

How does globalization affect ecological footprint? A Comparative analysis of India and Pakistan

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2 **How does globalization affect ecological footprint? A Comparative**
3 **analysis of India and Pakistan**

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10 **Abstract**

11 This paper focuses on the economies of Pakistan and India to figure out the potential influence of
12 globalization on ecological footprints (EF) which is rarely researched. Time series data both for Pakistan
13 and India is sources for the period 1991 to 2018 from internationally reliable sources. The latest
14 cointegration approach of NARDL is utilized for the estimation of models. The results indicated that
15 globalization has a greater impact on India as compared to Pakistan regarding environmental
16 degradation. Social globalization reacts asymmetrically to EF in case of Pakistan. In both economies,
17 negative shocks are dominant as compared to positive shocks. To avoid the drastic impacts of economic
18 globalization on environmental degradation, it is necessary that production techniques should be based
19 on modern technologies. Furthermore, long term economic policies related to globalization should be
20 made by governments of both economies to protect their environment from further degradation.

21 Keywords: Ecological footprint, Globalization, Gross domestic product, NARDL, India, Pakistan

22

23 **1. Introduction**

24 Globalization is the only reason behind development across the globe and it is strongly associated with
25 different aspects of human life like environmental, social, economic, and political aspects. Due to

26 globalization, the world is more interconnected, and globalization makes easy to exchange goods &
27 services, movement of capital, financial transaction, and transfer of technology & information. Trade
28 liberalization, economic & technological development and economic growth has strong impact on
29 environmental degradation. All countries want to achieve a desirable and sustainable economic growth
30 through technological transfer, FDI, trade openness, industrialization, and urbanization but all these
31 factors affect environment negatively at the same time. Consequently, pollution increases and hence the
32 overall quality of the environment degrades. Therefore, increase in economic activities has also increased
33 the ecological footprint (EF, hereafter) which degrades the environment. Energy consumption is the main
34 source in production, however, aggravates environmental degradation because of emissions of different
35 unfavorable gases in the air like carbon monoxide (CO), carbon dioxide (CO₂), sulfur dioxide (SO₂),
36 nitrogen dioxide (NO₂), methane (CH₄) and many other. Environmental degradation increases
37 greenhouse gases (GHGs) which has unwanted effects and a future intimidation for ecological imbalance
38 and climate change (Shahbaz et al. 2019). Further,

39 Due to weak environmental policies, globalization flourishes the pollution intensive industries in the
40 developing countries (Copeland and Taylor 2004). Industrialization owing to globalization is largely
41 dependent on energy which is obtained from dirty sources such as fossil fuel & coal for production
42 process. As a result, GHGs rises enormously, and hence environmental quality worsens. Increased GHGs
43 in the atmosphere are the primary cause of global warming and climate change. Over the past few
44 decades, global warming and climate change have been seen to increase, causing deforestation, storm,
45 rising sea levels, the depletion of ozone layer, loss of biodiversity, hurricanes, earthquakes, huge crop
46 reduction and draughts (Shahbaz et al. 2017).

47 Globalization can be divided into three dimensions such as economic, political and social (Dreher 2006).
48 The dimensions mentioned of globalization adversely affect the quality of environment (Borghesi and
49 Vercelli 2003). However, Stern (2004) argued that globalization can improve the quality of environment if
50 better environmental policy is adopted. Furthermore, dissemination of information about best business
51 norms and practices are possible due to social globalization. The good knowledge and information about
52 business practices may lead to energy efficiency in economic activities thus, results in environmental
53 sustainability. Finally, in global context, the signed agreements on environments uplift the environmental
54 standards domestically (Shahbaz et al 2018a, b).

55 Majority of South Asian economies have moved from agriculture sector towards industrial and services
56 sectors recently (Srinivasan 2013). But the issue of environmental degradation for South Asian countries
57 has to be addressed yet. The growing populations, industrialization, urbanization, number of vehicles are
58 the main drivers of air pollution in South Asia. Furthermore, in South Asia since 1990, GHGs have been
59 increased 3.3 percent (Khwaja et al. 2012). It is worrying that about 2 million peoples are dying every year
60 due to air pollution (Gallagher 2009).

61 The study at hand assesses the consequences of globalization on the environmental quality for India and
62 Pakistan as both are experiencing rapid globalization recently. At the same time, the quality of the overall
63 environment has worsened both in both countries. Therefore, an empirical investigation about the effect
64 of globalization on environmental degradation is needed. Consequently, the current study adds to the
65 ongoing related literature in several aspects. First, this research will focus on the causes of environmental
66 degradation in India and Pakistan, which has not been studied extensively before. Both countries rely on
67 dirty and traditional energy resources to produce goods and services. Recently, the demand for energy
68 has been seen to increase due to increase in industrialization, urbanization and economic growth. And so,
69 both production and consumption of energy lead to environmental degradation. Secondly, we will split
70 globalization into its components and examine the impact of each component on environmental
71 degradation. Third, for environmental degradation, we use EF which has two main types: one is carbon
72 footprint, and the other is non-carbon footprint. Carbon footprints include only CO₂ footprint while there
73 are five components of non-carbon that include built-up land, grazing land, crop land, seafood
74 production and forest. The EF tells us the productive use of land, it is desirable to produce goods and
75 services by ocean which is consumed by human and fit in the waste material of industry through advance
76 technology (Charfeddine and Mrabet 2017). The EF has never been used in the non-linear comparative
77 research study as an alternative to the environmental degradation in case of India and Pakistan.
78 Furthermore, environmental impacts improve the present stability rather than climate change as EF not
79 only captured greenhouse emissions but also discovered the pressure of human demand for natural
80 resources. The study considers that EF is the most suitable proxy for the investigation of non-linear
81 relationship for environmental pollution. This research study is going to explore the asymmetric impact
82 of globalization on EF for both India and Pakistan.

83 2. Literature Review

84 Godil et al. (2020) studied the asymmetric long run and short run relationship of globalization, financial
85 development, and tourism with EF by applying Quantile ARDL model in Turkey by covering the time
86 period from 1986-2018 with developing of new idea among researchers in exploring the environmental
87 quality through EF of different nations. Further, the researcher also investigated the Environmental
88 Kuznets Curve in the study. According to the results all the independent variables in the model has
89 positive and significant impact on EFP. This means that the increase in globalization, financial
90 development and tourism will further degrade the environment in Turkey. U-shaped Environmental
91 Kuznets Curve also confirms that the relationship of most of the variables is non-linear and asymmetric.
92 Therefore, future research directions and policies can be recommended.

93 Sabir and Gorus (2019) investigated the association of technological changes and economic globalization
94 with environmental degradation for the period of 1975 to 2017 in South Asian countries. To assess the
95 long run relationship between these projected variables, Westerlund co-integration tests is used. The
96 panel autoregressive distributive lag model was used to confirm that Environmental Kuznets Curve
97 exists or not in the model. The results of panel ARDL model confirms the Environmental Kuznets Curve
98 (EKC) hypothesis in the South Asian countries. Based on results the impact of economic globalization on
99 environmental degradation is positive and significant. However, technological changes have an
100 insignificant impact on EF. In South Asian Countries, based on empirical results economic globalization
101 degrade the environment along with unsustainable development. Eco friendly energy should use by
102 South Asian countries to protect the environment and avoid greenhouse gas emission.

103 Usman et al. (2020) investigated the influence of globalization and renewable energy on environmental
104 degradation using quarterly data from Q1:1985 to Q4:2014 in the United State of America (USA) by
105 adjusting the causes of real output and financial development. The following approaches were employed
106 in the study unit root test, multiple structural break co-integration test and ARDL model approach. Based
107 on empirical results, real output and renewable energy effects environmental degradation negatively
108 while globalization and financial development are positively associated with EF in log-run. Contrary, in
109 short run all these projected variables are positively associated with environmental degradation. In long
110 run the VECM confirms that environmental degradation, real output, globalization and consumption of
111 renewable energy Granger cause financial development while real output is Granger cause by EF,
112 renewable energy, globalization and financial development. The findings of the study also indicated that
113 EF causes by globalization and renewable energy and real output causes renewable energy, globalization

114 cause by renewable energy. According to the empirical results, the causality between globalization and
115 real output, financial development and globalization, is bi-directional. So, the study is recommended to
116 policy makers to move to renewable energy to protect the environment.

117 Kirikkaleli et al. (2020) examined the study to investigate the impact of globalization on environmental
118 degradation in case of Turkey while controlling economic growth, trade openness and energy
119 consumption. Dual adjustment approach is employed in the model to achieve research objectives. The
120 empirical results indicate that globalization effect EF positively in log-run and EF is reduced by trade
121 openness in the short-run, while the impact of GDP growth on environmental degradation is negative in
122 both short and long-run. So, the researcher advice that Turkey should shift towards green energy in order
123 to protect the environmental quality.

124 Yilanci and Gorus (2020) investigated the impact of globalization on environmental degradation.
125 Globalization is very important topic among researcher since globalization take place in the world. Many
126 researchers have examined the relationship between globalization and environment, but no previous
127 literature has been found that studied causal relationship between EF and globalization (KOF index).
128 Similar research study was done in which, a new panel data approach is developed namely, panel
129 Fourier Toda-Yamamoto approach for the causality analysis and applied to environmental degradation,
130 economic globalization relationship during the time spanning 1981-2016 in fourteen Middle East and
131 North Africa (MENA) countries. Findings of the study indicate that EF granger causes financial, trade
132 and economic globalization. More, financial globalization has calculated further environmental
133 degradation value in MENA countries. This paper also recommended some policy implication to
134 policymakers based on empirical results of the study. Specifically, in the executing of policies regarding
135 environment, policymaker should be very careful, as they may affect economic activities negatively.

136 Ansari et al. (2020) used EF as a proxy for environmental degradation. Some most consuming countries of
137 renewable energy were selected for study due to the significance of renewable energy for time spanning
138 1991 to 2016 in panel data framework. The empirical results show the existence of long-run relationship
139 in the model. In long-run, positive relationship was observed among non-renewable energy consumption
140 and economic growth with EF. While inversed relation was seen in case of globalization, urbanization,
141 and renewable energy consumption. Some policy recommendations have also been provided based on
142 empirical results.

143 Chikri et al. (2021) determined the determinants of environmental degradation in NARDL setting for
144 Morocco. This study reached to conclusion that asymmetry is important in modelling the determinants of
145 environmental degradation as the study determined long run and short run asymmetry cointegration
146 among environmental degradation, energy and forest area. Similarly, Khan and Yahong (2021) analyzed
147 the determinants of environmental degradation in ARDL and NARDL setting for Pakistan. Results of this
148 study documented that the determinants of environmental degradation are symmetry as well as
149 asymmetry cointegrated with environmental degradation.

150 3. Model and Estimating methodology

151 The basic aim of the study is to find the non-linear impact of globalization on EF for both India and
152 Pakistan. To meet the desired objective, we utilized annual data of both neighboring countries for the
153 period 1990-2018 which is extracted from Global Footprint Network, 2020 (GFP) and World Bank, 2019.
154 This research has concentrated on the short- and long-term effects of globalization on the environment. In
155 accordance with previously published literature, we developed the following linear model.

$$156 \quad EF_t = f(GDP_t + EG_t + SG_t + PG_t + EU_t) \quad (1)$$

157 Where EF_t is an abbreviation for EF. EF are further subdivided into two categories: general and specific.
158 There are two types of footprints: carbon footprint and non-carbon footprint. Carbon Footprint has a CO2
159 footprint (forests are required for carbon emission) and non-carbon footprints take the strain off grazing
160 land, crop land, ocean, forest, and build up land, whereas carbon footprints take the pressure of forest
161 and build up land. EG_t , SG_t , and PG_t are economic globalization, social globalization, and political
162 globalization shocks, respectively. GDP_t stands for gross domestic product shocks. EU_t is an abbreviation
163 for energy consumption shocks. The inclusion of energy consumption in our study is regarded important
164 considering the prevalence of fossil fuels in the economy and the associated environmental issues.
165 Equation (1) depicts the linear relationship between the variables represented on the graph. As the
166 primary goal of the research project is to investigate the asymmetric influence of globalization on EF
167 shocks, the following questions were addressed: As a result, the decomposition of time series was carried
168 out on the basis of the following regression:

169 Following the selection of the EF as the environmental representation, there are two policy definitions to
170 consider. It first displays the potential of globalization, and it is presently the best assessment instrument

171 for environmental sustainability when compared to pollution. Second, it indicates the promise of
 172 globalization. As for as Sustainable Development Goals (SDGs) are concerned the environmental
 173 footprint is a critical instrument that takes into account the natural and natural forces of the planet as they
 174 are manifested via a variety of economic activities (Nazar et al. 2018; Pan et al. 2019).

175 Second, natural resources (such as water, minerals, land assets, and forests) are exploited because of
 176 economic endeavors to exploit them. As a result, if emissions are used as a proxy for the environment,
 177 they will neglect the issue of environmental sustainability at that moment in time (Li et al., 2019; Ali et al.,
 178 2020). Table 1A in appendix section includes detailed information about variables and data sources.

$$179 \quad D_t = \phi^+ E_t^+ + \phi^- E_t^- + \mu_t \quad (2)$$

180 Here, ϕ^+ and ϕ^- relate to the long-term coefficient, and E_t is a vector of displayed variables. Where E_t^+
 181 and E_t^- are, respectively, the individual sums of negative and positive shocks in the independent variables
 182 represented on the graph. The separate sums of negative and positive changes in gross domestic product
 183 shocks, economic globalization shocks, social globalization shocks, and energy consumption shocks are
 184 represented by the equations below from (3-12).

$$185 \quad GDP^+ = \sum_{k=1}^n \Delta GDP_k^+ = \sum_{k=1}^n \max(\Delta GDP_k, 0) \quad (3)$$

186

$$187 \quad GDP^- = \sum_{k=1}^n \Delta GDP_k^- = \sum_{k=1}^n \min(\Delta GDP_k, 0) \quad (4)$$

$$188 \quad EG^+ = \sum_{k=1}^n \Delta EG_k^+ = \sum_{k=1}^n \max(\Delta EG_k, 0) \quad (5)$$

$$189 \quad EG^- = \sum_{k=1}^n \Delta EG_k^- = \sum_{k=1}^n \min(\Delta EG_k, 0) \quad (6)$$

190
$$SG^+ = \sum_{k=1}^n \Delta SG_k^+ = \sum_{k=1}^n \max(\Delta SG_k, 0) \quad (7)$$

191
$$SG^- = \sum_{k=1}^n \Delta SG_k^- = \sum_{k=1}^n \min(\Delta SG_k, 0) \quad (8)$$

192
$$PG^+ = \sum_{k=1}^n \Delta PG_k^+ = \sum_{k=1}^n \max(\Delta PG_k, 0) \quad (9)$$

193
$$PG^- = \sum_{k=1}^n \Delta PG_k^- = \sum_{k=1}^n \min(\Delta PG_k, 0) \quad (10)$$

194
$$EU^+ = \sum_{k=1}^n \Delta EU_k^+ = \sum_{k=1}^n \max(\Delta EU_k, 0) \quad (11)$$

195
$$EU^- = \sum_{k=1}^n \Delta EU_k^- = \sum_{k=1}^n \min(\Delta EU_k, 0) \quad (12)$$

196 In this section, we Introduced the negative and positive shocks in equation... (13). Therefore. equation
 197 (13) becomes.:

198
$$EF_t = f(GDP_t^+, GDP_t^-, EG_t^+, EG_t^-, SG_t^+, SG_t^-, PG_t^+, PG_t^-, EU_t^+, EU_t^-) \quad (13)$$

199 It was recently demonstrated by Shin et al., (2014) that the basic ARDL technique, which was first
 200 described by Pesaran and Shin (1999) and Pesaran et al., (2001), can also be used to non-linear ARDL
 201 problems. The nonlinear ARDL model predicts the elasticity of the depicted variables in both the short
 202 and long runs. Here are some examples of advanced research studies that are relevant to our subject,
 203 including (Godil et al., 2020; Omoke et al., 2020; Rafindad & Usman., 2020; Baz et al., 2018). In order to
 204 account for the non-linear impact of globalization on the EF, we developed the NARDL model shown
 205 below.

$$\begin{aligned}
206 \quad \Delta EF_t = & \emptyset + \sum_{i=1}^k \phi_k \Delta EF_{t-i} + \sum_{i=1}^k \phi_k \Delta GDP_{t-i}^+ + \sum_{i=1}^k \phi_k \Delta GDP_{t-i}^- + \sum_{i=1}^k \phi_k \Delta EG_{t-i}^+ + \sum_{i=1}^k \phi_k \Delta EG_{t-i}^- + \sum_{i=1}^k \phi_k \Delta SG_{t-i}^+ \\
207 \quad & + \sum_{i=1}^k \phi_k \Delta SG_{t-i}^- + \sum_{i=1}^k \phi_k \Delta PG_{t-i}^+ + \sum_{i=1}^k \phi_k \Delta PG_{t-i}^- + \sum_{i=1}^k \phi_k \Delta EU_{t-i}^+ + \sum_{i=1}^k \phi_k \Delta EU_{t-i}^- + \partial_1 EF_{t-1} \\
208 \quad & + \partial_2 GDP_{t-1}^+ + \partial_3 GDP_{t-1}^- + \partial_4 EG_{t-1}^+ + \partial_5 EG_{t-1}^- + \partial_6 SG_{t-1}^+ + \partial_7 SG_{t-1}^- + \partial_8 PG_{t-1}^+ + \partial_9 PG_{t-1}^- \\
209 \quad & + \partial_{10} EU_{t-1}^+ + \partial_{11} EU_{t-1}^- + \varepsilon_t \quad (14)
\end{aligned}$$

210 The short and long-run coefficients are provided by Equation (14); ∂ denote the long-term coefficients,
211 while the short-run coefficients are represented by \emptyset . We run the bound test, which was introduced by
212 Pesaran, Shin, and Smith (2001), after constructing equation (14), and we find that the bound test is
213 equally applicable to the model (14). The ARDL model provides several benefits including the fact that it
214 is applicable regardless of whether all variables are integrated in the same order or in a combination of
215 orders. The most significant advantage of this strategy is that it may be used even with a small number of
216 participants (Panopoulou & pittis, 2004).

217 4. Results and discussion

218 Descriptive statistics are presented in Table 1, which clarify that data is free from structural break and
219 outlier. The mean value of Indian GDP is US \$57945 followed by its energy consumption of 453 liter of
220 oil. Maximum India GDP value is US \$ 82457 and energy consumption are 636, with standard deviation
221 14304 and 78.9 in GDP and energy consumption respectively. The mean value of Indian EF, political
222 globalization, social globalization, and economic globalization are 1.10, 76.98, 25.89 and 34.01
223 respectively. Similarly, the mean value of Pakistan GDP is US \$57945 US\$ followed by its energy
224 consumption of 454 liter of oil. Maximum Pakistan GDP value is US \$ 82457 and energy consumption are
225 500 liter of oil. The mean values of EF, political globalization, social globalization, and economic
226 globalization are 1.26, 30.03, 84.35 and 35.20 respectively.

227 **Table 1: Descriptive Statistics of data series**

Country	Variables	Mean	Median	Max.	Min.	S.D
India	EF	1100	1000	1550	681	301
	GDP	57945.07	56983.92	82457.63	37874.82	14304.20
	EG	34.01	34.62	44.35	18.62	8.19
	SG	76.99	85.33	91.77	32.22	20.85
	PG	25.89	29.05	35.34	8.59	8.04

	EU	453.75	444.37	636.57	350.07	78.97
Pakistan	EF	126	131	161	81.76	25.51
	GDP	57945.07	56983.92	82457.63	37874.82	14304.20
	EG	35.20	36.92	42.34	24.90	5.50
	SG	84.35	85.85	89.38	67.17	5.42
	PG	30.03	34.81	37.87	14.21	9.02
	EU	454.09	461.45	500.43	397.09	25.65

228

229 The unit root problem is examined using the Augmented Ducky Fuller (ADF). Table 2 shows that all
 230 variables are non-stationery at level except social globalization for Pakistan and political globalization for
 231 India. However, on first difference, all variables are stationary.

232 **Table 2: Results of ADF**

Country	Variables	EF	GDP	EG	SG	PG	EU
India	Level	-1.00	-1.24	1.70	-0.54	-2.94**	-1.58
		0.74	0.64	0.42	0.87	<0.05	0.48
	1 st diff	-5.41*	-3.25**	-5.67*	-3.60*	-	-3.26**
		-5.41*	<0.05	<0.01	<0.01	-	<0.05
Pakistan	Level	-2.21	-1.23	-2.00	-3.31**	-1.54	-2.89
		-2.95	0.65	0.28	<0.05	0.50	0.06
	1 st diff	0.21	-3.24**	-4.55*	-	-4.07*	-3.40**
		<0.05	<0.05	<0.01	-	<0.01	<0.05

233 Note: *,** shows significance level of 1% and 5% respectively

234 After conducting the unit root analysis, we employed the NARDL for checking the possibility of
 235 cointegration among the variables. The values presented in the following Table 3 shows that F-statistic
 236 value is greater than upper bound value for both Pakistan and India which is the confirmation of
 237 presence of cointegrating relationship among the chosen variables.

238 **Table 3: Results of NARDL Bound Test**

		10%	5%	2.5%	1%
Country	k-values	F-statistic	I(0) I(1)	I(0) I(1)	I(0) I(1) I(0)
240	I(1)				
241					
242					

243	India	10	4.36*	1.76	2.77	1.98	3.04	2.18	3.28	2.41
244	3.61									
245										
246	Pakistan	10	3.55	1.83	2.94	2.06	3.24	2.28	3.5	2.54
247	3.86									

248
249 *5% level of statistical significance

250
251 The NARDL results in Table 4 shows dominant effect of globalization on environmental quality of both
252 economies. For Pakistan Negative shocks effects have significant contrast effect with positive shocks. For
253 India both shocks have equal effect on EF. GDP, energy consumption, political globalization, social
254 globalization and economic globalization are significant in short run for Pakistan economy. For Indian
255 economy, GDP, energy consumption, political globalization, economic globalization are main
256 components of environmental degradation in short run and GDP energy consumption, political
257 globalization, social globalization and economic globalization are determinants environmental
258 degradation in long-run. The comparative study of both countries shows that globalization is more
259 effective in environmental degradation for Indian economy and the energy consumption have almost
260 same impact in both countries. The results of the study resemble with the findings of Khan & Ullah
261 (2019), who found that all the three components of globalization (Eco, Political & Social) lead to
262 environmental degradation. Similarly, among others, Godil et al. (2020) and Usman et al. (2020) also
263 concluded that globalization contribute to environmental degradation. However, there are studies such
264 as Shehbaz et al., (2013) and Haseeb et al., (2018) researched to conclusion that globalization improves
265 environmental quality. Indian GDP, negative and positive shock coefficient is 0.71 and 0.47 respectively
266 and with probability of 0.4629 and 0.0358. This shows long run significant positive impact of GDP on EF
267 of India. Positive shocks in economic globalization have negative impact, and negative shocks have
268 positive impact on EF. The p-value shows that there is no significant globalization impact on EF in long
269 run. Social globalization positive shocks have insignificant positive relation with EF in long run. Social
270 globalization negative shocks have positive significant relation with EF with probability and coefficient
271 value of 0.0442 and 3.09 respectively. Negative and positive shocks in political globalization have direct
272 relation with EF, but negative shocks in political globalization have significant positive effects on EF,
273 while positive shock have insignificant direct relation. Negative and positive shocks in energy
274 consumption have direct significant relation with EF. In long run, negative shocks have dominant impact
275 on EF as compared to positive shocks. Respective variable's coefficient p-values are 0.748, 9.119 and

276 0.0001, 0.0516 respectively. For Pakistan GDP negative and positive shock coefficients values are -2.003,
 277 3.75 respectively with p-values 0.13 and 0.12. This shows that in long run GDP positive shocks have
 278 indirect insignificant impact on EF in Pakistan. Positive shock in economic globalization has direct
 279 relation and negative shock have positive relation with EF in long run. The p-value of both negative and
 280 positive shocks in economic globalization indicate no significant impact on EF in long run. In long run,
 281 both negative and positive shocks in social globalization have insignificant indirect relation with EF and
 282 respective coefficient p-values are 0.86 and 0.71 respectively. Positive political globalization shocks have
 283 direct relation with EF, negative shocks have inverse relation with EF, combined shocks i.e negative and
 284 positive have insignificant relation with EF. EF relation with positive energy consumption shocks in long
 285 run are significant and direct. Respective variables coefficient p-values are 4.81, -4.62 and 0.0093, 0.10
 286 respectively.

287 Table 4: NARDL Long-Run Results

Variables	India				Pakistan			
	Coefficient	Std.error	t.stat	p-value	Coefficient	Std.error	t.stat	p-value
LNGDP_POS	0.47	0.20	2.36	0.03	2.00	1.24	1.60	0.13
LNGDP_NEG	0.71	0.94	0.75	0.46	3.75	2.33	1.67	0.12
LNEGI_POS	0.17	0.10	1.64	0.12	0.57	0.45	1.26	0.23
LNEGI_NEG	0.24	0.16	1.67	0.11	1.46	0.77	1.89	0.08
LNSGI_POS	0.24	0.19	1.21	0.24	1.64	1.41	1.16	0.27
LNSGI_NEG	3.09	1.37	2.24	0.04	0.86	2.35	0.36	0.71
LNPGI_POS	0.01	0.02	0.75	0.46	0.20	0.14	1.42	0.18
LNPGI_NEG	0.77	0.25	2.99	0.01	3.04	2.20	1.38	0.19
LNENU_POS	0.74	0.13	5.75	0.0001	4.81	1.52	3.14	0.093
LNENU_NEG	9.11	4.21	2.16	0.05	4.62	2.62	1.76	0.01

288
 289 This section deals with relationship of dependent variables with independent variable in short run. The
 290 results show that the positive shock GDP coefficient is 0.78 in short run with probability of 0.0010. This
 291 shows that EF is significantly increased with positive shocks in GDP, by 1% increase in GDP, the EF
 292 increases by 0.78%. In short run, the negative shocks to GDP have also significant positive effect on EF in
 293 India, with p-value and coefficient 0.0073 and 2.42 respectively. It suggests that 1% GDP increase causes

294 2.42 % reduction in ecological footprint. The positive shock in economic globalization positively effects EF
 295 of India. Negative shocks in economic globalization have significant positive effect on ecological footprint
 296 by 5% in short run. While Social globalization positive shocks have insignificant impact on EF.

297 For Pakistan, positive shock coefficient is 1.10 with p-value of 0.0011, that indicate a positive shock of
 298 GDP have significant negative effect on EF. It implies that 1% rise in GDP causes 1.10% EF decrease. GDP
 299 negative shocks have significant positive impact on EF. Probability values and coefficient values are 0.15
 300 and 2.03 respectively that indicate EF is decreased by 2.03% percent increase in GDP. Positive shocks in
 301 economic globalization have positive effect on EF. Negative shocks in economic globalization have
 302 insignificant positive effect at 5% level in EF. Positive shocks in social globalization have coefficient and
 303 p-vale of 0.11 and 0.70 shows that social globalization have insignificant positive effect on EF. Negative
 304 and positive shocks in political globalization have significant inverse relation with EF, but positive shocks
 305 effects are significant and negative shocks effect are insignificant. Positive shocks in Political globalization
 306 have coefficient and p-values of -0.09 and 0.14 respectively, that shows no significant effect. While
 307 political globalization negative shocks have p-values and coefficient values of 0.002 and 1.77 respectively,
 308 indicating that 1% reeducation in political globalization causes 1.77% increases in EF. The energy
 309 consumption has inverse effect on EF. Table 5 presents the short-run results of NARDL model.

310 **Table 5: Short-Run Results of NARDL model and its estimation coefficients**

Variables	India				Pakistan			
	Coefficient	Std.error	t.stat	p-value	Coefficient	Std.error	t.stat	p-value
LNGDP_POS	20/38	0.02	766.43	0.00	18.11	0.14	121.65	0.00
LNGDP_NEG	0.78	0.18	4.33	0.001	1.10	0.25	4.36	0.001
LNEGI_POS	0.16	0.05	3.08	0.0094	0.34	0.09	3.75	0.0032
LNEGI_NEG	0.44	0.16	2.66	0.02	0.15	0.12	1.30	0.21
LNSGI_POS	0.29	0.17	1.69	0.11	0.11	0.29	0.39	0.70
LNSGI_NEG	1.36	1.02	1.33	0.20	4.17	0.97	4.30	0.0012
LNPGI_POS	0.02	0.02	1.15	0.27	0.09	0.05	1.55	0.14
LNPGI_NEG	1.23	0.30	4.02	0.001	1.77	0.45	3.87	0.026
LNENU_POS	1.14	0.15	7.47	0.0000	2.54	0.32	6.87	0.0000
LNENU_NEG	3.80	3.13	1.21	0.24	0.07	0.47	0.14	0.88

Cointeg (-1)	-1.56	0.24	-6.50	0.00	0.54	0.08	-6.39	0.0001
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311

312

313 The Wald test results of table (no) shows symmetric impact of GDP on EF. For India, positive and
 314 negative GDP shocks magnitude is equal. The table indicate political, social and economic globalization
 315 effect are symmetric, that shows that economic and political both types of shocks have same effects on
 316 Indian EF. The energy consumption effect is symmetric on EF in India.

317 Table 6 shows Symmetric effect of Pakistani GDP on EF, with same magnitude of positive and negative
 318 shocks. Political and economic globalization effect on ecological footprint is symmetric and same for
 319 Pakistan. But the social globalization effects on EF are asymmetric for Pakistan, thus we achieve our first
 320 objective. Energy consumption positive and negative shocks have asymmetric effects on environment in
 321 Pakistan.

322 **Table 6: Results of Wald test**

Country	Variable	Wald value	p-value	Result
INDIA	GDP	2.81	0.08	Symmetric
	EG	2.39	0.11	Symmetric
	PG	3.21	0.07	Symmetric
	SG	2.17	0.14	Symmetric
	EU	12.38	0.0006	Asymmetric
PAKISTAN	GDP	3.53	0.06	Asymmetric
	EG	2.44	0.11	Symmetric
	PG	2.37	0.12	Symmetric
	SG	3.99	0.03	Asymmetric
	EU	6.05	0.01	Asymmetric

323

324 Source: calculation by the author

325 **Residuals Stability**

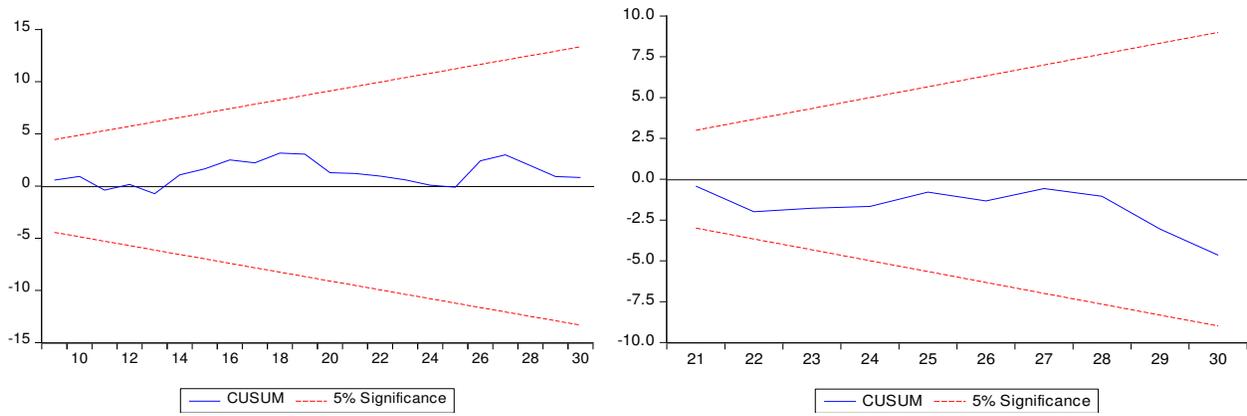
326 Residual stability is indeed an important component of NARDL Modeling. For this purpose, the widely
 327 used CUSUM and the square of CUSUM tests are conducted. The estimated lines presented in Figure 1
 328 are lying within the critical bounds at 5 % which is desirable. Similarly, the plotted lines of the square of
 329 CUSUM test in Figure 2 also shows stability. However, the plotted line for the Indian economy is slightly
 330 touching the critical lines which could be the limitation of the analysis.

331

332

333

Figure 1: CUSUM test



334

a=(India)

b=(Pakistan)

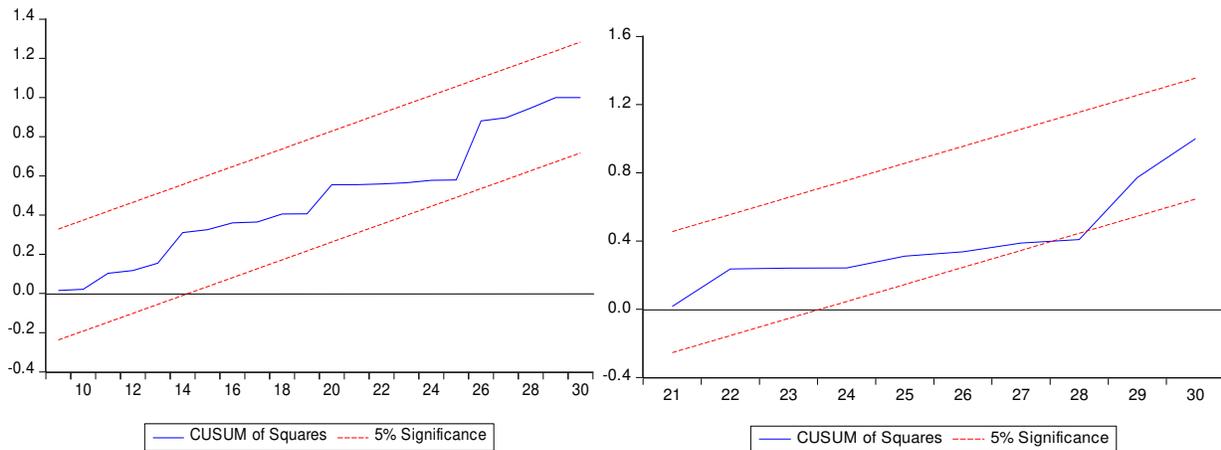
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Figure 2: CUSUM of Squares test



339

a = (India)

b = (Pakistan)

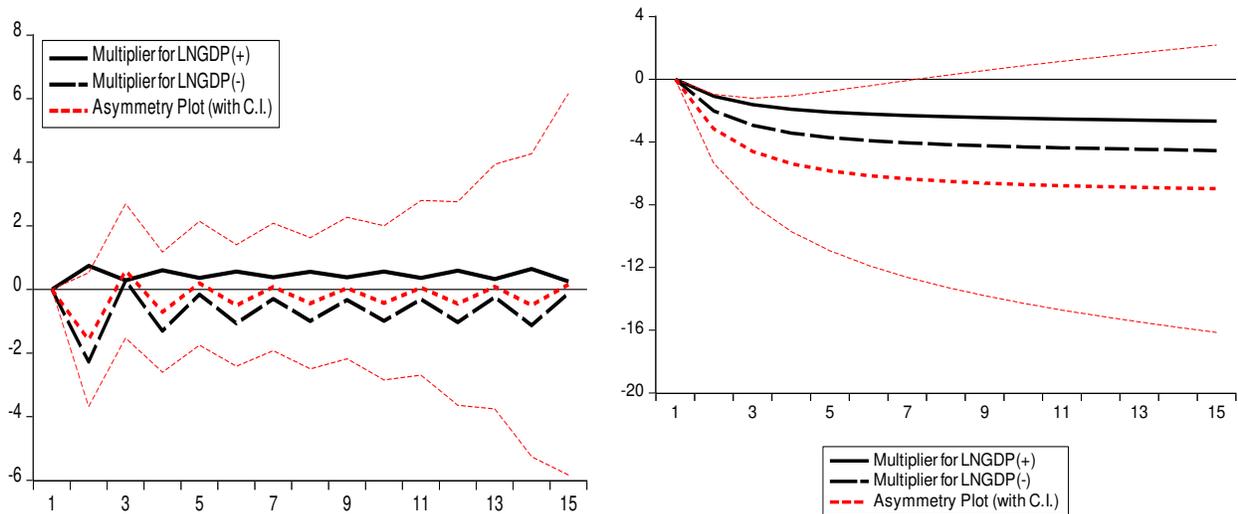
340

341

342 **Combined Dynamic Multiplier Effects of GDP**

343 The combined dynamic multiplier effects of GDP (positive and negative shocks) are highlighted in Figure
344 3. It could be inferred from Figure 3 that how EF come to equilibrium level in long run because of GDP
345 positive and negative shocks. Positive shocks are indicated by black continuous line, negative shocks are
346 indicated by the black dotted line and the red dotted line shows asymmetric effect of negative and
347 positive GDP shocks. Both parts (a and b) show the cumulative of negative and positive shock in GDP
348 responsible for the negative impact on EF, showing that GDP negative impacts are dominated over the
349 positive effect of GDP on EF.

350 **Figure 3: Combined dynamic multiplier effects of GDP.**



351
352 a = (India)

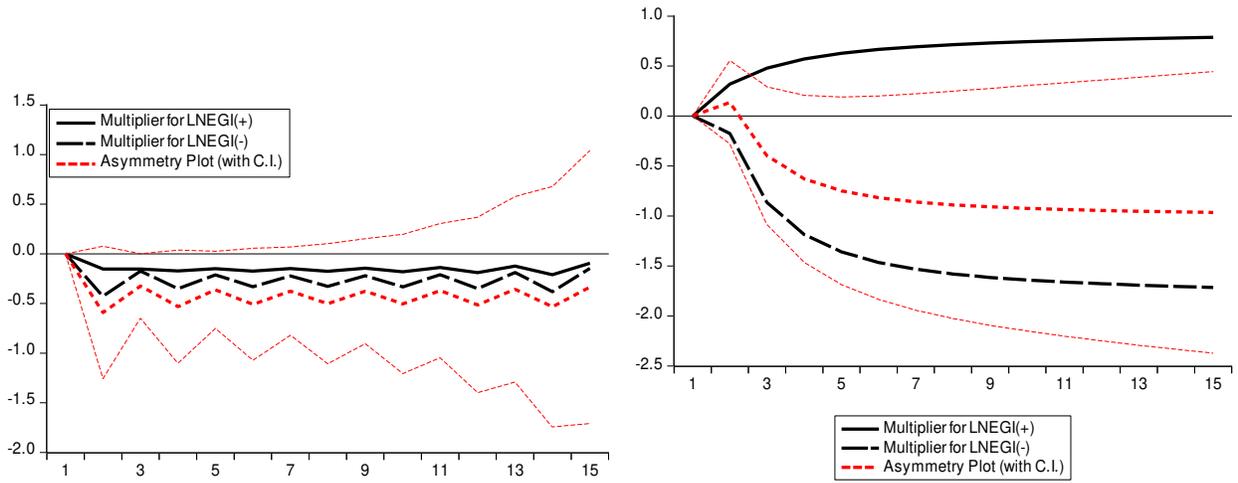
b = (Pakistan)

353 **Combined dynamic multiplier effects of economic globalization**

354 The combined positive and negative economic globalization economic shocks effect on EF are
355 demonstrated in Figure 4, which are significant negative over time. Economic globalization negative
356 shock impact on EF is asymmetric, while positive shocks have negative effect and stronger than the effect
357 of negative shocks.

358

Figure 4: Cumulative dynamic multiplier effects of EGI.



359

a = (India)

b = (Pakistan)

360

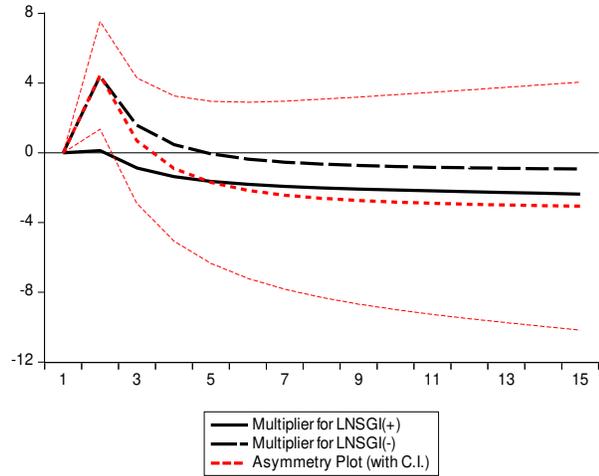
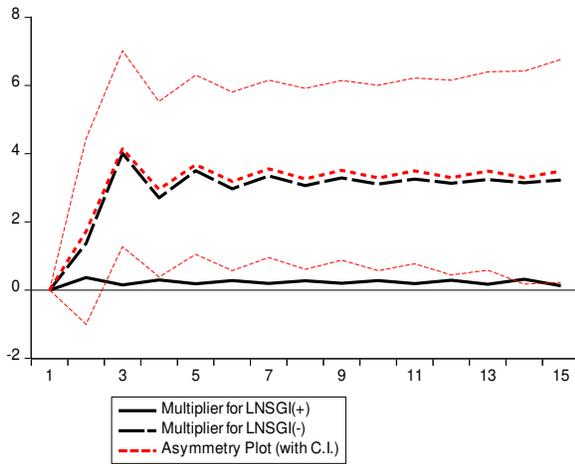
361 **Multiplier effects of social globalization**

362 Combined effects of negative and positive shocks of social globalization on EF for India is presented in
363 figure 5 a, that shows that negative shock have positive effect on EF and asymmetric effects are caused in
364 EF due to social globalization. The figure indicates that the negative shocks effects are stronger than the
365 positive shocks effects.

366 The same effect for Pakistan is presented in figure 5 b, which show similar result as that for India in
367 figure 5 a.

368

Figure 5: Cumulative dynamic multiplier effects of SG.



369

370

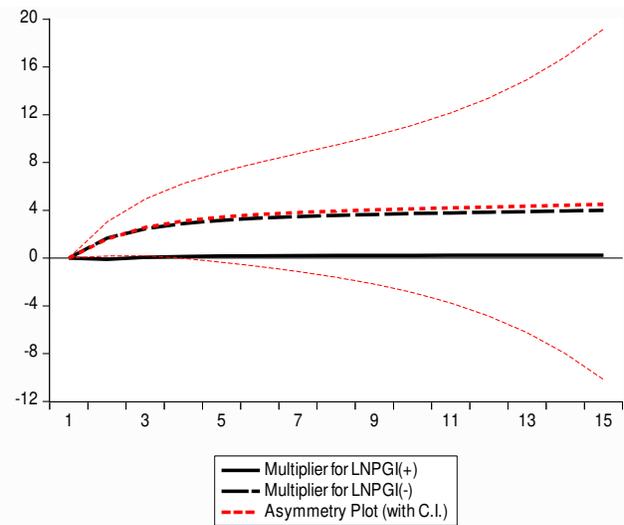
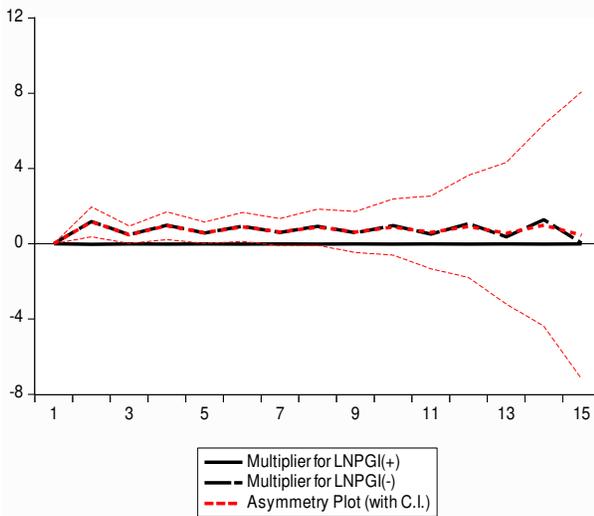
a = (India)

b = (Pakistan)

371 Figure 6 section "a" and "b" shows that negative political globalization shocks impact on EF are
 372 asymmetric, while positive shocks have no effect.

373

Figure 6: PG dynamic cumulative multiplier effects



374

375

a = (India)

b = (Pakistan)

376

377 **Multiplier effects of energy use**

398 In long run, the results show that negative shock of political globalization affects EF positively and
399 significantly in case of India. It implies that the political dimension of globalization is harmful from the
400 perspective of clean environment. Positive shocks of GDP and energy use have significantly and
401 positively affected the environment degradation of India. The impact of social globalization has also
402 positive and significant on environmental degradation. Social and political globalization has no
403 significant effect on EF in India in short run.

404 The result indicates that positive shock of GDP worsens environmental degradation and negative shock
405 causes environmental improvement. Thus, it is recommended that consumption and production of goods
406 and services be made environmentally friendly. This may be possible by adopting international
407 standards, awareness campaign and by adopting green technology and processes in production.
408 Economic globalization such as trade, financial openness and other economic integration with the global
409 world is responsible for environmental degradation, so it is recommended to adopt and improve rules
410 and regulation to combat the worse effects of economic globalization on environment. The effect of
411 energy on environmental degradation in both countries India and Pakistan is positive which means that
412 energy consumption is damaging the environmental quality; thus, it is advisable for both countries to
413 adopt green energy and should move to cleaner and renewable energy resources to maintain sustainable
414 development.

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428 data bases

429 Appendix Section

430 Table A1 Description of variables....

Variables	Abbreviation	Proxy Unit	Source
Ecological footprint.	EF	Global Hectare of Land	GFP
Economic Globalization	EG	Index	WB
Social Globalization	SG	Index	WB
Political Globalization	PG	Index	WB
Gross Domestic Product..	GDP	Constant 2010 US\$	WB
Energy Use..	EU	Kg of oil equivalent per capita	WB

431
432 Note: GFP represents (Global footprint networks, 2020) (<https://www.footprintnetwork.org/>) while WB denotes
433 (World Bank, 2019) (<https://data.worldbank.org>).

434 **References**

435 Ali S, Yusop Z, Kaliappan S. R, & Chin L (2020) Dynamic common correlated effects of trade openness, FDI, and
436 institutional performance on environmental quality: evidence from OIC countries. *Environmental Science and*
437 *Pollution Research*, 27, 11671–11682

438 Ansari M. A, Haider S, & Masood T (2021) Do renewable energy and globalization enhance ecological footprint: an
439 analysis of top renewable energy countries? *Environmental Science and Pollution Research*, 28(6), 6719–6732.

440 Baz K, Xu D, Ali H, Ali I, Khan I, Khan M M, & Cheng J (2020) Asymmetric impact of energy consumption and
441 economic growth on ecological footprint: using asymmetric and nonlinear approach. *Science of the total*
442 *environment*, 718, 137364.

443 Borghesi S, & Vercelli A (2003) Sustainable globalization. *Ecol Econ* 44(1): 77–89

444 Charfeddine L, Mrabet Z (2017) The impact of economic development and social-political factors on ecological
445 footprint: a panel data analysis for 15 MENA countries. *Renew Sust Energ Rev* 76:138–15

446 Chikri H, Moghar A, Kassou, M, & Hamza F (2021). New evidence from NARDL model on CO2 emissions: Case of
447 Morocco. In *E3S Web of Conferences* (Vol. 234). EDP Sciences.

448 Copeland B, Taylor M (2004) Trade, growth and the environment. *J Econ Lit* 42(1):7–71

- 449 Dreher A (2006) Does globalization affect growth? Evidence from a new index of globalization. *Appl Econ* 38:1091–
450 1110
- 451 Engle R. F, & Granger C W (1987) Co-integration and error correction: representation, estimation, and
452 testing. *Econometrica: journal of the Econometric Society*, 251-276.
- 453 Gallagher KP (2009) Economic globalization and the environment. *Annu Rev Environ Resour* 34:279–304
- 454 Global footprint networks (2020) Available at (<https://www.footprintnetwork.org/>)
- 455 Haseeb A, Xia E, Baloch MA, Abbas K (2018) Financial development, globalization, and CO2 emission in the presence
456 of EKC: evidence from BRICS countries. *Environ Sci Pollut Res* 25(31):31283–31296
- 457 Khan D, & Ullah, A (2019) Testing the relationship between globalization and carbon dioxide emissions in Pakistan:
458 does environmental Kuznets curve exist? *Environmental Science and Pollution Research*, 26(15), 15194-15208.
- 459 Khan S, & Yahong, W (2021) Symmetric and asymmetric impact of poverty, income inequality, and population on
460 carbon emission in Pakistan: new evidence from ARDL and NARDL co-integration. *Front Environ Sci*, 9, 1-13
- 461 Khwaja MA, Umer F, Shaheen N, Sherazi A, & Shaheen FH (2012) Air pollution reduction and control in South Asia,
462 Working paper series 121. Sustainable Development Policy Institute (SDPI) Islamabad.
- 463 Kirikkaleli D, Adebayo T S, Khan Z, & Ali S (2021) Does globalization matter for ecological footprint in Turkey?
464 Evidence from dual adjustment approach. *Environmental Science and Pollution Research*, 28(11), 14009-14017.
- 465 Li JX., Chen Y N, Xu C C, & Li Z (2019) Evaluation and analysis of ecological security in arid areas of Central Asia
466 based on the emergy ecological footprint (EEF) model. *Journal of Cleaner Production*, 235, 664-677.
- 467 Liu Y, Akin, S, Pan L, Uchida R, Arora N, Milić JV, ... & Grätzel M (2019) Ultra hydrophobic 3D/2D fluoroarene
468 bilayer-based water-resistant perovskite solar cells with efficiencies exceeding 22%. *Science advances*, 5(6),
469 eaaw2543.
- 470 Omoke P C, Nwani C, Effiong E L, Evbuomwan O O, & Emekwe C C (2020) The impact of financial development
471 on carbon, non-carbon, and total ecological footprint in Nigeria: new evidence from asymmetric dynamic
472 analysis. *Environmental Science and Pollution Research*, 27(17), 21628-21646.
- 473 Panopoulou E, & Pittis N (2004) A comparison of autoregressive distributed lag and dynamic OLS cointegration
474 estimators in the case of a serially correlated cointegration error. *The Econometrics Journal*, 7(2), 585-617.
- 475 Pesaran M H, Shin Y, & Smith R J (2001) Bounds testing approaches to the analysis of level relationships. *Journal of*
476 *applied econometrics*, 16(3), 289-326.
- 477 Pesaran M H, Shi Y, & Smith R. P (1999) Pooled mean group estimation of dynamic heterogeneous panels. *Journal of*
478 *the American statistical Association*, 94(446), 621-634.

- 479 Rafindadi AA, & Usman O (2021) Toward sustainable electricity consumption in Brazil: the role of economic growth,
480 globalization and ecological footprint using a nonlinear ARDL approach. *Journal of Environmental Planning*
481 *and Management*, 64(5), 905-929.
- 482 Rashid F L, Talib SM, Hadi A, & Hashim A (2018) Novel of thermal energy storage and release: water/(SnO₂-TaC)
483 and water/(SnO₂-SiC) nanofluids for environmental applications. In *IOP conference series: materials science*
484 *and engineering* (Vol. 454, No. 1, p. 012113). IOP Publishing.
- 485 Sabir S, & Gorus M S (2019) The impact of globalization on ecological footprint: empirical evidence from the South
486 Asian countries. *Environmental Science and Pollution Research*, 26(32), 33387-33398.
- 487 Shahbaz M, Khan S, Ali A, & Bhattacharya M (2017) The impact of globalization on CO₂ emissions in China. *Singap*
488 *Econ Rev* 62(4):929– 957.
- 489 Shahbaz M, Ozturk I, Afza T, Ali A (2013c) Revisiting the environmental Kuznets curve in a global economy. *Renew*
490 *Sust Energ Rev* 25:494– 502
- 491 Shahbaz M, Mahalik MK, Shahzad SJH, & Hammoudeh S (2019) Does the environment Kuznets curve exist between
492 globalization and energy consumption? Global evidence from the cross-correlation method. *Int J Financ*
493 *Econ* 24(1):540–557
- 494 Shahbaz M, Mallick H, Mahalik MK, & Loganathan N (2015) Does globalization impede environmental quality in
495 India? *Ecol Indic* 52:379– 393
- 496 Shahbaz M, Shahzad SJH, & Mahalik MK (2018a) Is globalization detrimental to CO₂ emissions in Japan? *New*
497 *Threshold Analysis. Environ Model Assess* 23(5):557–568
- 498 Shahbaz M, Shahzad SJH, Mahalik MK, & Sadorsky P (2018b) How strong is the causal relationship between
499 globalization and energy consumption in developed economies? A country-specific time-series and panel
500 analysis. *Appl Econ* 50(13):1479–1494
- 501 Sharif , Godil D I, Xu, B, Sinha, A., Khan S A R, & Jermisittiparsert K (2020) Revisiting the role of tourism and
502 globalization in environmental degradation in China: Fresh insights from the quantile ARDL
503 approach. *Journal of Cleaner Production*, 272, 122906.
- 504 Sharif A., Godil, D I, Xu, B, Sinha, A, Khan, S. A. R, & Jermisittiparsert, K (2020). Revisiting the role of tourism and
505 globalization in environmental degradation in China: Fresh insights from the quantile ARDL
506 approach. *Journal of Cleaner Production*, 272, 122906.
- 507 Srinivasan PV (2013) Dynamics of structural transformation in South Asia. *Asia Pac Dev J* 20(2):53–88
- 508 Stern DI (2004) The rise and fall of the environmental Kuznets curve. *World Dev* 32:1419–1439
- 509 Usman O, Alola A A, & Sarkodie S A (2020) Assessment of the role of renewable energy consumption and trade
510 policy on environmental degradation using innovation accounting: Evidence from the US. *Renewable*
511 *Energy*, 150, 266-277.

- 512 World Bank (2020) Available at (<https://data.worldbank.org>)
- 513 Zhang, Shao Y, Lotsch B, Hu Y S, Li H, Janek J, ... & Chen, L (2018) New horizons for inorganic solid state ion
514 conductors. *Energy & Environmental Science*, 11(8), 1945-1976.