Interlinkage of United Nations' SDG 1 "No Poverty" and SDG 2 "Zero Hunger" Goals: A Study on India with World Development Indicators

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Abstract

The United Nations' (UNs') Sustainable Development Goals (SDGs) provide a comprehensive framework for addressing global challenges ranging from poverty and hunger to inequality and climate change. Among these, SDG 1, "No Poverty," and SDG 2, "Zero Hunger," are intrinsically linked since the both seek to eradicate the root causes of deprivation, suffering, and malnutrition, which disproportionately affect vulnerable populations worldwide. These goals are not isolated objectives but are part of an integrated approach to achieving broader social and economic development. In exploring this expected interrelationship of interconnectedness, the present study has examined the World Bank's sustainable performance indicators for SDG 1 and SDG 2 along with the World Development Indicator variables empirically over the study period of 2004 to 2022. The study has employed correlation analysis, causality analysis, and cointegration analysis methodologically. The results show that with the sustainable performance indicator (SPI) data, there exists little causality or interlinkage between "No Poverty" i.e., SDG 1 and "Zero Hunger" i.e., SDG 2, in the context of India. The variable measures are either insufficient to examine the true theoretical interrelations between the variables of two sustainable development goals or the development performance of India is an exception of the said theoretical relationship, if so, exist in reality. However, there is presence of long-run speed of adjustment which runs out of self-targeting motives for both the SDG variables rather than through the impetus from the other development variable. Nonetheless, the world development indicators appeared to be ineffective in addressing the "Zero Hunger" as a sustainable development goal while the same are very much effective to address the goal for "No Poverty".

Key Words: Interlinkage of Sustainable Development Goals (SDGs); No Poverty and Zero Hunger; Causality and Intercorrelation; Sustainable Performance Indicator (SPI); and World Development Indicator (WDI).

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Introduction

The United Nations' (UNs') Sustainable Development Goals (SDGs), adopted in 2015 as part of the 2030 Agenda for Sustainable Development, provide a comprehensive framework for addressing global challenges ranging from poverty and hunger to inequality and climate change. Among these, SDG 1, "No Poverty," and SDG 2, "Zero Hunger," are intrinsically linked, as both seek to eradicate the root causes of deprivation, suffering, and malnutrition, which disproportionately affect vulnerable populations worldwide. These goals are not isolated objectives but are part of an integrated approach to achieving broader social and economic development.

India, home to over 1.4 billion people, faces a unique set of challenges in realizing these two SDGs. Despite significant progress in poverty reduction and food security over the past few decades, the country continues to grapple with high levels of poverty, malnutrition, and food insecurity, particularly in rural and marginalized areas. Understanding the nature of interlinkages and causality between SDG 1 and SDG 2 in the Indian context is critical for formulating effective policies and interventions that address both issues simultaneously.

This study aims to explore the complex relationship between poverty and hunger in India by analysing the roles of the key World Development Indicators (WDIs) that measure and contribute to the progress toward these two SDGs. By examining the correlation between the two SDGs with the economic, social, nutritional and agricultural indicators, the paper highlights the hidden challenges and opportunities India is facing in achieving the targets of "No Poverty" and "Zero Hunger" by 2030. The findings will provide insights into how targeted interventions can contribute to sustainable development and provide a pathway for policy-makers to design holistic solutions that tackle the root causes of poverty and hunger in the country.

The rest of the study is structured as follows. In Section-2, the study reviews the literature briefly and identifies the research gap. In Section-3, it describes the data and methodology, identifies the variables and puts forth the hypothesis. In Section-4, it depicts the results and analyses the findings. In

Section-5, the study concludes along with a few observations as recommendations.

Literature Review

The interlinkage between the UNs' SDG 1 "No Poverty" and SDG 2 "Zero Hunger" has garnered significant academic attention in recent years, particularly given the pervasive nature of poverty and hunger in many developing nations, including India. The relationship between these two goals is complex and multifaceted, involving economic, social, and environmental factors that often reinforce each other. This literature review examines existing research on the connections between poverty and hunger, with a particular focus on India, and highlights the role of World Development Indicators (WDIs) in measuring and understanding these connections.

According to FAO (2015), poverty is both a cause and a consequence of hunger, where individuals those are living in poverty often lack access to adequate food, and food insecurity, in turn, exacerbates poverty by hindering people's ability to engage in productive economic activities. There exists a symbiotic relationship between food waste, an inverse proxy for poverty and food security, that for hunger (Rocco, 2017). This symbiotic relationship is especially pronounced in the rural and marginalized communities, where lack of access to education, healthcare, and financial resources further deepens food insecurity (Siddiqui, et al., 2020). Rasheed (2023) has emphasized that dynamics of poverty and hunger are deeply interconnected and mutually reinforcing. In examining the nexus of poverty, malnutrition and diseases in Africa, Adeyeye, et al., (2023) have found that high population growth, inefficiency in agricultural and industrial production, poor governance and corruption, epidemic diseases and covid pandemic, poor and inadequate health infrastructure etc. have contributed to poverty and malnutrition in Africa. These all recognize interdependence between SDG 1 and SDG 2 and underscore the necessity of addressing both issues in tandem, rather than in isolation.

Now, India represents a unique case for studying the interlinkage of SDGs 1 and SDG 2. Despite significant progress in poverty reduction and improvements in food security over the past few decades, India remains home to a large proportion of the world's poor and food-insecure population. According to the World Bank (2020), the survey year of 2011 finds at national level 22.50% of India's population lives below the poverty line (US$ 1.90 a day), with rural areas (26.30%) disproportionately affected (as compared to the urban areas with 14.20%) while India ranks along with Nigeria, the top two countries in the world for malnutrition, with an estimated mortality rate upper and lower bound of 3.3% and 4.0%, 3.1% and 3.8%, and 2.8% and

3.4% of children under in 2018, 2019 and 2021 (UNICEF, 2019; UNICEF, 2021; UNICEF, 2023). These statistics underscore the continued challenges before India in achieving both SDG 1 and SDG 2.

However, a brief review of the literature shows that there is least research on the present research agenda: possible interlinkage of the United Nations' sustainable development goals viz., SDG 1 "No Poverty" and SDG 2 "Zero Hunger" specifically on Indian context with the use of the World Development Indicators. This study seeks to fill this exact research gap.

Variables, Data and Methodology

The study uses the index values from the World Bank's sustainable performance indicator (SPI) database for the SDG 1 and SDG 2 for India from the time period of 2004 to 2022. It also uses the World Bank's World Development Indicators (WDIs) for SDG indicator targets accomplished by India in assessing the progress towards SDGs 1 and SDG 2. These WDIs are pivotal in understanding the broader socio-economic context of poverty and hunger. The WDIs compiled by the World Bank include a range of economic, social, and environmental data points that can help measure the progress of countries towards achieving these goals. These encompass the income levels, food availability, nutrition outcomes, agricultural productivity, and other dimensions that directly or indirectly affect poverty and hunger.

A scrutiny of the UN's SDGs, their targets, and proposed indicators shows that SDG 1 includes – a country's development actions targets by 2030 to (i) eradicate extreme poverty for all people and it targets people living on less than $ 1.25 a day, (ii) to reduce its population below poverty level by half the proportion of men, women and children of all ages, (iii) implement nationally appropriate social protection systems and measures for all, including floors, and achieve substantial coverage of the poor and the vulnerable, (iv) ensure that the poor and the vulnerable have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance, and (v) build resilience of the poor and vulnerable and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.

The targets, and proposed indicators for SDG 2 includes – a country's development action targets by 2030 to (i) end hunger and ensure access by the poor and vulnerable including infants to safe, nutritious and sufficient food all year round, (ii) end all forms of malnutrition, including achieving targets on stunting and wasting in children under 5 years of age by 2025, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons, (iii) increase the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment, (iv) ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, help maintain ecosystems, strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality, and (v) maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge.

The study, firstly, employs the Spearman's correlation coefficient analysis to explore associations between the two SDG SPI variables. Then, it performs the Augmented Dickey-Fuller (ADF) Unit Root tests for examining the stationarity nature of the SDG variable at different level of significance. The ADF unit root test becomes a handy research tool for examining suitability of application of different causality test methods viz., the Granger causality test, Toda-Yamoto Wald Test Causality Method, Single equation cointegration test method, Johansen System Cointegration Method, and Autoregressive Distributed Lagged (ARDL) Model for interconnectedness between the variables. If the variables are all I(0) in nature, then Granger causality test method along with the Single equation cointegration test method can be applied. If the variables are all I(1) in nature, then Johansen System Cointegration Method can be applied. However, if the variables are I (0) and/or I(1), then the ARDL model can be applied since it has an inbuilt VAR cointegration system. Nonetheless, if either of the variables are at most I(2) in nature and none are I(0) in nature, then the Toda-Yamoto Wald Test Causality Method can be applied for identifying the causality or cointegration between the variables.

The present study proposes the following theoretical proposition for the interconnectedness between the two development goals SDG 1 "No Poverty" and SDG 2 "Zero Hunger".

Research Proposition: *Nation's poverty and hunger are interwikied socio-economic phenomena and the both have multifaceted dimensions of sustainability and development where nations' poverty depict its people's economic deprivation and the hunger depict their physiological deprivation.*

***Research Hypothesis*:** In exploring the above, the study has the following four specific research hypotheses while the general null is that the variables in H_{01}, H_{02}, H_{03}, and H_{04} have insignificant relationships.

H_{01}: The SPI index values of SDG 1 and SDG 2 are significantly correlated.

H_{02}: The SPI index values of SDG 1 and SDG 2 have significant bidirectional causal interrelationships.

H_{03}: The WDI variables have significant correlation coefficients with the SPI index values of SDG 1.

H_{04}: The WDI variables have significant correlation coefficient with the SPI index values of SDG 2.

Now, for simplicity and convenience of the readers to understand the implications of H_{03} and H_{04}, the present study includes the concerned variables of the World Development Indicators in Appendix 1 towards explaining their interlinkage with the SDG 1 and SDG 2 in terms of their significant correlation coefficients only. This also allows the author to make the study brief and focused as well.

Results and Findings

In categorising the results and findings of the study, we firstly depict the trend value of the World Bank's SPI data for SDG 1 and SDG 2 in Table 1. The index value of SDG 1 refers to the degree of poverty level, and this means that, at the magnitude of 1 for its index value, the goal for "No Poverty" will be achieved. The blue line in the figure shows that India's performance in terms of SDG 1 remained stagnant at the index value of 0.667 from 2005 to 2014, and then declined to 0.571 and 0.286 in 2015 and 2016 respectively and the same remained at that level till 2019 and thereafter, its magnitude increased and the index value in 2020 and during 2021 – 2022 were 0.571 and 0.857 respectively. Therefore, it is vividly visible that India is moving positively and by 2030, that is, with in the next six years, there is a good possibility of getting the target of "No Poverty" fulfilled.

In terms of India's performance for "No Hunger" that is, SDG 2 SPI variable, Figure 1 depicts that achieving the goal of "Zero Hunger" is not far distant since the index value which has been staying at about 0.667 in 2004 has been improved to 0.667 in 2005 and interestingly reached to the ideal or target index value of 1 during the period of 2006 to 2009, but thereafter declined to 0.875 in 2010, to 0.625 in 2011 and continued at that level for two consecutive years in 2012 and 2013. The index value improved to 0.778 in 2014, took momentum to 0.90 in 2015 and stayed at that level for next four consecutive years from 2016 to 2019 and finally, it reached to 0.909 in 2020, 0.90 in the consecutive two year of 2021 and 2022. Therefore, the target goal is remained unreached as yet by 10% from the target index value of 1.

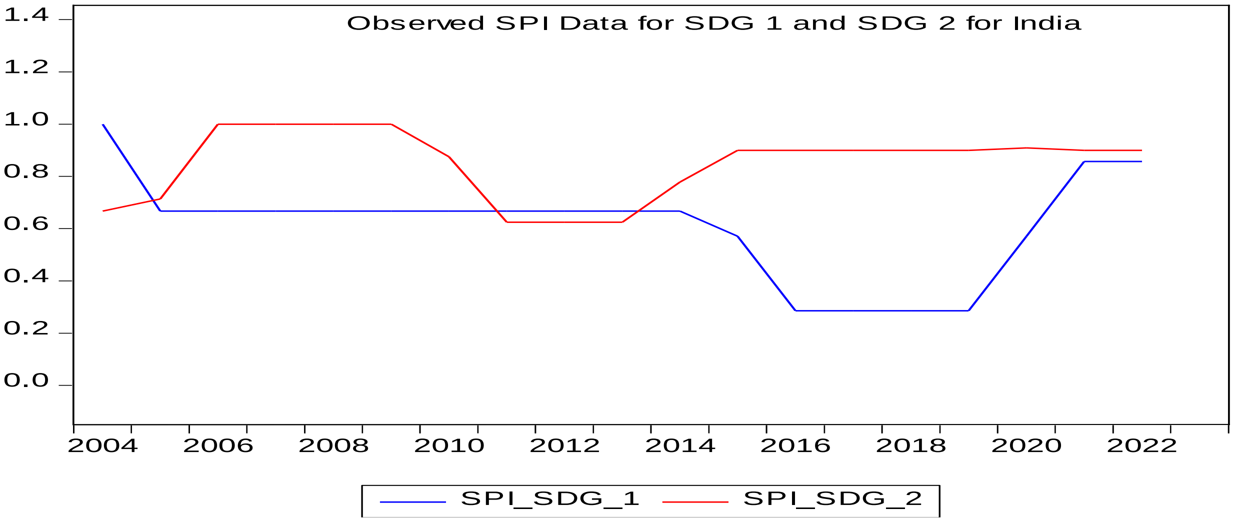

Figure 1: Observed SPI Data for SDG 1 and SDG 2 for India from 2004 to 2022

(Data Source: World Bank's Statistical Performance Indicators Database)
(Database link: https://databank.worldbank.org/source/statistical-performance-indicators-(spi))

Now, let us explore the observed correlation between the SPI data for SDG 1 and SDG 2 for India. In Table 1, the study shows that there is insignificant correlation coefficient (at ten percent level of significance) between the two performance index variables for India. The low number of the data size may be one factor for such insignificant relationship. Further, lesser variability in the values of the magnitudes for the performance index values might be another reason.

Table 1: Observed Correlation Coefficients between SDG 1 and SDG 2

(Table Source: Authors' Own Compilation in EViews 10)

Sample Data Period: 2004 - 2022		
SDI SPI Variables	**SPI_SDG_1**	**SPI_SDG_2**
Included observations:	**19**	**19**
Covariance Matrix:		
SPI_SDG_1	0.038380	-0.006857
SPI_SDG_2	-0.006857	0.016873
Correlation Matrix:		
SPI_SDG_1	1.000000	-0.269470
SPI_SDG_2	-0.269470	1.000000
t-Statistic Matrix:		
SPI_SDG_1	-----	-1.153733
SPI_SDG_2	-1.153733	-----
t-Statistic Probability Matrix:		

SPI_SDG_1	-----	0.2646
SPI_SDG_2	0.2646	-----

Table 2: Augmented Dickey-Fuller (ADF) Test Results for SDG 1 and SDG 2 during 2004 - 2022

[H_0: SDG 1 has unit root; H_1: SDG 1 does not have unit root]

(Table Source: Authors' Own Compilation in EViews 10)

Statistics	**With Level and Intercept**		**With Level and Trend & Intercept**		**1st Difference and Intercept**		**2nd Difference and Trend & Intercept**	
	SDG 1	**SDG 2**	**SDG 1**	**SDG 2**	**SDG 1**	**SDG 2**	**SDG 1**	**SDG 2**
t-Statistics	-1.73576	**-3.09294**	**-3.43285**	-2.9688	**-3.4803**	-2.82646	-3.25383	-2.74801
Sig. Level	0.3969	**0.0464**	**0.0846**	0.168	**0.0222**	0.0754	0.1074	0.2321
I(0) / I(1) at α <0.10	-	**I(0)**	**I(0)**	**-**	**I(1)**	**I(1)**	-	**-**
I(0) / I(1) at α <0.050	-	**I(0)**	**-**	**-**	**I(1)**	**-**	-	**-**

Our results for the Augmented Dickey-Fuller **(**ADF) unit root test for checking of the stationarity of the two series of values of the variables SDG 1 and SDG 2, in Table 2, shows that at a higher viz., ten percent level of significance, the level data of the two time series variable of SDG 1 and SDG 2 are I(0) in nature. Here, the variable of SDG 1 becomes I(0) once the same is considered for its level data with trend and intercepts effects while the variable of SDG 2 data becomes I(0) in nature once the same data is considered at level is considered along with intercept but not with trend and intercept. In the other words, the ADF test results clearly show that the SDG 2 variable, that is, "Zero Hunger" has no trend component within it while SDG 1, that is, "No Poverty" has a trend component within it. However, if we re-examine the ADF unit root test results at higher viz., five percent level of significance, the level data of SDG 2 with intercept only becomes stationary while with the trend and intercept effect, none of SDG 1 and SDG 2 are stationary, that is, at five percent level of significance, the variable SDG 1 is I(0) in nature and SDG 2 is I(1) in nature.

Therefore, Table 2 suggests that depending upon the choice for our selection of acceptance level of significance in considering the stationarity level, the present study has some flexibility to apply the Pairwise Granger causality test method and the ARDL method simultaneously. Nonetheless, in Table 3, our results with the Pair-wise Granger causality test (at the use of the lags of 2) of the SDG 1 and SDG 2 variables show that none of the two variables has significant bidirectional causal relationship in India. Therefore, the expected relationship of interconnectedness between SDG 1 and SDG 2 is not found with the Indian data in Table 2.

Table 3: Pair-Wise Granger Causality Test Results for SDG 1 and SDG 2 during 2004 – 2022

(Table Source: Authors' Own Compilation in EViews 10)

Pairwise Granger Causality Tests			
Date: 11/15/24 Time: 16:05			
Sample: 2004 - 2022			
Lags: 2			
Null Hypothesis:	**Obs**	**F-**	**Prob.**
SPI_SDG_2 does not Granger Cause	17	0.2488	0.7837
SPI_SDG_1 does not Granger Cause	17	0.47536	0.6329

Table 4: ARDL (Unrestricted) Model Results Explaining SDG 1 with SDG2

(Table Source: Authors' Own Compilation in EViews 10)

Dependent Variable: SPI_SDG_1				
Method: ARDL				
Date: 11/15/24 Time: 16:09				
Sample (adjusted): 2008 - 2022				
Included observations: 15 after adjustments				
Maximum dependent lags: 4 (Automatic selection)				
Model selection method: Akaike info criterion (AIC)				
Dynamic regressors (4 lags, automatic): SPI_SDG_2				
Fixed regressors: C @TREND				
Number of models evaluated: 20				
Selected Model: ARDL (4, 0)				
Variable	**Coefficient**	**Std.**	**t-**	**Prob.***
SPI_SDG_1(-1)	**1.025352**	0.287928	3.561139	**0.0074**
SPI_SDG_1(-2)	-0.63277	0.46927	-1.3484	0.2145
SPI_SDG_1(-3)	-0.09749	0.441233	-0.22094	0.8307
SPI_SDG_1(-4)	-0.56457	0.309188	-1.82597	0.1053
SPI_SDG_2	-0.08278	0.231153	-0.35814	0.7295
C	**1.131118**	0.408287	2.770397	**0.0243**
@TREND	**-0.02871**	0.012375	-2.32045	**0.0489**
R-squared	0.860786	Mean dependent		0.577933
Adjusted R-	**0.756376**	S.D. dependent var		0.198617
S.E. of regression	0.098034	Akaike info		-1.50228
Sum squared	0.076885	Schwarz criterion		-1.17186
Log likelihood	18.26711	Hannan-Quinn		-1.5058
F-statistic	**8.244281**	Durbin-Watson stat		2.405124
Prob(F-statistic)	**0.004452**			
*Note: p-values and any subsequent tests do not account for model				

Table 5: ARDL Model (Long Run Form and Bounds Test) Results Explaining SDG 1 with SDG 2

(Table Source: Authors' Own Compilation in EViews 10)

ARDL Long Run Form and Bounds Test

Dependent Variable: D(SPI_SDG_1)				
Selected Model: ARDL (4, 0)				
Case 5: Unrestricted Constant and Unrestricted Trend				
Date: 11/15/24 Time: 16:17				
Sample: 2004 2023				
Included observations: 15				
Conditional Error Correction Regression				
Variable	**Coefficie**	**Std. Error**	**t-Statistic**	**Prob.**
C	**1.131118**	0.408287	2.770397	**0.0243**
@TREND	**-**	0.012375	-2.320448	**0.0489**
SPI_SDG_1(-1)*	**-**	0.386802	-3.281960	**0.0112**
SPI_SDG_2**	-	0.231153	-0.358135	0.7295
D(SPI_SDG_1(-1))	**1.294820**	0.343716	3.767120	**0.0055**
D(SPI_SDG_1(-2))	0.662054	0.420847	1.573146	0.1543
D(SPI_SDG_1(-3))	0.564569	0.309188	1.825972	0.1053
* p-value incompatible with t-Bounds distribution.				
** Variable interpreted as Z = Z(-1) + D(Z).				
Levels Equation				
Case 5: Unrestricted Constant and Unrestricted Trend				
Variable	**Coefficie**	**Std. Error**	**t-Statistic**	**Prob.**
SPI_SDG_2	-	0.180963	-0.360359	0.7279
EC = SPI_SDG_1 - (-0.0652*SPI_SDG_2)				
F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic	
F-statistic	5.385648	10%	5.59	6.26
k	1	5%	6.56	7.3
		2.5%	7.46	8.27
		1%	8.74	9.63
Actual Sample Size	15		Finite Sample: n=30	
		10%	6.01	6.78
		5%	7.36	8.265
		1%	10.605	11.65
t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-	10%	-3.13	-3.4
		5%	-3.41	-3.69
		2.5%	-3.65	-3.96
		1%	-3.96	-4.26

Given the absence of interrelationship and collinearity between SDG 1 and SDG 2 variables for India, now it becomes imperative to go for further analysis of the two variables with the autoregressive distributed lag (ARDL) model. The model becomes handy for exploring long-run adjustment speed between two or more stationary or non-stationary variable in the nature of I(0) and / or I(0) but none being I(2) in nature. Our data for the SDG 1 and SDG 2 are I(0) in nature at ten percent level of significance while I(1) and I(0) in nature respectively at five percent level of significance, therefore, the present study does not need to transform the data for making it I(0) or I(1) in nature.

The results in the ARDL model with SDG 1 being the explained variable and SDG 2 being the explanatory variable are shown in Table 4, Table 5 and Table

6. Table 4 shows the unrestricted or unconditional version of the model while Table 5 and Table 6 show the restricted or conditional versions of the model. In Table 5, the conditional version of the ARDL model is the long-run form (along with bound test results) of the model while in Table 6, the model shows the results with respect to the conditional error correction version of the model. Nonetheless, the study performs the ARDL model with the SDG 2 as explained variable and SDG 1 being the explanatory variable in Table 7 (for the unrestricted version), Table 8 (for the long-run form along with its bound-test results) and Table 9 (for the conditional error correction version).

Our results, in Table 4, show that the SDG 2 variable has insignificant one year lagged impact on the SDG 1 variable while there exists significant trend effect. Besides, the SDG 1 variable shows significant coefficient value for the constant intercept term and this suggests for the presence of imbedded structural effect in improving the performance of the SDG 1 variable in India. Nonetheless, the model has significant value for the adjusted R-square parameter suggesting that with the SDG 2 as an explanatory variable, the model can explain 75.6376 percent variations in the SDG 1 variable.

In Table 5, the study shows that the conditional long-run form of the ARDL model has insignificant bound-test results suggesting the null-hypothesis that there exists no level relationship between the variables SDG 1 and SDG 2 has been accepted. The t-bound test statistics result also confirms the same. The table further shows that the SDG 1 variable has significant one-period lag effect (that is, long run effect), trend effect and constant intercept effect as well. Nonetheless, there is presence of short-run effect of the SDG 1 variable as reported with the significant coefficient value for the D(SPI_SDG_1(-1)) parameter.

Table 6: ARDL Model (Error Correction Model) Results Explaining SDG 1 with SDG 2

(Table Source: Authors' Own Compilation in EViews 10)

ARDL Error Correction Regression				
Dependent Variable: D(SPI_SDG_1)				
Selected Model: ARDL (4, 0)				
Case 5: Unrestricted Constant and Unrestricted Trend				
Date: 11/15/24 Time: 16:27				
Sample: 2004 2023				
Included observations: 15				
ECM Regression				
Case 5: Unrestricted Constant and Unrestricted Trend				
Variable	**Coefficie**	**Std. Error**	**t-Statistic**	**Prob.**
C	**1.131118**	0.348653	3.244255	**0.0118**
@TREND	**-**	0.011568	-2.482143	**0.0380**
D(SPI_SDG_1(-1))	**1.294820**	0.323961	3.996837	**0.0040**
D(SPI_SDG_1(-2))	0.662054	0.396755	1.668675	0.1337

D(SPI_SDG_1(-3))	**0.564569**	0.274482	2.056856	**0.0737**
CointEq(-1)*	**-**	0.364680	-3.481050	**0.0083**
R-squared	0.693752	Mean dependent		0.012667
Adjusted R-squared	**0.523614**	S.D. dependent var		0.133912
S.E. of regression	0.092427	Akaike info criterion		-1.635614
Sum squared resid	0.076885	Schwarz criterion		-1.352394
Log likelihood	18.26711	Hannan-Quinn		-1.638631
F-statistic	**4.077585**	Durbin-Watson stat		2.405124
Prob(F-statistic)	**0.032725**			
* p-value incompatible with t-Bounds distribution.				
F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
F-statistic	5.385648	10%	5.59	6.26
k	1	5%	6.56	7.3
		2.5%	7.46	8.27
		1%	8.74	9.63
t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-	10%	-3.13	-3.4
		5%	-3.41	-3.69
		2.5%	-3.65	-3.96
		1%	-3.96	-4.26

In Table 6, with the observations in the conditional error correction version of the ARDL model, the study shows that the SDG 1 variable has significant magnitude for the coefficient (at the magnitude of -1.269468) of its long-run speed of adjustment parameter ***CointEq(-1)*** besides the presence of significant constant intercept value and the lagged coefficient values in the long-run error correction model. Here, it is interesting to report that in the error correction model, the short-term effects of the SDG 1 variable are observed from its first-year and third year lag variables as well. These results suggests that the SDG 1 variable suffers from short-run vicious cycle effects and maintaining the correction needs greater adjustment speed.

On stability of the model coefficients in Table 4 and Table 6, the study finds that the respective F-statistics are significant at one percent level and five percent level of significance respectively. The Durbin-Watson statistics in the models, which are mostly at magnitude of 2.40 confirm presence of acceptable level of stability in terms of the residual errors in the ARDL models. The same can also be observed from the insignificant Jarque-Bera (JB) Normality Test statistics for the residuals in the model as depicted in Figure 2. Nonetheless, the diagnostic test results with the CUSUM Test for the residuals in Figure 3 show that the model has less stability while the same with the CUSUM of the squared-residuals in Figure 4 show stability of the model. This apparent conflict, however, can be attributed to the sample size of the study. The CUSUM of the residuals could show stability if more explanatory variables have been incorporated as well. The said apprehension could be justified with the further residual diagnostic test results depicted in Appendix 2 and Appendix 4.

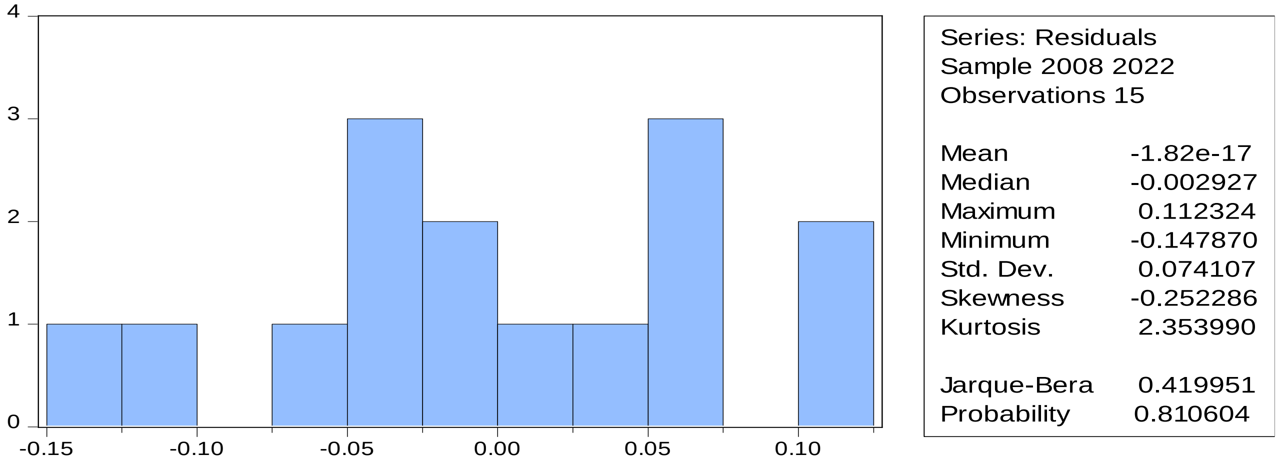

Figure 2: Jarque-Bera Normality Test of Residuals in ARDL Model Explaining SDG 1 with SDG 2

(Figure Source: Authors' Own Compilation in EViews 10)

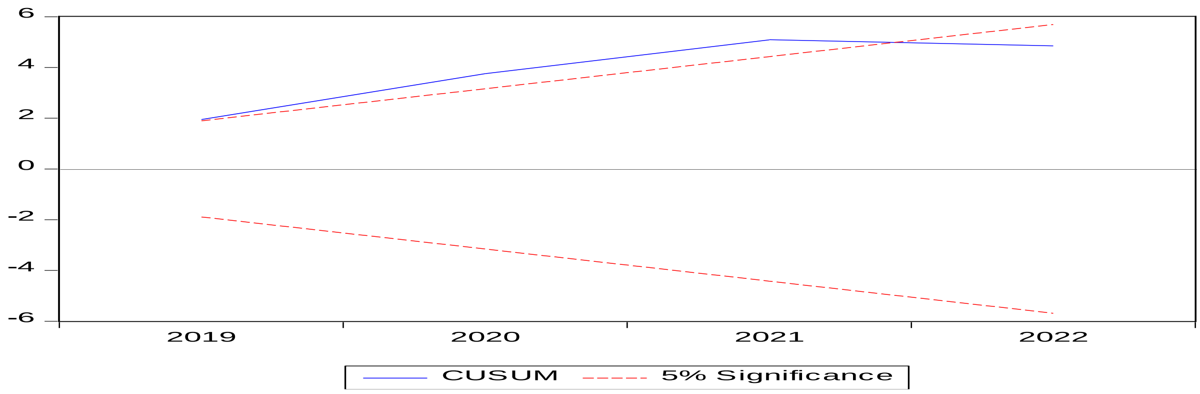

Figure 3: CUSUM of Residuals of ADRL Model explaining SDG 1 with SDG 2

(Source: Authors' Own Compilation in EViews 10)

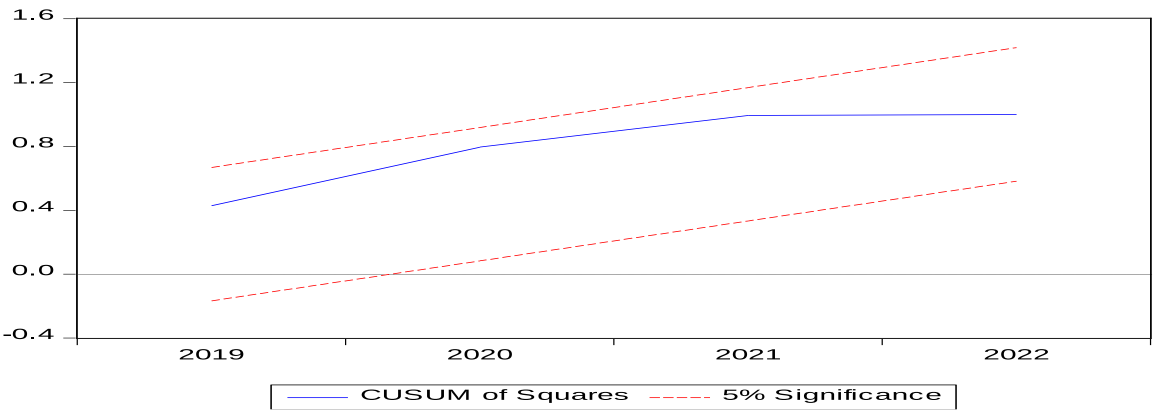

Figure 4: CUSUM of Squared Residuals of ADRL Model explaining SDG 1 with SDG 2

(Source: Authors' Own Compilation in EViews 10)

Now, the study empirically explores the ARDL model with the SDG 2 variable as explained variable and the SDG 1 variable as the explanatory variable in Table 7, Table 8 and Table 9. Interestingly, the unrestricted version of the ARDL model in Table 7 shows that only the constant intercept of the model is significant at five percent level of significance. Besides, the model has 69.7949 percent of explanatory power in the terms of its adjusted R-square value but with presence of lesser degree of stability for the model itself at its F-statistics being significant at six percent level of significance only. Furthermore, the Durbin-Watson statistics is at very high magnitude mostly of 2.95. The model results suggest for inability to explain the SDG 2 variable by the SDG 1 variable with the Indian data.

Table 7: ARDL (Unrestricted) Model Results Explaining SDG 2 with SDG 1

(Table Source: Authors' Own Compilation in EViews 10)

Dependent Variable: SPI_SDG_2				
Method: ARDL				
Date: 11/15/24 Time: 16:30				
Sample (adjusted): 2008 2022				
Included observations: 15 after adjustments				
Maximum dependent lags: 4 (Automatic selection)				
Model selection method: Akaike info criterion (AIC)				
Dynamic regressors (4 lags, automatic): SPI_SDG_1				
Fixed regressors: C @TREND				
Number of models evalulated: 20				
Selected Model: ARDL(4, 3)				
Variable	**Coefficien**	**Std. Error**	**t-Statistic**	**Prob.***
SPI_SDG_2(-1)	0.590995	0.336741	1.755046	0.1396
SPI_SDG_2(-2)	-0.263204	0.356606	-0.738081	0.4936
SPI_SDG_2(-3)	-0.004847	0.288685	-0.016789	0.9873
SPI_SDG_2(-4)	-0.534680	0.265748	-2.011982	0.1004
SPI_SDG_1	0.076653	0.216995	0.353246	0.7383
SPI_SDG_1(-1)	0.000901	0.318407	0.002830	0.9979
SPI_SDG_1(-2)	-0.136831	0.365135	-0.374741	0.7232
SPI_SDG_1(-3)	-0.350355	0.337615	-1.037734	0.3470
C	**1.355060**	0.523385	2.589031	**0.0489**
@TREND	-0.009822	0.010230	-0.960066	0.3811
R-squared	0.892125	Mean dependent var		0.849133
Adjusted R-squared	**0.697949**	S.D. dependent var		0.126393
S.E. of regression	0.069465	Akaike info criterion		-2.261274
Sum squared resid	0.024127	Schwarz criterion		-1.789240
Log likelihood	26.95955	Hannan-Quinn		-2.266302
F-statistic	**4.594414**	Durbin-Watson stat		2.947337
Prob (F-statistic)	**0.053917**			
*Note: p-values and any subsequent tests do not account for model selection				

Our results in Table 8 with the conditional long-run model of the SDG 2 variable show that the long-run model has significant coefficients for the constant intercept term, its one-period lag variable as well as the first order differentiation variable at the second lag while the F-Bound test statistic is significant at ten percent level of significance suggesting that the existence of level relationship is very week but significant at higher level of significance, that is, ten percent level. Here also, the SDG 1 variable has been found making no influence on the SDG 2 variable. The variable SDG 2 purely derives its dynamic effects in relationship from its own long-run lagged effect and its short-term structural effect in terms of its significant constant intercept value.

Table 8: ARDL Model (Long Run Form and Bounds Test) Results Explaining SDG 2 with SDG 1

(Table Source: Authors' Own Compilation in EViews 10)

ARDL Long Run Form and Bounds Test				
Dependent Variable: D(SPI_SDG_2)				
Selected Model: ARDL (4, 3)				
Case 5: Unrestricted Constant and Unrestricted Trend				
Date: 11/15/24 Time: 16:31				
Sample: 2004 2023				
Included observations: 15				
Conditional Error Correction Regression				
Variable	**Coefficie**	**Std. Error**	**t-Statistic**	**Prob.**
C	**1.35506**	0.523385	2.589031	**0.0489**
@TREND	-	0.010230	-0.960066	0.3811
SPI_SDG_2(-1)*	**-**	0.350515	-3.457010	**0.0181**
SPI_SDG_1(-1)	-	0.350572	-1.168469	0.2953
D(SPI_SDG_2(-1))	0.802730	0.270411	2.968559	0.0312
D(SPI_SDG_2(-2))	**0.53952**	0.245971	2.193457	**0.0797**
D(SPI_SDG_2(-3))	0.534680	0.265748	2.011982	0.1004
D(SPI_SDG_1)	0.076653	0.216995	0.353246	0.7383
D(SPI_SDG_1(-1))	0.487186	0.367239	1.326619	0.2420
D(SPI_SDG_1(-2))	0.350355	0.337615	1.037734	0.3470
* p-value incompatible with t-Bounds distribution.				
Levels Equation				
Case 5: Unrestricted Constant and Unrestricted Trend				
Variable	**Coefficie**	**Std. Error**	**t-Statistic**	**Prob.**
SPI_SDG_1	-	0.252206	-1.340390	0.2378
EC = SPI_SDG_2 - (-0.3381*SPI_SDG_1)				
F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptoti	
F-statistic	**6.26091**	10%	5.59	6.26
k	1	5%	6.56	7.3
		2.5%	7.46	8.27
		1%	8.74	9.63
Actual Sample Size	15		Finite Sample: n=30	
		10%	**6.01**	6.78
		5%	7.36	8.265
		1%	10.605	11.65

t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
t-statistic	**-**	10%	-3.13	-3.4
		5%	**-3.41**	-3.69
		2.5%	-3.65	-3.96
		1%	-3.96	-4.26

Our results with the conditional error correction model of the SDG 2 variable as explained by the SDG 1 variable in Table 9 show that SDG 2 has significant long-run speed of adjustment (-1.211735) in the terms of its coefficient value for the parameter of *CointEq(-1).* The model has significant values for its constant intercept parameter along with its three short-term lagged variables. Interestingly, there exists short-run long-run significant effect of the SDG 1 variable at its one period lag at mostly nine percent level of significance. The F-Bound F-statistics confirms the speed of adjustment (-1.211735) as well significant at 10 percent level of significance while the presence of level relationship is evident with the significant value of t-bound t-test statistics at two and half percent level of significance. But the model results' stability is very week and the is significant only at eleven percent level of significance in the terms of the F-statistics value. These all suggests for presence of week cointegration effects of the SDG 1 variable on the SDG 2 variable for India.

Table 9: ARDL Model (Error Correction Model) Results Explaining SDG 2 with SDG 1

(Table Source: Authors' Own Compilation in EViews 10)

ARDL Error Correction Regression				
Dependent Variable: D(SPI_SDG_2)				
Selected Model: ARDL(4, 3)				
Case 5: Unrestricted Constant and Unrestricted Trend				
Date: 11/15/24 Time: 16:32				
Sample: 2004 2023				
Included observations: 15				
ECM Regression				
Case 5: Unrestricted Constant and Unrestricted Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	**1.355060**	0.362491	3.738192	**0.0135**
@TREND	-0.009822	0.005624	-1.746481	0.1412
D(SPI_SDG_2(-1))	**0.802730**	0.243957	3.290461	**0.0217**
D(SPI_SDG_2(-2))	**0.539526**	0.224476	2.403487	**0.0614**
D(SPI_SDG_2(-3))	**0.534680**	0.242553	2.204383	**0.0787**
D(SPI_SDG_1)	0.076653	0.160818	0.476641	0.6537
D(SPI_SDG_1(-1))	**0.487186**	0.228568	2.131473	**0.0862**
D(SPI_SDG_1(-2))	0.350355	0.216801	1.616022	0.1670
CointEq(-1)*	**-1.211735**	0.312596	-3.876364	**0.0117**
R-squared	0.791855	Mean dependent var		-0.006667
Adjusted R-squared	**0.514329**	S.D. dependent var		0.090992
S.E. of regression	0.063412	Akaike info criterion		-2.394607
Sum squared resid	0.024127	Schwarz criterion		-1.969777
Log likelihood	26.95955	Hannan-Quinn criter.		-2.399132
F-statistic	**2.853261**	Durbin-Watson stat		2.947337

Prob(F-statistic)	**0.109141**			
* p-value incompatible with t-Bounds distribution.				
F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
F-statistic	**6.260914**	**10%**	**5.59**	6.26
k	1	5%	6.56	7.3
		2.5%	7.46	8.27
		1%	8.74	9.63
t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	**-3.876364**	10%	-3.13	-3.4
		5%	-3.41	-3.69
		2.5%	**-3.65**	-3.96
		1%	-3.96	-4.26

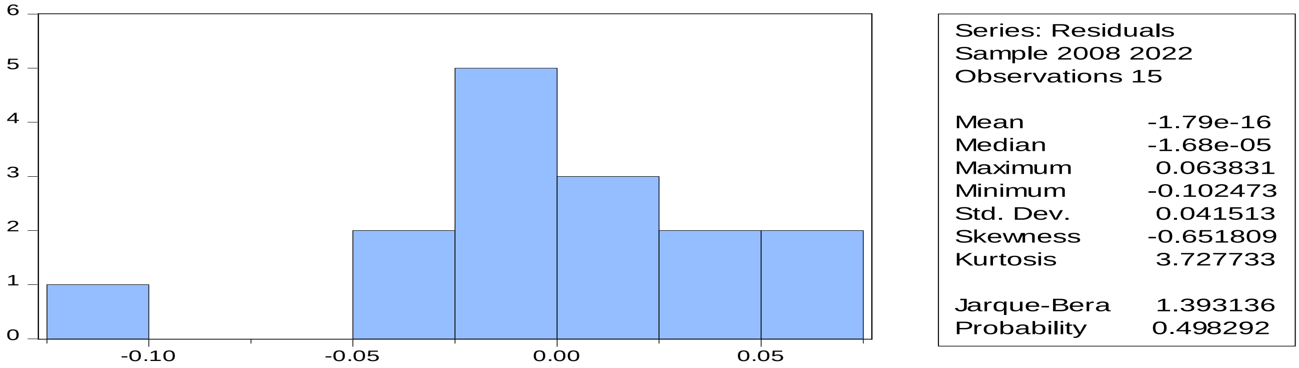

Figure 5: Jarque-Bera Normality Test of Residuals in ARDL Model Explaining SDG 2 with SDG 1

(Figure Source: Authors' Own Compilation in EViews 10)

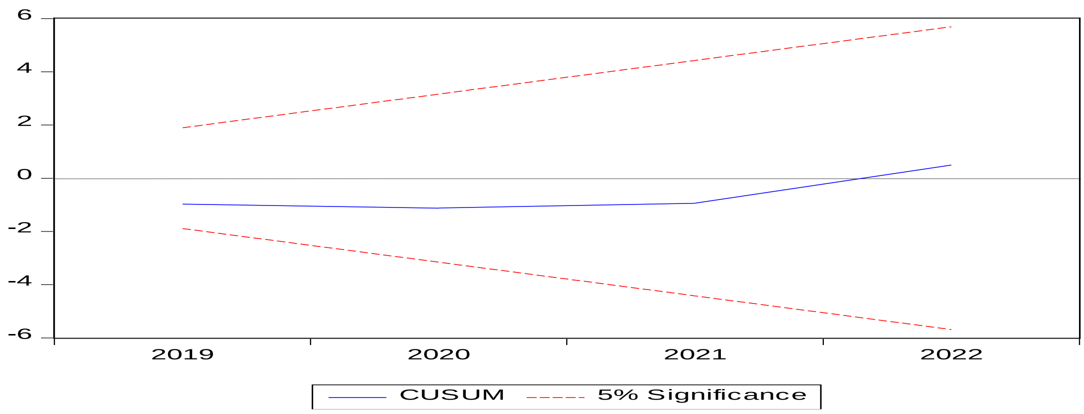

Figure 6: CUSUM of Residuals of ADRL Model explaining SDG 2 with SDG 1

(Source: Authors' Own Compilation in EViews 10)

Besides the above, the diagnostic test results suggests that there exists stability of the model. For example, the J-B Normality test statistics in Figure 5 shows insignificant parameter value while Figure 6 and Figure 7 find that the CUSUM of the residuals and the squared residuals of the model are within the limits of stability. The aforementioned findings could be justified with additional diagnostic test results for the ARDL regression residual autocorrelation test results (refer to Appendix 2 and Appendix 4) and residual heteroskedasticity test results (Appendix 4 and Appendix 5).

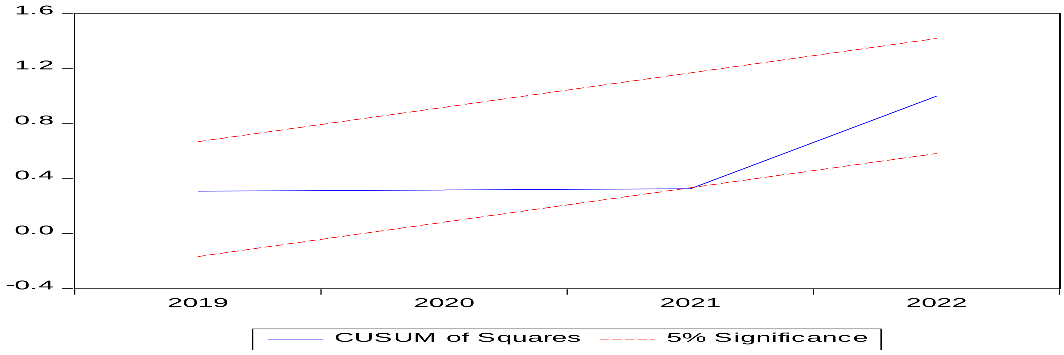

Figure 7: CUSUM of Squared Residuals of ADRL Model explaining SDG 2 with SDG 1

(Source: Authors' Own Compilation in EViews 10)

Finally, our results with the relationships of the one hundred sixty-six World Development Indicator variables (please see the list in the Appendix 5) related to the socio-economic status of the people in India as depicted in Table 10 show their respective magnitudes for the Pearson correlation coefficients of the SDG 1 and SDG 2 variables. The table shows that with the SDG 1 variable, there are eighty-eight instances of significant (ten percent level of significance) correlation coefficients for the WDI variables while with the SDG 2 variable, there are only seven instances of significant corelation coefficients of the WDI variables.

Out of the eighty-eight cases, SDG 1 is found negatively correlated with the WDI variables of access to clean fuels, access to electricity, adjusted national income, percentage of female populations in 25-29 ages, percentage of both male and female populations within the ages of 30-34, 55-59, and 60-64 but percentage of female populations within the ages of 75-79 but that of male populations within ages of 80-above. Besides, the SDG 1 variable is found to be negatively correlated expenses for subsidies and other transfers, the total female unemployment rate, both youth male and female unemployment rate, with children's vitamin A supplement coverage rate, and with wages of salaried workers. SDG 1 has less gender bias. Nonetheless, agricultural irrigated land, water stress level, life expectancy at birth, maternal life-time death risk, population age, unemployment rate, employment in industry, employment in services, and child immunization for DTP and measles have negative correlation with SDG 1. However, SDG 1 has significantly positive correlation with a batch of WDI variable such as percentage of adjusted gross savings, age dependency ratio, employment in agriculture for all categories, percentage population employment above 15, female fertility rate, percentage of participation of labour force of age 15-24 and 15-64, percentage of female labour force, population employment rate of ages 15-24, population's adult male mortality rate, life expectancy of male at birth, total life expectancy, anaemia with pregnant women and children, government subsidies and transfers, unemployment of the youth male and female, maternal death and life-time risk, suicide death rates, poor status of people's nourishment, female employment in agriculture, male employment in services, wage and salaries of female employment, hazardous or vulnerable employment of the female etc. A long depiction of the correlation of WDI with SDG 1 is avoided to save space. Interested readers may study Table 10 at convenience. These suggest that there exist a long network of influence and industry bias those influence "No Hunger" while the direction and extent of magnitudes might be different.

Out of the seven cases of the WDI variables as correlated with the SDG 2 variable, three cases are observed respectively with the variable of percentage of "people with basic handwashing facilities including soap and water" in the total population, in the rural population, and in the urban population. Another instance with the number of people involved in "Net migration", besides the other three cases with the unemployment rate viz., unemployment rate for the youth, for female, and for total population. That is, WDI variables perform as strong proxy for exploring poverty eradication goals but little for eradicating hunger.

Table 10: Correlation Coefficients of World Development Indicators (WDI) with SDG 1 and SDG 2

(Correlation Coefficient Source: Authors' Own Compilation in EViews 10)

WDI Data Source: World Bank's World Development Indicator Database					
SPI Data Source: World Bank's Statistical Performance Indicators Database					
Sl. No	**WDI Variables**	**SDG 1**	**Sig. Level**	**SDG 2**	**Sig. Level**
1	"Access to clean fuels and technologies for cooking (% of population)"	-0.2693	0.265	0.2009	0.4096
2	"Access to clean fuels and technologies for cooking, rural (% of rural population)"	-0.2119	0.3838	0.2194	0.3668
3	"Access to clean fuels and technologies for cooking, urban (% of urban population)"	**-0.4141**	**0.078**	0.1458	0.5513
4	"Access to electricity (% of population)"	**-0.4168**	**0.0758**	0.1776	0.4669

5	“Access to electricity, rural (% of rural population)”	**-0.4016**	**0.0883**	0.1803	0.4602
6	“Access to electricity, urban (% of urban population)”	**-0.4499**	**0.0533**	0.1889	0.4386
7	“Adjusted net national income (annual % growth)”	0.2249	0.3695	-0.0139	0.9563
8	“Adjusted net national income per capita (annual % growth)”	0.2022	0.421	0	0.9999
9	“Adjusted net national income per capita (constant 2015 US$)”	**-0.6225**	**0.0058**	0.1577	0.532
10	“Adjusted net savings, excluding particulate emission damage (% of GNI)”	0.2954	0.2341	-0.0428	0.866
11	“Adjusted net savings, including particulate emission damage (% of GNI)”	0.2533	0.3105	-0.0228	0.9286
12	“Adjusted savings: gross savings (% of GNI)”	**0.433**	**0.0727**	-0.0616	0.8083
13	“Age dependency ratio (% of working-age population)”	**0.401**	**0.0889**	-0.1443	0.5557
14	“Age dependency ratio, old (% of working-age population)”	-0.2725	0.259	0.2528	0.2964
15	“Age dependency ratio, young (% of working-age population)”	0.3843	0.1043	-0.1635	0.5037
16	“Agricultural irrigated land (% of total agricultural land)”	**-0.4224**	**0.0808**	0.2215	0.377
17	“Agricultural land (% of land area)”	0.3782	0.1217	-0.2746	0.2701
18	“Crop production index (2014-2016 = 100)”	-0.3267	0.1721	0.1066	0.6641
19	“Employment in agriculture (% of total employment) (modeled ILO estimate)”	**0.5904**	**0.0078**	-0.071	0.7726
20	“Employment in agriculture, female (% of female employment) (modeled ILO estimate)”	**0.6819**	**0.0013**	-0.0316	0.8979
21	“Employment in agriculture, male (% of male employment) (modeled ILO estimate)”	**0.549**	**0.0149**	-0.0963	0.6949
2“2	“Employment in industry (% of total employment) (modeled ILO estimate)”	**-0.4629**	**0.046**	-0.0603	0.8064

23	“Employment in industry, female (% of female employment) (modeled ILO estimate)”	**-0.5074**	**0.0266**	-0.3068	0.2014
24	“Employment in industry, male (% of male employment) (modeled ILO estimate)”	**-0.4235**	**0.0708**	-0.0011	0.9966
25	“Employment in services (% of total employment) (modeled ILO estimate)”	**-0.6314**	**0.0037**	0.2101	0.388
26	“Employment in services, female (% of female employment) (modeled ILO estimate)”	**-0.5976**	**0.0069**	0.199	0.4141
27	“Employment in services, male (% of male employment) (modeled ILO estimate)”	**-0.636**	**0.0034**	0.2367	0.3293
28	“Employment to population ratio, 15+, female (%) (modeled ILO estimate)”	**0.6067**	**0.0059**	0.1212	0.6212
29	“Employment to population ratio, 15+, male (%) (modeled ILO estimate)”	**0.4422**	**0.058**	-0.2503	0.3013
30	“Employment to population ratio, 15+, total (%) (modeled ILO estimate)”	**0.5794**	**0.0093**	-0.0942	0.7012
31	“Employment to population ratio, ages 15-24, female (%) (modeled ILO estimate)”	**0.4722**	**0.0412**	-0.1183	0.6296
32	“Employment to population ratio, ages 15-24, male (%) (modeled ILO estimate)”	**0.5187**	**0.0229**	-0.0846	0.7305
33	“Employment to population ratio, ages 15-24, total (%) (modeled ILO estimate)”	**0.5042**	**0.0277**	-0.0964	0.6945
34	“Fertility rate, total (births per woman)	**0.4096**	**0.0816**	-0.1509	0.5374
35	“Immunization, DPT (% of children ages 12-23 months)”	**-0.4922**	**0.0323**	-0.0172	0.9443
36	“Immunization, measles (% of children ages 12-23 months)	**-0.5056**	**0.0272**	0.0786	0.749
37	“Labor force participation rate for ages 15-24, female (%) (modeled ILO estimate)”	**0.417**	**0.0757**	-0.1254	0.6089
38	“Labor force participation rate for ages 15-24, male (%) (modeled ILO estimate)”	**0.4243**	**0.0702**	-0.0995	0.6853

39	"Labor force participation rate for ages 15-24, total (%) (modeled ILO estimate)"	**0.4214**	**0.0723**	-0.1094	0.6556
40	"Labor force participation rate, female (% of female population ages 15-64) (modeled ILO estimate)"	**0.5526**	**0.0141**	0.1032	0.6741
41	"Labor force participation rate, male (% of male population ages 15-64) (modeled ILO estimate)"	**0.4016**	**0.0883**	-0.2423	0.3176
42	"Labor force participation rate, total (% of total population ages 15-64) (modeled ILO estimate)"	**0.5287**	**0.02**	-0.0849	0.7297
43	"Labor force, female (% of total labor force)"	**0.4975**	**0.0302**	0.2398	0.3228
44	"Labor force, total	-0.3451	0.1478	0.1659	0.4972
45	"Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	**-0.5945**	**0.0118**	0.0254	0.9229
46	"Life expectancy at birth, female (years)	**-0.752**	**0.0002**	0.0898	0.7148
47	"Life expectancy at birth, male (years)"	**-0.7798**	**0.0001**	0.0938	0.7024
48	"Life expectancy at birth, total (years)"	**-0.7692**	**0.0001**	0.0916	0.7093
49	"Lifetime risk of maternal death (%)"	**0.7165**	**0.0012**	-0.1062	0.6849
50	"Lifetime risk of maternal death (1 in: rate varies by country)"	**-0.7096**	**0.0014**	0.1245	0.634
51	"Mortality caused by road traffic injury (per 100,000 population)"	**0.5031**	**0.047**	-0.2297	0.392
52	"Mortality from CVD, cancer, diabetes or CRD between exact ages 30 and 70 (%)"	**0.4544**	**0.077**	-0.1518	0.5746
53	"Mortality from CVD, cancer, diabetes or CRD between exact ages 30 and 70, female (%)"	-0.2596	0.3316	-0.1983	0.4615
54	"Mortality from CVD, cancer, diabetes or CRD between exact ages 30 and 70, male (%)"	**0.5485**	**0.0278**	-0.0827	0.7608
55	"Mortality rate, adult, female (per 1,000 female adults)"	**0.6609**	**0.0021**	0.0538	0.8268

56	“Mortality rate, adult, male (per 1,000 male adults)”	**0.8799**	**0**	-0.0795	0.7462
57	“Mortality rate, infant (per 1,000 live births)”	**0.4004**	**0.0894**	-0.1508	0.5377
58	“Mortality rate, infant, female (per 1,000 live births)”	**0.3964**	**0.0929**	-0.1511	0.5369
59	“Mortality rate, infant, male (per 1,000 live births)”	**0.4044**	**0.086**	-0.1461	0.5505
60	“Mortality rate, neonatal (per 1,000 live births)”	0.3693	0.1197	-0.1598	0.5133
61	“Mortality rate, under-5 (per 1,000 live births)”	**0.4156**	**0.0768**	-0.1447	0.5546
62	“Mortality rate, under-5, female (per 1,000 live births)”	**0.4154**	**0.0769**	-0.1449	0.5538
63	“Mortality rate, under-5, male (per 1,000 live births)”	**0.4151**	**0.0772**	-0.1432	0.5586
64	“Net migration	-0.0931	0.7047	**-0.5342**	**0.0185**
65	“Newborns protected against tetanus (%)”	-0.2091	0.3902	0.1673	0.4936
66	“Number of deaths ages 10-14 years	0.3718	0.117	-0.1712	0.4835
67	“Number of deaths ages 15-19 years	0.37	0.1189	-0.1527	0.5326
68	“Number of deaths ages 20-24 years	0.3667	0.1225	-0.1482	0.5449
69	“Number of deaths ages 5-9 years	**0.4199**	**0.0735**	-0.1341	0.5842
70	“Number of infant deaths	**0.4115**	**0.08**	-0.1597	0.5137
71	“Number of maternal deaths	**0.7446**	**0.0006**	-0.1029	0.6944
72	“Number of neonatal deaths	**0.3905**	**0.0983**	-0.1667	0.4951
73	“People practicing open defecation (% of population)”	0.3715	0.1173	-0.1638	0.5029
74	“People practicing open defecation, rural (% of rural population)”	0.3651	0.1243	-0.1656	0.4979
75	“People practicing open defecation, urban (% of urban population)”	0.3673	0.1218	-0.1647	0.5005
76	“People using at least basic drinking water services (% of population)”	-0.3738	0.1149	0.1628	0.5054

77	"People using at least basic drinking water services, rural (% of rural population)"	-0.3664	0.1228	0.165	0.4998
78	"People using at least basic drinking water services, urban (% of urban population)"	-0.3673	0.1219	0.1647	0.5005
79	"People using at least basic sanitation services (% of population)"	-0.3702	0.1187	0.1647	0.5005
80	"People using at least basic sanitation services, rural (% of rural population)"	-0.3687	0.1203	0.1653	0.4988
81	"People using at least basic sanitation services, urban (% of urban population)"	-0.3546	0.1363	0.1687	0.49
82	"People using safely managed drinking water services, rural (% of rural population)"	-0.3522	0.1392	0.1694	0.4881
83	"People using safely managed sanitation services (% of population)"	-0.3729	0.1159	0.1627	0.5056
84	"People using safely managed sanitation services, rural (% of rural population)"	-0.3701	0.1188	0.165	0.4998
85	"People using safely managed sanitation services, urban (% of urban population)"	-0.3399	0.1544	0.1651	0.4993
86	"People with basic handwashing facilities including soap and water (% of population)"	0.0613	0.8423	**0.649**	**0.0164**
87	"People with basic handwashing facilities including soap and water, rural (% of rural population)"	0.0729	0.813	**0.644**	**0.0175**
88	"People with basic handwashing facilities including soap and water, urban (% of urban population)"	0.0729	0.813	**0.644**	**0.0175**
89	"Population ages 00-04, female (% of female population)"	**0.3979**	**0.0916**	-0.1689	0.4895
90	"Population ages 00-04, male (% of male population)"	**0.3924**	**0.0966**	-0.1751	0.4734
91	"Population ages 0-14 (% of total population)"	0.3674	0.1218	-0.1736	0.4773
92	"Population ages 0-14, female (% of female population)"	0.3712	0.1176	-0.1725	0.48

93	"Population ages 0-14, male (% of male population)"	0.3638	0.1257	-0.1745	0.4748
94	"Population ages 05-09, female (% of female population)"	0.3563	0.1343	-0.1435	0.5578
95	"Population ages 05-09, male (% of male population)"	0.3494	0.1426	-0.1425	0.5605
96	"Population ages 10-14, female (% of female population)"	0.3387	0.1561	-0.2173	0.3716
97	"Population ages 10-14, male (% of male population)"	0.3231	0.1773	-0.2181	0.3698
98	"Population ages 15-19, female (% of female population)"	0.3065	0.2019	-0.1414	0.5638
99	"Population ages 15-19, male (% of male population)"	0.2477	0.3066	-0.2037	0.403
100	"Population ages 15-64 (% of total population)"	**-0.3913**	**0.0976**	0.1479	0.5457
101	"Population ages 15-64, female (% of female population)"	**-0.3984**	**0.0911**	0.1464	0.5498
102	"Population ages 15-64, male (% of male population)"	-0.3849	0.1036	0.1492	0.5421
103	"Population ages 20-24, female (% of female population)"	0.3058	0.203	-0.1185	0.6289
104	"Population ages 20-24, male (% of male population)"	0.2583	0.2857	0.0285	0.9079
105	"Population ages 25-29, female (% of female population)"	**-0.4912**	**0.0327**	-0.1143	0.6412
106	"Population ages 25-29, male (% of male population)"	-0.386	0.1026	-0.0377	0.8781
107	"Population ages 30-34, female (% of female population)"	**-0.4349**	**0.0628**	0.1985	0.4152
108	"Population ages 30-34, male (% of male population)"	**-0.4318**	**0.0649**	0.1814	0.4573
109	"Population ages 35-39, female (% of female population)"	-0.2504	0.3012	0.1838	0.4514
110	"Population ages 35-39, male (% of male population)"	-0.2595	0.2834	0.1868	0.4437
111	"Population ages 40-44, female (% of female population)"	-0.3197	0.1821	0.1778	0.4665
112	"Population ages 40-44, male (% of male population)"	-0.2859	0.2354	0.1888	0.4389
113	"Population ages 45-49, female (% of female population)"	-0.314	0.1905	0.1855	0.4472

114	"Population ages 45-49, male (% of male population)"	-0.2667	0.2697	0.2037	0.403
115	"Population ages 50-54, female (% of female population)"	-0.3701	0.1188	0.1709	0.4842
116	"Population ages 50-54, male (% of male population)"	-0.3536	0.1375	0.1872	0.4427
117	"Population ages 55-59, female (% of female population)"	**-0.4147**	**0.0775**	0.1355	0.5803
118	"Population ages 55-59, male (% of male population)"	**-0.4188**	**0.0743**	0.1572	0.5204
119	"Population ages 60-64, female (% of female population)"	**-0.4028**	**0.0873**	0.0959	0.6961
120	"Population ages 60-64, male (% of male population)"	**-0.4112**	**0.0803**	0.0701	0.7754
121	"Population ages 65 and above (% of total population)"	-0.2925	0.2243	0.2349	0.3331
122	"Population ages 65 and above, female (% of female population)"	-0.2925	0.2243	0.231	0.3413
123	"Population ages 65 and above, male (% of male population)"	-0.2925	0.2244	0.2387	0.325
124	"Population ages 65-69, female (% of female population)"	-0.2853	0.2365	0.2592	0.2838
125	"Population ages 65-69, male (% of male population)"	-0.3278	0.1707	0.2581	0.2861
126	"Population ages 70-74, female (% of female population)"	-0.1209	0.6219	0.2233	0.3581
127	"Population ages 70-74, male (% of male population)"	-0.101	0.6808	0.2272	0.3496
128	"Population ages 75-79, female (% of female population)"	**-0.4113**	**0.0802**	0.1421	0.5618
129	"Population ages 75-79, male (% of male population)"	-0.3436	0.1498	0.2007	0.4101
130	"Population ages 80 and above, female (% of female population)"	-0.3806	0.1079	0.2212	0.3629
131	"Population ages 80 and above, male (% of male population)"	**-0.4168**	**0.0759**	0.2063	0.3967
132	"Population growth (annual %)"	0.2009	0.4096	-0.2462	0.3096
133	"Population in the largest city (% of urban population)"	-0.3544	0.1366	0.1673	0.4937
134	"Prevalence of anemia among children (% of children ages 6-59 months)"	**0.8147**	**0.0001**	-0.0452	0.8681

135	"Prevalence of anemia among non-pregnant women (% of women ages 15-49)"	**0.6759**	**0.0041**	0.1236	0.6484
136	"Prevalence of anemia among pregnant women (%)"	**0.8207**	**0.0001**	-0.0489	0.8574
137	"Prevalence of anemia among women of reproductive age (% of women ages 15-49)"	**0.6772**	**0.004**	0.1047	0.6997
138	"Prevalence of HIV, total (% of population ages 15-49)"	**0.5613**	**0.0124**	-0.1885	0.4396
139	"Prevalence of undernourishment (% of population)"	**0.6973**	**0.0013**	-0.1431	0.5712
140	"Rural population (% of total population)"	0.3358	0.1599	-0.1779	0.4662
141	"Rural population growth (annual %)"	0.2225	0.36	-0.2412	0.3198
142	"Sex ratio at birth (male births per female births)"	0.1511	0.537	-0.244	0.3142
143	"Subsidies and other transfers (% of expense)"	**-0.8139**	**0.0002**	0.0993	0.7249
144	"Suicide mortality rate (per 100,000 population)"	**0.7612**	**0.0006**	-0.0817	0.7637
145	"Suicide mortality rate, female (per 100,000 female population)"	**0.7708**	**0.0005**	-0.1582	0.5585
146	"Suicide mortality rate, male (per 100,000 male population)"	**0.7404**	**0.001**	-0.0184	0.946
147	"Tuberculosis case detection rate (%, all forms)"	-0.3619	0.1278	0.2976	0.2159
148	"Tuberculosis treatment success rate (% of new cases)"	0.3813	0.1185	-0.0656	0.7959
149	"Unemployment, female (% of female labor force) (modeled ILO estimate)"	0.0008	0.9974	-0.1832	0.4527
150	"Unemployment, female (% of female labor force) (national estimate)"	**-0.6465**	**0.0832**	0.6213	0.1001
151	"Unemployment, male (% of male labor force) (modeled ILO estimate)"	0.0005	0.9983	-0.1401	0.5674
152	"Unemployment, male (% of male labor force) (national estimate)"	-0.4289	0.289	**0.6751**	**0.0662**
153	"Unemployment, total (% of total labor force) (modeled ILO estimate)"	0.001	0.9967	-0.156	0.5236
154	"Unemployment, total (% of total labor force) (national estimate)"	-0.4776	0.2314	**0.6705**	**0.0688**

155	"Unemployment, youth female (% of female labor force ages 15-24) (modeled ILO estimate)"	**-0.7236**	**0.0005**	0.0959	0.6962
156	"Unemployment, youth female (% of female labor force ages 15-24) (national estimate)"	-0.4685	0.2416	**0.7423**	**0.035**
157	"Unemployment, youth male (% of male labor force ages 15-24) (modeled ILO estimate)"	**-0.7258**	**0.0004**	0.0381	0.877
158	"Unemployment, youth total (% of total labor force ages 15-24) (modeled ILO estimate)"	**-0.7273**	**0.0004**	0.0523	0.8316
159	"Vitamin A supplementation coverage rate (% of children ages 6-59 months)"	**-0.5008**	**0.0572**	-0.0823	0.7706
160	"Vulnerable employment, female (% of female employment) (modeled ILO estimate)"	**0.6276**	**0.004**	-0.1607	0.5111
161	"Vulnerable employment, male (% of male employment) (modeled ILO estimate)"	**0.5033**	**0.0281**	-0.1311	0.5926
162	"Vulnerable employment, total (% of total employment) (modeled ILO estimate)"	**0.5528**	**0.0141**	-0.1386	0.5715
163	"Wage and salaried workers, female (% of female employment) (modeled ILO estimate)"	**-0.6288**	**0.0039**	0.1601	0.5127
164	"Wage and salaried workers, male (% of male employment) (modeled ILO estimate)"	**-0.547**	**0.0154**	0.12	0.6246
165	"Wage and salaried workers, total (% of total employment) (modeled ILO estimate)"	**-0.5825**	**0.0089**	0.1333	0.5866
166	"Women's share of population ages 15+ living with HIV (%)"	-0.3745	0.1141	0.1811	0.458

Conclusion

The present empirical study has explored if there is presence of possible cointegration or causality or interlinkages of the United Nations' SDG 1 "No Poverty" and SDG 2 "Zero Hunger" goals for India besides exploring their interlinkages with the use of the World Development Indicators (WDIs) for India. It has utilized established econometric methodologies for exploring the interconnectedness or interrelations between the econometric variables viz., correlation analysis, causality analysis and congregation analysis as well. The study has revealed that with the sustainable performance indicator (SPI) data of the World Bank, there exists little causality or interlinkage between “No Poverty” i.e., SDG 1 and “Zero Hunger” in the context of India. The results indicate towards the ingenious findings that the SDG variables are either insufficient to measure the true theoretical interrelations between the variables or the performance of India is an exception of the said theoretical relationship, if so, exist in reality. However, there is presence of long-run speed of adjustment which runs out of self-targeting motives for both the SDG variables rather than through the impetus from the other development variable. These refer to the empirical validity of the idea that there exist two vicious cycles, one in poverty and another in hunger yet active in the Indian economy. Nonetheless, the world development indicators largely appear to be and insufficient or ineffective in addressing the “Zero Hunger” as a sustainable development goal while the same are very much effective to address the goal for “No Poverty”.

In addressing policy suggestion, the study offers the following two inputs:

(i) It appears necessary to relook into the specific measures to address the targets for “Zero Hunger” by the administrative departments in policy making for public benefits.

(ii) Timely census is a prerequisite to any planning of governments’ development activity and pending census of Indian population creates obstruction in targeting fulfilment of sustainable development goals like “Zero Hunger”.

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Appendix 1: World Development Indicator (WDI) Variables on the interlinkage of SDG 1 and SDG 2

(WDI Data Source: World Bank's World Development Indicator Database)
(Database Link: https://databank.worldbank.org/source/world-development-indicators)

	Variables in World Development Indicators Used to Explain SDG 1 and SDG 2 SPI Data
1	"Access to clean fuels and technologies for cooking (% of population)"
2	"Access to clean fuels and technologies for cooking, rural (% of rural population)"
3	"Access to clean fuels and technologies for cooking, urban (% of urban population)"
4	"Access to electricity (% of population)"
5	"Access to electricity, rural (% of rural population)"
6	"Access to electricity, urban (% of urban population)"
7	"Adjusted net national income (annual % growth)"
8	"Adjusted net national income per capita (annual % growth)"
9	"Adjusted net national income per capita (constant 2015 US$)"
10	"Adjusted net savings, excluding particulate emission damage (% of GNI)"
11	"Adjusted net savings, including particulate emission damage (% of GNI)"

12	"Adjusted savings: gross savings (% of GNI)"
13	"Age dependency ratio (% of working-age population)"
14	"Age dependency ratio, old (% of working-age population)"
15	"Age dependency ratio, young (% of working-age population)"
16	"Agricultural irrigated land (% of total agricultural land)"
17	"Agricultural land (% of land area)"
18	"Crop production index (2014-2016 = 100)"
19	"Employment in agriculture (% of total employment) (modeled ILO estimate)"
20	"Employment in agriculture, female (% of female employment) (modeled ILO estimate)"
21	"Employment in agriculture, male (% of male employment) (modeled ILO estimate)"
22	"Employment in industry (% of total employment) (modeled ILO estimate)"
23	"Employment in industry, female (% of female employment) (modeled ILO estimate)"
24	"Employment in industry, male (% of male employment) (modeled ILO estimate)"
25	"Employment in services (% of total employment) (modeled ILO estimate)"
26	"Employment in services, female (% of female employment) (modeled ILO estimate)"
27	"Employment in services, male (% of male employment) (modeled ILO estimate)"
28	"Employment to population ratio, 15+, female (%) (modeled ILO estimate)"
29	"Employment to population ratio, 15+, male (%) (modeled ILO estimate)"
30	"Employment to population ratio, 15+, total (%) (modeled ILO estimate)"
31	"Employment to population ratio, ages 15-24, female (%) (modeled ILO estimate)"
32	"Employment to population ratio, ages 15-24, male (%) (modeled ILO estimate)"
33	"Employment to population ratio, ages 15-24, total (%) (modeled ILO estimate)"
34	"Fertility rate, total (births per woman)
35	"Immunization, DPT (% of children ages 12-23 months)"
36	"Immunization, measles (% of children ages 12-23 months)
37	"Labor force participation rate for ages 15-24, female (%) (modeled ILO estimate)"
38	"Labor force participation rate for ages 15-24, male (%) (modeled ILO estimate)"
39	"Labor force participation rate for ages 15-24, total (%) (modeled ILO estimate)"
40	"Labor force participation rate, female (% of female population ages 15-64) (modeled ILO estimate)"

41	"Labor force participation rate, male (% of male population ages 15-64) (modeled ILO estimate)"
42	"Labor force participation rate, total (% of total population ages 15-64) (modeled ILO estimate)"
43	"Labor force, female (% of total labor force)"
44	"Labor force, total
45	"Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
46	"Life expectancy at birth, female (years)
47	"Life expectancy at birth, male (years)"
48	"Life expectancy at birth, total (years)"
49	"Lifetime risk of maternal death (%)"
50	"Lifetime risk of maternal death (1 in: rate varies by country)"
51	"Mortality caused by road traffic injury (per 100,000 population)"
52	"Mortality from CVD, cancer, diabetes or CRD between exact ages 30 and 70 (%)"
53	"Mortality from CVD, cancer, diabetes or CRD between exact ages 30 and 70, female (%)"
54	"Mortality from CVD, cancer, diabetes or CRD between exact ages 30 and 70, male (%)"
55	"Mortality rate, adult, female (per 1,000 female adults)"
56	"Mortality rate, adult, male (per 1,000 male adults)"
57	"Mortality rate, infant (per 1,000 live births)"
58	"Mortality rate, infant, female (per 1,000 live births)"
59	"Mortality rate, infant, male (per 1,000 live births)"
60	"Mortality rate, neonatal (per 1,000 live births)"
61	"Mortality rate, under-5 (per 1,000 live births)"
62	"Mortality rate, under-5, female (per 1,000 live births)"
63	"Mortality rate, under-5, male (per 1,000 live births)"
64	"Net migration
65	"Newborns protected against tetanus (%)"
66	"Number of deaths ages 10-14 years
67	"Number of deaths ages 15-19 years
68	"Number of deaths ages 20-24 years
69	"Number of deaths ages 5-9 years
70	"Number of infant deaths
71	"Number of maternal deaths
72	"Number of neonatal deaths
73	"People practicing open defecation (% of population)"
74	"People practicing open defecation, rural (% of rural population)"
75	"People practicing open defecation, urban (% of urban population)"

76	"People using at least basic drinking water services (% of population)"
77	"People using at least basic drinking water services, rural (% of rural population)"
78	"People using at least basic drinking water services, urban (% of urban population)"
79	"People using at least basic sanitation services (% of population)"
80	"People using at least basic sanitation services, rural (% of rural population)"
81	"People using at least basic sanitation services, urban (% of urban population)"
82	"People using safely managed drinking water services, rural (% of rural population)"
83	"People using safely managed sanitation services (% of population)"
84	"People using safely managed sanitation services, rural (% of rural population)"
85	"People using safely managed sanitation services, urban (% of urban population)"
86	"People with basic handwashing facilities including soap and water (% of population)"
87	"People with basic handwashing facilities including soap and water, rural (% of rural population)"
88	"People with basic handwashing facilities including soap and water, urban (% of urban population)"
89	"Population ages 00-04, female (% of female population)"
90	"Population ages 00-04, male (% of male population)"
91	"Population ages 0-14 (% of total population)"
92	"Population ages 0-14, female (% of female population)"
93	"Population ages 0-14, male (% of male population)"
94	"Population ages 05-09, female (% of female population)"
95	"Population ages 05-09, male (% of male population)"
96	"Population ages 10-14, female (% of female population)"
97	"Population ages 10-14, male (% of male population)"
98	"Population ages 15-19, female (% of female population)"
99	"Population ages 15-19, male (% of male population)"
100	"Population ages 15-64 (% of total population)"
101	"Population ages 15-64, female (% of female population)"
102	"Population ages 15-64, male (% of male population)"
103	"Population ages 20-24, female (% of female population)"
104	"Population ages 20-24, male (% of male population)"
105	"Population ages 25-29, female (% of female population)"
106	"Population ages 25-29, male (% of male population)"
107	"Population ages 30-34, female (% of female population)"
108	"Population ages 30-34, male (% of male population)"

109	“Population ages 35-39, female (% of female population)”
110	“Population ages 35-39, male (% of male population)”
111	“Population ages 40-44, female (% of female population)”
112	“Population ages 40-44, male (% of male population)”
113	“Population ages 45-49, female (% of female population)”
114	“Population ages 45-49, male (% of male population)”
115	“Population ages 50-54, female (% of female population)”
116	“Population ages 50-54, male (% of male population)”
117	“Population ages 55-59, female (% of female population)”
118	“Population ages 55-59, male (% of male population)”
119	“Population ages 60-64, female (% of female population)”
120	“Population ages 60-64, male (% of male population)”
121	“Population ages 65 and above (% of total population)”
122	“Population ages 65 and above, female (% of female population)”
123	“Population ages 65 and above, male (% of male population)”
124	“Population ages 65-69, female (% of female population)”
125	“Population ages 65-69, male (% of male population)”
126	“Population ages 70-74, female (% of female population)”
127	“Population ages 70-74, male (% of male population)”
128	“Population ages 75-79, female (% of female population)”
129	“Population ages 75-79, male (% of male population)”
130	“Population ages 80 and above, female (% of female population)”
131	“Population ages 80 and above, male (% of male population)”
132	“Population growth (annual %)”
133	“Population in the largest city (% of urban population)”
134	“Prevalence of anemia among children (% of children ages 6-59 months)”
135	“Prevalence of anemia among non-pregnant women (% of women ages 15-49)”
136	“Prevalence of anemia among pregnant women (%)”
137	“Prevalence of anemia among women of reproductive age (% of women ages 15-49)”
138	“Prevalence of HIV, total (% of population ages 15-49)”
139	“Prevalence of undernourishment (% of population)”
140	“Rural population (% of total population)”
141	“Rural population growth (annual %)”
142	“Sex ratio at birth (male births per female births)”
143	“Subsidies and other transfers (% of expense)”
144	“Suicide mortality rate (per 100,000 population)”
145	“Suicide mortality rate, female (per 100,000 female population)”
146	“Suicide mortality rate, male (per 100,000 male population)”
147	“Tuberculosis case detection rate (%, all forms)”
148	“Tuberculosis treatment success rate (% of new cases)”

149	"Unemployment, female (% of female labor force) (modeled ILO estimate)"
150	"Unemployment, female (% of female labor force) (national estimate)"
151	"Unemployment, male (% of male labor force) (modeled ILO estimate)"
152	"Unemployment, male (% of male labor force) (national estimate)"
153	"Unemployment, total (% of total labor force) (modeled ILO estimate)"
154	"Unemployment, total (% of total labor force) (national estimate)"
155	"Unemployment, youth female (% of female labor force ages 15-24) (modeled ILO estimate)"
156	"Unemployment, youth female (% of female labor force ages 15-24) (national estimate)"
157	"Unemployment, youth male (% of male labor force ages 15-24) (modeled ILO estimate)"
158	"Unemployment, youth total (% of total labor force ages 15-24) (modeled ILO estimate)"
159	"Vitamin A supplementation coverage rate (% of children ages 6-59 months)"
160	"Vulnerable employment, female (% of female employment) (modeled ILO
161	"Vulnerable employment, male (% of male employment) (modeled ILO
162	"Vulnerable employment, total (% of total employment) (modeled ILO
163	"Wage and salaried workers, female (% of female employment) (modeled ILO
164	"Wage and salaried workers, male (% of male employment) (modeled ILO
165	"Wage and salaried workers, total (% of total employment) (modeled ILO
166	"Women's share of population ages 15+ living with HIV (%)"

Appendix 2: B-P-G Serial Correlation LM Test of ARDL Model explaining SDG 1 with SDG 2

(Source: Authors' Own Compilation in EViews 10)

F-statistic	5.371995	Prob. F(2,6)		0.0460
Obs*R-squared	9.624937	Prob. Chi-Square(2)		0.0081
Null Hypothesis: There is no serial correlation of any order up to *p*				
Alternative Hypothesis: There is serial correlation of any order up				
Test Equation:				
Dependent Variable: RESID				
Method: ARDL				
Date: 11/23/24 Time: 07:00				
Sample: 2008 2022				
Included observations: 15				
Pre-sample missing value lagged residuals set to zero.				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
SPI_SDG_1(-1)	0.400603	0.410542	0.975789	0.3669
SPI_SDG_1(-2)	-0.011874	0.649228	-0.018289	0.9860
SPI_SDG_1(-3)	-0.032171	0.516743	-0.062257	0.9524
SPI_SDG_1(-4)	0.224190	0.224823	0.997183	0.3572
SPI_SDG_2	0.353509	0.197329	1.791468	0.1234
C	-0.748646	0.401606	-1.864129	0.1116
@TREND	0.009738	0.009526	1.022290	0.3461
RESID(-1)	**-1.083190**	0.491377	-2.204398	**0.0697**
RESID(-2)	**-1.015678**	0.421405	-2.410220	**0.0526**
R-squared	0.641662	Mean dependent var		-1.82E-17
Adjusted R-squared	0.163879	S.D. dependent var		0.074107

S.E. of regression	0.067763	Akaike info criterion	-2.261894
Sum squared resid	0.027551	Schwarz criterion	-1.837064
Log likelihood	25.96421	Hannan-Quinn criter.	-2.266420
F-statistic	**1.342999**	Durbin-Watson stat	2.100481
Prob(F-statistic)	**0.369817**	**Decision: Null Hypothesis rejected**	

Appendix 3: B-P-G Heteroskedasticity Test of ARDL Model explaining SDG 1 with SDG 2

(Source: Authors' Own Compilation in EViews 10)

Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	1.358334	Prob. F(6,8)		0.3351
Obs*R-squared	7.569661	Prob. Chi-Square(6)		0.2714
Scaled explained SS	1.457670	Prob. Chi-Square(6)		0.9623
Null Hypothesis: There is no Heteroskedasticity of the residuals				
Alternative Hypothesis: There is Heteroskedasticity of the residuals				
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Date: 11/23/24 Time: 07:06				
Sample: 2008 2022				
Included observations: 15				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.027776	0.023939	-1.160283	0.2794
SPI_SDG_1(-1)	-0.023041	0.016882	-1.364827	0.2095
SPI_SDG_1(-2)	0.038029	0.027515	1.382150	0.2043
SPI_SDG_1(-3)	-0.018169	0.025871	-0.702301	0.5024
SPI_SDG_1(-4)	0.021202	0.018129	1.169510	0.2759
SPI_SDG_2	0.014960	0.013553	1.103808	0.3018
@TREND	0.000864	0.000726	1.190758	0.2679
R-squared	0.504644	Mean dependent var		0.005126
Adjusted R-squared	0.133127	S.D. dependent var		0.006174
S.E. of regression	0.005748	Akaike info criterion		-7.175196
Sum squared resid	0.000264	Schwarz criterion		-6.844772
Log likelihood	60.81397	Hannan-Quinn criter.		-7.178715
F-statistic	**1.358334**	Durbin-Watson stat		2.981862
Prob(F-statistic)	**0.335083**	**Decision: Null Hypothesis accepted at**		

Appendix 4: B-P-G Serial Correlation LM Test of ARDL Model explaining SDG 2 with SDG 1

(Source: Authors' Own Compilation in EViews 10)

F-statistic	1.883661	Prob. F(2,3)	0.2952
Obs*R-squared	8.350397	Prob. Chi-Square(2)	0.0154
Null Hypothesis: There is no serial correlation of any order up to *p*			
Alternative Hypothesis: There is serial correlation of any order up to *p*			
Test Equation:			
Dependent Variable: RESID			
Method: ARDL			
Date: 11/23/24 Time: 07:23			
Sample: 2008 2022			

Included observations: 15				
Presample missing value lagged residuals set to zero.				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SPI_SDG_2(-1)	0.494302	0.413162	1.196386	0.3175
SPI_SDG_2(-2)	-0.386691	0.443389	-0.872127	0.4473
SPI_SDG_2(-3)	-0.011338	0.282471	-0.040138	0.9705
SPI_SDG_2(-4)	0.204146	0.252760	0.807667	0.4784
SPI_SDG_1	-0.014134	0.196417	-0.071959	0.9472
SPI_SDG_1(-1)	-0.013872	0.280930	-0.049379	0.9637
SPI_SDG_1(-2)	-0.053176	0.315196	-0.168707	0.8768
SPI_SDG_1(-3)	0.038807	0.294461	0.131791	0.9035
C	-0.189770	0.461869	-0.410873	0.7088
@TREND	-0.003515	0.008981	-0.391399	0.7216
RESID(-1)	-1.163340	0.603261	-1.928420	0.1494
RESID(-2)	-0.235501	0.583819	-0.403380	0.7137
R-squared	0.556693	Mean dependent var		-1.79E-16
Adjusted R-squared	-1.068765	S.D. dependent var		0.041513
S.E. of regression	0.059709	Akaike info criterion		-2.808100
Sum squared resid	0.010696	Schwarz criterion		-2.241660
Log likelihood	33.06075	Hannan-Quinn criter.		-2.814134
F-statistic	0.342484	Durbin-Watson stat		2.495989
Prob(F-statistic)	0.918307	**Decision: Null Hypothesis accepted at α**		

Appendix 5: B-P-G Heteroskedasticity Test of ARDL Model explaining SDG 1 with SDG 2

(Source: Authors' Own Compilation in EViews 10)

Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	0.777484	Prob. F(9,5)		0.6507
Obs*R-squared	8.748624	Prob. Chi-Square(9)		0.4608
Scaled explained SS	1.325773	Prob. Chi-Square(9)		0.9982
Null Hypothesis: There is no Heteroskedasticity of the residuals				
Alternative Hypothesis: There is Heteroskedasticity of the residuals				
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Date: 11/23/24 Time: 07:24				
Sample: 2008 2022				
Included observations: 15				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.036436	0.022380	-1.628025	0.1644
SPI_SDG_2(-1)	0.010966	0.014399	0.761547	0.4807
SPI_SDG_2(-2)	0.005873	0.015249	0.385163	0.7160
SPI_SDG_2(-3)	-0.010873	0.012344	-0.880798	0.4187
SPI_SDG_2(-4)	0.022283	0.011364	1.960873	0.1072
SPI_SDG_1	0.001563	0.009279	0.168446	0.8728
SPI_SDG_1(-1)	1.62E-05	0.013615	0.001190	0.9991
SPI_SDG_1(-2)	0.000525	0.015613	0.033604	0.9745
SPI_SDG_1(-3)	0.017059	0.014437	1.181638	0.2905
@TREND	0.000319	0.000437	0.729411	0.4985
R-squared	0.583242	Mean dependent var		0.001608
Adjusted R-squared	-0.166924	S.D. dependent var		0.002750

S.E. of regression	0.002970	Akaike info criterion	-8.565535
Sum squared resid	4.41E-05	Schwarz criterion	-8.093502
Log likelihood	74.24151	Hannan-Quinn criter.	-8.570563
F-statistic	**0.777484**	Durbin-Watson stat	2.981943
Prob(F-statistic)	**0.650731**	**Decision: Null Hypothesis accepted at**	