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Econometric Assessment of Institutional Quality in Mitigating Global Climate-Change Risk

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Abstract: Background: Environmental deterioration is the alarming situation that results from rapid urbanization and development. The rising temperature and climate volatility are accounted for by the massive carbon dioxide (CO_2) emissions. The research on climate-change mitigation is trying to curtail the situations before they become irreversible and unmanageable. This study explores the role of institutions in mitigating climate change by moderating the impact of environmental quality on climate change risk. Methodology: Global data sets have been collected from world big data depositories like the World Economic Forum (WEF), the World Development Indicators (WDI), and the International Country Risk Guide (ICRG). Countries that are listed in WEF were used as the sample of the study. An analysis was based on 114 countries that are based on the availability of data. For estimation, descriptive statistics, correlation analysis, change effects, and a Panel Feasible Generalized Least Squares (FGLS) model were used for estimating the results. Results: The global assessment indicates that CO_2 emissions increase the climate risk, but its impact can be reduced by increasing the quality of institutions. Additionally, an increase in renewable energy consumption and economic growth reduces the climate risk. Implications: It is an instrumental study that empirically investigated the role of institutions in reducing climate risk by moderating CO_2 emissions. The results of this study will help policymakers to formulate policies regarding environmental protection.

Keywords: CO_2 emissions; climate hazards; health hazards; institutional quality; panel data

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1. Introduction

Climate presents as a "hazard" and a "resource." "Climate resource" is the characteristics of climate that put constraints or allow activity. For example, seasonal temperature cycles affect the heating/cooling demand of energy, and rainfall patterns affect the production of crops. Where this resource is excessively used, the occurrence of some discrete events present itself as hazardous consequences. These events are drought, windstorms, floods, hot and cold spells discussed in terms of magnitude, frequency, duration, likelihood timing, spatial extent and variability [1].

Environmental deterioration is an alarming situation that results from rapid growth. Human exploration of things and non-regulated activities resulted in abrupt changes in the environment [2]. Economic activities are responsible for increasing air, water, and many other forms of pollution [3], which has unmanageable and irreversible consequences [4].

In South Asia, more than 750 million people depend on these glaciers. Approximately 9% of the present ice-covered area in 1970 disappeared in 2000. Climate change is the leading cause of glaciers melting in the Himalayas, altering temperature and precipitation. A primary reason for this change is the existence of black carbon deposits that have resulted from human activity, resulting in glaciers absorbing solar radiation and increasing the temperature. Melting glaciers, changing precipitation, and loss of seasonal snow are causing the risk of water resources in South Asia. According to estimates, by 2050, about 70–81% of the population will suffer due to water scarcity in South Asia [5].

According to the estimates of 2018, China emitted 10.06 metric gigatons of CO_2 emission. In terms of CO_2 emission per capita, Saudi Arabia is first with 18.48 metric tons of CO_2 emissions per capita. Developed and emerging countries are leading in terms of CO_2 emissions compared to developing nations. CO_2 emissions per capita are high in developed countries, while the growth rate of CO_2 emission is high in developing countries [6].

In Xiangyang, China's average concentration of PM2.5 is 169.29 ± 56.98 μg m^{-3}. PM2.5 (Particulate Matter) has a significant impact on global warming and creates asthma and premature deaths. This emission has threatened the life of 600 million people of 17 provinces in 2013. The carcinogenic and non-carcinogenic risk associated with PM2.5 that depends on the absorption of metal is higher in adults (3.07×10^3 & 3.78×10^{-3}) than in the children (2.71×10^3 & 2.99×10^{-3}) [7].

Due to rapid economic growth in China, the exposed population to flood are expected to rise in the future. Projected flood losses at global warming 1.5 °C and 4 °C are 4 and 17 times the present losses in China, respectively. With a 0.5 °C reduction in global warming, these losses can be reduced by approximately USD 67 billion [7]. Wang et al. [8] projected the deaths in the densely populated cities of China at a global warming of 1.5 °C and 2 °C, and the adaptation capacity mortality rate in China will increase annually from 32.1 per million residents in 1986–2005 to 48.8–67.1 per million for 1.5 °C and 59.2–81.3 per million for 2 °C. When all urban residents of 831 million are considered, additional warming from 1.5–2 °C will cause more than 27.9 thousand deaths annually.

Abadie [9] used the diffusion model to calculate the future damage and risk associated with sea level in 120 major coastal cities by considering the uncertainty. In 2100, the expected damage for New Orleans and Guangzhou was USD 1,251,732 million and USD 1,196,517 million, respectively. According to the risk measurements, in 5% worse cases, the damage will be USD 2,800,756 million and USD 1,832,466 million for Guangzhou and New Orleans, respectively. Both the USA and China need to focus on the development of infrastructure in future.

Two factors determine the vulnerability of climate change. One is the "sensitivity to climate change" and the other is "adaptive capacity." Sensitivity determines the physical impact of climate change. At the same time, adaptive capacity describes the ability of a nation to deal with climate risk [10]. These adaptation measures are necessary to decrease the loss associated with rising sea levels. In 2100, 0.2% to 4.6% of the world population is expected to be flooded under a mean sea level rise of 25–123 cm if adaptive measures are not followed. This rise in sea level will incur an annual cost of 0.3 to 9.3% of the world's Gross Domestic Product (GDP) [11]. With the rise in 1 m and 5 m sea-level, the total expected loss of the global GDP will lie between 1.3–6.05 percent [12].

Developing countries are more vulnerable to climate change than developed countries because developing nations mostly rely on the agriculture sector. They face high sensitivity to climate change, and their lower ability to deal with the climate shocks causes severe consequences in these countries [13,14]. Climate change causes severe consequences for the countries that rely on rainfall and agricultural productivity [14]. In the case of developing countries, climate change affects the level of output and affects the growth in these economies. Climate change seriously impacts labor productivity and growth [15]. A temperature rise is not only associated with agriculture, industrial output, and investment but also increases political instability. A 1 °C increase in the temperature in a year will decrease the economic growth in these countries by 1.1% points on average [16]. The World Bank launched the Economics of Adaptation to Climate Change (EACC) in 2009 to study the adaptation cost of climate change for developing countries. The adaptation cost to stabilize the temperature at 2 °C by 2050 was USD 70 to 100 billion per year for the years 2010–2050 [17].

Many countries are paying attention to the quality of the environment. For this purpose, the USA, the EU, and China are focusing on reducing CO_2 emissions. They have formulated their policies with environmental protection by reducing carbon emissions. Due to abrupt climate changes, many nations have added the objective to raise renewable energy as part of their policies [18]. The efforts to stabilize the global temperature at 2 °C with 0.66 probability require that cumulative carbon emissions 2000 to 2500 should not exceed the median estimate of 590 pentagrams of carbon (PgC) (200–950 PgC range). If a temperature target of 2 °C is to be achieved with a probability of 0.9, then allowable cumulative carbon emissions are 170 PgC (−220–700 PgC range) [19].

Renewable energy consumption reduces environmental pollution. Renewable energy is derived from natural resources that are repetitively renewed. Different renewable energy sources are solar, hydropower, biothermal, and wind [20]. The literature has revealed the positive role of renewable-energy consumption in mitigating climate change [18,21]. Regulatory authorities play an essential role in the mitigation of climate change. Different institutions set various standards and codes to reduce environmental pollution [22].

The problem of global warming cannot be resolved without government regulations and policies to protect the environment. Government's costly policies rely on the public that supports government spending to protect the environment. This relationship is dependent on the quality of government where institutions are fair, non-corrupt, and effective [23]. Climate-change policies, projects, and programs either control the greenhouse gases and carbon emissions to mitigate the impact of climate change or create necessary conditions for people to adapt to climate risk and variability [24]. Public policies play an essential role in mitigation or adaptation to climate change [25].

First, to investigate the role of institutions in reducing climate risk by controlling carbon emissions, institutions play an essential role in the mitigation of climate risk. This study highlights the importance of institutions in reducing the environmental pollution that brings abrupt climate changes. For this purpose, this study used the panel-data FGLS method, and the sample comprised 114 countries at risk of climate change. The generalized estimates will be a stepping stone in developing a cross-national strategy to mitigate the climate-change risks.

The structure of the article is organized as follows. The literature of the previous studies is discussed in Section 2. Section 3 will cover the theoretical framework and methodology of the study. The results of the estimated models are presented in Section 4, while Section 5 will cover the conclusion and policy recommendation of the study.

2. Literature Review

There are empirical studies available that have focused on the regional antecedents of climate-change risk. Being regional reduces their generalizability for national and international policy makers [26,27]. In order to develop a generalizable model, multi-country macroeconomic determinants must be explored. There are several studies that have introduced the macroeconomic variables against climate change, and the most important of them are discussed in this study [28–31].

2.1. Carbon Emission and Climate Change

Carbon emission is closely related to climate change; it relates to black carbon or the carbon-sink effect. Although these emissions produce pollution in the environment, they are also responsible for global warming, the ecological footprint, and abrupt climate changes. A reduction in greenhouse gases and emissions is the only way to reduce the risk of climate change. Zickfeld et al. [19] set the emissions targets as a way to reduce the climate risk. They adopted the risk-management approach to present the carbon-cycle modelling. Their results indicate that a temperature target of 2 °C can only be achieved if CO_2 emissions are removed from the atmosphere.

Molina et al. [4] discussed the abrupt changes in climate due to CO_2 emissions. They used the Montreal Protocol to reduce the amount of CO_2 emissions, and besides reducing carbon emissions, they proposed the fastest strategy that brings the fastest climate-change response. The implementation time of this strategy was 5–10 years, and this plan will take a decade or earlier to bring a climate response. The literature also points out that an increase in the CO_2 concentration in the economy is highly correlated with global warming [32,33], which is the major driver for climate- related hazards for the ecosystems [34] and standard of living [35,36]. Hence, in developing any model related to climate-change risk, CO_2 content in the environment must be considered as an important indicator.

2.2. Institutional Quality and Climate Change

According to Starker [22], regulation plays a vital role in climate mitigation, like codes in different mandatory standards. Abduqayumov et al. [37] investigated the impact of institutional quality on the environment in the 15 post-Soviet countries from 2001 to 2017 by using the Generalized Method of Moments (GMM) approach. The findings of this study indicate a positive impact of institutional quality on the environment quality.

Problems that are related to climate change cannot be solved without the regulation of the government [2,38]. Kulin and Johansson Sevä [23] highlighted the importance of institutions' quality in implementing the government's environmental-protection policies.

Arnell et al. [1] calculated the policy-relevant indicators responsible for changing the climate risk in the UK in the health, transport, water, floods, energy, and agriculture sectors. They adopted the approach that focuses on climate-change changes in risk components by using climate projection UNCP18. The finding of this study indicates that climate risk will increase in the absence of adaptation. Extreme heat will also increase and affect health, productivity, infrastructure, etc. So, in order to incorporate the adaptability effect of institutional quality, it has been used as a moderator to reduce the harmful effects of CO_2 emissions on the economy [39,40].

2.3. Renewable Energy and Climate Change

Renewable energy and climate change are interrelated with each other. The literature has revealed the positive impact of renewable energy on the mitigation of climate-change effects. Renewable energy reduces the carbon emissions in the atmosphere and helps increase the standard of living [41,42] and reduce the resource dependency. Therefore, it is used as a policy tool to mitigate climate change, and it plays a very important role in adaptation strategies. Eitan [43] examined whether the policymakers in Israel should focus on renewable energy as a mitigation strategy or an adaptive strategy. The results indicate the minor impact of Israel on the world carbon emissions, so policymakers should promote renewable energy as a mitigation strategy rather than an adaptive strategy.

Mathiesen et al. [18] analyzed the model of 100-percent renewable energy for Denmark by 2050. Its results indicate the positive impact of energy-saving and renewable energy on the mitigation of climate change. In addition, this system will generate employment that has positive socio-economic effects. Lima et al. [21] reviewed the government strategies to promote the use of renewable energy in Brazil to mitigate climate change. Expansion in the use of renewable energy in Brazil reduces greenhouse gases' emission.

Hence, while studying the antecedents of climate change, renewable energy policy plays an important role. The level of renewable energy may define how other policies are abating climate change.

2.4. Economic Growth and Climate Change

Climate change causes serious consequences and reduces the growth of countries. At one side, there are several studies that advocate that an increase in economic activity produces friction, which is observed in the form of the carbon footprint and global warming [2,44,45]. At the same time, high growth in countries reduces the climate risk. Fankhauser and Tol [46] used different approaches to investigate the link between climate change and economic growth. They investigated the dynamic effects of saving and the accumulation of capital. Theoretical analysis suggests that net saving will decrease because of climate change that reduces physical capital. With constant saving, reducing output due to climate change will lower future welfare, decreasing investment and economic growth. If saving is endogenous, forward-looking rational agents can change their saving behavior to reduce future climate change.

Some studies revealed the effect of high growth in the mitigation of climate risk. Thus, growth can cushion the negative consequences of climate change. Economic growth is an essential factor that builds the adaptive capacity of people. The adaptive capacity that reduces the adverse impact of climate change depends on the economic status. Developing countries are more vulnerable to climate change than developed countries with high adaptive capacity [47]. Bowen et al. [13] investigated the link between climate change and economic growth. Economic growth decreases the vulnerability of climate change. Different growth policies like access to finance and investment to enhance skills decrease vulnerability to climate change.

2.5. Population Density and Climate Change

Samson et al. [48] investigated the relationship between climate change and the human population. For this purpose, they developed a global index of the predicted impact of change in climate on the population. The findings of this study indicate the negative impact of climate on humans in different regions of Africa, Southeast Asia, Central America, the Arabian Peninsula, and Central South America. These regions are away from high-latitude areas where the impact of climate change is high.

Ahmadalipour et al. [49] assessed the drought risk in Africa during three future periods between 2010–2100. The results indicate that drought risk will rise in future, and control of population growth can mitigate the drought risk.

Population density is linked with climate risk. Therefore, it can be used to reduce climate hazards in the future, such as droughts [50]. Baur et al. [51] investigated the 62 cities of Europe to analyze the importance of population density in reducing the CO_2 emissions in the environment and in mitigating climate change. This study indicates that in European urbanities, carbon emission increased with household size and household wealth reduction.

Lastly, empirical studies have underexplored the linear socio-economic determinants of climate-change risk for a data set of 114 countries. This study also interacts the role of institutional quality with CO_2 emissions to assess the regulatory efforts in limiting the CO_2 emissions and its effect on climate-change risk, while controlling for contextual factors like renewable energy, economic growth, and population density. This macroeconomic assessment based on secondary data will provide the guidelines to policymakers to abate climate-change risk.

3. Methodology

3.1. Theoretical Framework

Carbon emissions and greenhouse gases cause pollution in the environment, but these emissions are also responsible for high temperatures and unpredictable changes in the climate. Abrupt climate changes cause extreme events and climate-change risks (link shown in Figure 1).

Figure 1. Steps that lead toward climate risk.

Climate change causes negative consequences on the economic growth of the countries. In addition, climate change has a severe impact on the productivity of labor. There are two main reasons for the reduction in productivity. One is through the health issues of labor caused by climate change, and the second is the direct effect of climate on productivity due to abrupt changes in weather, i.e., hot and cold weather [15].

Economic growth reduces the negative impact of climate change and its risk. However, it depends on the adaptive capacity of the people to deal with climate change. The adaptive capacity of people can only be increased by economic growth because it is linked with the development indicators like education, income, and quality of institutions [13]. The literature revealed that countries that mainly rely on such activities directly affected by climate change suffer due to climate risk. Renewable energy is used as a policy tool in the mitigation of climate change and adaptation capacity. The promotion of renewable energy can mitigate the impact of climate change [43].

Densely populated areas of low-income countries are affected mainly by a change in the climate. The impact can be reduced by developing the infrastructure in those areas. At the same time, the experience of middle- and high-income countries shows that highly urbanized populations and the structure of production can be developed with lesser climate risk [52]. Population density is associated with climate risk. Population density reduces the climate risk, i.e., droughts that affect nutrition and create health issues [50]. Climate change harms humans in the regions where the population primarily relies on the climate [48]. Figure 2 presents the connection between variables that are interlinked with each other and cause climate risk.

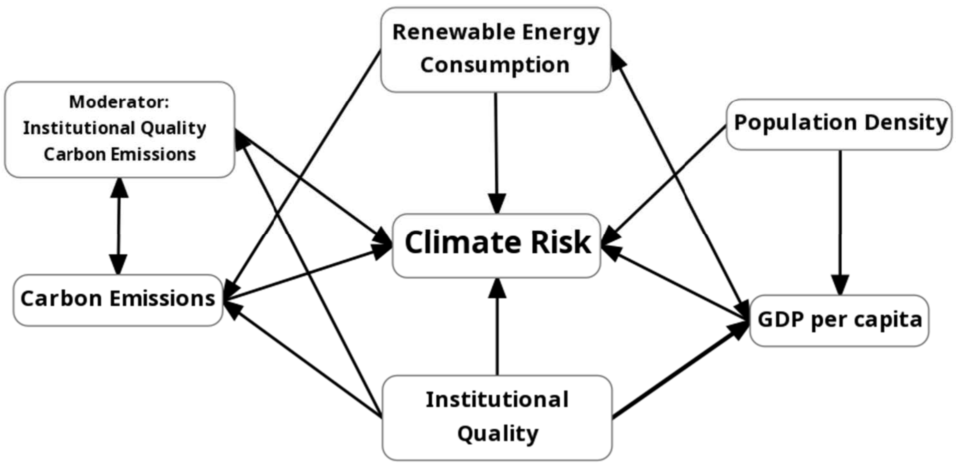

Figure 2. Connection between variables.

Regulations can control extreme events. Institutional quality plays an important role to mitigate the impact of climate change. The literature revealed that the better institutions respond quickly to the problem as it arises. This quick mitigating response results in reducing the damage of output arising from climate shocks. These institutions also increase the adaptive capacity of people to deal with climate risk [13,16].

3.2. Model Specification

To investigate the role of institutions in reducing climate risk by controlling CO_2 emissions, a linear-panel-data model with moderation was utilized. This model conducts a spatial temporal assessment of empirical patterns of selected independent and dependent variables to provide its marginal effects. Here, the climate-risk index was used as a dependent variable in the model, and CO_2 emissions, institutions, renewable-energy consumption, population density, and GDP per capita were used as explanatory variables in the model. The interaction term of CO_2 emissions and institutions was used to assess the moderating role of institutions. Although CO_2 emissions increase the risk of climate, institutions can mitigate its impact by controlling CO_2 emissions. Renewable-energy consumption, population density, and GDP per capita are transformed into natural-logarithm form.

The following is the parameterized equation, which linearly estimates the effect of independent variables on the climate-risk index for the selected empirical data.

$$CRI_{it} = \alpha + \beta_1\, CO_{2it} + \beta_2\, CO_2 \times NS_{it} + \beta_3\, INS_{it} + \beta_4\, RENE_{it} + \beta_5\, PDEN_{it} + \beta_6\, GDP_{it} + \mu_t$$

3.3. Data Source

In order to investigate the impact of CO_2 emissions on climate risk, the climate-risk index was used as a dependent variable in the model. Its data were taken from Germanwatch. The data of explanatory variables, i.e., CO_2 emissions, renewable-energy consumption, population density, and GDP per capita were taken from WDI. The data source of institutional quality was ICRG. Countries that are listed in WEF were used as the sample of the study. An analysis was based on 114 countries. These countries were selected based on the availability of data. Table 1 presents the representation and transformation of variables.

Table 1. Variable representation and their composition.

Variables	**Climate-Risk Index**	**CO_2 Emission Per Capita**	**Institutional Quality**	**Renewable Energy Consumption % of Total**	**Population Density**	**GDP Per Capita**
Symbol	CRI_{it}	CO_{2it}	INS_{it}	$RENE_{it}$	$PDEN_{it}$	GDP_{it}
Definition	Index	$\ln(CO_2)$	Index	ln(RENE)	ln(PDEN)	ln(GDP)
Data Source	Germanwatch, WEF, WDI, ICRG					
Where i represents country and t represents time						

3.4. Estimation Method

Different steps were adopted to obtain the empirical results of the study. Initially, descriptive statistics were estimated to check the mean and standard deviation of the variables. Then, the normality of the variables was checked by using the skewness and kurtosis test of normality. The correlation matrix and variance inflation factor were estimated in the next step to check the multicollinearity of the data.

This study resorted to the panel-data models, which have an inherit ability to account for the contemporaneous effects of estimates in the one cross section to other. The model that is being discussed asks for the data setup to allow the effects of one country to spillover to another. Such a setup was missing in past studies, which have focused on regional assessment. A commonly random or fixed-effect model were used in panel data, but they fail to account for the differences across countries. Finally, the panel FGLS method was used to find the empirical results of the study. It solves the heteroscedasticity problem in the data [53]. There are several studies that have used the generalization approach of panel data and then explored the country-specific estimates with the help of moderators [54–57]. This model was also used in assessing the vulnerability to climate change for 73 countries between 1998 to 2013 [58]. Further, Pedroni [59] states that the dynamic-panel data are only used if the data are more than 20 years per cross section.

4. Results

Estimation of descriptive statistics reported in Table 2 is the first step to start any empirical investigation. It provides information about the variables mean, standard, median, and maximum and minimum values, etc. The values of Kurtosis and skewness show that most variables were non-normal. All the mean values of data except the mean value of CO_2 were greater than their standard deviation, which means that these variables were under-disbursed and CO_2 emission was over-disbursed.

Table 2. Descriptive statistics.

Variable	CRI	CO_2	INS	RENE	PDEN	GDP
Observation	1765	7308	1386	7221	7522	6884
Mean	73.4568	5.03218	4.10134	2.58412	4.22296	8.44514
Std. Dev.	32.2568	8.58498	0.87287	2.06109	1.49869	1.48168
Min	1.5	−18.35	2.45888	−23.034	−1.9919	5.10192
Max	126.17	161.463	6.18644	5.01895	9.97064	12.1743
Median	74.5	2.651481	3.893463	3.12242	4.209285	8.379764
Skewness	−0.13987	7.65178	0.589475	−3.18187	0.152262	0.097784
Kurtosis	1.994916	100.0134	2.391352	24.58772	5.059564	2.120888

Table 3 provides the results of a correlation matrix. None of the variables showed a very high correlation with other variables. The high correlation was 0.71, which was between GDP and Institutions.

Table 3. Correlation matrix.

	CRI	CO_2	INS	RENE	PDEN	GDP
CRI	1					
CO_2	0.094	1				
INS	0.1585	0.5412	1			
RENE	−0.1523	−0.6661	−0.2008	1		
PDEN	−0.0541	−0.0524	0.0505	−0.107	1	
GDP	0.1361	0.6888	0.7186	−0.3927	0.0042	1

The multicollinearity of the data was checked through a variance-inflating factor. As the VIF of all the variables was less than 10, there was no multicollinearity problem in the data [60]. Its results are presented in Table 4.

Table 4. Variance-inflating factor.

CRI	CO_2	INS	RENE	PDEN	GDP
CRI	1				
CO_2	1.008915	1			
INS	1.02577	1.414222	1		
RENE	1.023746	1.797556	1.042015	1	
PDEN	1.002935	1.002753	1.002557	1.011582	1
GDP	1.018873	1.902752	2.067765	1.182331	1.000018

Table 5 presents the results of the panel FGLS method. This model climate-risk index was used as a dependent variable. In contrast, CO_2 emissions, institutions, renewable-energy consumption, population density, and GDP per capita were used as explanatory variables in the model. In addition, the interaction term of CO_2 emissions and institutions was used in the analysis with the view that CO_2 emissions increase the climate risk. Still, institutional quality plays an essential role in mitigating the effect of CO_2 emissions and reducing climate risk.

Table 5. Cross-sectional time-series FGLS regression (dependent variable = climate-risk index).

VARIABLES	CRI
CO_2	3.29846 **
	(1.26151)
$CO_2 * INS$	−0.93113 ***
	(0.25815)
INS	13.6563 ***
	(1.9004)
RENE	−3.3718 ***
	(0.59235)
PDEN	−2.4143 ***
	(0.59775)
GDP	−1.5329 *
	(0.88843)
Id	−0.03320 **
	(0.010)
Year	1.4188 ***
	(0.24659)
Constant	−2801.47 ***
	(496.04)
Observations	1196
Number of id	114

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The empirical results show a positive association between carbon emissions and climate risk. These results indicate that a 1 unit increase in CO_2 emissions will increase the climate risk by 3.29 units. A 1-unit increase in institutions will increase the climate risk by 13.65 units.

5. Discussion

This study included the moderating role of institutions in abating the climate-change risk. The interaction terms of CO_2 emissions and institutions showed that an increase in CO_2 emissions and the quality of institutions will decrease the climate risk by 0.93 units. CO_2 pollution increases the climate risk, and institutional quality mitigation is supported in the literature [19,37,58]. Hence, when there is an increase in the institutional quality, it places a higher cost of CO_2 emissions in the society; hence, the economy resorts to other carbon-saving production measures. Second, a 1-percent increase in renewable-energy consumption will decrease the climate risk by 3.37 units. The inverse relationship of renewable energy with climate change is empirically supported because if its sustainability effects [18,21]. Third, a 1 percent-increase in GDP per capita will decrease the climate risk by 1.5 units. Economic growth decreases the vulnerability of climate change, as the developed countries have done by financing climate-resilient and sustainable systems [13]. All the variables were statistically significant. Figure 3 presents the relationship between CO_2 emissions and climate risk in the presence of institutional quality. Figure 3 indicates that when institutional quality is low, CO_2 emissions increase the climate risk, but high institutional quality decreases the climate risk by controlling CO_2 emissions.

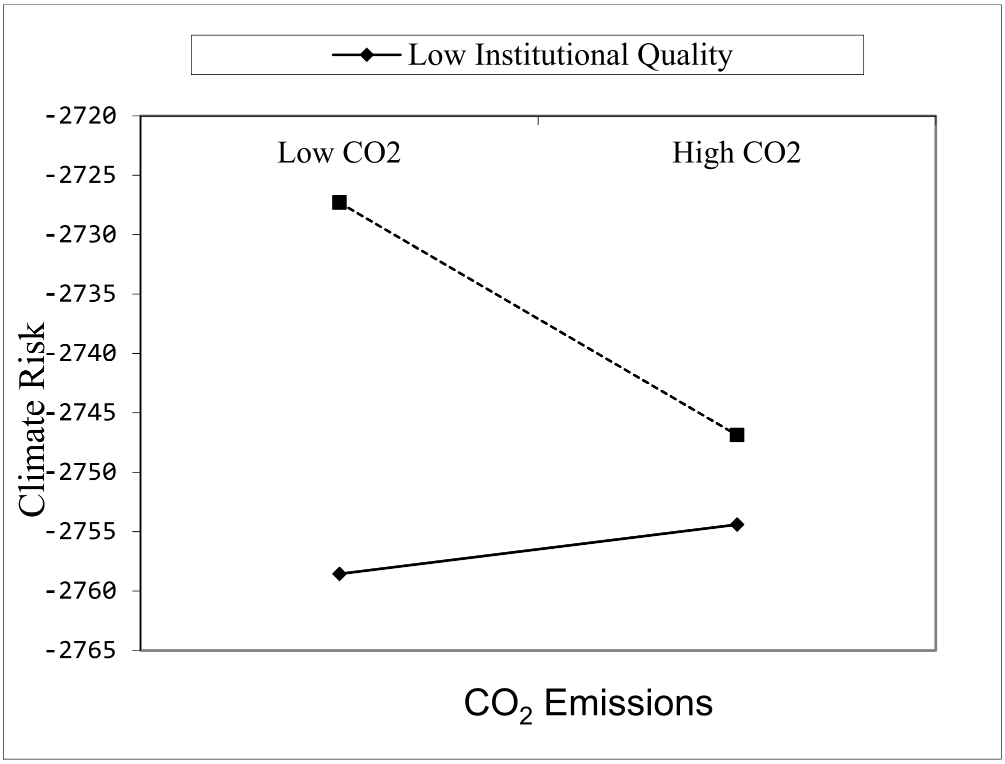

Figure 3. CO_2 emissions and climate risk.

6. Conclusions and Policy Recommendation

Rapid development and human exploration of new things have deteriorated the alarming environment for the whole world [2]. Furthermore, rapid changes in the environment and discrete events like drought, rising sea levels, high atmospheric temperature, floods, etc. have worsened the situation. A high temperature lowers economic growth in developing countries as compared to developed countries. It causes severe consequences by lowering the productivity of the agriculture and industrial sector. Besides these effects, it reduces investment in poor developing countries and increases political instability [16]. CO_2 emissions and greenhouse gases are responsible for these changes. If these emissions are not controlled properly, they can bring even worse situations that will be irreversible and unmanageable.

The current study highlights the importance of renewable energy, economic activity, and institutions in mitigating climate change. The estimated model provides guidelines in controlling global warming and, most importantly, the risks associated with climate change. Many countries have formulated policies regarding environmental protection, but there was a lack of studies providing a macroeconomic framework for them to follow. Hence, because of this, developing countries suffer more due to climate change because agriculture is a major profession in these nations and directly depends on climate change [13,14], and they have lower ability to mitigate the adverse conditions.

To investigate the role of institutions in moderating the impact of CO_2 emissions on climate change, this study used the panel FGLS method as an estimation technique. This moderator setup in the panel data helps to explore the cross-country heterogeneities within the overall model with respect to the differences in the institutional quality. A sample is comprised of countries that are listed in the WEF. One-hundred fourteen countries were selected based on the availability of the data. Its results indicate that CO_2 emissions increase the climate risk, but its impact can be reduced by increasing the quality of institutions. Here, the direct effect of institution was positive, but the moderating effect was negative; this shows that with the increase in institutions, it creates ease an of doing business that increases global warming—but with the formation of regulations, the economic activities are transformed to be environment friendly, thus reducing climate-change risk. Other results of this study indicate that an increase in renewable-energy consumption and economic growth reduces the climate risk. All the variables were significant, and its outcomes were complied with the literature.

This study proposed that countries listed in the WEF should focus on the quality of institutions, improve the adaptive capacity, and encourage the use of renewable energy. Coupled together, they will help in regulating the economic activity by using environment-friendly energy in order to engage in a combined effort in reducing the climate-change risk.

This study provided estimates that are valid for the selected countries and the selected time period; hence, estimation in extended data must also suffice for the linear-regression assumptions. Future studies should also explore different sub-dimensions of climate-change risk and institutional quality and split the sample into countries in terms of similar climate-change extreme events and hazards to see the effectiveness of institutional quality in mitigating climate-change risk.

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