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Does Institutional Quality Improve Environmental Quality? New Evidence from NARDL Approach

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ABSTRACT

The current research intends to look at the asymmetrical influence of institutional quality (IQ) on carbon emissions (CO_2e) by incorporating additional variables i.e., trade openness (TO), population growth (PG), and energy use (E) over the period 1980-2020. The current study used nonlinear ARDL to demonstrate the nonlinear influence of IQ on CO_2e. The empirical finding suggests that positive fluctuation in institutional quality considerably improves the environmental quality in Pakistan in the short and long run. At the same time, the outcomes show that negative fluctuations in IQ lead to considerably contributed to CO_2e in long run. GDP and E are positively connected with CO_2e. The policy makers could need to enhance the institutional quality leads to attaining the long-term ecological objectives.

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1. Introduction

The institutional economics research undoubtedly recognized that institutional quality (IQ) is one of the most considerable elements affecting OG as the founding works of Williamson (1989) and North (2018). Institutions develop regulatory norms and policies in public by enacting appropriate restrictions. In general, IQ is connected to domestic institutions' policies that form the legal and cultural framework within which socioeconomic activity occurs. Consequently, it demonstrates the

government's capacity to develop and enact policies and regulations that stimulate the private sector, enhance contract execution quality, safeguard property rights, maintain a strict rule of law, and shield institutions from political interference. On the other hand, weak governance supports the private sector, resulting in bribery, inefficient bureaucracy, and low environmental restrictions.

Furthermore, institutions may have an influence on the environment by enacting policies such as carbon taxes, feed-in tariffs, and the abolition of financial support in EC. (Ellis, 2010; Wong et al.,2010). Thus, a country's institutional quality influences its energy demand by influencing its level of energy efficiency. It could be accomplished precisely vie reducing energy consumption (EC) or indirectly through green technological advancement. Further, the study by Shah et al. (2020) observed that IQ is a necessity for ensuring ecological preservation. This study indicates that a gradual switch to green energy, accompanied by better strategies and high-tech, is essential for long-term development without jeopardizing developing countries' financial well-being. Institutional quality also significantly impacts regional energy inequalities through the efficient financial market system (Yao et al., 2020). Reduced energy inequities between and within regions contribute to environmental quality since nations are cross-sectionally reliant on various social, economic, and cultural aspects. Consequently, accounting for cross-sectional dependency and variability among nations is crucial. As a result, institutional quality is critical in energy transition and energy efficiency, which influence energy consumption on GHG emissions, notably CO_2 emissions, which account for 76% of total GHGs (Hsu et al., 2017).

Hence, developing countries like Pakistan face numerous challenges in boosting output growth (OG). Expanding economic activity necessitates increased EC, and less developed economies have consumed a huge amount of fossil fuels. It is rapidly draining, and their rates are volatile. Also, the price fluctuations hurt developing countries and are confronted with the issue of IQ (Bellakhal et al., 2019). To enhance social and economic conditions, the government must respond to the populace's needs (Shah et al., 2020). Additionally, EC boosts in countries with higher institutional quality (Adams et al., 2016). As a result, OG infers a different impact on CO_2 e emissions in the developing and developed worlds. Besides, the role of IQ in economic development as well as ecological problems is still being debated, and it requires serious consideration.

To conclude, this study intends to scrutinize the asymmetric effect of IQon CO_2efrom 1984-2020 in Pakistan. Besides, the influence of the rule of law on the tipping point at which economic development enhances environmental quality. The primary contribution will be to highlight the relevance of the rule of law in controlling ecological degradation by examining this institution's direct and indirect consequences. Our results emphasize the relevance of institutional enforcement for environmental protection and contribute to establishing strategies for sustainable development in Pakistan.

The remaining sections are organized as follows: "Literature survey" discussed in the ahead section, "Data, Methodology and econometric technique" have been elaborated in section 3, "Empirical results and discussions" Findings and results in the discussion “described in section 4. And the final section explores the Concluding remark and policy recommendation.

2. Literature Survey

We would look at two techniques for experimentally exploring the association betweenCO_2e and OG in the first strand of inquiry. Like an outcome, this method focuses on inferring the existence of the

Environmental Kuznets Curve (EKC) theory. It is contended that the relationship between output growth per capita andCO_2e shows a bell-shaped curvature. Besides, the result indicates that output growth and$CO2$e rise in the initial phase. Beyond a certain point, it becomes a decline in carbon emissions against the rise in OG (Grossman and Krueger, 1991, 1995). The empirical findings of testing this concept have always been debatable. However, solid environmental regulations are formed as the economy progresses, and pollution-free technology improves ecological quality. Several cross-national and country-specific research has previously been conducted to investigate this notion. For example, Ahmad et al. (2017) used the autoregressive distributive lag technique to investigate the non-linear relationship between output growth per capita and CO_2e. Furthermore, Panayotou, (1993) found similar results that verified the bell-shaped EKC hypothesis. The findings verify the occurrence of EKC in Croatia.

A few empirical past studies were conducted to study the role of IQ in the OG -$CO2$e. Solarin et al. (2017) verified the EKC theory in India and China. Their results validated the EKC hypothesis in the nations analyzed. Tamazian and Rao (2010), for example, investigated the impact of IQ on environmental protection in 24 transition nations from 1993 to 2004 using the GMM estimating approach. The empirical turns out of this research indicated the relevance of IQ in enhancing environmental quality in the nations studied. Furthermore, another study by Lau et al. (2014) evaluated the influence of IQ in the OG-$CO2$e nexus from1984-2008 in the Malaysian economy. The out comes from the ARDL bound test indicated that unbiased and competent internal organizations are fundamental for reducing $CO2$e throughout OG.

Further, A few institutional experts argue that countries' institutions are not uniform, resulting in economic development divergence. North (1992) Menard and Shirley (2008) argue in their scholarly papers that countries governed by different European nationals owned multiple sets of institutions from their colonial rulers. This is theoretically supported by actual evidence. The implication is that nations that inherited different institutions from their colonial rulers saw diverse degrees of post-colonial economic growth. Countries dominated by the British, for example, received British institutions, but Frenchex-colonies acquired French institutions; consequently, economic development and IQ in British and French ex-colonies varied. (North,1989; Grier,1999; Bertocchi &Canova, 2002).

There is limited information on the environmental effect of institutions. There is, however, a lot of literature on institutions and economic progress. Omri, (2014) contends that institutions impact economic development and the effectiveness of energy programs. Bhattacharya et al. (2017) suggested that institutions that support property rights protection foster voluntary trading and help governments formulate and execute ecological improvement strategies. Consequently, the success of ecological and renewables policies depends on the functioning of institutions, deprived of which government programs would fail to generate the intended effects.

Abid's (2016) empirical results reveal that government efficacy, peace and stability, and corruption control contributed to $CO2$e reductions. Furthermore, improved institutions increase energy efficiency and renewable energy uptake, leading to stricter energy and environmental legislation (Stern, 2012; Fredriksson et al., 2004; Cadoret & Padovano, 2016). In Sub-Saharan African countries, however, controlling quality and the state of law do not curb the growth in$CO2$e. Extending on the previous study, Abid (2017) discovered that in the EU, good governance, rule of law, peace and stability, corrupt practices control, and the limit the growth of $CO2$e. However, none of these institutional measures have a meaningful effect on $CO2$e in countries in the Middle East and North Africa.

3. Methodology and Data Description

3.1 Data Collection

To achieve the aim of the study, the data was extracted from the World Development Indicators database (WDI). In our analysis dependent variable is $CO2$e and the focus variable is the institutional quality (IQ) is comprising of four indicators i.e., rule of law, corruption, accountability, and government stability, and other independent variables are energy use (E), gross domestic product (GDP), trade openness (TO), population growth (PG). Details descriptions and symbols of variables are reported in table1.

Table1 Displays Description and Symbols of Variables

Variables	Symbol	Definition	Source
Carbon dioxide emissions	CO_2e	Carbon dioxide emissions (Kilotons)	WDI
Institutional Quality	IQ	The IQ assesses the rule of law, corruption,	WGI
		Accountability and government stability.	
Energy use	E	Energy use (KG of oil equivalent per capita)	WDI
Trade Openness	TO	trade openness (calculated as export imports/GDP, constant US$, 2010)	WDI
Gross domestic product	GDP	GDP per capita (constant 2010 US$)	WDI
Population growth	PG	Population growth (annual %)	WDI

3.2 Model Specification and Methodology

The key goal of the current research is to look at the nonlinear connection between IQ and $CO2$e in Pakistan. Furthermore, this research (Tamazain and Rao, 2010; Lau et al., 2020) included IQ in their model to explore the influence of IQ on $CO2$e. The following model created by Salman et al. combines the focal variables as IQ in this investigation. The functional form of the relationship between IQ, TO, GDP, E, and $CO2$e is as follows:

$$CO_{2,t} = \beta_0 + \beta_1 IQ_t + \beta_2 EU_t + \beta_3 GDP_t + \beta_4 TO_t + \beta_5 POP_t + u_t \quad (1)$$

To obtain long and short estimates, the above equation (1) was reconfigured with an error-correction structure, which is shown below in equation (2)

$$\begin{aligned}\Delta CO_{2,t} = \beta_0 + \Sigma_{k=1}^{p}\theta_k \Delta CO_{2,t-k} + \Sigma_{k=0}^{p}\pi_k \Delta IQ_{t-k} + \Sigma_{k=0}^{p}\delta_k \Delta EU_{t-k} + \Sigma_{k=0}^{p}\lambda_k \Delta GDP_{t-k} \\ + \Sigma_{k=0}^{p}\eta_k \Delta TO_{t-k} + \Sigma_{k=0}^{p}\rho_k \Delta POP_{t-k} + \alpha_1 CO_{2,t-1} + \alpha_2 TOR_{t-1} + \alpha_3 EU_{t-1} \\ + \alpha_4 GDP_{t-1} + \alpha_5 TO_{t-1} + \alpha_6 POP_{t-1\epsilon t} \quad (2)\end{aligned}$$

Shin et al. (2014) suggested the nonlinear ARDL econometric framework applied in this research (2014). This approach explores the nonlinear influence of the variables under evaluation, which alludes to both positive and negative changes (Mensi et al., 2018). Hence, NARDL has an advanced form of ARDL and better technique as compared to ARDL. Furthermore, some scholars in environmental economics have applied the NARLD approach (Ahmad et al., 2019; Munir and Riaz, 2020). The present research is the first to look at the asymmetric link between IQ and$CO2$e in Pakistan. The primary purpose of this study is to look at the nonlinear influence on Pakistan. This research focused on the nonlinear effect of IQ on $CO2$ e. Besides, NARDL categorizes IQ into two parts: positive and negative.

3.3 Econometric Technique

A series of econometric techniques were used in this study to find linear and nonlinear relationships among the considered variables. The first step was to perform a unit root to assess the level of stationary such as the Augmented Dicker–Fuller (ADF) and Phillips–Perron (PP) tests. And in the coming step to detect asymmetric connections between the incorporated variables. This study used nonlinear cointegration tests. Finally, a diagnostic and stability test has performed to ensure that the NARDL models were secure and stable. The asymmetric effects of the explanatory variables are investigated using the NARDL version contingent error correction, which is derived from the ARDL model. Equation (3) has been developed to represent the nonlinear association between these two attributes. Shin et al. (2014) postulated the NARDL for the bound test approach used in this analysis.

$$\Delta CO_{2,t} = \beta_0 + \Sigma_{k=1}^{p}\theta_k \Delta CO_{2,t-k} + \Sigma_{k=0}^{p}\pi_k \Delta IQ_{t-k}^{+} + \Sigma_{k=0}^{p}\pi_k \Delta IQ_{t-k}^{-} + \Sigma_{k=0}^{p}\delta_k \Delta EU_{t-k} + \Sigma_{k=0}^{p}\lambda_k \Delta GDP_{t-k} + \Sigma_{k=0}^{p}\eta_k \Delta TO_{t-k} + \Sigma_{k=0}^{p}\rho_k \Delta POP_{t-k} + \alpha_1 CO_{2,t-1} + \alpha_2 TOR_{t-1} + \alpha_3 EU_{t-1} + \alpha_4 GDP_{t-1} + \alpha_5 TO_{t-1} + \alpha_6 POP_{t-1\epsilon t} \quad (3)$$

So, in equation (4) $IQ+$ Signifies the positive fluctuation in IQ. On the other hand, $IQ-$ infers the negative fluctuating in IQ. Besides the link between IQ and $CO2$e is considered the nonlinear in the condition of changes in positive and negative resulting in an inflow of IQ. Further, the F- State-bound test is used to explore the long-run cointegration among the selected variables. Hence, the null hypothesis shows the absence of cointegration while the alternative revealed the presence of cointegration. Also, the Wald testis adopted to assess the nonlinear association between IQ and $CO2$e.

$$IQ_t^{+} = \Sigma_{n=1}^{t} \Delta IQ_t^{+} = \Sigma_{n=1}^{t} max(\Delta IQ_t^{+}, 0) = \quad (4)$$

$$IQ_t^{+} = \Sigma_{n=1}^{t} \Delta IQ_t^{+} = \Sigma_{n=1}^{t} min(\Delta IQ_t^{+}, 0) = \quad (5)$$

4. Results and Discussion

The time series properties have been examined to determine the integration pattern of the variables using the Augmented Dickey-Fuller (ADF) test and the Phillips–Perron (PP) test (Khan et al., 2021). Besides, the PP and ADF unit root tests specify that the variables have a unit root as their null hypothesis. The nonstationary null hypothesis is generated at the significance levels of 10, 5, and 1%. Table 2 shows the results of unit root tests. The outcomes of the tests show that IQ, TR, and POP are stationary at the level. The results of the ADF tests on the 1stdifference, on the other hand, clearly show that carbon emissions and energy use are stationary after the 1stdifference at the 1, 5, and 10% significance levels, respectively, declining the null hypothesis. As a result, the overall results of the ADF tests describe the mixed order of integration. The results of the ADF test have been verified by adopting the PP unit root tests.

Further, the PP test also shows similar results. According to the outcome of the unit root tests, all the considered variables are an integrated series of only order I (0) and I (1). As a result, none of the variables are integrated at I (2), necessitating the use of the NARDL technique.

Table 2 Unit Root Test Results

Variables	ADF (Level)	PP(Level)
CO_2e	0.031	0.031
IQ	-0.171***	-0.130***
EU	-0.043	-0.043
GDP	-0.02	0.029
TR	-0.239***	-0.239***
POP	-0.007**	-0.007**

Note: ***, **, and * are significant at the 1%, 5%, and 10% levels, respectively. The null hypothesis for the ADF test is that the attribute does have a unit root. The null hypothesis for the PP test is that the attribute has a unit root.

The nonlinear ARDL long-run values of coefficients are extracted in table 3. The turnout illustrates that positive shocks in IQ significantly improve the environmental quality (EQ) in the long run. On the contrary, the negative surprise in IQ stimulates $CO2e$. The results highlighted that a 1% increase (decrease) in intuitional quality impacts carbon emissions to about -0.040% (0.033) at the 10% and 5% significance levels in Pakistan in the long run. Additionally, the outcomes infer that EU and GDP are positively associated with $CO2e$ in the long run. It shows that a 1% rise in EU and OG enhances $CO2e$ to about 5.532% and 0.463% at a 1% significate level, respectively, in the long run in Pakistan. At the same time, the empirical finding depicts that TOR demonstrates a negative impact on $CO2e$. The results indicate that a 1% upsurge in TOR declined the $CO2e$ to about 0.364%, while the coefficient of POP does not show a statistically significant influence on $CO2e$.

Table 3 NARDL Long Run Estimates DV CO2e

Variables	Coefficients	Std. Error
IQ	-0.040*	0.021
IQ	0.033**	0.017
EU	5.532***	2.727
GDP	0.463***	0.157
TR	-0.364*	0.20
POP	0.459	0.39

Note: ***, **, and *are significant at the1%,5%, and10%levels, respectively

Table 4 displays the short-run estimates from NARDL. The empirical findings highlight that the results infer that those positive shocks in IQ offer a substantially negative influence on $CO2$ e in the short run in Pakistan. In comparison, negative surprise in the short run has an insignificant effect on $CO2e$. Thus, the short-run results indicate that EU and GDP accelerate$CO2e$ in the short run meaningfully. On the other hand, the empirical findings confer that TOR and POP are significantly negatively associated with the $CO2e$ in short in Pakistan. Table 4's bottom panel displays the results of various diagnostic tests. The value of the Lagrange multiplier (LM) test shows an insignificant, indicating that the residuals are autocorrelation-free. Ramsey RESET test, Heteroskedasticity test, and some other diagnostic tests. The RESET test coefficients appear statistically insignificant, showing that the functional forms of our models are suitable. Similarly, the coefficient of the Heteroskedasticity test seems to be statistically insignificant, indicating that Heteroskedasticity does not affect the model. Finally, the stability of the calculated nonlinear ARDL models is evaluated using the CUSUM and CUSUM-squared tests, as illustrated in figs. 1 and 2. Furthermore, in the case of IQ and $CO2e$, the ECT

term is negative and statistically significant at the 5% level, suggesting the existence of cointegration among variables in the model. The ECT terms offer that IQ ($CO2$e) readjusts extremely fast to its long-run equilibrium level, at 82 percent per year in the presence of other measurable factors.

As a result of the Wald test results, the asymmetry between IQ and $CO2$ e seems to be significantly significant in both the long and short term. The asymmetry dynamic multiplier curve has been denoted by a difference between the positive and negative portions of the curves, which reflects the linear mixing of dynamic multipliers associated with positive and negative shocks of IQ on $CO2$e, as illustrated in fig.3.

Table 4 NARDL Short Run Estimates DV CO2e

Variables	**Coefficients**	**Std. Error**
ΔIQ_t^+	-0.057***	0.013
ΔIQ_{t-1}^+	-0.018	0.01
ΔIQ_t^-	-0.009	0.008
ΔEU_t	1.138***	0.291
ΔGDP_{t-1}	2.398***	0.527
ΔGDP_{t-1}	1.514***	0.588
ΔTR_t	-0.106	0.087
ΔPOP_t	-4.103***	0.908

Note: ***, **, and *are significant at the1%,5%, and10%levels, respectively

Table 5 Diagnostics Test DV CO2e

R-squares	99.081	
Adjusted R-squares	91.902	
ECM_{t-1}	0.082***	0.03
LM test	3.021	
F-test	8.416***	
RESET test	0.043	
Heteroscedasticity test	2.139	

Note: The critical values of the RESET, and LM, and at the 10 % level of significance are 2.12 and 3.823

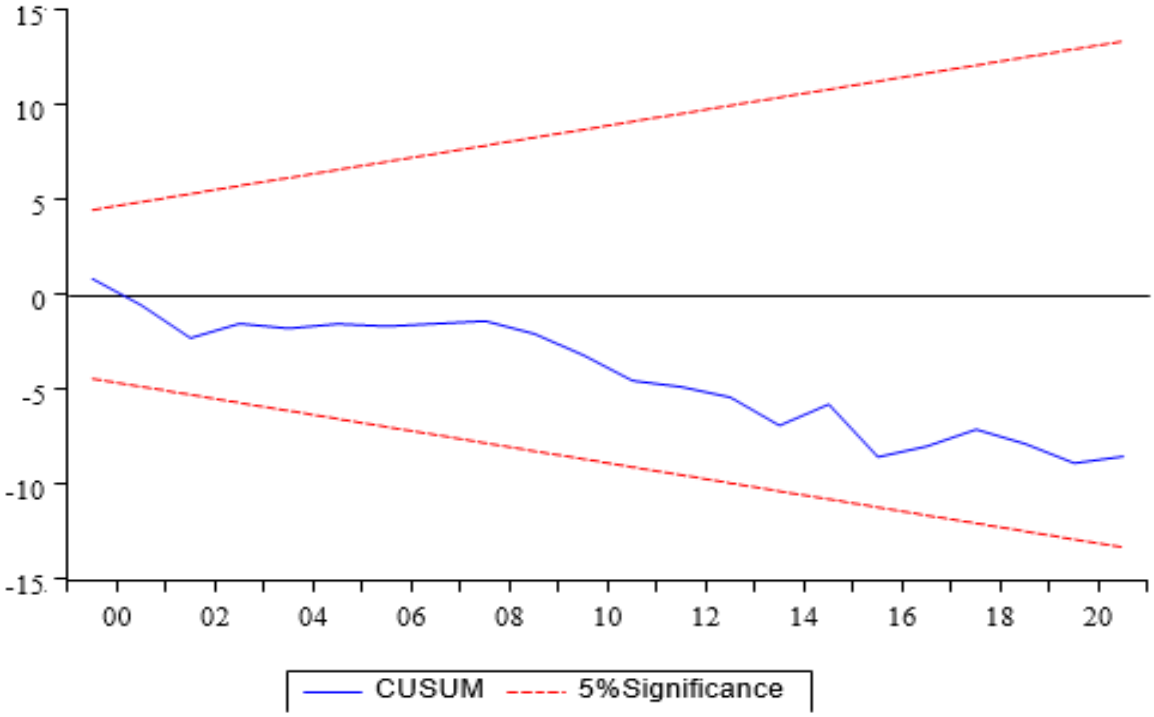

Fig.1CUSUM

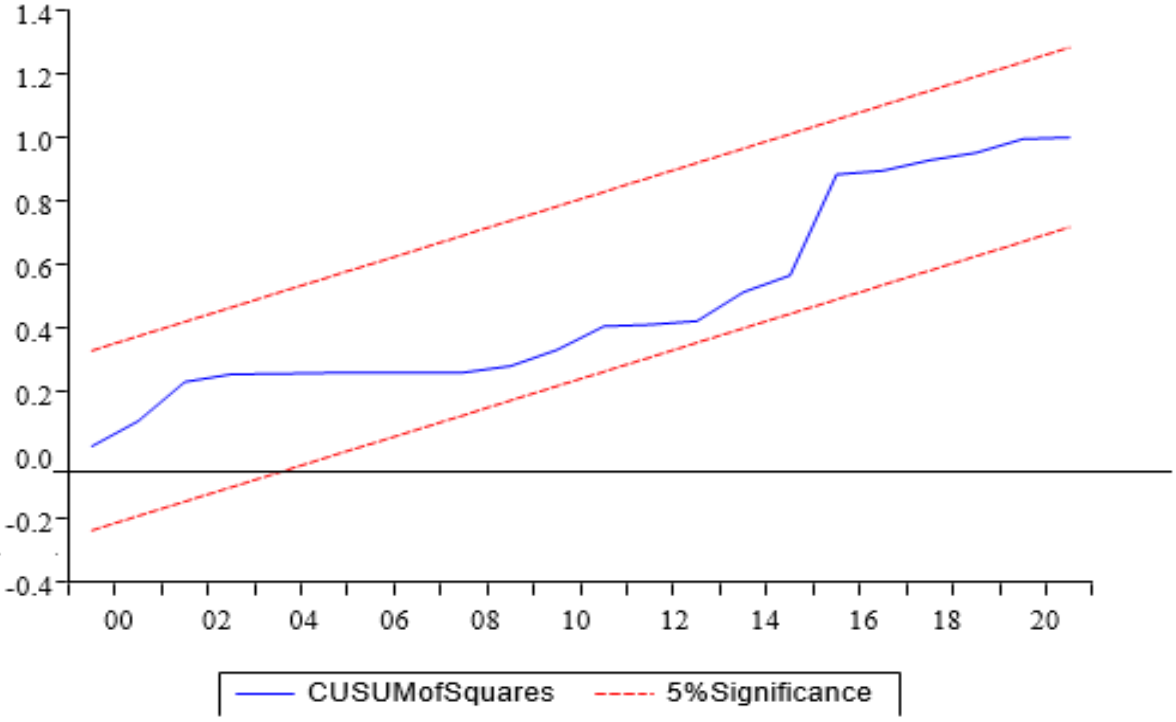

Fig.2 CUSUM of Squares

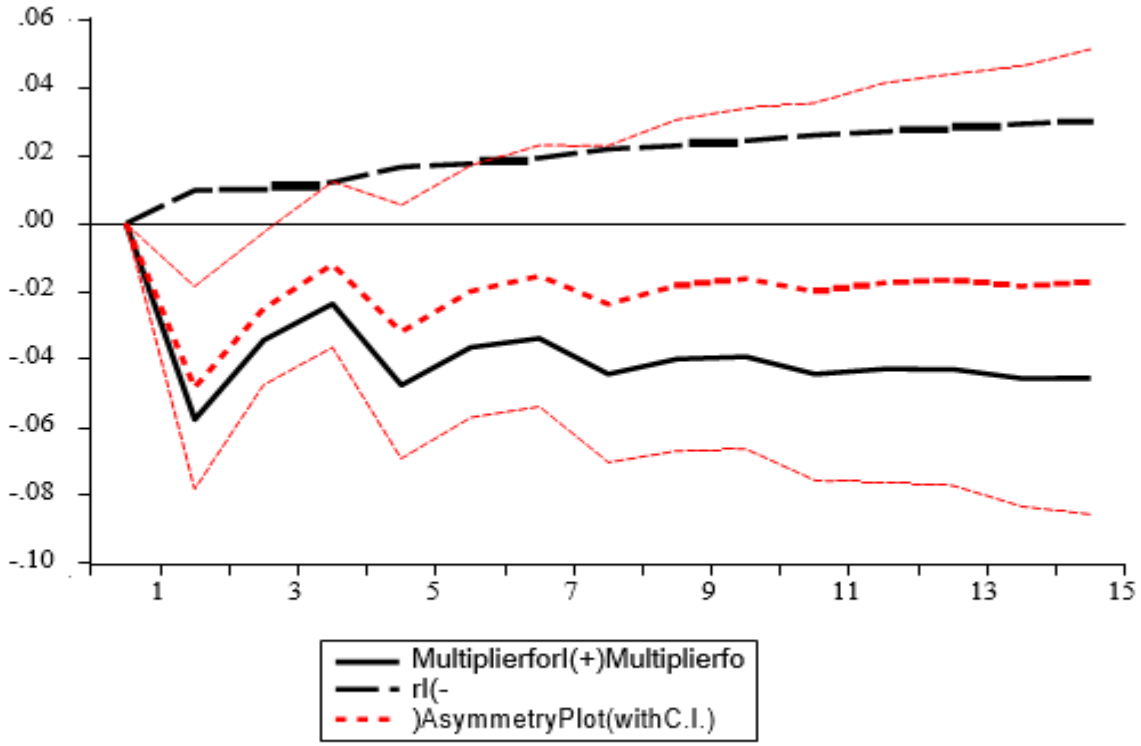

Fig.3 Dynamic Multiplier

A significant and positive influence of IQ positively affects Pakistan's environmental performance by lowering $CO2$e. In contrast, a substantial and negative influence on IQ is expected to harm Pakistan's environmental performance by increasing $CO2$ e. Besides, the nonlinear form between IQ and environment has been proved by differing levels in their coefficients in both periods (long-run and short-run). As a result, a positive influence on Pakistan's IQ may have a meaningful (at 1%) and positive impact on the quality of Pakistan's environment by reducing emissions by 0.040(0.4) in both the long and short run, respectively. In Pakistan, a negative surprise to institutional quality will result in a significant(at1%) and negative change in EQ by increasing $CO2$e by 0.033 only in the long run. Thus, the finding revealed that the positive and negative performance of institutional quality on the environment in Pakistan is mainly dependent on long-term changes in the country's institutions. This discovery is related to the quality of Pakistani institutions. This discovery highlights the need for support of useful and competent administration of Pakistan by govt representatives through its regulatory agencies and institutions. Therefore, for the scenario to continue, the country's institutions must be determined and free of corruption to deliver effective and efficient policy implementation and intensive care. As a result, the occurrences may necessitate regulatory requirements to combat market participants' excesses in electricity, and effluence-concentrated consumption; however, this may be accomplished if the country's governing strategies are prioritized over individual requirements and pursued without favor or discrimination. This finding is consistent with the author's expectations for $CO2$ control in accomplishing carbon neutrality and improving EQ through the channel of efficient institutional mechanism the outcome is consistent with the results (Uzar, 2020; Aron, 2000; Panayotou, 1997; Vogel (1997; Abid,2016). They believe that IQ is an effective tool for reversing environmental degradation. On the other hand, Wawrzyniak and Dory's (2020) study effect IQ on $CO2$e between authority efficacy and handling exploitation of power. They discovered that government effectiveness positively affects the $CO2$e, whereas corruption control has the opposite effect. Moreover, the finding suggests that the rise in the EU has a meaningful effect on $CO2$einPakistan. The outcomes are

consistent with past studies such as those (Saidi and Hammami, 2015; Nilritetal. (2017). These studies suggest that spikes in energy consumption significantly contributed to carbon emissions.

5. Conclusion and Policy Implications

This research looks in to the factors that have helped Pakistan to maintain a consistent improvement in its environmental performance by reducing carbon emissions. The real goal provides perspective on Pakistan's accomplishing carbon neutrality and conceivably offers suggestions for some other states to develop. Hence, it would undoubtedly spark a concerted effort to reduce the climate crisis via individual action in slowing down the rate of global emissions. To achieve the study's goal effectively, the present study utilized nonlinear ARDL to inspect the asymmetric effect of IQ on carbon emissions in Pakistan over the period 1980-2020.This study also employed additional variables, i.e., GDP, energy use, TO, and population. The emphasis on the effect of IQ and TO in determining environmental performance. This is the effectiveness of policies in controlling negative phenomena, for instance, $CO2$e. The efficiency and competency in policies that are implemented to attain their targeted outcomes are directly related to the quality and capabilities of the existing institutions entrusted with a task.

Also, TO has been used in many studies to test environmental performance. The turns out infer a (positive and negative) TO impacting negatively on the environment of developing countries due to laxity in policies of those countries. It is not enough to generalize that institutions' rooted policies positively control the negative phenomenon without research. Bearing in mind Pakistan's positive trend of handling $CO2$e, the present paper hypothesized that Pakistan's government's institutional quality positively impacts the environment quality. The outcomes from the NARDL indicate a positive component of IQ, assisting EQ certainly causes the reduction in $CO2$e.TOR has also been used in numerous studies to assess environmental performance. It shows a mixed finding (positive and negative) that TO is hurting the environment of less developed economies with the ineffectiveness of policies in the countries. Without research, that is not enough to generalize that institutionally deeply ingrained initiative favorably handle the negative occurrence. Given Pakistan's positive trend in reducing carbon emissions, the current paper hypothesized that the government's institutional quality positively impacts environmental quality. The NARDL findings indicate that IQ has a positive component that benefits the environment by lowering carbon emissions. The outcome infers that the EU and OG evoke the carbon emissions in Pakistan.

In contrast, the higher the level of TOR is negatively connected with carbon emissions. It infers that the TOR level increases the environmental quality by decreasing carbon emissions in Pakistan. The following strategies have been endorsed: the outcomes confirm the potency of handling $CO2$ethrough IQ, the primary concern, and increased interest in IQ to maintain good environmental performance. Further, OG may be supported with help of long- and short-term policies. For this purpose, special interest is paid to the use of green energy and also ensures the relaxation of carbon-intensive economic activities; thus, it effectively reduces carbon emissions. Besides, it will aid in advocating energy decentralization and the steady transition away from fossil fuels and toward green energy sources such as solar and hydro.

Furthermore, with responsible consumption and production as one of the Sustainable Development Goals (SDG-12) targets, a policy that will help to moderate the country's consumption and production patterns is critical. It could impose a tax on the manufacturing sectors if the target is not met. The institution's instrument should be directed toward regulating the activities of foreign

investors and assigning the investor the task of adhering to the energy transition agenda. Further, the study is helpful for policy debates about Pakistan and South Asian economies and global economic development. Furthermore, the results of a specific analysis can be used to develop specific recommendations for that region. It is also beneficial to establish the channels through which these institutional qualities improve the quality of the environment. The research will also help determine the primary role of institutional quality in developing a Pakistani economy.

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