Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

Does Environmental Governance Performance Have a Positive Influence on Regional Economic Growth?

——Evidence from Guangdong Province, China

Yishan Wu[1], Shujian Zhang[2*]

1.Yishan Wu, Research assistant, Shenzhen Senior High School

2.Shujian Zhang, Associate professor, Global Megacity Governance Institute, Shenzhen University

*Correspondence author（zsj@szu.edu.cn）

ABSTRACT

This study examines the influence of environmental governance efficiency on regional economic growth in Guangdong Province, China. By employing the Data Envelopment Analysis (DEA) method, we evaluate the environmental governance efficiency of 21 cities, considering both expected outputs and unexpected outputs. The findings reveal a significant positive relationship between environmental governance efficiency and regional economic growth, highlighting the role of effective environmental policies in promoting sustainable economic development. Our research underscores the importance of integrating environmental strategies into economic planning, suggesting that robust environmental governance can enhance economic performance by fostering innovation, attracting investments, and reducing health costs. This study contributes to the broader discourse on sustainable development, providing policymakers with actionable insights to balance economic growth and environmental sustainability effectively.

KEYWORDS

Environmental governance, Economic growth, DEA, Guangdong, China

http://doi.org/10.62220/j.ssbpa.2024.01.007

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

1.Introduction

Environmental governance has become an integral aspect of sustainable development, particularly in rapidly industrializing regions where the balance between economic growth and environmental sustainability is critical. This study aims to explore the relationship between environmental governance efficiency and regional economic growth in Guangdong Province, China, by focusing on per capita Gross Domestic Product (GDPpc) as a measure of economic performance. The central question addressed in this research is whether effective environmental governance can positively influence regional economic growth.

Guangdong Province, known as the powerhouse of China's economic development, offers a unique context for this study. Over the past few decades, Guangdong has experienced unprecedented economic expansion, becoming one of the most economically advanced regions in China. However, this rapid growth has also led to significant environmental challenges, including air and water pollution, resource depletion, and ecological degradation. Recognizing these challenges, the provincial government has implemented a series of environmental policies aimed at promoting sustainable development. These initiatives include stringent pollution control measures, investment in green technologies, and policies to enhance resource efficiency.

The theoretical framework underpinning this study is based on the concept of sustainable development, which posits that long-term economic growth can be achieved without compromising environmental integrity. According to this framework, environmental governance plays a crucial role in ensuring that economic activities do not exceed the carrying capacity of the environment. Effective environmental governance can lead to improved environmental quality, which in turn can enhance the attractiveness of a region for investment, reduce health costs, and foster innovation in green technologies. Consequently, this study hypothesizes that higher environmental governance efficiency is associated with higher regional economic growth.

To empirically test this hypothesis, this study employs the Data Envelopment Analysis (DEA) method to estimate the environmental governance efficiency scores for 21 cities in Guangdong Province. DEA is a non-parametric method used to evaluate the efficiency of decision-making units (DMUs) by considering multiple inputs and outputs. This approach is particularly suitable for this study as it allows for the inclusion of both expected outputs, such as reductions in pollution levels and improvements in resource efficiency, and unexpected outputs, such as economic costs and compliance burdens associated with environmental regulations.

The data for this analysis is drawn from a variety of sources, including provincial statistical yearbooks, environmental reports, and economic databases. Key variables include indicators of environmental governance, such as pollution control expenditures, implementation of green technologies, and enforcement of environmental regulations, as well as economic indicators such as GDPpc, industrial output, and foreign direct investment (FDI). The inclusion of control variables, such as population density and industrial structure, ensures a robust analysis that accounts for potential confounding factors.

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

A significant aspect of our research is the use of the DEA method to estimate the value of environmental governance efficiency, considering both expected and unexpected outputs, rather than merely taking fiscal expenditures as the sole indicator of environmental governance performance. By incorporating a broader range of outputs, this approach allows for a more comprehensive representation of the level of environmental governance in each city. Expected outputs include intended outcomes such as improved air and water quality, while unexpected outputs consider unintended consequences such as economic costs and regulatory compliance burdens. This comprehensive evaluation provides a nuanced understanding of how environmental governance impacts economic performance, offering a more accurate and holistic assessment than traditional methods.

The findings of this study are expected to provide valuable insights for policymakers and stakeholders. By demonstrating the positive impact of environmental governance efficiency on regional economic growth, this research underscores the importance of integrating environmental considerations into economic planning. Moreover, the study offers a methodological contribution by applying the DEA approach to the assessment of environmental governance efficiency, providing a framework that can be replicated in other regions and contexts.

In addition to its empirical contributions, this study engages with broader theoretical debates on the relationship between environmental governance and economic development. It challenges the traditional view that environmental regulations are merely a cost to businesses and economic growth, instead highlighting the potential for such regulations to drive innovation, improve public health, and enhance long-term economic performance. This perspective aligns with the growing body of literature advocating for green growth, which emphasizes the compatibility of environmental sustainability and economic prosperity.

In conclusion, this study aims to fill a critical gap in the literature by providing empirical evidence on the positive influence of environmental governance efficiency on regional economic growth in Guangdong Province. By doing so, it contributes to the ongoing dialogue on sustainable development and offers practical recommendations for policymakers seeking to foster both economic growth and environmental sustainability. The following sections will delve into the literature review, methodology, empirical results, and policy implications of the study, providing a comprehensive analysis of the nexus between environmental governance and economic performance.

2.Literature Review

The relationship between environmental governance and economic growth has been a topic of extensive academic inquiry, especially in the context of sustainable development. This literature review examines the existing body of research on environmental governance, its measurement through efficiency analysis, and its impact on regional economic growth, with a specific focus on the application of Data Envelopment Analysis (DEA) in evaluating governance efficiency.

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

2.1 Environmental Governance and Economic Growth

Environmental governance refers to the policies, regulations, and practices that governments implement to manage natural resources and environmental impacts effectively. It aims to balance economic development with environmental sustainability, ensuring that economic activities do not degrade environmental quality. Numerous studies have explored the link between environmental governance and economic performance, often highlighting a complex and multifaceted relationship.

One strand of the literature argues that stringent environmental regulations can impose additional costs on businesses, potentially hindering economic growth in the short term [1,2]. These costs include compliance expenses, investments in cleaner technologies, and potential reductions in productivity. However, other studies suggest that effective environmental governance can lead to long-term economic benefits by fostering innovation, improving public health, and creating a more attractive environment for investment [3,4].

The Porter Hypothesis, proposed by Michael Porter, posits that well-designed environmental regulations can stimulate innovation and improve competitiveness, ultimately leading to economic gains. This hypothesis has been supported by empirical evidence in various contexts, indicating that environmental governance can enhance economic performance by driving technological advancements and efficiency improvements [5,6].

2.2 Measurement of Environmental Governance Efficiency

Evaluating the efficiency of environmental governance involves assessing how effectively resources are utilized to achieve desired environmental outcomes. Traditional measures often rely on fiscal expenditures on environmental protection as a proxy for governance performance. However, this approach has limitations, as it does not account for the actual environmental outcomes or the unintended consequences of regulatory measures.

Data Envelopment Analysis (DEA) has emerged as a powerful tool for measuring the efficiency of environmental governance. DEA is a non-parametric method that evaluates the relative efficiency of decision-making units (DMUs) by considering multiple inputs and outputs. It provides a more comprehensive assessment by incorporating both expected outputs and unexpected outputs [7].

Several studies have applied DEA to evaluate environmental performance. For instance, [8] used DEA to assess the environmental performance of Chinese provinces, considering both desirable and undesirable outputs. Their findings highlighted significant regional disparities in environmental efficiency and underscored the need for targeted policies to improve governance. They also employed DEA to measure the environmental efficiency of industrial sectors in China, providing insights into sector-specific challenges and opportunities for improvement.

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

2.3 Environmental Governance in China

China's rapid economic growth has been accompanied by severe environmental challenges, prompting the government to implement various environmental policies and regulations. The effectiveness of these policies has been a subject of extensive research. Studies have examined the impact of China's environmental governance on air quality, water pollution, and resource management, often highlighting mixed results [9].

Guangdong Province, as one of China's most economically advanced regions, provides a unique context for studying the relationship between environmental governance and economic growth. The province has implemented a range of environmental initiatives aimed at reducing pollution and promoting sustainable development. Research on Guangdong's environmental governance has shown that while significant progress has been made, challenges remain in terms of enforcement and regional disparities [10].

2.4 Impact on Regional Economic Growth

The impact of environmental governance on regional economic growth has been a critical area of study. Empirical research has produced varied results, reflecting the complex interplay between regulatory measures and economic performance. Some studies have found a positive relationship between environmental governance and economic growth, suggesting that effective governance can enhance economic performance by improving environmental quality and fostering innovation [11].

In contrast, other studies have identified potential trade-offs, where stringent regulations may impose short-term economic costs. However, the long-term benefits, such as enhanced public health, reduced environmental degradation, and increased investment in green technologies, often outweigh these initial costs [12].

The literature on environmental governance and economic growth highlights the importance of measuring governance efficiency comprehensively. By using the DEA method to incorporate both expected and unexpected outputs, this study aims to provide a nuanced understanding of how environmental governance impacts economic performance in Guangdong Province. The findings will contribute to the ongoing debate on sustainable development and offer valuable insights for policymakers seeking to balance economic growth with environmental sustainability.

3.Data, variables and methodology

The data used in this paper are from Guangdong Provincial Statistical Yearbook, Guangdong Provincial Social Statistical Yearbook, China Statistical Yearbook and China Urban Statistical Yearbook from 2001 to 2020. There are 21 cities in Guangdong Province, China. The panel data is strongly balanced, and number of areas is more than number of years means it’s a short panel. (Table 1)

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

Table 1. Descriptive Statistics.

Variable	Obs	Mean	Std. dev.	Min	Max
GDPpc	420	47494.45	42096.89	1210.4	210931
Efficiency	420	.8878959	.512677	.006024	2.765199
Popu	420	488.6666	282.9899	128.45	1874.03
Sufficiency	420	.566762	.2510869	.1354	1.168413
FDI	420	98521.27	155847	1611	862924.8
Industry	420	3.97e+07	6.16e+07	334569	3.85e+08
Electron	420	1701199	2285434	24663	1.01e+07
Tertiary	420	41.48755	8.31252	24.44	72.50714
Ecar	420	2635.686	6207.747	43	38728
GovtSize	420	.1228089	.0331438	.0509	.2204
AVTax	420	.2111544	.0671794	.0661	.4003852
EnvInput	420	98517.71	296233.9	469	3316349
AreaDummy	419	.4295943	.49561	0	1

3.1 Independent variable

In this study, Environmental Governance Efficiency is chosen as the independent variable to explore its impact on regional economic growth, measured by GDP per capita (GDPpc), in the 21 cities of Guangdong Province, China. (Figure 1) Environmental Governance Efficiency captures the effectiveness of policies and practices aimed at managing and protecting the environment. Effective environmental governance is crucial for sustainable development, balancing economic growth with environmental preservation. By evaluating governance efficiency, the study addresses the broader goal of achieving long-term sustainability, which is essential for maintaining economic stability and quality of life. Assessing Environmental Governance Efficiency provides actionable insights for policymakers. Understanding how efficiently environmental policies are implemented can help identify areas for improvement and guide resource allocation. This is particularly relevant for Guangdong Province, where rapid industrialization necessitates effective environmental management to sustain economic growth.

The Data Envelopment Analysis (DEA) method used to estimate Environmental Governance Efficiency allows for a nuanced evaluation by incorporating multiple inputs and outputs. This method captures the complexity of environmental governance, providing a detailed understanding of its efficiency and impact on economic growth. We estimate regional environmental governance efficiency based on super-efficiency SBM method (Tone, 2001、2010). Suppose the total number of decision units (DMU) in period T is K, and each DMU uses M input factors and produces I desired outputs and R undesired outputs, $x_k \in \mathrm{R}^M$, $y_k \in R^I$

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

and $b_k \in R^R$ respectively represent the input vector, expected output vector and unexpected output vector of the k DMU, then, the input-output of the k DMU in period t is expressed as (x_k^t, y_k^t, b_k^t). Define the production possibility set constructed by other DMU other than DMU_k as follows:

$$P^t = \{(x^t, y^t, b^t) \mid x^t \geq \sum_{j=1, j\neq k}^{K} x_j^t \lambda_j,\ y^t \leq \sum_{j=1, j\neq k}^{K} y_j^t \lambda_j,\ b^t \geq \sum_{j=1, j\neq k}^{K} b_j^t \lambda_j,\ \lambda_j \geq 0\} \quad (1)$$

Where, λ_j is the weight coefficient vector (intensity vector), here we assume that scale returns are variable (i.e. VRS), so the sum of weight coefficients of all decision making units is equal to 1, i.e $\sum_{j=1, j\neq k}^{K} \lambda_j = 1$. Here, DMU is each district in Guangdong Province, and the input variable of each area is environmental input. The expected output variable is waste water utilization rate and solid waste treatment rate, and the unexpected output variable is sulfur dioxide and nitrogen oxide. Therefore, M=1, *I*=2, R=2.

The super-efficiency SBM efficiency value of decision unit K $k \in \{1, 2, \cdots, K\}$ can be obtained by solving the following programming problem:

$$IE_{SuperSBM}^t (x_k^t, y_k^t, b_k^t, \lambda) = \min \frac{1 + (1/M)\sum_{m=1}^{M} (s_m^{x,-} / x_{m,k}^t)}{1 - [1/(I+R)][\sum_{i=1}^{I} (s_i^{y,+} / y_{i,k}^t) + \sum_{r=1}^{R} (s_r^{b,-} / b_{r,k}^t)]} \quad (2)$$

$$s.t. \quad \sum_{j=1, j\neq k}^{K} x_{m,j}^t \lambda_j - s_m^{x,-} \leq x_{m,k}^t$$

$$\sum_{j=1, j\neq k}^{K} y_j^t \lambda_j + s_i^{y,+} \geq y_{i,k}^t$$

$$\sum_{j=1, j\neq k}^{K} b_j^t \lambda_j - s_{r,k}^{b,-} \leq b_{r,k}^t$$

$$s^{x,-} \geq 0,\ s^{y,+} \geq 0,\ s^{b,-} \geq 0,\ \lambda \geq 0,\ \sum_{j=1, j\neq k}^{K} \lambda_j = 1$$

$$m = 1, 2, \cdots, M;\quad i = 1, 2, \cdots, I;\quad r = 1, 2, \cdots, R$$

Among them, $IE_{SuperSBM}$ stands for regional efficiency and its value is between [0,1]. The larger the value is,

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

the higher the regional efficiency is. When $IE_{SuperSBM}=1$, it means that the decision-making unit is an effective unit, that is, it is located on the production frontier. $s_m^{x,-}$, $s_i^{y,+}$, $s_r^{b,-}$ respectively represent the relaxation variables corresponding to input variables, expected output variables and non-expected output variables. To solve Equation (2), we use the method of Charnes and Cooper (1978) to convert the equation into the following linear programming problem.

$$IE^t_{SuperSBM\_L}(x_k^t, y_k^t, b_k^t, \lambda) = \min \tau + (1/M)\sum_{m=1}^{M}(S_m^{x,-}/x_{m,k}^t) \tag{3}$$

$$\begin{aligned} s.t.\quad & 1 = \tau - [1/(I+R)][\sum_{i=1}^{I}(S_i^{y,+}/y_{i,k}^t) + \sum_{r=1}^{R}(S_r^{b,-}/b_{r,k}^t)] \\ & \sum_{j=1,\, j\neq k}^{K} x_{m,j}^t \Lambda_j - S_m^{x,-} \le \tau x_{m,k}^t \\ & \sum_{j=1,\, j\neq k}^{K} y_j^t \Lambda_j + S_i^{y,+} \ge \tau y_{i,k}^t \\ & \sum_{j=1,\, j\neq k}^{K} b_j^t \Lambda_j - S_{r,k}^{b,-} \le \tau b_{r,k}^t \\ & S^{x,-} \ge 0, S^{y,+} \ge 0, S^{b,-} \ge 0, \Lambda \ge 0, \tau > 0, \sum_{j=1,\, j\neq k}^{K} \Lambda_j = \tau \\ & m = 1,2,\cdots,M;\quad i = 1,2,\cdots,I;\quad r = 1,2,\cdots,R \end{aligned}$$

Let the optimal solution of equation (3) of linear programming be $(IE^*_{SuperSBM\_L}, S^{x,-,*}, S^{y,+,*}, S^{b,-,*}, \tau^*, \Lambda^*)$, then the optimal solution of the original nonlinear programming problem (2) is:

$$IE^*_{SuperSBM} = IE^*_{SuperSBM\_L}, \quad \lambda^* = \Lambda^*/\tau^* \tag{4}$$

$$s^{x,-,*} = S^{x,-,*}/\tau^*, \quad s^{y,+,*} = S^{y,+,*}/\tau^*, \quad s^{b,-,*} = S^{b,-,*}/\tau^*$$

Accordingly, we can also get the efficiency of each input-output variable:

$$DE_{k,t}^{in} = (x_{k,t}^{in} - s_{k,t}^{in})/x_{k,t}^{in} \tag{5}$$

$$DE_{k,t}^{uo} = (b_{k,t}^{uo} - s_{k,t}^{uo})/b_{k,t}^{uo}$$

$$DE_{k,t}^{do} = y_{k,t}^{do}/(y_{k,t}^{do} + s_{k,t}^{do})$$

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

Among them, $DE_{k,t}^{in}$, $DE_{k,t}^{uo}$, $DE_{k,t}^{do}$ respectively represents the efficiency of input variable, expected output variable and unexpected output variable, and its value is between [0,1]. The larger the value is, the higher the efficiency of the input or output factor is.

3.2 Dependent variable

In this study, GDP per capita (GDPpc) is selected as the dependent variable to represent each city's economic growth level in Guangdong Province. it encapsulates the overall economic activity within a city, providing a clear picture of economic health and prosperity. It takes into account the total output of goods and services, thereby reflecting the productivity and economic efficiency of the region. GDPpc allows for standardized comparisons across different cities and regions, enabling a consistent and uniform assessment of economic performance. This is crucial for a comparative analysis across the 21 cities in Guangdong Province, ensuring that variations in economic growth are accurately captured. Policymakers often use GDPpc as a key indicator to formulate and evaluate economic policies. By focusing on it, this study aligns its findings with policy frameworks and discussions, providing actionable insights that can directly influence economic planning and policy decisions.

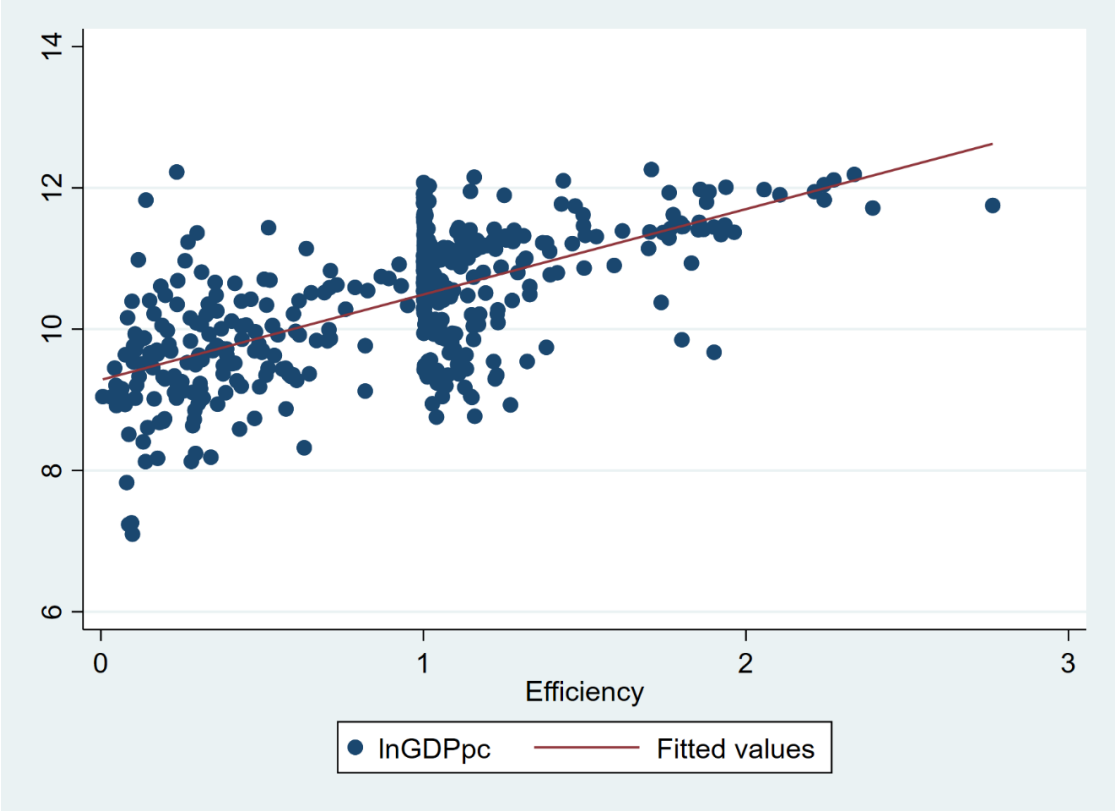

Figure 1. Partial correlation graph between the core variable and the explained variable

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

3.3 Controlling Variables

In the process of regression analysis, it is crucial to control for several variables to ensure the robustness of the results. First and foremost, we must control for the population base (Popu), as it is the most fundamental variable. Additionally, indicators that have a direct relationship with economic growth, such as total industrial output (Industry), overall electricity consumption (Electron), and total value-added tax (AVTax), must also be controlled. Guangdong Province is one of the fastest-growing economic regions in China and attracts substantial foreign direct investment (FDI). The developed service industry further drives the rapid economic and social growth of the province. Hence, FDI and the proportion of the tertiary industry (Tertiary) are essential control variables to consider.

In recent years, Guangdong Province has emphasized the integration of industrial development and carbon emission reduction, vigorously promoting the adoption of electric vehicles. Shenzhen, located in Guangdong, is home to China's largest electric vehicle manufacturer. Therefore, we include the number of electric buses (ECar) in each city as a control variable to represent the local government's environmental awareness. Furthermore, local governments in Guangdong invest significant financial resources annually to improve the ecological environment (EnvInput), and this variable is controlled in some regression analyses.

Local governments in China often play a leading role in economic development. In this study, it is necessary to control for the financial scale of urban governments (GovtSize), which serves as a basic variable for government size, and the impact of financial self-sufficiency (Sufficiency), which measures the actual wealth of local governments, on the dependent variable. Finally, the economic development levels across different regions in Guangdong Province vary significantly. To account for this, we include regional dummy variable (AreaDummy) to differentiate between the Pearl River Delta region and other cities, thereby testing the impact of regional differences on economic development.

4.Results

As each city in the province is different, there may be omitted variables that do not vary over time, and there may be time effects that do not vary geographically. Based on the above reasons, we adopted the two-way fixed effects model:

$$\ln GDPpc_{it} = \beta_0 + \beta_1 Efficiency_{it} + \delta Controls_{it} + \mu_i + \gamma_t + \varepsilon_{it}$$
$$(i = 1, \cdots, 21; t = 1, \cdots 20)$$

We estimate the two-way fixed effects model with the null hypothesis $H_0: all\ \mu_i = 0$. The P-value corresponding to the F-test result is 0, which is much less than 0.01, indicating that we reject the null hypothesis and should choose the fixed effects model. Next, we conducted an F-test of the regional dummy

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

variable, and the P-value was less than 0.1, suggesting we can reject the null hypothesis and that individual effects exist. Finally, the model passes the Hausman test, which strongly rejects the null hypothesis, confirming our choice of the fixed effects model. To ensure the robustness of the model, we conducted three additional regression analyses, controlling for different important variables (Table 2).

Table 2. Regression Results.

	(1) OLS	(2) FE	(3) FE	(4) FE	(5) FE
Efficiency	6.7955**	11.537***	9.107**	8.4376***	11.7705***
	(2.28)	(3.15)	(3.03)	(2.12)	(2.95)
Popu	-0.5148*	0.0511	-0.112	0.8358*	0.102
	(0.26)	(0.12)	(0.37)	(0.41)	(0.35)
Sufficiency	-0.473	2.1768	-3.9597*		2.117
	(1.56)	(1.88)	(2.01)		(1.98)
FDI	-0.1711	-3.0302**		-2.5807*	1.055
	(1.24)	(1.09)		(1.31)	(1.86)
Industry	3.0432	-4.3778*	5.0213	8.3398*	
	（2.78）	（2.12）	(4.21)	(4.15)	
Electron	0.0290	0.0184	-1.5381*		-0.1267
	(1.39)	(0.67)	(0.73)		(0.98)
Tertiary	1.1789	1.3235*		0.2971	3.1459*
	（0.98）	（0.66）		(0.25)	（1.59）
ECar	0.1488	0.6304*	1.1147*	0.9718	
	(0.15)	(0.32)	(0.51)	(0.88)	
GovtSize	-2.3471*	0.9881	-2.6837*		-1.063
	(1.19)	(0.77)	(1.23)		(0.82)
AVTax	-4.1976*	6.3347**		3.2202	7.1198
	(2.05)	(2.12)		(6.48)	（11.23）
EnvInput	1.34876	-2.4789	2.9963*	-1.773	
	(1.03)	（1.98）	（1.31）	（1.26）	
AreaDummy	1.3486	2.7685	1.5653	2.9918	3.0121
	(1.26)	(2.12)	(1.37)	(2.01)	(3.35)
_cons	4.713**	7.026**	6.175*	1.383	2.279
	(1.04)	(1.97)	(3.16)	(1.32)	(2.87)
N	420	420	420	420	420

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

In the results of regression analysis, we can see that the environmental governance efficiency of the explanatory variable has a significant positive impact on the per capita economic growth of the explained variable, which is in line with the significance of this study. The effect of population size is not uniform, while the effect of government size is more negative, indicating that the government should maintain a moderate size. The effect of government financial adequacy ratio on economic growth is also not obvious, but there is a significant negative effect in the result. We see a relatively negative impact of FDI, which is surprising in an export-oriented economy like Guangdong. Reflecting the economic fundamentals of the total industrial output value, the whole society electricity consumption is not consistent performance, but the total value-added tax situation has a more positive impact. It is also surprising that electric bus use has a consistent positive effect on economic growth across regions. Also uniformly positive are the regional dummy variables, which may be consistent with Guangdong's basic economic outlook. The impact of local government environmental spending is inconsistent.

5.Policy Suggestions

Strengthening Environmental Governance Infrastructure. Guangdong Province should continue to invest in robust environmental governance infrastructure. This includes enhancing monitoring systems for pollution control, implementing advanced waste management technologies, and upgrading water treatment facilities. Effective infrastructure is crucial for ensuring that environmental policies are enforced efficiently and sustainably.

Promoting Green Technologies. Encouraging the development and adoption of green technologies can drive both environmental and economic benefits. Policies should support research and development in renewable energy, electric vehicles, and energy-efficient industrial processes. Incentives such as tax breaks, grants, and subsidies for businesses that invest in green technologies can accelerate this transition.

Enhancing Regulatory Frameworks. Strengthening regulatory frameworks to ensure compliance with environmental standards is essential. This includes setting clear, achievable targets for pollution reduction and resource efficiency, as well as establishing stringent penalties for non-compliance. Transparent and consistent enforcement of regulations will help build trust and accountability.

Encouraging Public Participation. Fostering greater public participation in environmental governance can lead to more effective and accepted policies. Mechanisms such as public consultations, community-based monitoring, and environmental education programs can empower citizens to contribute to environmental protection efforts. Engaging the public also helps raise awareness about the importance of sustainability and fosters a culture of environmental stewardship.

Integrating Environmental and Economic Planning. Policymakers should integrate environmental

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

considerations into economic planning processes. This involves conducting environmental impact assessments for major economic projects and ensuring that economic policies support sustainable development goals. By aligning economic and environmental objectives, Guangdong can achieve balanced and sustainable growth.

Addressing Regional Disparities. Given the significant regional disparities in economic development and environmental governance within Guangdong, targeted policies are needed to support less developed areas. Investments in environmental infrastructure, capacity building, and economic incentives for green development should be prioritized in these regions to promote equitable growth and environmental sustainability.

6.Conclusion

This study has empirically examined the positive influence of environmental governance efficiency on regional economic growth in Guangdong Province, China, using the Data Envelopment Analysis (DEA) method. The findings underscore the critical role that effective environmental governance plays in enhancing economic performance. By integrating environmental considerations into economic planning, fostering innovation in green technologies, and ensuring robust regulatory frameworks, Guangdong can achieve sustainable development that balances economic growth with environmental preservation.

The results of this study provide valuable insights for policymakers not only in Guangdong but also in other regions facing similar challenges. The comprehensive evaluation approach adopted in this research can be replicated in different contexts to assess the impact of environmental governance on economic growth. By demonstrating the long-term economic benefits of effective environmental governance, this study contributes to the broader discourse on sustainable development and offers practical recommendations for achieving both economic and environmental objectives.

In conclusion, enhancing environmental governance efficiency is essential for promoting sustainable economic growth. Policymakers should prioritize investments in green technologies, strengthen regulatory frameworks, encourage public participation, and address regional disparities to ensure that economic development does not come at the expense of environmental health. By doing so, Guangdong Province can continue to lead as a model for sustainable development in China and beyond.

References

[1] Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. 1995. Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us? *Journal of Economic Literature*, 33(1), 132-163.

[2] Porter, M. E., & van der Linde, C. 1995. Toward a New Conception of the Environment-Competitiveness Relationship. *Journal*

Social Sciences in Business and Policy Analysis
www.aprdi.org/all-categories/category-journal

of Economic Perspectives, 9(4), 97-118.

[3] Ambec, S., Cohen, M. A., Elgie, S., & Lanoie, P. 2013. The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness? *Review of Environmental Economics and Policy*, 7(1), 2-22.

[4] Stavins, R. N. 1999. The Costs of Carbon Sequestration: A Revealed-Preference Approach. *The American Economic Review*, 89(4), 994-1009.

[5] Ambec, S., & Barla, P. 2006. Can Environmental Regulations be Good for Business? An Assessment of the Porter Hypothesis. *Energy Studies Review*, 14(2), 42-62.

[6] Cooper, W. W., Seiford, L. M., & Tone, K. 2007. Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software. Springer.

[7] Charnes, A., Cooper, W. W., & Rhodes, E. 1978. Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research*, 2(6), 429-444.

[8] Zhou, P., Ang, B. W., & Poh, K. L. 2008. A Survey of Data Envelopment Analysis in Energy and Environmental Studies. *European Journal of Operational Research*, 189(1), 1-18.

[9] Ma, X., & Ortolano, L. 2000. Environmental Regulation in China: Institutions, Enforcement, and Compliance. Rowman & Littlefield.

[10] He, G., Mol, A. P. J., & Lu, Y. 2016. Public Participation and Trust in Nuclear Power Development in China. *Renewable and Sustainable Energy Reviews*, 62, 125-137.

[11] Costantini, V., & Mazzanti, M. 2012. On the Green and Innovative Side of Trade Competitiveness? The Impact of Environmental Policies and Innovation on EU Exports. *Research Policy*, 41(1), 132-153.

[12] Lanoie, P., Patry, M., & Lajeunesse, R. 2008. Environmental Regulation and Productivity: New Findings on the Porter Hypothesis. *Journal of Productivity Analysis*, 30(2), 121-128.