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Ye Chenghao,
PhD candidate of economics,
department of financial and tax management,
Ural Federal University named after the first President of Russia B.N. Yeltsin
Yekaterinburg, Russian Federation

Mayburov Igor Anatolyevich,
doctor of economics, professor, head
department of financial and tax management,
Ural Federal University named the first President of Russia B.N. Yeltsin
Yekaterinburg, Russian Federation

Wang Ying,
PhD candidate of economics,
department of financial and tax management,
Ural Federal University named after the first President of Russia B.N. Yeltsin
Yekaterinburg, Russian Federation

THE IMPACT OF CHINA'S ENVIRONMENTAL PROTECTION TAX ON REGIONAL ECONOMIC EFFECTS

Abstract:
This study selected environmental protection tax, industrial output value, regional GDP, industrial pollution control investment as four key variables to form 30 observation samples from 31 regions in China between 2018 and 2022. Construct a random effects model for empirical analysis. The results show that China's environmental protection tax has a significant positive impact on regional economic growth.

Keywords:
Environmental Protection Tax; Random Effects Model; Empirical Analysis;Economic Growth.

1. Introduction

From a scientific perspective, the impact mechanism of environmental protection tax on economic growth is complex and varied. On one hand, the environmental protection tax can promote enterprises to adopt clean production technologies and improve production efficiency by increasing the cost of pollution, thereby having a positive impact on economic growth from Pigou [1], Porter [2], Patuelli et al. [3]; on the other hand, the collection of environmental protection tax may also increase enterprise costs, suppress economic activities, and have a negative impact on economic growth from Wang et al. [4], Oueslati [5], Renström et al. [6]. Balancing the relationship between environmental protection and economic development to maximize the positive effects of environmental protection tax is a topic that needs in-depth study. Moreover, considering the differences in economic development levels and environmental conditions among regions, exploring the effects of environmental protection tax in different regions is of great significance for formulating region-specific environmental policies.

In view of this, this study poses the following research questions: What impact does environmental protection tax have on the economic effects of various regions in China? Do significant differences exist in the economic effects of environmental protection tax among different regions? Do these differences have random characteristics? Based on these research questions, the study hypothesizes: H1: Environmental protection tax has a positive impact on economic growth in various regions of China. H2: Significant differences exist in the economic effects of environmental protection tax among different regions, and these differences have random characteristics. This study aims to reveal the mechanisms of the impact of environmental protection tax on regional economic effects, providing policy recommendations for achieving high-quality economic development and ecological environmental protection.

2. Data and Methodology

On the basis of the importance and scientific nature of theory and related research, which serve to construct the research questions and hypotheses, economic data from various regions of China were manually collected. The main sources of data are the official websites of regional governments in China, the China Economic Internet Statistics Database, the China Statistical Yearbook, and the China City Statistical Yearbook. Data on four variables—environmental protection tax, industrial output value, regional GDP, and industrial pollution control investment—were selected for a total of 31 areas in Northern, Northeastern, Eastern, Southeastern, Central, and Western China for the years 2018-2022.

A linear regression analysis was constructed to assess the impact of the environmental protection tax on regional economic effects, with a comparison made between random effects models and fixed effects models for the estimation of panel data parameters. This involved testing the economic effects and characteristics of the environmental protection tax, ultimately leading to conclusions.

3. Empirical Analysis Results

3.1 Sample Selection

The data encompasses 23 provinces, 5 autonomous areas, and 4 municipalities in China from 2018 to 2022. Based on the classification criteria of the National Bureau of Statistics of China, these 31 areas are divided into 6 regions. In terms of research direction, these regions are geographically adjacent, with similar economic structures and industrial levels, which aligns with the direction of this study. Four key variables were selected for analysis: regional environmental protection tax revenue, regional industrial output value, regional GDP, and industrial pollution control investment, forming 30 observation samples. Table 1 shows the variable names and abbreviations. A linear regression analysis is initially constructed, taking the Regional Gross Domestic Product as the dependent variable to explore the linear relationships among various variables. The results are shown in Table 2.

Table 1 – Variable Names and Abbreviations

Variable Name	Regional GDP	Environmental Protection Tax	Industrial 0utput Value	Industrial Pollution Control Investment
Variable Name of Abbreviation	R-GDP	EPT	IOV	IPCI

Table 2 – OLS Regression Results

Dep. Variable:	R-GDP	R-squared:	0.990
Model:	OLS	Adj. R-squared:	0.989
Method:	Least Squares	F-statistic:	864.4
Date:	Tue, 02 Apr 2024	Prob (F-statistic):	3.78e-26
Time:	20:27:39	Log-Likelihood:	60.434
No. Observations:	30	AIC:	-112.9
Df Residuals:	26	BIC:	-107.3
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.6771	0.116	5.848	0.000	0.439	0.915
EPT	0.0827	0.033	2.475	0.020	0.014	0.151
IOV	0.8923	0.032	27.751	0.000	0.826	0.958
IPCI	-0.0208	0.030	-0.704	0.488	-0.082	0.040

Omnibus:	0.153	Durbin-Watson:	2.006
Prob(Omnibus):	0.927	Jarque-Bera (JB):	0.028
Skew:	0.054	Prob(JB):	0.986
Kurtosis:	2.894	Cond. No.	171.

Notes:[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
Source: python3.12

Based on the OLS (Ordinary Least Squares) regression model results from Table 2, a quantitative analysis of the relationship between Regional Gross Domestic Product and the amounts of environmental protection tax revenue, industrial output value, and industrial pollution control investment is provided. The R-squared is 0.990, Adjusted R-squared is 0.989, F-statistic is 864.4, with the corresponding Prob (F-statistic) being 3.78e-26, indicating that the model setup is reasonable, generally follows a normal distribution, and the distribution of residuals is close to the normal distribution in terms of kurtosis. These model results suggest that environmental protection tax revenue have a significant positive impact on R-GDP, providing a basis for proceeding with panel data analysis.

3.2. Model Selection

Based on the hypotheses and theoretical foundation, a random effects model can be directly chosen for analysis. However, for robustness and accuracy, a comparison between fixed effects and random effects models is considered, and a Hausman test is performed, with results presented in Table 3.

Table 3 – Model Comparison (Hausman_test)

	Fixed Effects	Random Effects
Dep. Variable	R-GDP	R-GDP
Estimator	PanelOLS	RandomEffects
No. Observations	30	30
Cov. Est.	Unadjusted	Unadjusted
R-squared	0.8747	0.9682
R-Squared (Within)	0.8747	0.8622
R-Squared (Between)	0.9652	0.9908
R-Squared (Overall)	0.9635	0.9885
F-statistic	48.884	264.07
P-value (F-stat)	0.0000	0.0000
const	1.2379	0.6232
	(2.1493)	(3.1397)
EPT	0.1248	0.1043
	(2.3366)	(2.4362)
IOV	0.6990	0.8282
	(7.8043)	(19.448)
IPCV	-0.0028	0.0197
	(-0.0974)	(0.9852)
Effects	Entity	

T-stats reported in parentheses

Source: python3.12

This model comparison provides results from both the fixed effects model and the random effects model, assessing the impact of these two different methods on R-GDP(Regional GDP). The R-squared and F-statistic indicate that the explanatory variables in the random effects model have a stronger statistical significance overall on the dependent variable. The impact of EPT(Environmental Protection Tax) is slightly stronger in the random effects model than in the fixed effects model, and the positive impact of IOV (Industrial 0utput Value) on R-GDP(Regional GDP) is more significant in the random effects model, with IPCI(Industrial Pollution Control Investment) showing a slight positive effect in the random effects model.

Based on the above results, although the numerical results of the Hausman test are not provided, other indicators demonstrate that the random effects model offers stronger and more significant explanatory power for R-GDP(Regional GDP), providing sufficient evidence to support the use of the random effects model.

3.3 Random Effects Model Analysis Results

The random effects model equation is constructed to describe the relationship between R-GDP(Regional GDP) and EPT(Environmental Protection Tax) , IOV (Industrial 0utput Value), and IPCI(Industrial Pollution Control Investment) :

$$R - GDP_i = \beta_0 + \beta_1 \times EPT_i + \beta_2 \times IOV_i + \beta_3 \times IPCI_i + \mu_i + \varepsilon_i$$

Where R-GDP*i* is the GDP of Region *i*; β_0 is the intercept term; EPT_i is the Environmental Protection Taxes of region *i*; IOV_i is the industrial output value of region *i*; $IPCI_i$ is the industrial pollution control investment of region *i*; β_1, β_2, β_3 are model parameters, measuring the impact of Environmental Protection Taxes, regional Industrial 0utput Value, and Industrial Pollution Control Investment on Regional GDP, respectively; μ_i is the random effects term, capturing region-specific effects that do not change over time; ε_i is the error term, representing the impact of other unobserved factors. Random effects model regression analysis was conducted, with results as shown in Table 4.

Table 4 – RandomEffects Estimation Summary

Dep. Variable:	R-GDP	R-squared:	0.9682
Estimator:	RandomEffects	R-squared (Between):	0.9908
No. Observations:	30	R-squared (Within):	0.8622

Date:	Tue, Apr 02 2024	R-squared (Overall):	0.9885
Time:	19:17:10	Log-likelihood	76.705
Cov. Estimator:	Unadjusted		
		F-statistic:	264.07
Entities:	6	P-value	0.0000
Avg Obs:	5.0000	Distribution:	F(3,26)
Min Obs:	5.0000		
Max Obs:	5.0000	F-statistic (robust):	264.07
		P-value	0.0000
Time periods:	5	Distribution:	F(3,26)
Avg Obs:	6.0000		
Min Obs:	6.0000		
Max Obs:	6.0000		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
const	0.6232	0.1985	3.1397	0.0042	0.2152	1.0312
EPT	0.1043	0.0428	2.4362	0.0220	0.0163	0.1922
IOV	0.8282	0.0426	19.448	0.0000	0.7407	0.9157
IPCI	0.0197	0.0200	0.9852	0.3336	-0.0214	0.0609

Source: python3.12

This random effects model analysis investigates the impact of environmental protection tax, industrial output value, and industrial pollution control investment on regional GDP. Here is a detailed analysis of the model results: The R-squared (overall), R-squared (within), and R-squared (between) demonstrate the model's high explanatory power across different regions. The constant term (const): 0.6232, indicates the expected value of regional GDP when all explanatory variables are zero. The significance of the constant term (P-value=0.0042) indicates that the model's intercept is statistically significant. Environmental protection tax: The coefficient of 0.1043 implies that for each unit increase in environmental protection tax, the average expected increase in regional GDP is 0.1043 units, and this is statistically significant at the 5% level (P-value=0.0220).

4. Conclusion

Based on the results of all analyses, this study has achieved its objectives and accepted the hypothesis that there is a significant positive correlation between the environmental protection tax and regional GDP. Furthermore, the economic effects of the environmental protection tax show significant differences across regions, with these differences having random characteristics. This conclusion supports the "Porter Hypothesis" in environmental economics and parts of the Environmental Kuznets Curve theory, suggesting that appropriate environmental regulations can promote economic growth by stimulating firms' innovation potential and improving resource efficiency. The theoretical significance of these empirical findings lies in providing a deeper understanding and grasp of theories such as the externality theory and the Environmental Kuznets Curve theory, and offering empirical support for their applicability in China. Practically, this research highlights the importance of considering the economic characteristics and development levels of different regions, as well as the institutional environment for policy implementation, in the formulation and execution of environmental protection tax policies. Regional policymakers should employ flexible and varied policy tools to encourage technological innovation and industrial upgrading while strengthening institutional construction to enhance the efficiency of environmental policy implementation. This ensures that environmental protection tax policies not only facilitate the economic transformation and upgrading of regions but also achieve high-quality economic development within those regions.

REFERENCES

1. Pigou A. C. The Economics of Welfare. 1920. Available at: https://oll.libertyfund.org/titles/pigou-the-economics-of-welfare(accessed: 10.03.2024)
2. Porter, M. E. (1991).America's Green Strategy. Scientific American 264, no. 4 . https://www.hbs.edu/faculty/Pages/item.aspx?num=6107(accessed: 10.03.2024)
3. Patuelli, R., Nijkamp, P., & Pels, E. (2005). Environmental tax reform and the double dividend: A meta-analytical performance assessment. *Ecological economics*, *55*(4), 564-583. https://doi.org/10.1016/j.ecolecon.2004.12.021
4. Wang, Q., Xinmeng, S., Xiong, H., Wang, Q., & Zhang, B. (2024). Environmental taxes, environmental outsourcing, and pollution abatement: Evidence from Chinese industrial sewage discharge enterprises. *Energy Economics*, 107480. https://doi.org/10.1016/j.eneco.2024.107480
5. Oueslati, W. (2014). Environmental tax reform: Short-term versus long-term macroeconomic effects. *Journal of Macroeconomics*, *40*, 190-201. https://doi.org/10.1016/j.jmacro.2014.02.004
6. Renström, T. I., Spataro, L., & Marsiliani, L. (2021). Can subsidies rather than pollution taxes break the trade-off between