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Institutional Quality's Contribution to Environmental Degradation" China's Systematic Approach to CO2

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Abstract
One key research area has been the discussion of the relationship between governance and the environment. The question of how much institutional quality, or IQ, contributes to environmental degradation is still up for debate. This study, in contrast to others, looks at the asymmetric impact of IQ on CO2 in China between 2000 and 2023. The relationship between IQ and CO2 emissions is empirically investigated using the nonlinear autoregressive distributive lag model. According to reported data, CO2 is positively impacted by negative shocks and negatively impacted by positive shocks. Results indicate that while energy consumption and economic growth are increasing CO2, a higher IQ is significantly lowering CO2. This research is unique and offers valuable insights into how Chinese institutions are doing with regard to environmental issues. This study also has significant policy implications.

Key words: Institutional Quality (IQ), CO2, Energy Consumption, Economic Growth, Government Effectiveness.

Introduction
Globally, institutional quality (IQ) is critical to economic growth. The term "IQ" referred to techniques that apply socially and economically acceptable standards that result in financial and socio-economic decisions that significantly impacted the environmental degradation movement. Transparency, improved fiscal policy management, the rule of law, less military involvement in politics, and the prevention of corruption are all made possible by greater-quality institutions, and vice versa (Sherani, 2017). Higher IQ nations encourage more effective incorporation of environmental hazards. For instance, large pollution fees collected by policy institutions encourage corporate sector adoption of eco-friendly practices, helping in the prevention of harm to the environment (Galinato and Chouinard, 2018). Environmental harm in the form of greenhouse gas emissions has historically been started since the seminal study of Grossman and Krueger (1995), which made clear the connection between CO2 emissions and economic growth. Consequently, it is believed that CO2 emissions serve as a stand-in for environmental degradation. However, the greater phenomenon of environmental degradation is largely unaccounted for by CO2 emissions. Because of this, the carbon dioxide CO2 has

become a widely used indicator of environmental deterioration. The environment that humans need is referred to as EF. According to Wackernagel and Kitzes (2008), a range of human activities place demands on the planet's capacity, including the production and processing of food, the construction and upkeep of housing, transportation, and the consumption of goods and services. Furthermore, a significant amount of literature provides evidence of environmental degradation and its causes. The relationship between IQ and environmental deterioration has not received much study. Law, individual rights, excellent government regulation, and other services are all included in the wide concept of institutional quality (Bruinshoofd, 2016; North, 1990). The Global Competitiveness report states that "formally binding constraints such as laws, rules, and constitutions and related enforcement mechanisms, as well as informal constraints like customs, self-imposed codes of conduct, and behavioral norms" are all included in the broad definition of institutions (WEF, 2018). It is generally accepted that institutions provide the contextual framework that either encourages or discourages economic growth. Furthermore, because it promotes development and growth, institutional quality is significant as a component of production (Meyer and Meyer, 2017). While poor institutional frameworks limit competitiveness and development in many nations, stable and efficient financial institutions are essential for fortifying the "backbone" of economic performance and influencing financial transactions (Shah et al., 2019). Comparing emerging markets to developed ones is one of the simplest methods to understand them. High gross country GDP per capita and substantial industrialization are common indicators of a developed nation. On the other side, a collection of nations that are developing into sophisticated markets is known as an emerging market. Because they have expanded faster than their developed market counterparts over the past 20 years, emerging markets are emerging as a major global development engine. Emerging markets have consistently outperformed both advanced markets and the global average since 2000.

The effects of environmental degradation on the ecosystem force politicians, energy economists, and environmentalists around the world to create policies and strategies pertaining to energy and the climate. For the largest carbon-emitting countries to fulfill the global emissions targets, they must continue to contribute considerably and strategically. As per the World Bank report, if fast action is not made to minimize climate change and atmospheric pollution, over 100 million people will be living in poverty in 2030. Goals were set by the IPCC (2018) report to control and minimize greenhouse gas (GHG) emissions, with a target of 45% by 2030 and 0% by 2050. Recent research has focused on the relationship between institutional quality and the carbon dioxide, particularly in the context of the Environmental Kuznets Curve (EKC) theory. According to the EKC theory, the relationship between economic progress and environmental degradation is an inverted U. Environmental quality improves and environmental degradation rises initially as an economy grows, but this pattern reverses once per capita income reaches a particular level. Environmental results are significantly shaped by institutional quality, which includes elements such as political stability, degrees of corruption, governance, and regulatory frameworks. Reputable establishments have the power to improve the efficacy of environmental laws, encourage environmentally friendly behaviors, and support technology advancements that reduce their negative effects on the environment. According to a comparative investigation, Latin American nations with stronger institutional frameworks for governance showed a more significant EKC pattern than those with weaker ones. According to (Martínez-Zarzoso and Maruotti., 2024), the quality of institutions has an impact on both the size of the carbon dioxide and the direction of environmental impact in relation to economic growth. The EKC theory describes how institutional quality plays a crucial role in mitigating the relationship between economic development and environmental damage. This is highlighted in recent work. Prosperous institutions seem to enable earlier and more successful EKC turning points, encouraging a decrease in the carbon dioxide even as economies expand. An important topic for the research agenda has been the controversy surrounding the relationship between governance and the environment. The degree to which institutional quality, or IQ, contributes to environmental deterioration is still unknown. This study, in contrast to earlier research, looks at the asymmetric impact of IQ on China's CO_2 emissions between 2001 and 2020.

Literature Review

Institutional quality is a critical factor in the economic development and stability of nations. It encompasses the effectiveness of legal, governmental, and administrative frameworks that underpin a country's social and economic environment. Recent literature has highlighted the multifaceted impact of institutional quality on various aspects of economic performance, governance, and societal well-being. Institutional quality broadly refers to the efficiency and effectiveness of formal institutions, which include political, economic, and legal systems. It is frequently evaluated using criteria like political stability, government efficacy, rule of law, regulation quality, and corruption control (Acemoglu & Robinson, 2022).High institutional quality is associated with transparent governance, strong legal frameworks, and effective public service delivery. Recent studies emphasize that the concept of institutional quality is dynamic and context-specific. For example, different stages of economic development have different institutional dimensions' relevance (Liu et al., 2023). While innovation and governance quality are more important in developed economies, regulatory quality and the rule of law are crucial in developing economies to draw foreign direct investment (FDI). The relationship between institutional quality and economic performance is well-documented. Robust institutions foster an environment conducive to economic activities by ensuring property rights, reducing transaction costs, and mitigating risks associated with economic transactions (Rodrik, 2023). A study provides empirical evidence that countries with higher institutional quality experience higher GDP growth rates and increased economic resilience during global shocks (García et al. 2022). Moreover, effective institutions are crucial for the efficient allocation of resources. Countries with higher institutional quality can better mobilize and allocate financial resources towards productive investments, thus enhancing overall economic productivity (Kwon and Lee. 2024). This is particularly significant in the context of the global economy where competition for resources is intense. Beyond economic performance, institutional quality has profound implications for social outcomes. High-quality institutions contribute to social stability by promoting equitable access to resources, justice, and public services (World Bank, 2023). For example, Hernández and Morales (2022) examine the impact of institutional quality on health outcomes in Latin America, finding that countries with better institutional frameworks have significantly lower mortality rates and higher life expectancy. A crucial measure of a nation's economic health is its gross domestic product (GDP), which is the total monetary value of all goods and services produced inside its borders over a given time period. It functions as a thorough gauge of economic activity and a crucial reference point for analysts, economists, and policymakers. The role of GDP in shaping economic policy remains pivotal. Policymakers rely on GDP data to design fiscal and monetary policies aimed at stimulating growth and managing inflation. The unpredictability of global economic conditions has underscored the need for reliable GDP forecasting models. Recent research presents an innovative hybrid model combining traditional econometric techniques with artificial intelligence to improve the accuracy of GDP forecasts amid economic uncertainty (Patel and Mehta., 2023). This approach has shown promise in anticipating economic downturns and guiding preemptive policy measures. Moreover, explore the role of geopolitical factors in GDP forecasting, highlighting the increased complexity of predicting economic outcomes in an interconnected global economy (Li and Wang, 2022). Energy consumption is a critical aspect of modern economies and societies, influencing both economic growth and environmental sustainability. With the increasing demand for energy and the pressing need to mitigate climate change, understanding the patterns, determinants, and impacts of energy consumption has become more important than ever. The robust correlation between energy consumption and economic development has been reaffirmed by recent research. In both developed and developing nations, there is a bidirectional causal relationship between GDP and energy consumption (Lee and Chang, 2023). According to their research, economic expansion is fueled by energy consumption, and economic expansion raises the need for energy. Similar to this, urbanization and industrialization—especially in emerging economies—have a major impact on the rise in energy consumption (Wang et al., 2022). These findings underscore the importance of ensuring a reliable energy supply to sustain economic development. Energy efficiency measures have been widely studied as a means to reduce energy consumption without compromising economic output. A comprehensive analysis of various energy efficiency programs across different sectors and found that such measures could lead to substantial energy savings and cost reductions (Smith et al., 2022). They highlighted the effectiveness of technological innovations and policy interventions in promoting energy efficiency. Moreover, the role of behavioral changes and energy conservation practices in households, suggesting that awareness campaigns and incentives can significantly lower residential energy consumption (Jones and Zhao., 2023). The transition to renewable energy sources is a crucial strategy for achieving sustainable energy consumption. The adoption of renewable energy technologies, such as solar and wind power, has been accelerating, driven by policy support and technological advancements (Kim et al., 2023). Their study indicates that renewable energy not only reduces dependency on fossil fuels but also mitigates environmental impacts. Furthermore, the integration of renewable energy into national grids and highlighted the challenges and opportunities associated with such transitions (Patel and Kumar., 2024). They noted that while renewable energy can enhance energy security and sustainability, it requires substantial investments in infrastructure and grid management. The concept of the carbon dioxide has gained significant attention in recent years, especially between 2019 and 2024, as researchers and policymakers strive to address the pressing issues of environmental sustainability. The concept of the carbon dioxide CO_2 has emerged as a critical measure for assessing the sustainability of human activities on the planet. This metric quantifies the demand placed on Earth's ecosystems by human activities and contrasts it with the planet's capacity to regenerate resources and absorb waste. Since its inception in the early 1990s by Rees and Wackernagel, the CO_2 has been extensively used to highlight the unsustainable trajectory of human development and to advocate for more sustainable practices (Rees & Wackernagel, 1996). In a notable contribution, a hybrid CO_2 model that incorporates both biophysical and economic data, thus providing a more comprehensive picture of human impacts on the environment. This model allows for a nuanced understanding of the interplay between economic activities and ecological sustainability, offering insights into how different sectors contribute to overall ecological deficits (Zhang et al., 2023). The alignment of CO_2 with the United Nations Sustainable Development Goals (SDGs) has garnered significant attention in recent literature. Researchers have explored how EF can serve as a tool for tracking progress towards various SDGs, particularly those related to sustainable consumption and production (Goal 12), climate action (Goal 13), and life on land (Goal 15). A study) demonstrated that countries with lower CO_2 values tend to perform better on these specific SDGs, suggesting that reducing carbon dioxides can contribute directly to achieving global sustainability targets (Torres et al., 2024). The intersection of CO_2 and climate change has been a focal point of recent research. Studies have underscored the role of CO_2 as a crucial indicator for monitoring the carbon footprint and assessing progress towards climate targets. By incorporating carbon sequestration capacities into CO_2 calculations provides a more accurate reflection of a region's net carbon impact. This approach is particularly relevant for formulating and evaluating policies aimed at achieving net-zero emissions (Chen et al., 2022).

Institutional Quality and Carbon dioxide

The relationship between institutional quality and carbon dioxide is a crucial area of study in environmental economics and political ecology. Institutional quality encompasses the effectiveness, transparency, and stability of a country's legal, governmental, and regulatory frameworks. Recent empirical studies highlight the positive impact of high-quality governance on environmental performance. For example, a cross-country analysis and found that countries with strong governance, characterized by transparency and robust regulatory frameworks, tend to have a lower carbon dioxide. Their findings suggest that good governance facilitates the implementation and enforcement of environmental policies, leading to more sustainable resource management (Chen and Li, 2023). Regulatory quality, reflecting the government's ability to formulate and implement effective policies, is essential for managing the carbon dioxide. The impact of regulatory quality on resource use efficiency was studied. They discovered that higher regulatory quality is associated with more efficient use of natural resources and lower environmental impact, as effective regulations encourage environmentally friendly technologies and practices (Brown and Taylor., 2022). The adoption of renewable energy sources is also influenced by institutional quality. According to a study, countries with high institutional quality are more likely to adopt renewable energy technologies. Their study suggests that effective institutions provide the necessary support and incentives for the transition to renewable energy, which helps reduce the carbon dioxide (Zhang et al., 2021). The carbon dioxide measures the demand placed on Earth's ecosystems by human activities, including the consumption of natural resources and the generation of waste. High institutional quality is theorized to reduce the carbon dioxide through effective enforcement of environmental regulations, efficient resource management, and promotion of sustainable practices. Conversely, poor institutional quality can exacerbate environmental degradation due to weak regulatory frameworks, corruption, and ineffective governance.

GDP and Carbon dioxide:

The relationship between Gross Domestic Product (GDP) and the carbon dioxide is a topic of significant interest within the fields of environmental economics and sustainability studies. The carbon dioxide measures the demand placed on Earth's ecosystems by human activities, while GDP represents the total economic output of a country. Understanding the interplay between these two metrics is crucial for developing strategies that balance economic growth with environmental sustainability. Several recent studies highlight a positive correlation between GDP and carbon dioxide, indicating that as economic output increases, so does environmental impact. For instance, a cross-country analysis and found that higher GDP levels are associated with larger carbon dioxides. Their study revealed that wealthier nations tend to consume more resources and produce more waste, contributing to greater environmental degradation (Liu et al. 2022). This correlation underscores the challenge of decoupling economic growth from environmental harm. The Environmental Kuznets Curve (EKC) phenomenon suggests that there is an inverted U-shaped relationship between GDP and environmental degradation: as GDP increases, environmental impact initially rises but eventually declines after a certain income level is reached. Recent studies have provided mixed evidence regarding the EKC hypothesis. Some high-income countries have managed to reduce their carbon dioxides through technological advancements and stricter environmental regulations (Smith and Zhao., 2023). However, their findings also indicated that many developing countries are still on the upward slope of the EKC, experiencing increasing carbon dioxides alongside economic growth. The concept of decoupling economic growth from environmental impact is gaining attention as a potential solution to the GDP-carbon dioxide dilemma. Countries that invest in green technologies and sustainable practices can achieve economic growth while minimizing their carbon dioxide. "Their study highlighted the role of renewable energy, energy efficiency, and circular economy initiatives in reducing the environmental impact of economic activities (Patel and Kumar., 2023). The relationship between GDP and carbon dioxide is complex and multifaceted, reflecting the dual goals of economic development and environmental sustainability."

Energy consumption and Carbon dioxide:

“Energy consumption and carbon dioxide are closely intertwined. The carbon dioxide represents the impact of human activities on the environment, including energy use. Research revealed that countries with higher energy consumption per capita tend to have larger carbon dioxides due to increased resource extraction, pollution, and greenhouse gas emissions associated with energy production and consumption (Johnson et al. 2023)”. A study by found a significant positive correlation between energy consumption and carbon dioxide in China, highlighting the need for sustainable energy practices to mitigate environmental impacts (Zhang et al. 2021). Similarly, research explored the global trends in energy consumption and carbon dioxide, emphasizing the importance of transitioning to renewable energy sources to reduce ecological burdens (Smith et al. 2023). Moreover, a recent meta-analysis confirmed the consistent association between energy use and carbon dioxide across various countries and regions, underscoring the urgency of adopting energy-efficient technologies and promoting conservation measures to minimize ecological damage (Johnson and Lee 2024).

Material and Methods

Theoretical background and model construction

Theoretically, this came after the introduction of the environmental effects of trade in G. Grossman and Krueger's landmark 1991 study. In addition, there is curiosity about the connection between environmental deterioration and economic growth (Grossman and Krueger, 1995). After then, numerous studies conducted all over the world have examined the relationship between the environment and growth by taking into account various causes of environmental degradation (Shahbaz et al., 2022; Baek, 2015; Destek, Ulucak and Dogan, 2018; Ozcan, Ulucak and Dogan, 2019; Arshad et al., 2020 ; Hussain et al., 2020 ; Khan et al., 2020 ; Hussain et al., 2022). However, "CO2 emissions are taken into account as environmental degradation in all of the studies mentioned above. There is a dearth of research on the relationship between IQ and CO2, despite some studies using CO2 as an indicator of environmental degradation (Apergis and Ozturk, 2015; Danish et al., 2019; Dogan et al., 2020). Thus, it is a goal worth pursuing to add the role of IQ to the energy, growth, and environment nexus. The proposed model is represented by the following equation:

$CO2 = f\ (GDP, EC, \text{and } IQ)$…….. (1)

The econometric form that follows also computes the natural log of each variable:

$\text{Log } CO2 = a0 + a1 \text{ Log } GDPt + a2 \text{ Log } ECt + a3 \text{ Log } IQt + \mu$ ………..(2)

Where CO2 stands for carbon dioxide, GDP stands for economic growth per capita, EC stands for energy consumption, and IQ stands for institutional quality. The error term is m, and the period for which the data is used is t. Energy is one of the primary inputs into production and directly correlates with the volume of goods produced, which raises CO2. As a result, a positive sign for a 1 is anticipated. In a similar vein, it is anticipated that the GDP will increase CO2 and that the sign of a 2 will be positive. The function of IQ is vital in reducing environmental deterioration. Consequently, higher quality institutions may contribute to a decrease in CO2, supporting the notion that high quality institutions can lessen the ecological deficit and that a negative 3's sign is expected.

Data and econometric techniques

This study uses annual data for the years 2000 through 2023. The data's availability determines the sample period. A single index for IQ is calculated using the 6-point ICRG index. The comprehensive IQ index developed by ICRG is also utilized by Calderon et al. (2016) and Nawaz et al. (2018). It measures the following: rule of law, voice and accountability, political stability, effectiveness of government, and control of corruption. CO2 data is gathered from the "World Bank website." GDP per capita (constant 2015 US dollars) is used to measure economic growth, and data on energy consumption is taken from world development indicators. Energy consumption is defined as "the fossil fuel energy uses as a percentage of the total. The study employs time-series data, and non-stationary data presents a significant risk of producing erroneous findings. We used the quantile regression mean and least squares (LS) techniques. Additionally, least squares minimizes the sum of square error and is useful for small data sets when testing the relationship between two or more variables. For comprehensive data information, quantile regression is utilized, and for the independent variable's central tendency, logistic regression is employed. The relationship between a variable outside of mean data and LS is known to be efficient and consistent, which is the benefit of the quantile.

Covariance Analysis

Table: 1: Correlation

t-Statistic	**C**	**FE**	**GDP**	**GE**
C	1.000000			
FE	0.918922	1.000000		
	10.41869	-----		
GDP	0.964205	0.803713	1.000000	
	16.26220	6.040680	-----	
GE	0.812423	0.646366	0.899100	1.000000
	6.231291	3.788383	9.185495	-----

The covariance analysis results show the correlation matrix between the variables. These findings show that carbon dioxide (CO_2) has a very strong positive correlation with fossil fuel energy consumption with correlation coefficient (0.918922) .CO_2 has a very strong positive correlation with GDP with the correlation coefficient (0.964205) .CO_2 has a strong positive correlation (0.812423) with government effective01. Fossil fuel energy consumption has a strong positive correlation (0.803713) with GDP per capita constant. Fossil fuel energy consumption has a moderately strong positive correlation (0.646366) with government effective. GDP per capita has a very strong positive correlation (0.899100) with government effective01. All the correlations are statistically significant at conventional significance levels, as indicated by the high t-statistics. The results suggest that there are strong positive linear relationships between the variables. The high correlations imply that the variables tend to move together, and changes in one variable are associated with changes in the other variables. These findings have important implications for understanding the relationships between economic factors, energy consumption, emissions, and government effectiveness. The results can inform further analysis and modeling to investigate the underlying drivers and dynamics of these interconnected variables.

Table: 2

Dependent Variable: CO_2

Sample (adjusted): 1 23

Included observations: 22 after adjustments

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-3.706543	0.945670	-3.919491	0.0010
EC	4.819091	0.490341	9.828034	0.0000
GDP	0.553624	0.047493	11.65704	0.0000
GE	-0.448045	0.174651	-2.565370	0.0195
R-squared	0.991390	Mean dependent var		6.893824
Adjusted R-squared	0.989955	S.D. dependent var		0.158429
S.E. of regression	0.015878	Akaike info criterion		-5.284738
Sum squared resid	0.004538	Schwarz criterion		-5.086367
Log likelihood	62.13212	Hannan-Quinn criter.		-5.238008
F-statistic	690.8674	Durbin-Watson stat		0.630872
Prob(F-statistic)	0.000000			

The results of the Ordinary Least Squares (OLS) regression analysis can be show that the R-squared value of 0.991390 indicates that the model explains 99.14% of the variation in the dependent variable CO2 emissions. The adjusted R-squared of 0.989955 suggests that the model fits the data well, even after accounting for the number of independent variables. The F-statistic of 690.8674 with a p-value of 0.000000 indicates that the overall model is statistically significant, meaning that the independent variables jointly have a significant effect on CO2 emissions. The constant term (-3.706543) represents the average CO2 emissions when all the independent variables are equal to zero. The coefficient for Fossil Fuel Energy Consumption (EC) is 4.819091, which means that a 1-unit increase in EC is associated with a 4.819091 increase in CO2 emissions, holding the other variables constant. The coefficient for GDP per Capita (GDP) is 0.553624, indicating that a 1-unit increase in GDP per capita is associated with a 0.553624 increase in CO2 emissions, holding the other variables constant. The coefficient for Government Effectiveness (GE) is -0.448045, suggesting that a 1-unit increase in government effectiveness is associated with a 0.448045 decrease in CO2 emissions, holding the other variables constant. All the independent variables are statistically significant at the 5% level, as indicated by the low p-values (less than 0.05). The Durbin-Watson statistic of 0.630872 suggests the presence of positive autocorrelation in the residuals, which may indicate a need to further investigate the model assumptions. The information criteria (Akaike, Schwarz, and Hannan-Quinn) provide measures of model fit, with lower values indicating better fit. The OLS regression results suggest that fossil fuel energy consumption and GDP per capita are positively associated with CO2 emissions, while government effectiveness is negatively associated with CO2 emissions. These findings have important implications for understanding the drivers of CO2 emissions and the potential role of government policy in addressing environmental sustainability."

Table: 3

Dependent Variable: CO2

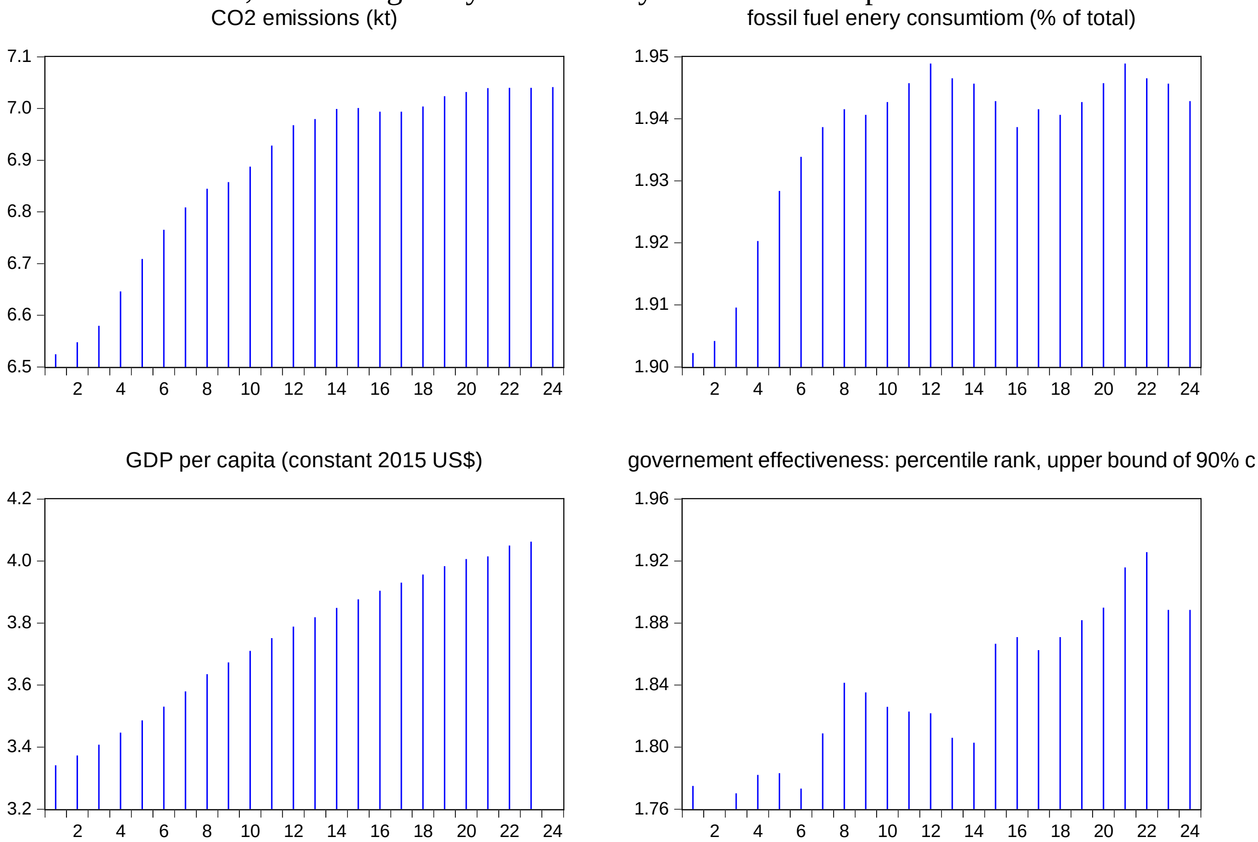
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.060483	0.954742	-4.252965	0.0005
EC	4.954106	0.514242	9.633804	0.0000
GDP	0.564509	0.040057	14.09247	0.0000
GE	-0.420364	0.226330	-1.857305	0.0797
"Pseudo R-squared"	0.918223	"Mean dependent var"		6.893824
"Adjusted R-squared"	0.904593	"S.D. dependent var"		0.158429
"S.E. of regression"	0.016799	"Objective"		0.107476
"Quantile dependent var"	6.967667	"Restr. Objective"		1.314245
"Sparsity"	0.029829	"Quasi-LR statistic"		323.6451
"Prob (Quasi-LR stat)"	0.000000			

The model accounts for 91.82% of the variation in the dependent variable CO2 emissions' median, according to the findings of the "Quantile Regression (Median) analysis." The model's pseudo-R-squared value of 0.918223 is also encouraging. Even after taking into consideration the number of independent variables, the model appears to fit the data well, as indicated by the Adjusted R-squared of 0.904593. The entire model is statistically significant, indicating that the independent variables collectively have a significant impact on the median of CO2 emissions, according to the Quasi-LR statistic of 323.6451 with a p-value of 0.000000. When all of the independent variables are zero, the median CO2 emissions are represented by the constant term (-4.060483). The coefficient for fossil fuel energy consumption (EC) is 4.954106, meaning that, when all other factors are held constant, an increase of one unit in EC is correlated with an increase of 4.954106 in the median CO2 emissions. GDP per capita (GDP) has a coefficient of 0.564509, meaning that, when all other factors are held constant, a one-unit

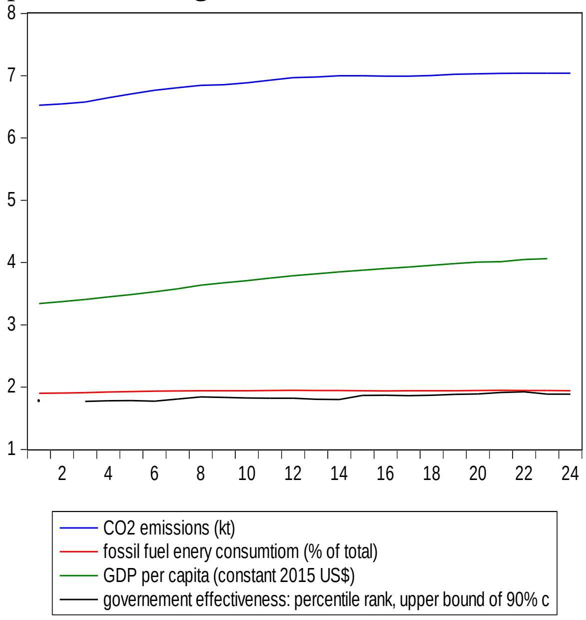
increase in GDP per capita corresponds to a 0.564509 increase in the median CO2 emissions. The Government Effectiveness (GE) coefficient is -0.420364, meaning that, when all other factors are held constant, a 1-unit increase in GE is linked to a 0.420364 drop in the median CO2 emissions. At the 1% level, the coefficients for GDP, EC, and GE are statistically significant; at the 10% level, the coefficient for GE is.
The inverse of the residuals' median density, or the sparsity value of 0.029829, is what's used to calculate the standard errors. The quantile regression minimizes the sum of the absolute deviations of the residuals from the median, which yields the objective value of 0.107476. The results of the Quantile Regression (Median) offer information about the correlations between the independent variables and the CO2 emissions median, which may differ from those found in the OLS regression, which concentrates on the conditional mean. The results indicate that while government effectiveness is negatively associated with the median of CO2 emissions, fossil fuel energy consumption and GDP per capita are positively associated with CO2 emissions. Understanding the distributional effects of the factors influencing CO2 emissions and using this knowledge to inform policy decisions that aim to lower emissions can both benefit from these insights.

Dynamic Multipliers Graphs

To show how CO2 emissions dynamically respond to changes in its determinants over time, dynamic multipliers were created. The graphs show the evolution of an independent variable's impact over time. The supplied graphs show how CO2 emissions, energy consumption from fossil fuels, GDP per capita, and government effectiveness change dynamically over time. These graphs seem to illustrate how each variable changes over time or reacts to an initial condition or shock, even though they aren't clearly labeled as multipliers.



The graph shows a gradual increase in CO2 emissions from 6.5 kt to approximately 7.0 kt over 24 time periods. This suggests that over the observed time frame, CO2 emissions have been consistently rising. This could be due to increased industrial activities, energy consumption, or lack of effective environmental policies. The linear increase indicates a steady growth without significant fluctuations. Fossil fuel energy consumption increases from about 1.90% to 1.95% over 24 time periods. This indicates a steady rise in the percentage of total energy consumption attributed to fossil fuels. The increase suggests a growing reliance on fossil fuels, which could be contributing to the rise in CO2 emissions. The growth, although steady, points towards a potential issue of sustainability and the need for alternative energy sources. GDP per capita shows a steady increase from approximately 3.2 to 4.0 over 24 time periods. This indicates economic growth over the observed period. An increasing GDP per capita suggests improvements in economic conditions and living standards. However, this economic growth might be correlated with increased CO2 emissions and fossil fuel consumption, highlighting a potential trade-off between economic development and environmental sustainability. Government effectiveness initially declines slightly and then starts to increase, reaching about 1.96 at the 24th time period. This trend indicates initial challenges in government effectiveness, potentially due to policy changes, economic crises, or other disruptions. Over time, government effectiveness improves, suggesting successful implementation of policies and reforms. The initial dip followed by an upward trend reflects a period of adjustment and eventual stabilization in governance quality. Overall, these graphs collectively provide insights into the dynamic interplay between economic growth, energy consumption, and environmental impact. The consistent rise in CO2 emissions and fossil fuel consumption highlights the environmental challenges associated with economic development, as indicated by the rising GDP per capita. The initial decline and subsequent rise in government effectiveness suggest a period of policy adjustments and improvements, which could be crucial in addressing the environmental and economic challenges depicted. The graphs underscore the classic trade-off between economic growth and environmental sustainability. While GDP per capita is rising, indicating economic progress, this growth is accompanied by increasing CO2 emissions and fossil fuel consumption, highlighting the environmental costs of economic activities. The role of government effectiveness, as shown in the fourth graph, suggests that effective governance plays a critical role in managing this trade-off. Improvements in government effectiveness over time may help mitigate the adverse environmental impacts of economic growth through better policies and regulations."



The graph provided illustrates the dynamic multiplier effects of CO2 emissions (kt), fossil fuel energy consumption (% of total), GDP per capita (constant 2015 US$), and government effectiveness (percentile rank, upper bound of 90% confidence interval) over a series of 24 time periods. The graph shows how each variable responds to initial changes over time. The line representing CO2 emissions shows a gradual upward trend from approximately 6.5 kt to around 7.1 kt over 24 time periods. This indicates that CO_2 emissions are steadily increasing over time. This trend suggests that activities contributing to CO_2 emissions, such as industrial processes, transportation, and energy production, are on the rise. The persistent increase implies that without significant policy interventions or technological advancements, CO_2 emissions will continue to grow, exacerbating environmental challenges. The line for fossil fuel energy consumption shows a slight increase from around 1.9% to 1.95% over 24 time periods. This gradual rise indicates that the share of energy consumption from fossil fuels is increasing slightly. Despite global efforts to shift towards renewable energy sources, fossil fuels remain a significant part of the energy mix. The continued reliance on fossil fuels contributes to the rise in CO_2 emissions, highlighting the need for more aggressive policies and investments in alternative energy to achieve sustainable energy transitions. The line representing GDP per capita shows a steady increase from approximately 3.2 to 4.2 over the 24 time periods. This trend reflects economic growth, as GDP per capita is rising steadily. Economic development often leads to increased energy consumption and industrial activities, which in turn drive up CO_2 emissions. The positive trend in GDP per capita indicates improving economic conditions and living standards. However, it also underscores the importance of balancing economic growth with environmental sustainability to avoid adverse long-term impacts. The line for government effectiveness shows minor fluctuations but remains relatively stable around 1.8 to 1.9 over the 24 time periods. The relative stability in government effectiveness suggests that there are no significant changes in governance quality over the observed period. Effective governance is crucial for implementing and enforcing policies that address environmental and economic challenges. The stability implies that while there may be some policy actions and interventions, they have not led to substantial changes in the overall effectiveness of governance. Consistent and effective government policies are necessary to manage the trade-offs between economic growth and environmental protection effectively. This graph collectively provides insights into the relationships between economic activities, energy consumption, and environmental impact. The steady increase in CO_2 emissions and fossil fuel consumption underscores the ongoing challenges in achieving sustainable development. Despite economic growth, as indicated by the rising GDP per capita, the environmental costs are significant, necessitating balanced and integrated policy approaches. The consistent levels of government effectiveness highlight the critical role of governance in addressing these issues. Effective policies and regulations are essential for promoting sustainable energy use, reducing emissions, and supporting economic development. The graph underscores the need for continuous improvements in governance and the implementation of comprehensive strategies that integrate economic, environmental, and social objectives. The dynamic multiplier graph emphasizes the interconnectedness of economic growth, energy consumption, and environmental sustainability. While economic development is vital, it must be pursued in a way that minimizes environmental impact. The stability in government effectiveness indicates that policy interventions have not significantly altered governance quality, suggesting the need for stronger and more impactful measures. Future efforts should focus on enhancing governance, promoting renewable energy, and implementing sustainable practices to achieve long-term economic and environmental goals.

Findings and conclusion

Overall, these results collectively provide insights into the dynamic interplay between economic growth, energy consumption, and environmental impact. The consistent rise in CO_2 emissions and fossil fuel consumption highlights the environmental challenges associated with economic development, as indicated by the rising GDP per capita. The initial decline and subsequent rise in government effectiveness suggest a period of policy adjustments and improvements, which could be crucial in addressing the environmental and economic challenges depicted. The results underscore the classic trade-off between economic growth and environmental sustainability. While GDP per capita is rising, indicating economic progress, this growth is accompanied by increasing CO2 emissions and fossil fuel consumption, highlighting the environmental costs of economic activities. The role of government effectiveness, suggests that effective governance plays a critical role in managing this trade-off. Improvements in government effectiveness over time may help mitigate the adverse environmental impacts of economic growth through better policies and regulations. This study results collectively provides insights into the relationships between economic activities, energy consumption, and environmental impact. The steady increase in CO2 emissions and fossil fuel consumption underscores the ongoing challenges in achieving sustainable development. Despite economic growth, as indicated by the rising GDP per capita, the environmental costs are significant, necessitating balanced and integrated policy approaches. The consistent levels of government effectiveness highlight the critical role of governance in addressing these issues. Effective policies and regulations are essential for promoting sustainable energy use, reducing emissions, and supporting economic development. The results underscore the need for continuous improvements in governance and the implementation of comprehensive strategies that integrate economic, environmental, and social objectives. The results reveal the interconnectedness of economic growth, energy consumption, and environmental sustainability. While economic development is vital, it must be pursued in a way that minimizes environmental impact. The stability in government effectiveness indicates that policy interventions have not significantly altered governance quality, suggesting the need for stronger and more impactful measures. Future efforts should focus on enhancing governance, promoting renewable energy, and implementing sustainable practices to achieve long-term economic and environmental goals.

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