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The Impact of Productivity on Governance Quality: A Case Study of Selected Countries

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ABSTRACT

Governance quality, as a core pillar of sustainable development, is strongly shaped by countries “economic structures and resource - use patterns. Using panel data for 61 countries over 2010 - 2022, this study examines the role of productivity in explaining governance outcomes . The results show that higher productivity has increased CO_2 emissions - used here as an inverse indicator of governance - particularly in economies heavily dependent on fossil fuels. This finding reflects the dominance of the scale effect, whereby productivity gains expand production and energy use without improving environmental efficiency. The theoretical analysis further indicates that the effect of productivity on governance is highly dependent on countries " energy mix and institutional capacity; hence, productivity cannot be regarded as an inherently sustainability - enhancing factor. Empirical evidence also confirms that in the absence of an energy transition, productivity improvements may intensify environmental pressures rather than mitigate them. Accordingly, strengthening governance requires aligning productivity - enhancement strategies with clean - energy deployment, green taxation, and investment in low - carbon technologies. Such integration can shift productivity from a source of environmental risk to a driver of improved governance and sustainable development.

KEYWORDS: Governance, Productivity, Bootstrap, Environment

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1. Introduction

In recent decades, good governance has become one of the central concepts in the discourse on development, institutional legitimacy, and sustainability. First introduced by the World Bank in the early 1990s with a focus on bureaucratic efficiency and corruption control, the concept gradually broadened to include dimensions such as transparency, accountability, participation, regulatory quality, and the rule of law (Addink, 2019). Particularly in the development literature, good governance is no longer merely a political or institutional issue; rather, it represents an interdisciplinary capacity that depends on the optimal management of economic and environmental resources, balancing growth, social justice, and ecological sustainability (Sundaram & Chowdhury, 2012; Kardos, 2012). From this perspective, effective governance not only provides the foundation for legitimacy and public trust but also constitutes a prerequisite for achieving long-term sustainable development goals (Pomeranz & Stedman, 2020).

Despite its conceptual expansion, measuring good governance remains a subject of debate. Common indicators, such as the Worldwide Governance Indicators, provide a general picture of institutional quality but face limitations in comparability and statistical reliability due to their heavy reliance on perception-based data (van Doeveren, 2011; Pomeranz & Stedman, 2020). Moreover, these indicators often neglect the environmental dimension of governance, while pressures from climate change demonstrate that sustainable resource management and the reduction of emissions are inseparable from governance quality. CO_2 emissions from fossil fuel consumption can serve as a meaningful indicator in this regard. High emission levels reflect inefficiency and unsustainable patterns, whereas reductions indicate effective, forward-looking management aligned with the principles of good governance (Cetin et al., 2025). Energy productivity has increasingly attracted attention as a key variable linking governance and sustainable development. It not only enhances economic efficiency, cost savings, and competitiveness but also plays a central role in reducing greenhouse gas emissions and combating climate change (Aydin & Erdem, 2024; Soto & Martinez-Cobas, 2024). From this perspective, improving productivity can serve as an objective reflection of institutional effectiveness in resource management and as a factor in strengthening governance capacities. 5ver, most existing studies have treated good governance as the cause of productivity improvements, while the possibility of reverse causality—the role of productivity in reinforcing governance—has received relatively less attention. Conceptually, the study rests on an integrated framework that interlinks governance, productivity, and the environment as mutually reinforcing dimensions of sustainable development. Governance is understood not only as an institutional mechanism of control and accountability but also as a system of adaptive capacities that respond to environmental and economic pressures. Productivity functions as the operational expression of this capacity—an indicator of how effectively institutions and markets transform resources into welfare under ecological constraints. The environmental dimension, in turn, embodies the feedback mechanism through which governance quality is manifested: high emissions signal institutional inefficiency and policy inertia, whereas lower emissions indicate coherent, forward-looking management. Situating the analysis within this triadic framework allows the study to move beyond a unidirectional causality and to conceptualize governance as both a determinant and an outcome of productive, sustainable resource use.

This study aims to fill this gap by focusing on a set of selected countries over the period 2010–2022. The study's novelty lies in two interrelated contributions. First, it measures governance quality inversely through CO_2 emissions from fossil fuel consumption, thereby integrating the environmental dimension into institutional assessment. Second, it employs the bootstrap-based estimation of energy productivity, which enhances the statistical reliability of cross-country efficiency comparisons. The synthesis of these elements enables a re-examination of the governance–productivity nexus, revealing that governance is not only a determinant of efficiency but also an emergent property of sustainable resource utilization. In doing so, the study offers an analytical framework that connects institutional quality, environmental management, and economic performance within a dynamic, mutually reinforcing structure that supports sustainable development objectives.The paper is structured in five sections. Following the introduction, Section Two reviews theoretical frameworks and the literature on empirical studies relevant to the present topic. Section Three analyzes research methods and estimation models. Section Four presents the findings of the estimation models. Finally, Section Five discusses the results and provides policy recommendations.

2. Theoretical Foundations and Research Background

Governance, as a central concept in development economics and political economy, refers to the quality of institutions, regulatory frameworks, and the state's capacity to design and implement effective policies. Although conventional definitions typically associate good governance with indicators such as accountability, political stability, government effectiveness, regulatory quality, the rule of law, and control of corruption (Kaufmann et al., 2011), part of the literature argues that perception-based indicators alone are insufficient. According to this view, governance quality must also be assessed through observable and tangible outcomes. Within this framework, environmental performance—particularly the ability to reduce CO_2 emissions from fossil fuel consumption—has emerged as a valid indicator of good governance. Countries with stronger institutional and regulatory capacities are generally more successful in implementing environmental policies, promoting technological innovation, and reducing carbon intensity (Halkos & Tzeremes, 2013). Thus, the inverse of fossil CO_2 emissions can serve as an objective reflection of governance quality, as it indicates the extent to which governments align policy effectiveness with sustainable development goals.

Parallel to this perspective, the economic growth literature identifies productivity as the primary engine of long-term development and the most significant factor explaining income disparities across countries. Classic studies show that differences in productivity account for a larger share of income gaps than variations in capital or labor (Hall & Jones, 1999; Rodrik et al., 2004). Higher productivity implies more efficient resource allocation, reduced waste, enhanced innovation, and improved energy efficiency. Beyond its economic impacts, productivity can strengthen the financial and administrative capacity of governments, thereby enhancing their ability to design, fund, and implement sustainable policies (Besley & Persson, 2011). From this standpoint, productivity functions not only as a driver of economic growth but also as a foundation for institutional efficiency.

Recent empirical findings suggest a reciprocal relationship between productivity and governance, particularly in the environmental domain. Productivity gains facilitate the adoption of clean technologies, improve energy efficiency, and reduce dependence on fossil fuels, thereby helping to lower carbon emissions (Wang & Su, 2020). Conversely, effective governance—with strong regulatory quality, low transaction costs, and coherent policy frameworks—creates the necessary conditions for productive investment and green innovation (Halkos & Tzeremes, 2013). Taken together, these findings indicate that productivity and effective governance can reinforce each other in advancing sustainable development.

Empirical studies also provide evidence supporting this theoretical framework. For example, Addai et al. (2022) examined Germany from 1990Q1 to 2019Q4 using the ARDL model and found that energy productivity reduces carbon emissions. Similarly, Kirikkaleli et al. (2023), using the FARDL approach for Bulgaria, concluded that investments in energy productivity lower CO_2 emissions. Zhang et al. (2023) analyzed Morocco (1990–2020) and reported that renewable energy productivity is a key factor in reducing carbon emissions in both the short and long term. In another study using panel data for OECD countries (1990–2020), Zhang et al. (2023) found that energy productivity contributes significantly to decarbonization and the transition to clean energy. Aydin & Erdem (2024) showed, using panel data for selected EU countries, that productivity has considerable potential to reduce greenhouse gas emissions. Bergougui (2024), using an ARDL model for Algeria, found that positive productivity shocks exert stronger mitigating effects on environmental degradation than negative shocks. Finally, Shen et al. (2025) examined seven major hydrogen-consuming countries (1995–2019) and concluded that energy productivity enhances environmental sustainability.

Overall, theoretical and empirical evidence suggests that energy productivity and effective governance can jointly promote sustainable development by reducing carbon emissions, fostering green innovation, and improving institutional quality. A substantial body of empirical research has examined the multidimensional relationships among productivity, environmental performance, and governance quality. Many studies highlight the crucial role of governance in shaping environmental outcomes and enabling the adoption of cleaner technologies (Halkos & Tzeremes, 2013; Pomeranz & Stedman, 2020). At the same time, an extensive literature has investigated the impact of energy productivity on carbon emissions, producing mixed and context-dependent results. For instance, Addai et al. (2022), Kirikkaleli et al. (2023), and Zhang et al. (2023) report that improvements in energy productivity reduce CO_2 emissions, whereas other studies—especially those focusing on carbon-intensive economies—find evidence supporting the dominance of the scale effect, whereby productivity gains increase emissions (Soto & Martinez-Cobas, 2024).

Despite these valuable contributions, existing research generally treats governance as a determinant of productivity or environmental outcomes. The reverse relationship—how productivity influences governance—remains largely unexplored. Moreover, few studies integrate productivity, CO_2 emissions, and governance within a single empirical framework. This gap highlights the need for a cross-country investigation that incorporates countries' energy structures and institutional capacities into the productivity–governance nexus. Addressing this gap constitutes the main contribution of the present study.

3. Data and Research Methodology

This study is of an applied nature, and the data collection method is based on library and documentary research. The period under investigation spans the years 2010 to 2022 and includes 61 countries. The countries examined are: Argentina, Germany, Angola, Austria, Jordan, Uzbekistan, Spain, Australia, Estonia, the United Arab Emirates, Indonesia, the United States, Italy, Ireland, Brazil, Belarus, Belgium, Benin, Pakistan, Peru, Tajikistan, Tanzania, Thailand, Turkey, Tunisia, Djibouti, Chad, Chile, China, Denmark, Russia, Romania, Japan, Singapore, Senegal, Somalia, Sudan, Switzerland, Saudi Arabia, France, Finland, the Philippines, Kyrgyzstan, Kazakhstan, Qatar, Canada, Colombia, Kuwait, Guatemala, Libya, Madagascar, Malawi, Malaysia, Hungary, Egypt, Mexico, Norway, Niger, Vietnam, the Netherlands, and India.

The data required for this study were collected using statistics and reports available on the World Bank and Our World in Data websites. The research model was estimated using a panel data approach, in which time-series observations are recorded for multiple cross-sectional units. Here, the cross-sectional unit is denoted by i and time by t. In general, the following equation represents a panel data model:

$$Y_{it} = \alpha_{it} + \sum_{k=1}^{k} \beta_{kit} X_{kit} + \varepsilon_{it} \tag{1}$$

Where i=1,2,..,n represents the cross-sectional units and t=1,2,…,T denotes time. Y_{it} is the dependent variable for the i-th cross-sectional unit in year t, and K_{it} is the K-th independent explanatory variable for i-th cross-sectional unit in year t. ε_{it} is the disturbance term, and β_{kit} are the model parameters. To examine the impact of productivity on governance in the selected countries, the following model has been employed:

$$LCOE_{it} = \beta_{it} + \beta_2 LPRO_{it} + \varepsilon_{it} \tag{2}$$

Where $LCOE_{it}$ denotes the logarithm of CO_2 emissions from all fossil fuels, which is employed as an inverse indicator of governance. $LPRO_{it}$ represents the logarithm of productivity. In this study, productivity is computed using the Bootstrap Data Envelopment Analysis (BDEA) approach. This method estimates the test statistic or the distribution of an estimator through resampling of the existing data. One of the advantages of the BDEA method is that it provides consistent estimation without imposing any specific assumptions regarding the underlying model (Lin & Lu, 2024; Efron & Tibshirani, 1994). The bootstrap procedure involves the following steps:

Step 1: Technical efficiency $\hat{\theta}_j$ is estimated using Equation (3):

$$\hat{\theta}_j = min\{\theta_j | y_j \leq Y\lambda;\ \theta_j X\lambda;\ \sum_{j=1}^{N} \lambda_j = 1;\ \theta_j > 0;\ \lambda_j \geq 0\ , j = 1, \dots, N\} \qquad (3)$$

Step 2: Using the bootstrap and smooth resampling from $\hat{\theta}_1, \dots, \hat{\theta}_N$, the bootstrap replications $\theta_1^*, \dots, \theta_N^*$ are obtained.

Step 3: For j=1,…,N a set of pseudo-data $\left(x_{j,b}^*, y_{j,b}^*\right)$ is generated such that $x_{j,b}^* = \left(\frac{\hat{\theta}_j}{\theta_j^*}\right) x_j$ and $y_{j,b}^* = y_j$. Then, the new DEA score $\hat{\theta}_j^*$ is calculated using the pseudo-data.

Step 4: Steps 1 through 3 are repeated B times, and the new DEA technical efficiency scores $\hat{\theta}_j^*$ are obtained for j=1,…,N. Accordingly, the bias-corrected estimator of $\hat{\theta}_j^*$ is computed as follows:

$$\hat{\hat{\theta}}_j = \beta^{-1} \sum_{b=1}^{B} \hat{\theta}_j^* \qquad (4)$$

Step 5: Confidence interval (1-α) for technical efficiency is constructed by finding the values a_α and b_α such that $Pr\left(-a_\alpha \leq \hat{\theta}_j - \theta_j \leq -b_\alpha\right) = 1 - \alpha$ is determine. Since the distribution of $(\hat{\theta}_j - \theta_j)$ is unknown, the bootstrap values such that $Pr(-\hat{a}_\alpha \leq \hat{\theta}_j^* - \hat{\theta}_j \leq -\hat{b}_\alpha) = 1 - \alpha$ are used to find $\hat{a}_\alpha$ and $\hat{b}_\alpha$. Therefore, the estimated confidence interval with the (1-α) level for the j-th technical efficiency will be as follows (Long et al., 2020):

$$\hat{\theta}_j + \hat{b}_\alpha \leq \theta_j \leq \hat{\theta}_j + \hat{a}_\alpha \qquad (5)$$

4. Finding

Considering the panel structure of the data employed in this study, panel unit root tests such as Levin, Lin, and Chu (LLC) and Pesaran's test were conducted to assess the stationarity properties of the variables. The empirical results are reported in Table 1.

Table (1): Survey of variables Stationary

Variable	Pesaran Statistic	Probability	LLC Statistic	Probability	Result
LCOE	-2.60	0.00	-6.11	0.00	S
LPRO	-6.91	0.00	-10.12	0.00	S

The results indicate that the variables are stationary at level; hence, the issue of spurious regression is no longer a concern. Prior to estimating the model, the F-Limer test was employed to determine whether the pooled OLS estimator or a panel data estimation method is more appropriate for the specified equation. Table 2 reports the results of the F-Limer test used to compare these models.

Table (2): Limer (Chav) test

Criteria	Statistic	Probability
F criteria	2482.87	0.00
Chi- square criteria	3976.46	0.00

The test results indicate that the null hypothesis is rejected; therefore, the appropriate specification for the model under consideration is panel data. Consequently, in the next step, the fixed effects model must be compared with the random effects model. For this comparison, the Hausman test is employed. Table 3 reports the results of the Hausman test.

Table (3): Hausman test

Criteria	Statistic	Probability
Hausman	3.17	0.07

In the Hausman test, the null hypothesis regarding the superiority of the random effects model cannot be rejected. Therefore, the random effects model is ultimately used to examine the effects of the variables. The results of this model are as follows:

Table (4): Random Model

Variable	Coefficient	t-Statistics	Probability
LPRO	0.88	7.18	0.00
C	18.24	71.27	0.00

The estimation results indicate that the coefficient of productivity is 0.88 and statistically significant. The estimated coefficient for productivity (0.88) indicates an almost unitary elasticity between productivity and CO_2 emissions. This implies that a one-percent increase in productivity, on average, results in a 0.88-percent rise in carbon emissions. The magnitude of this coefficient—high and close to unity—suggests that in the countries under investigation, improvements in productivity are translated almost proportionally into higher fossil-fuel consumption and consequently increased pollutant emissions. Such a pattern reflects the strong dominance of the Scale Effect, meaning that productivity growth expands economic activity and energy use without being offset by the Composition Effect or the Technique Effect. This quantitatively derived result indicates that the energy structures of these countries have not yet undergone the transformation required for productivity to play a mitigating role in emission reduction. Therefore, productivity in these economies has not only failed to enhance governance quality but, by intensifying environmental pressures, has indirectly contributed to the weakening of governance capacity. In other words, a one percent increase in productivity, on average, leads to a 0.88 percent increase in CO_2 emissions. Given that CO_2 emissions originate from fossil fuels, and since CO_2 emissions in this study are considered as an inverse indicator of governance quality, it can be inferred that productivity growth in the countries under review, instead of improving governance, has reduced governance quality through increasing dependence on fossil fuels and intensifying environmental consequences. This finding demonstrates the dominance of the Scale Effect over the Composition Effect and the Technique Effect of energy during the period 2010–2022; meaning that higher productivity in the studied economies has expanded production activities and fossil fuel consumption, resulting in greater pollution and a weakening of the governance index (Grossman & Krueger, 1995; Cole, 2004; Stern, 2004; Shahbaz et al., 2016).

5. Conclusion and Recommendations

The findings of this study reveal that productivity growth in 61 selected countries during the period 2010–2022 has led to an increase in CO_2 emissions resulting from fossil fuel consumption. Since CO_2 emissions were considered as an inverse indicator of good governance, the results indicate that within an energy structure dominated by fossil fuels, improvements in productivity have in fact weakened governance quality. The positive and statistically significant elasticity coefficient of carbon emissions with respect to productivity provides strong evidence of the dominance of the Scale Effect. This implies that productivity improvements, by expanding economic activity and energy consumption without a corresponding enhancement in the energy mix or technological efficiency, have increased emission levels.

This finding carries a key policy implication: productivity, in itself, cannot be regarded solely as a positive driver of development. These findings are theoretically significant as well, because unlike the evidence from OECD and EU countries—where productivity is typically associated with reductions in pollutant emissions—productivity in the countries examined here has contributed to higher emission levels. This divergence indicates that the direction of the productivity–environment nexus is heavily shaped by the underlying energy structure, the stage of economic development, and institutional capacity. The present results highlight the need for a transition from “traditional productivity” to “green productivity,” whereby productivity gains are achieved not through expanding fossil-fuel consumption but through low-carbon technologies and improvements in energy intensity. According to the quantitative evidence of this study, without such a transformation, productivity not only fails to enhance governance quality but may, by intensifying environmental pressures, ultimately undermine it. In economies highly dependent on fossil fuels, productivity growth entails the risk of being locked into a pathway with higher carbon intensity and adverse consequences for governance. Therefore, the central challenge is not merely to increase productivity, but to ‘green’ productivity in such a way that productivity gains are accompanied by reductions in energy intensity, decarbonization of production, and technological upgrading.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.