Re-Investigation of Institutional Quality and Ecological Footprint: A Case Study of Pakistan

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Abstract

The discourse on the environment and growth nexus has been an important research agenda. However, the debate on the role of institutional quality (IQ) in environmental degradation is not adequate. Unlike others, this study examines the asymmetric effect of IQ towards ecological footprint (EF) from 1984 to 2014 in Pakistan. The non-linear autoregressive distributive lag model revealed that positive shocks are negatively effecting EF and negative shocks are positively effecting EF. Our findings suggest that a better IQ is substantially reducing EF, whereas energy consumption and economic growth are increasing EF. The study has robust policy implications.

Keywords: Institutional Quality; Economic growth; Ecological footprint; Energy consumption; NARDL; Pakistan.

1. Introduction

The institutional quality is essential for economic development around the globe. The IQ referred to the strategies that implement legitimate and cultural rules that lead to financial and socio-economic actions, which had a strong effect on the movement against environmental degradation. Higher quality institutions pave the way to

27 eradicate corruption, hold the rule of law, the minimum intervention of the military in
28 politics, transparency, and better management of fiscal policy and vice versa.
29 (Sherani, 2017). Implementation of government policies is not easier for inefficient
30 institutions (Acemoglu and Johnson, 2005). Varying institutional settings lead to
31 different motives for the stakeholders of energy policies. For example, according to
32 one view, countries with autocratic establishments may implement the environmental
33 policies in a better way than the democratic countries and vice versa (Shearman and
34 Smith, 2007; Bernauer and Koubi, 2009).

35 Additionally, countries with efficient IQ promote better ways to internalize
36 environmental externalities. For example, high taxes on pollution by policy
37 institutions promote environmental-friendly policies in the corporate sector, which
38 helps to control environmental degradation (Galinato and Chouinard, 2018). In
39 Europe, environmental degradation is reduced during the start of this century due to a
40 better IQ. Moreover, corruption represents weaker institutional implementation which
41 results in poor environmental performance (Damania, Fredriksson, economics, &
42 2003; Pellegrini & Gerlach, 2006; Zugravu, Millock, & Duchene, 2008). Strong
43 institutional developments are necessary for developing countries especially because
44 they require investment for economic growth with a sustainable environment (Lau,
45 Choong and Eng, 2014). Therefore, the quality of institutions is a problem in the way
46 of sustainable development in the form of environmental degradation.

47 Environmental degradation in the form of CO₂ emissions is traditionally incepted
48 since the influential work of G. M. Grossman & Krueger (1995), in which the linkage
49 of CO₂ emissions and economic growth is explained. Afterward, CO₂ emissions are
50 perceived as the proxy for environmental degradation. However, environmental
51 degradation is a comprehensive phenomenon, and CO₂ emissions consider only a part

52 of it. Therefore, the ecological footprint (EF) has emerged as a comprehensive
53 measure of environmental degradation. EF refers to the environment required by
54 people. According to Wackernagel & Kitzes, (2008), “Many human activities place
55 demands on the planet’s capacity, including the provision and processing of food, the
56 construction, and maintenance of housing, transportation, and the consumption of
57 goods and services”. Moreover, the EF has certain advantages over CO₂ emissions.
58 For example, EF highlights the direct and indirect effect of human activities on the
59 environment. The production of crops on earth is direct to the effect of EF on the
60 environment, whereas the use of energy in the production and cultivation of crops is
61 an indirect effect (Ulucak and Bilgili, 2018). Moreover, EF affects production as well
62 as consumption activities, which directly and indirectly worsen environmental quality.
63 Due to the higher pressure of these activities, the ecological footprint is getting scarce.
64 The scarcity of ecological resources as compared to demand is resulting in
65 environmental degradation (Khan & Hussain, 2019). So, EF is assumed to be a better
66 measure of environmental degradation, also used by Baloch, Zhang, Iqbal, & Iqbal
67 (2019), Danish, Hassan, Baloch, Mehmood, & Zhang (2019), and Dogan, Ulucak,
68 Kocak, & Isik (2020).

69 Additionally, substantial literature is evidence of environmental degradation and
70 its determinants. For example, biomass energy (Mahmood *et al.*, 2019), renewable
71 energy (Dogan and Ozturk, 2017), financial development (Xu *et al.*, 2018), imported
72 technologies (Danish, Wang and Wang, 2017), deforestation (Arshad *et al.*, 2020),
73 public-private investment in energy (Shahbaz *et al.*, 2020), natural resources (Anees
74 *et al.*, 2019), and urbanization and renewable energy consumption (Danish and wang,
75 2019). However, the attention on the linkage of institutional quality and

76 environmental degradation is limited. Moreover, the IQ and EF of a developing
77 country such as Pakistan could be interesting due to the following reasons.

78 The IQ in Pakistan is worse. According to the 2018 report on corruption by
79 transparency international, Pakistan has owned only 33 points on the scale of 0-100.
80 Pakistan ranked 117/180, which is seriously alarming (“Corruption Perceptions Index
81 2018-Transparency International”). The rule of law is also weak in Pakistan.
82 According to the “World Justice Project (WJP)”, Pakistan is having a value of 0.39/1
83 in rule of law index and falls in the lower middle category (“WJP Rule of Law Index
84 2019 | World Justice Project”). In the presence of weak rule of law, high corruption,
85 and lower justice; the environmental policies may not be fairly executed, which could
86 lead to higher high EF. Being, the fifth most populous country in the world, Pakistan
87 has utilized more ecological resources than it owns (Danish, Hassan, Baloch,
88 Mehmood, *et al.*, 2019). The environmental quality of Pakistan is also alarming and
89 needs immediate attention (Danish *et al.*, 2017; Hassan *et al.*, 2018; Danish, Hassan,
90 Baloch, Mahmood, *et al.*, 2019; Mahmood *et al.*, 2019). In Pakistan, the ecological
91 deficit is 114% (GFN, 2018). Nonetheless, better IQ could help to minimize
92 environmental degradation (Hassan *et al.*, 2019). But it is not yet a priority in the eyes
93 of environmental and institutional policymakers.

94 By extending the argument, this study has twofold potential contributions; firstly,
95 it is first of its kind to investigate the asymmetric role of IQ in determining EF in
96 Pakistan for the period 1984 to 2014. Unlike others, we use a comprehensive index of
97 IQ developed by international country risk guide (ICRG). Secondly, we use an
98 asymmetric autoregressive distributive lag econometric model (NARDL) to
99 investigate the long- and short-run asymmetric relationship between the IQ and EF.
100 Moreover, NARDL is the latest econometric approach that can handle positive and

negative shocks of IQ. Nonetheless, IQ's positive and negative shock's effect on EF in Pakistan is silent in literature. The rest of the paper consists of a literature review, material and methods, a series of econometric techniques with the results and discussions, and at the end conclusion with policy implications.

2. Literature Review

The literature on the linkage of IQ and EF is scarce. However, the existing papers on institutional quality and CO₂ emissions is summarized in table 1.

Table 1: Summary of studies on institutional quality and environmental degradation

Authors	Data Period	Panel/ Country	Env. Proxy	Econometric Method	Comments
(Awais and Wang, 2019)	1996-2017	BRICS	CO ₂	DK Regression, PMG, DOLS	Better governance is helping to clean environment.
(Salman <i>et al.</i> , 2019)	1990-2016	East Asian countries	CO ₂	FMOLS, DOLS	IQ causes to reduce CO ₂ .
(Hassan <i>et al.</i> , 2019)	1984-2014	Pakistan	CO ₂	ARDL	IQ substantially helps to reduce CO ₂ .
(Sinha <i>et al.</i> , 2019)	1990-2017	BRICS & N-11 Countries	CO ₂	GMM, CCE	N-shaped EKC with negative role of corruption.
(Zakaria and Bibi, 2019)	1984-2015	South Asian countries	CO ₂	GLS	EKC holds, IQ has a significant negative influence on CO ₂ .

(Galinato and Chouinard, 2018)	1984-1996	European countries	ER	SDM, FE, RE	Better IQ directly affects ER.
(Goel, Herrala and Mazhar, 2013)	2004-2007	100 countries	CO ₂	2SLS	More corrupt nations with shadow economies have low CO ₂ .
(Abid, 2017)	1990-2011	MEA & EU(99 countries	CO ₂	GMM	IQ can help to foster environmental quality
(Amuakwa-Mensah and Adom, 2017)	1990-2011	43 Sub-Saharan African countries	CO ₂	GMM	Quality of institutions promotes quality of environment without EKC
(Lau, Choong and Ng, 2018)	2002-2014	100 developed and developing countries	CO ₂	GMM	Inverted U-shaped EKC holds with a significant negative relationship between IQ and CO ₂ emissions.
(Bhattacharya, Awaworyi Churchill and Paramati, 2017)	1991-2012	85 countries	CO ₂	GMM, FMOLS	IQ has a positive effect on GDP and a negative effect on CO ₂ .

(Ibrahim and Law, 2016)	2000-2010	40 African countries	CO ₂	GMM	The moderating role of IQ is supporting CO ₂ emissions reduction.
(Azam, Liu and Ahmad, 2020)	1991-2017	66 Developing countries	CO ₂ , CH ₄ , Forest area, Energy Consum	GMM, TSLS	Unlike others, the negative role of IQ towards environmental degradation.
(Ali <i>et al.</i> , 2019)	2004-2010	47 developing countries	CO ₂	DPGMM	IQ helps to reduce CO ₂ emissions.

Note: ER=Environmental regulation, SDM= Spatial Durbin Model

All the above-mentioned studies considered the role of institutions in different panels of developed and countries by using CO₂ emissions as a measure of environmental degradation. Against this background, it can be concluded that the literature is scarce in explaining the role of IQ towards EF. Moreover, in the best knowledge of the authors, no previous study has investigated the role of IQ, energy consumption and economic growth in determining EF in Pakistan. So, this study is an effort to contribute to the existing body of knowledge by using the latest data available.

3. Material and Methods

3.1. Theoretical background and Model Construction

Theoretically, we followed the seminal work of G. Grossman & Krueger (1991), in which the environmental effects of trade are introduced. Moreover, the relationship between economic growth and environmental degradation is intrigued (Grossman and Krueger, 1995). Afterward, environment and growth nexus is explored by a large number of studies around the globe by considering different inputs of environmental degradation (Shahbaz *et al.*, no date; Baek, 2015; Destek, Ulucak and Dogan, 2018; Ozcan, Ulucak and Dogan, 2019; Arshad *et al.*, 2020; Khan *et al.*, 2020).

However, all the above-mentioned studies consider CO₂ emissions as environmental degradation. Although some studies used EF as environmental degradation (Apergis and Ozturk, 2015; Danish, Hassan, Baloch, Mehmood, *et al.*, 2019; Dogan *et al.*, 2020), the literature on institutional quality and ecological footprint's nexus is silent. Therefore, to contribute to the energy, growth, and environment nexus by adding the role of IQ is a target to be investigated. Following equation reflect the hypothesized model;

$$EF = f(GDP, EC, IQ)$$

In the following econometric form; the natural log of all the variables is also calculated:

$$LogEF = \alpha_0 + \alpha_1 LogEC_t + \alpha_2 LogGDP_t + \alpha_3 LogIQ_t + \mu \quad (1)$$

where EF is representing ecological footprint, IQ is institutional quality, EC is energy consumption and GDP is economic growth per capita. t is the period for which data is used and μ is the error term. As, energy is one of the major production inputs and it has a direct relationship with the level of production of goods, so it leads to increase EF. Therefore, the sign of α_1 is expected to be positive. Similarly, the GDP is also assumed to increase EF and the sign of α_2 is expected to be positive. IQ's role

is crucial in abating environmental degradation. Therefore, the better quality of institutions may help to reduce EF, which leads to the idea that quality institutions can help to reduce the ecological deficit and α_3 's sign is anticipated to be negative.

3.2 Data and Econometric Techniques

Annual data is used for the period starting from 1984 to 2014. The sample period is selected on the availability of the data. For Institutional quality, 12 point ICRG's index is used for the calculation of a single index. ICRG's index for IQ is a comprehensive index also used by (Calderón, Duncan and Schmidt-Hebbel, 2016; Asif and Majid, 2018; Nawaz *et al.*, 2018). The data of ecological footprint is collected "Global Footprint Network (GFN)". The ecological footprint is measured as ecological consumption per capita. Economic growth is assumed as GDP per capita (constant 2005 US\$), energy consumption is "the fossil fuel energy uses as a percentage of the total" and data is extracted from world development indicators (WDI).

As time-series data is used in this study and non-stationarity of the time series data is a serious issue, which may lead to spurious results. To check the stationarity of the data; the unit root test is applied. "Augmented Dickey-Fuller (ADF), Dickey-Fuller GLS (ERS), and Phillips Pearson (PP)" techniques are traditionally used first-generation unit root tests, but to identify structural breaks in the time series data, we apply Zivot & Andrews, (1992) unit root test". Additionally, we applied the "Non-linear autoregressive distributive lag (NARDL)" model, which is developed by (Shin, Yu and Greenwood-Nimmo, 2014). NARDL is an extended version of ARDL, which was initially introduced by (Pesaran, Shin and Smith, 2001a) and also extended with the name of hidden co-integration (Granger and Yoon, 2002; Schorderet, 2003). Moreover, NARDL is used to test asymmetric or symmetric relationships and it is

168 equally beneficial for the small data set and it simultaneously deals with short- and
 169 long-run integration. If the variables having asymmetric relation, then the NARDL
 170 technique is used but in the case of the symmetric or linear relationship, linear ARDL
 171 is used. The advantage of opting NARDL is that it can handle the positive and negative
 172 shocks of the targeted variable, which can help to understand the actual properties of
 173 that variable. So, to estimate NARDL, following (Pesaran, Shin and Smith, 2001a),
 174 error correction approach is adopted in the following form.

$$\begin{aligned}
 \Delta \text{Log}EF_t = & \lambda + \sum_{k=1}^A \lambda_K \Delta \text{Log}EF_{t-k} + \sum_{k=1}^B \lambda_K \Delta \text{Log}EC_{t-k} + \sum_{k=1}^C \lambda_K \Delta \text{Log}GDP_{t-k} + \\
 175 & \sum_{k=1}^D \lambda_K \Delta \text{Log}IQ_{t-k} + \gamma_0 \text{Log}EF_{t-1} + \gamma_1 \text{Log}EC_{t-1} + \gamma_2 \text{Log}GDP_{t-1} + \gamma_3 \text{Log}IQ_{t-1} + \varepsilon
 \end{aligned} \tag{2}$$

176 The above equation is almost similar to (Engle and Granger, 1987).
 177 Nevertheless, there is a minor alteration, to estimate short and long term effects by
 178 replacing the lag of the error term. Long run coefficients are λ_A , λ_B , λ_C and λ_D
 179 whereas short-run are identified are λ_0 , λ_2 , λ_2 , and λ_3 . In the equation mentioned
 180 above, the asymmetric relationship is hypothesized, in the pursuit of this hypothesis,
 181 all the independent variables are decomposed into the negative and positive sums.
 182 This can be shown in the form of asymmetric regression;

$$183 \quad y_t = \beta^+ x_t^+ + \beta^- x_t^- + \mu.$$

184 Where β^+ and β^- are considered as coefficients, whereas x_t^+ and x_t^- is assumed as
 185 representative of independent variables and decomposed as under;

$$186 \quad x_t = x_0 + x_t^+ + x_t^-$$

187 Where x^+ and x^- are the assumed independent variables with a partial sum of positive
 188 and negative changes. Following equations are the partial sums of the negative and
 189 positive changes in institutional quality;

$$LogIQ^+ = \sum_{i=1}^t \Delta LogIQ_i^+ = \sum_{i=1}^t \max(\Delta LogIQ_i, 0) \quad (3)$$

$$LogIQ^- = \sum_{i=1}^t \Delta LogIQ_i^- = \sum_{i=1}^t \max(\Delta LogIQ_i, 0) \quad (4)$$

To create NARDL, above mentioned partial positive and negative sum of IQ in equations 3, 4 are combined in the following way in equation 2. This equation is developed by (Shin, Yu and Greenwood-Nimmo, 2014).

$$\Delta LogEF_t = \lambda + \sum_{k=1}^A \lambda_k \Delta LogEF_{t-k} + \sum_{k=1}^B \lambda_k \Delta LogEC + \sum_{k=1}^C \lambda_k \Delta LogGDP_{t-k} + \sum_{k=1}^D \lambda_k \Delta LogIQ_t^+ + \sum_{k=1}^E \lambda_k \Delta LogIQ_{t-k}^- + \gamma_0 LogEF_{t-1} + \gamma_1 LogEC_{t-1} + \gamma_2 LogGDP_{t-1} + \gamma_3 LogIQ_{t-1}^+ + \gamma_4 LogIQ_{t-1}^- + \varepsilon \quad (5)$$

where Δ is difference operator, λ (A, B, C, D, E) are the long-run coefficients and ε is the error term, $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ are the short-run coefficients.

3.3 Results

To check the stationarity of the data, the ZA unit root test applied and the results of the stationarity are given in table 2. As shown in the results, all the variables are non-stationary at the level and after taking the first difference they become stationary. Different time breaks are also visible in different variables. Ecological footprint has time break in 2007, Energy consumption got it in 2008, Institutional quality has it in 1994 and economic growth has time break in 2001. Possible reasons for these time breaks might be due to the following reasons faced by the economy, during these years.

The ecological footprint's time break in 2007, might be due to the major economic changes i.e 2007 economic crises around the globe might affect all the economic activities in Pakistan as well. Energy consumption time break is also linked to the fact stated above and due to energy crises during the first decade of this century. Economic growth shows a time break in 2001, the possible reason is the change in government

212 in 1999 from democratic to military and all the policies are also changed. Pakistan has
 213 also adopted practical initiatives to mitigate environmental issues during this period
 214 i.e. (*Pakistan Environmental Protection Act, 1997*), which was mainly targeted to
 215 protect the environment and to smoothening sustainable development. It was
 216 rejuvenated in 2003 and implemented thereafter with focused attention on
 217 environmental protection issues.

Table:2 Zivot Andrew's Unit Root Test

Variables	<u>At Level</u>		<u>First Difference</u>		Order of Integration
	T-Statistic	Time Break	T-Statistic	Time Break	
LogEF	-4.032[1]	2009	-3.563*[1]	2007	I(1)
LogEC	-1.901[3]	2008	-2.552*[1]	2008	I(1)
LogIQ	-2.574[6]	2004	-4.298*[1]	1994	I(1)
LogGDP	-4.314[4]	1996	-3.892*[4]	2001	I(1)

218 Note: * is the significance at 1%.

Table 3: Non-Linear ARDL Bound Test

Test Statistics	Value	Result
F-Statistc	11.30504***	Integration

219 Note: *** shows the significance of at1%.

Table 4: Non-Linear ARDL Short-run Results

Variables	Coefficient	T- Statistics	P-Value
ΔLogEC	2.525912	7.888682	0.0000***
ΔLogGDP	2.18737	3.198823	0.02481**

$\Delta \text{LogIQ-P}$	-.200098	-4.205370	0.0007***
$\Delta \text{LogIQ-N}$	0.189812	2.676724	0.0165**
Constant	-.3848564*	-1.99	0.082

Note: *, **, *** indicates significance@10%,5%,1%.

Table 5: Non-Linear ARDL Long run Results

Variables	Coefficient	T- Statistics	P-Value
ΔLogEC	2.265487	6.685947	0.0000***
ΔLogGDP	4.16805	5.287846	0.00161***
$\Delta \text{LogIQ-P}$	-0.179468	-4.141841	0.0008***
$\Delta \text{LogIQ-N}$	0.170242	2.775125	0.0135**

Note: P and N are a positive and negative component of regressors. *, **, *** shows significance at 10, 5&1%.

Table 6: Short and Long-run Asymmetry Results

Regressor	Short-run asymmetry		Long run asymmetry	
	F- Statistics	P-Value	F- Statistics	P-Value
LogIQ	1.452	0.27	1.760	0.18

Note: Wald test is used to check the asymmetric results.

Table 7: ARDL Bounds Test

	F-statistic	Decision
$\text{LogEF} = f(\text{LogIQ}, \text{LogGDP}, \text{LogEC})$	14.024***	Integration

Note: ***Represent a significance level of @1%.

Non-linear ARDL bound test is applied and the results are reported in table 3. The bound test is used to verify the co-integration between the variables. The value of F-statistics is greater than the upper bound value at any level of significance, so it is verified that co-integration exists between the variables. In table 4, short-run NARDL results are reported. To find the asymmetric or non-linear relationship between IQ and

EF(Shin, Yu and Greenwood-Nimmo, 2014) method is applied. According to the asymmetric approach, IQ is composed of two components; positive shocks and negative shocks. Interestingly, positive and negative shocks of IQ are significantly effecting the ecological footprint in the short-run in Pakistan. Positive shocks are negatively and significantly effecting ecological footprint and negative shocks are positively and significantly affecting ecological footprint.

Table 5 reports the long-run NARDL results obtained through asymmetric ARDL. According to the reported results of long-run asymmetric results, IQ's negative shocks are positively effecting the ecological footprint and positive shocks are negatively effecting the ecological footprint and the intensity of both the components is statistically significant. Energy consumption and economic growth are reported to be significantly effecting ecological footprint in the short- and long-run. These results are aligned with (Abid, 2016; Lau, Choong, Ng, Liew, & Ching, 2018; Mavragani, Nikolaou, Tsagarakis, & Rosen, Marc A, 2016). In table 6, the asymmetry diagnostic Wald test is reported, according to the short and long run asymmetry test results, the null hypothesis of no asymmetry is accepted and the alternative hypothesis of asymmetry is rejected. So, it is found that there is no asymmetric relationship between institutional quality and ecological footprints. Therefore, these results are suggesting the linear ARDL model for further analysis.

The next step is to check the linear co-integration, for that linear ARDL bound testing is adopted, which is proposed by (Pesaran, Shin, and Smith, 2001b). It provides dynamic results and has exceptional properties. The results of bound testing are shown in table 7. The value of F-statistic is greater than the upper bound value at 1%. It means the existence of co-integration between the underlying variables; ecological footprint, economic growth, energy consumption, and institutional quality. These

results are consistent with (Shahbaz, Zeshan, and Afza, 2012; Danish *et al.*, 2017; Mahmood, Wang, and Hassan, 2019).

Dynamic Multipliers Graph in figure 1 reflects the asymmetry in the long run due to positive and negative shocks. The symmetric or difference curve indicates the combinations of dynamic multipliers due to both positive and negative shocks to IQ (institutional quality). The IQ-positive and negative shocks reported information of asymmetric adjustment of ecological footprint to negative and positive shocks of IQ. The results show that ecological footprints respond to negative and positive equally in the short run as well as in the long run.

Figure: 1 Dynamic Multipliers Graph

For the robustness of the results stability statistics helped to satisfy the confirmation. “cumulative sum of residuals (CUSUM)” and “cumulative sum of the square of residuals (CUSUM)²” diagnostic tests are selected to serve the purpose. Figure 1 is evident of the fact in which the CUSUM test shows the blue line in between the red lines, which is the confirmation of the stability of the model applied. Similarly,

270 in the figure, the CUSUM sum of the square of residuals test (CUSUM)² also confirms
 271 the robustness in the form of the blue line lies within the critical region.

272

273 Figure 2: Robustness by CUSUM Test

274

275 Figure 3: Robustness by CUSUM Test

276 3.4 Discussion

277 Based on the findings stated-above in the result section, further discussion can be
 278 extended in the following ways. Firstly, the asymmetric effect of IQ is categorically
 279 tested against EF. Interestingly, findings of NARDL showed that IQ's positive shocks
 280 are negatively effecting the EF, which means that good quality of institutions can help
 281 to reduce EF in Pakistan. Moreover, strong IQ (positive shocks) helps to promote a

sustainable environment in the long- and short-run in Pakistan. Additionally, weak IQ (negative shocks) is worsening the environment. Therefore, IQ can be used as a tool to control EF. By doing so, environmental degradation can be minimized in the short- and long-run (Hassan *et al.*, 2019).

Secondly, energy consumption's role is found to be negative in determining EF. It means the EC is responsible for the weak quality of the environment. Fossil fuel energy consumption with a share of 80% in the total energy consumption is dominating (Baloch, Kaloi, and Memon, 2016). Therefore, the share of EC is needed to be minimized to achieve a better quality of the environment. Thirdly, the GDP is also significantly increasing the EF, which means that economic growth is one of the major reasons for high EF. Being a developing country, Pakistan is at the early development stage, which is deteriorating the environment (Arshad *et al.*, 2020). After, a certain growth-level, environmental degradation may decrease.

4. Conclusion and policy implications

This study explores an asymmetric linkage between institutional quality and ecological footprint by controlling the role of EC and GDP for Pakistan from 1984 to 2014. The latest econometric techniques are applied to support the hypothetical linkage between the variables. Positive and negative shocks of IQ are significantly effecting the EF. The symmetric relationship is evident. Energy consumption and economic growth are increasing environmental degradation, institutional quality is helping to reduce the ecological footprint in the short-and long-run in Pakistan.

For the policymakers, the following suggestions could be helpful. *Firstly*, IQ is found to help in decreasing EF in Pakistan. The institutions have a substantial role to play in abating environmental degradation. Strong institutional quality could lead to a better quality of the environment (Awais and Wang, 2019). *Secondly*, energy

consumption is found to be harmful to the environment. Policymakers should re-consider the energy sources for better environmental quality.,

Thirdly, GDP is also increasing the EF. As a developing country, Pakistan's economic growth's goal is inevitable but the environmental aspect should not be ignored. Sustainable growth policies are needed to achieve better environmental quality. *Lastly*, educational institutions and media houses can play their role in the awareness about environmental degradation and its seriousness. Local governments could take immediate steps at sub-division as well as the union council level to promote awareness in local institutions to motivate every stakeholder. Further investigation of the phenomenon can elaborate on more detailed results. Future studies can use other measures of institutional quality and environmental quality to observe this phenomenon in other parts of the world.

Ethics approval and consent to participate

All the authors hereby agree to give consent on ethical approval as per the terms and conditions given in the guidelines.

Consent for publication

The authors hereby agree to give consent for publication of the manuscript.

Availability of data and material

Data will be made available on demand.

Competing interests

All the authors hereby agree to give consent that they have no competing interests related to the paper.

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Authors' contributions

All the authors contributed equally in conceptualization, methodology, writing, and editing of the paper.

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Figures

Figure 1

Dynamic Multipliers Graph

Figure 2

Robustness by CUSUM Test

Figure 3

Robustness by CUSUM Test