficiency. *Energies*, *16*(6), p.2511. https://doi.org/10.3390/en16062511

Li, Z., Khurshid, A., Rauf, A., Qayyum, S., Calin, AC, Iancu, LA and Wang, X., 2023. Climate change and the UN-2030 agenda: Do mitigation technologies represent a driving factor? New evidence from OECD economies. *Clean Technologies and Environmental Policy*, *25*(1), pp.195-209. https://doi.org/10.1007/s10098-022-02396-w

Ma, C., Li, H., Saleem, S.F. and Mone, F., 2023. Balancing progress and sustainability: industrial innovation's impact on Europe's emission management, economic expansion, and financial growth. *Romanian Journal of Economic Forecasting*, *26*(3), p.129. Available at https://www.researchgate.net/profile/Firicel-Mone/publication/374784140

Mahran, HA, 2023. The impact of governance on economic growth: spatial econometric approach. *Review of Economics and Political Science*, *8*(1), pp.37-53. https://doi.org/10.1108/REPS-06-2021-0058

Murshed, M., 2020. An empirical analysis of the non-linear impacts of ICT-trade openness on renewable energy transition, energy efficiency, clean cooking fuel access and environmental sustainability in South Asia. *Environmental Science and Pollution Research*, *27*(29), pp.36254-36281. https://doi.org/10.1007/s11356-020-09497-3

Nam, H.J. and Ryu, D., 2023. FDI and human development: The role of governance, ODA, and national competitiveness. *Journal of International Financial Markets, Institutions and Money*, *85*, p.101769. https://doi.org/10.1016/j.intfin.2023.101769

Okolie, U.C. and Ikenga, F.A., 2024. Public Administration and Sustainable Development in Nigeria. *International Journal of Public Administration Studies*, *3*(2), pp.59-69. Available at https://ojs.unimal.ac.id/ijpas/article/view/13892

Opoku, E.E.O., Dogah, K.E. and Aluko, O.A., 2022. The contribution of human development towards environmental sustainability. *Energy Economics*, *106*, p.105782. https://doi.org/10.1016/j.eneco.2021.105782

Pesaran, M.H., Shin, Y. and Smith, J.R., 1999. Bond testing approach to the analysis of long run relationship. *Journal of the American Statistical Association*, *94*(446), pp.621-634.

Pesaran, M.H. and Shin, Y., 1995. *An autoregressive distributed lag modelling approach to co-integration analysis* (Vol. 9514, pp. 371-413). Cambridge, UK: Department of Applied Economics, University of Cambridge.

Qiang, S., Khurshid, A., Calin, AC and Khan, K., 2019. Do remittances contribute to the development of financial institutions? New evidence from the developing world. *Romanian Journal of Economic Forecasting*, *22*(2), pp.78-97. Available at https://ipe.ro/rjef/rjef2_19/rjef2_2019p78-97.pdf

Rahmawati, F. and Intan, M.N., 2020. Government Spending, Gross Domestic Product, Human Development Index (Evidence from East Java Province). *KnE Social Sciences*, pp.774-786. https://doi.org/10.18502/kss.v4i6.6641

Saleem, S.F., Khan, M.A. and Tariq, M., 2024, January. Moderating role of government effectiveness and innovation in sustainable economic growth relationship in Middle East & North Africa countries. In *Natural Resources Forum*. Oxford, UK: Blackwell Publishing Ltd. https://doi.org/10.1111/1477-8947.12397

Solow, R.M., 1956. A contribution to the theory of economic growth. *The quarterly journal of economics*, *70*(1), pp.65-94. https://doi.org/10.2307/1884513

Ullah, S., Arif, M., Hussain, S. and Al-Faryan, M.A.S., 2024. Climate change, governance, and economic growth in Asia: a panel co-integration analysis. *Cogent Economics & Finance*, *12*(1), p.2299125. https://doi.org/10.1080/23322039.2023.2299125

Wang, X., Khurshid, A., Qayyum, S. and Calin, AC, 2022. The role of green innovations, environmental policies and carbon taxes in achieving the sustainable development goals of carbon neutrality. *Environmental Science and Pollution Research*, pp.1-15. https://doi.org/10.1007/s11356-021-16208-z

Westerlund, J., Thuraisamy, K. and Sharma, S., 2015. On the use of panel co-integration tests in energy economics. *Energy Economics*, *50*, pp.359-363. https://doi.org/10.1016/j.eneco.2014.08.020

World Bank, 1990. *World development report 1990: Poverty*. The World Bank. https://doi.org/10.1596/0-1952-0851-X

Yanto, H., Pujiati, A., Handayani, B.D., Ridzuan, A.R., Keshminder, J.S. and Rachman, M.A., 2024. Good Government Governance as a Moderator in Achieving Sustainable Development Goals in Indonesia. *International Journal of Sustainable Development & Planning*, *19*(2). https://doi.org/10.18280/ijsdp.190228

Zhang, F., Xu, W. and Khurshid, A., 2023. The interplay of migrant Workers' working hours, income, and well-being in China. *Sustainability*, *15*(14), p.11409. https://doi.org/10.3390/su151411409

Appendix

Table A. List of Countries

1	Algeria	9	Egypt	17	Mozambique	25	Tajikistan
2	Bangladesh	10	El Salvador	18	Nepal	26	Tanzania
3	Benin	11	India	19	Zimbabwe	27	Togo
4	Bolivia	12	Zambia	20	Nigeria	28	Ukraine
5	Cambodia	13	Indonesia	21	Pakistan	29	Uzbekistan
6	Cameroon	14	Iran	22	Philippines	30	Venezuela
7	Congo, Rep.	15	Kenya	23	Sri Lanka		
8	Vietnam	16	Morocco	24	Sudan		

Table B. PMG (ARDL) outcomes

	(1)		(2)		(3)		(4)	
	LR	SR	LR	SR	LR	SR	LR	SR
__ec		-		-		-		-0.86***
		(0.008)		(0.071)		(0.051)		(0.052)
GOV			-0.047**	-0.078**			-	-0.853
			(0.019)	(0.024)			(0.556)	(0.529)
CFT			0.011***	0.034***			0.045***	0.831
			(0.004)	(0.002)			(0.011)	(1.097)
INV			0.013***	0.023			0.232*	9.124**
			(0.029)	(0.016)			(0.101)	(3.730)
AD			-	0.010**				
			(0.0012)	(0.004)				
POP			-	-1.552	1.28***	234.6		
			(0.019)	(1.353)	(0.485)	(227.2)		
GFCF			0.033***	0.021*	0.022***	0.062***		
			(0.005)	(0.013)	(0.003)	(0.013)		
ICT	0.002***	0.001*					0.137*	0.171
	(0.001)	(0.0004)					(0.077)	(0.374)
EEHE	0.014***	0.038					0.063***	0.121***
	(0.001)	(0.042)					(0.014)	(0.055)
HHPC	0.035*	0.013			-0.019**	0.039		
	(0.015)	(0.030)			(0.001)	(0.027)		
GVEE	0.024**	0.034**			0.028***	-0.023		
	(0.001)	(0.002)			(0.007)	(0.100)		
CC	-	0.014			1.534***	20.33***		
	(0.022)	(0.024)			(0.519)	(7.287)		
REA					0.093***	0.275		
					(0.007)	(0.328)		
GDPC	0.014***	0.033**						
	(0.001)	(0.006)						
Constant		-		-		95.63***		7.418***
		(0.002)		(0.068)		(5.409)		(0.505)
Obs.	630	630	630	630	630	630	630	630

*Note: *** p<0.01, ** p<0.05, * p<0.1*

Source: Authors' calculations