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# Research on the Economic Effects of Environmental Protection Tax

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***Abstract:*** *Since China implemented the environmental protection tax policy in 2018, its economy has moved to high-quality development, making it important to analyse its economic impact. This study takes China's current environmental protection tax as the research object, uses the double difference model (DID) with urban panel data from 2003 to 2019 to empirically analyse the impact of China's current environmental protection tax collection standard rise on urban economic growth. The results reveal that environmental protection tax does not increase regional economic quantity but does improve regional economic quality. In order to achieve sustainable economic growth in quality and quantity, the environmental protection tax system should be upgraded, the collection and management capacity and level should be increased, and the collection standard should be adjusted in some regions.*

***Keywords:*** *Environmental protection tax, Changes in tax rate standard, Economic effect, DID*

## 1. Introduction

The environmental protection tax, which was officially implemented in China in 2018, replaces the pollution fees system and plays an obvious role in reducing pollution and emission, but the impact on economic growth needs to be further explored. In this context, this paper constructs urban panel data to analyze the economic effect of environmental protection tax through theory and empirical evidence.

At the macroeconomic level, Pigou put forward the "Pigouvian tax" in 1920, which believes that the regulation of taxation can reduce the negative externalities[1].Pearce found that the environmental protection tax can bring the economic and social "double dividend" of environmental improvement and efficiency[2]. Lu Hongyou and other scholars evaluated China's current environmental protection tax policy from the perspective of "double dividend", and found that the policy can produce good environmental effects and cannot promote economic growth[3] . Later, scholars at home and abroad have analyzed the policy trend and optimal tax rate design of environmental protection tax [4-5], the positive effects of environmental protection tax policy on resource energy consumption, environmental protection, green innovation [6-9], and the impact of policy implementation on environmental investment, industrial structure optimization, and governance effects [10-12].

At the microeconomic level, Sun Yupeng et al. studied the impact of environmental protection tax on corporate innovation investment based on the data of listed companies as a sample, and concluded that environmental protection tax would promote corporate upgrading[13] . Later, based on the data of listed companies in China, they studied how environmental protection tax affects the environmental behavior of enterprises[14-17], and verified that environmental protection tax has a significant impact on corporate profitability, environmental performance, and performance of heavily polluting enterprises[18-20].

As seen from the above literature, there have been many studies on the impact of the implementation of environmental protection tax policy on economic growth, but there are not many studies on the impact on the quality of economic growth. In this paper, when studying the economic impact of environmental protection tax policy, we establish an economic quality evaluation system based on Five Concepts for Development, and study both the quantity and quality of economic growth at the same time.

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## 2. Theory and research hypotheses

### *2.1 Environmental protection tax and economic growth quantity*

From a theoretical perspective, environmental protection tax policy hinders production efficiency, which hinders regional economic growth, and on the other hand, it forces enterprises to upgrade the production process and optimise the production structure, which boosts regional economic growth. Li Huijuan(2018)observed that environmental tax inhibits macroeconomic and firm development in China[21]. Long Feng(2021)found no economic effect of environmental protection tax on micro-enterprise efficiency [22]. According to the theoretical analysis above, there are still great differences in the research on the impact of environmental protection tax levy on the growth of macroeconomic quantity, and the "cost effect" and "compensation effect" of environmental protection tax coexist. This study proposes research hypothesis 1: Raising the environmental tax collection standard does not have significant effect on the growth of economic quantity.

### *2.2 Environmental protection tax and economic growth quality*

Based on studies, experts generally believe that environmental protection taxes have environmental consequences and can reduce pollutants and emissions, although the influence of economic growth is unclear. Tao Jing(2019) noted that increasing environmental regulation intensity promotes China's economic quality under the economic quality system, which incorporates economic structure and sustainability[23]. Wang Jun(2018) discovered that China's green tax policy hurts economic quality and quantity[24]. The quality level of economic growth systematically measures relevant environmental and economic indicators, which can reflect the economic effect of environmental protection tax more comprehensively and the emission reduction effect more prominently, this paper proposes the research hypothesis 2: Raising the environmental tax collection standard does have a significant effect on the improvement of economic quality.

## 3. Research design and data description

### *3.1 Economic Growth Quality Index measurement*

*Table 1: Evaluation indicators for quality development.*

| Tier 1 indicators | Tier 2 indicators | Properties |
|---|---|---|
| Economic optimization | GDP per capita(X1) | + |
| | Share of primary sector output(X2) | - |
| | Share of output value of the second industry(X3) | + |
| | Share of tertiary sector output(X4) | + |
| | General budget of local finances expenditures(X5) | + |
| | General budget of local finances income(X6) | + |
| Innovation capacity | Expenditures for education services(X7) | + |
| | Expenditures for scientific endeavors(X8) | + |
| People's welfare | Year-end balance of savings for urban and rural residents(X9) | + |
| | Average wage of employees(X10) | + |
| Resource environment | Sulfur dioxide emissions(X11) | - |
| | Comprehensive utilization rate of industrial solid waste(X12) | + |
| | Non-hazardous treatment rate of domestic waste(X13) | + |
| | Green coverage(X14) | + |

The quality of economic growth is still measured inconsistently. This project will build a four-dimensional quality evaluation system to measure economic growth quality in each city.

(1) Economic optimisation: China's economy relies on ongoing economic structure optimisation. Lower proportion of primary industry, higher proportion of secondary and tertiary industries' output value, higher industrial structure upgrading. (2) Innovation ability: Scientific and technological innovation and educational innovation both contribute to high-quality economic development, so local financial investment in scientific and educational undertakings represents their innovation ability. (3) People's livelihood and welfare: Happiness has become an important goal of economic development. The year-end savings balance of urban and rural populations and the average employee income measure people's living standards. (4) Resources and environment: sulphur dioxide emissions, greening coverage of built-

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up urban areas, comprehensive industrial solid waste utilisation, and harmless domestic garbage treatment represent environmental protection and pollution control, respectively.

According to the economic growth quality evaluation index system, the economic growth quality score index (Score) of 288 prefectural-level Chinese cities from 2003 to 2019 is used to explain economic growth quality.

### *3.2 Model Setting and Description of Variables*

#### *3.2.1 Model Construction and Variable Selection*

In order to test the role of environmental protection tax implementation on economic growth, this paper constructs a double-difference (DID) regression model:

$$Y_{it}= \beta_0+\beta_1 time\times treat+\lambda X+\gamma_t+\mu_i+\varepsilon_{it} \quad (1)$$

Where $Y_{it}$ is the economic growth representative variable of city i in year t, containing the quality score index (Score) and logarithmic value of GDP per capita (Lpgdp), which assess quality and quantity, respectively. Time is a dummy variable with values of 0 and 1, taken as 0 before the environmental protection tax and 1 afterward; treat is 1 when the urban environmental protection tax collection standard is increased and 0 otherwise. $\beta_1$ is the coefficient that this paper is concerned about, indicating whether the implementation of environmental protection tax policy has economic effect and the direction of its effect on economic growth. X represents the vector group of control variables, this study introduces four control variables to govern the impact of three views on economic growth. One is the fraction of primary industry production value (I1), to manage industrial structure, which determines regional economic growth and its quality and per capita GNP. The logarithm of education expenditure (Ledu) and science expenditure (Ltec), respectively, control the impact of local innovation environment. High-quality economic development and GNP enhancement require more scientific and technological innovation and educational innovation, and regional financial attention to and investment in science and technology and education affects regional economic development. Thirdly, the financial self-sufficiency rate (Gdep) is calculated as follows: financial self-sufficiency rate = general budget revenue/general budget expenditure to control the impact of the local government's financial capacity, which affects investment in local pollution control, environmental protection, infrastructure construction, people's welfare, etc. and represents the health level of the local government. In short, $\gamma_t$ represents the year fixed effect and $\mu_i$ represents the district fixed impact. The term $\varepsilon_{it}$ represents the random error term.

#### *3.2.2 Data description*

This paper uses data from "China Urban Statistical Yearbook 2003-2019" and 288 prefecture-level cities across the country as a sample. Table 2 shows the descriptive statistics of each variable, which is used to establish a regression model using the double-difference method and analyse the economic impacts of environmental protection tax policy on the region. Due to Tibet, Inner Mongolia and Yunnan are relatively lagging behind in raising environmental tax collection standards.,they are excluded from this paper's sample scope.

*Table 2: Descriptive statistics.*

| Variable | Number of samples | Mean value | Standard deviation | Minimum value | Maximum value |
|---|---|---|---|---|---|
| Lpgdp | 4482 | 10.5091 | 0.7824 | 7.5213 | 15.6752 |
| Score | 4556 | 1.0601 | 0.6499 | 0.0000 | 10.5161 |
| I1 | 4528 | 7.1275 | 7.0928 | 0.0300 | 60.4700 |
| Gdep | 4551 | 0.4826 | 0.2258 | 0.0500 | 1.5400 |
| Ledu | 4551 | 9.5503 | 1.8608 | -2.0402 | 15.5292 |
| Ltec | 4551 | 12.1797 | 1.7570 | -0.9942 | 16.2456 |

#### *3.2.3 Parallel trend test*

The target variables for the treatment and control groups can only use DID if the parallel trend assumption is met before the policy occurs. Figure 1 is a time trend plot of the treatment and control groups, respectively, with Lpgdp and Score as the explained variables. The logarithmic value of GDP per capita and the quality index of economic growth were similar for both treatment and control groups before the environmental protection tax law (2018) was implemented. Thus, the time trend assumption between the two groups before the policy implementation year is basically satisfied, and the difference in the trend line after the policy implementation year is basically caused by the environmental protection

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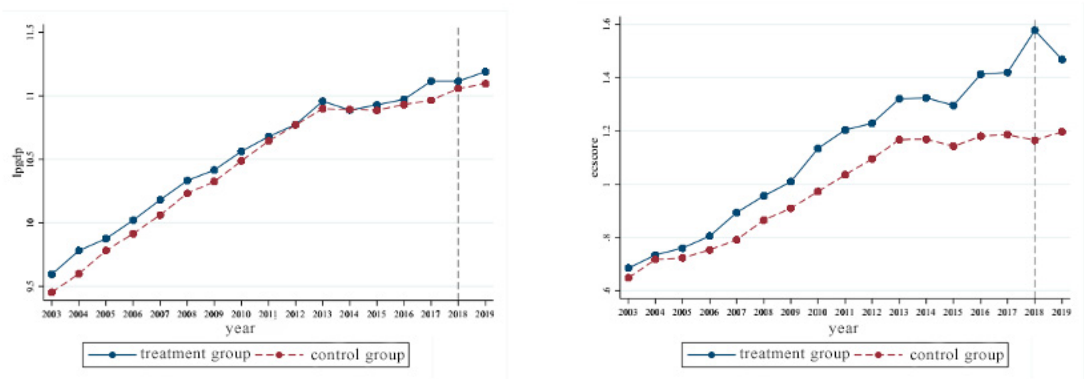
tax law.




*Group A Lpgdp* *Group B Score*

*Figure 1: Time Trend Plot for Lpgdp and Score.*

## 4. Regression analysis

### *4.1 Basic regression analysis*

Table 3 shows how environmental protection tax policy affects economic growth. Columns (1) and (2) demonstrate the impact of environmental protection tax on economic growth quantity, with positive but non-significant logarithmic coefficients of time×treat and GDP per capita with control variables. Columns (3) and (4) examine the impact on quality, with significant positive correlation between Environmental protection tax and the quality of economic growth index at the 1% level. Therefore, hypothesis 1 and 2 are tested: Increasing the environmental protection fee improved China's economic growth quality but not quantity.

*Table 3: Results of the impact of environmental protection tax policies on economic growth.*

| Variable | (1)Lpgdp | (2)Lpgdp | (3)Score | (4)Score |
|---|---|---|---|---|
| time×treat | $0.6861^{***}$ (14.28) | 0.0017 (0.10) | $0.4941^{***}$ (12.49) | $0.2167^{***}$ (6.15) |
| I1 | | $-0.0386^{***}$ (-32.07) | | 0.0031 (1.41) |
| Gdep | | $0.3659^{***}$ (8.33) | | $0.2736^{***}$ (3.31) |
| Ledu | | $0.0425^{***}$ (7.51) | | $0.0836^{***}$ (7.86) |
| Ltec | | $0.0781^{***}$ (7.78) | | 0.0132 (0.70) |
| _cons | $10.4677^{***}$ (887.72) | $8.7070^{***}$ (95.30) | $1.0299^{***}$ (105.39) | $-0.5110^{***}$ (-2.98) |
| n | 4482 | 4477 | 4556 | 4525 |
| R-squared | 0.0435 | 0.7653 | 0.0331 | 0.3744 |

Note: *, **, and *** indicate significant at 10%, 5%, and 1% levels, respectively, with corresponding T-values in parentheses.

### *4.2 Robustness test*

In this study, we use lagging one period, replacing variables, and data to conduct robustness tests to verify the benchmark regression of the double-difference model.

#### *4.2.1 One-period latency*

This research takes the explanatory variables to lag one period of operation in the robustness analysis since policy influences in the prior year can alter regression results in the following year. Table 4 displays economic growth analysis with one lag. The coefficients of the dummy variable time×treat with the regional GDP per capita (Lpgdp) are insignificant, while the coefficients with the index of economic

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growth quality (Score) are significant and positive at a 5% level. The regression results in Table 4 show that after the robustness test using the one-period lag method, the environmental protection tax policy does not affect economic quantitative growth but does affect qualitative growth.

*Table 4: Results of one-period lagged robustness tests.*

| Variable | (1)Lpgdp | (2)Lpgdp | (3)Score | (4)Score |
|---|---|---|---|---|
| time×treat | 0.0017<br>(0.10) | | $0.21674^{***}$<br>(6.15) | |
| L.time×treat | | 0.0231<br>(0.90) | | $0.1142^{**}$<br>(2.32) |
| I1 | $-0.0386^{***}$<br>(-32.07) | $-0.0399^{***}$<br>(-30.46) | 0.0031<br>(1.41) | 0.0040<br>(1.61) |
| Gdep | $0.3659^{***}$<br>(8.33) | $0.3846^{***}$<br>(8.47) | $0.2736^{***}$<br>(3.31) | $0.2342^{***}$<br>(2.67) |
| Ledu | $0.0425^{***}$<br>(7.51) | $0.0504^{***}$<br>(8.38) | $0.0836^{***}$<br>(7.86) | $0.0694^{***}$<br>(5.97) |
| Ltec | $0.0781^{***}$<br>(7.78) | $0.0616^{***}$<br>(5.16) | 0.0132<br>(0.70) | $0.0645^{***}$<br>(2.79) |
| _cons | $8.7070^{***}$<br>(95.30) | $8.8472^{***}$<br>(66.10) | $-0.5110^{***}$<br>(-2.98) | $-0.6179^{*}$<br>(-2.39) |
| n | 4477 | 4212 | 4525 | 4260 |
| R-squared | 0.7653 | 0.7504 | 0.3744 | 0.3714 |

Note: *, **, and *** indicate significant at 10%, 5%, and 1% levels, respectively, with corresponding T-values in parentheses.

#### *4.2.2 Replace indicators and data*

In the further robustness test, the dummy variable time×treat is replaced the amount and rate of change in the environmental tax levy for air pollutants for regression analysis, examining its impact on economic growth. In optimising the collection standard, the $SO_2$ emission collection standard is the strongest among air pollutant collection standards, Therefore, the core variables replaced in this section are the amount of change in the environmental tax rate for $SO_2$ pollutants, $D_1$, and the rate of change,$D_2$. Results are in Table 5, core variables $D_1$ and $D_2$ are not significant for quantity economic growth, while the coefficients are positive for quality. The coefficients of growth are significantly positive, indicating that $SO_2$ pollutant emission standards have a positive effect on economic growth quality but not quantity, as expected.

*Table 5: Results of Robustness Tests for Replacement Variables.*

| Variable | (1)Lpgdp | (2)Score | (3)Lpgdp | (4)Score |
|---|---|---|---|---|
| D1 | -0.0114<br>(-1.53) | $0.0644^{***}$<br>(4.57) | | |
| D2 | | | -0.0147<br>(-1.15) | $0.0493^{**}$<br>(2.04) |
| i1 | $-0.0385^{***}$<br>(-32.01) | 0.0032<br>(1.45) | $-0.0386^{***}$<br>(-32.06) | 0.0035<br>(1.58) |
| Gdep | $0.3679^{***}$<br>(8.37) | $0.2528^{***}$<br>(3.05) | $0.3678^{***}$<br>(8.37) | $0.2576^{***}$<br>(3.10) |
| Ledu | $0.0426^{***}$<br>(7.54) | $0.0870^{***}$<br>(8.17) | $0.0426^{***}$<br>(7.53) | $0.0872^{***}$<br>(8.18) |
| Ltec | $0.0785^{***}$<br>(7.83) | 0.0160<br>(0.85) | $0.0785^{***}$<br>(7.82) | 0.0169<br>(0.89) |
| _cons | $8.7013^{***}$<br>(95.41) | $-0.5572^{***}$<br>(-3.25) | $8.7021^{***}$<br>(95.39) | $-0.5713^{***}$<br>(-3.33) |
| N | 4477 | 4525 | 4477 | 4525 |
| R-squared | 0.7656 | 0.3761 | 0.7656 | 0.3740 |

Note: *, **, and *** indicate significant at 10%, 5%, and 1% levels, respectively, with corresponding T-values in parentheses.

#### *4.2.3 Placebo test*

A kernel density estimation plot of the interaction term regression coefficients after randomization and a scatter plot of the p-values were obtained for 500 random samples of the treatment group variables,

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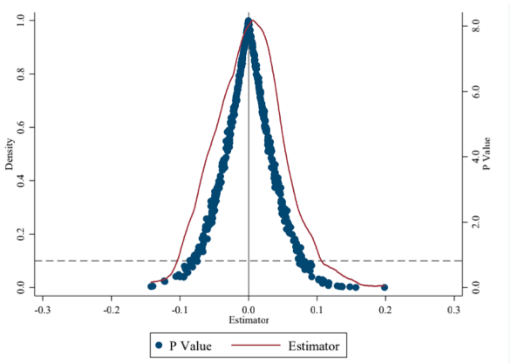
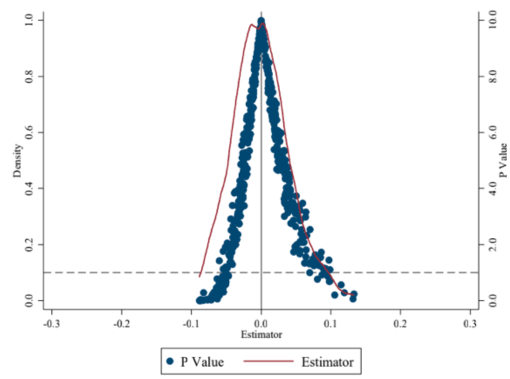
as shown in Figure 2.The vertical solid line is the mean of the coefficients of the 500 interaction terms after randomization , which are all concentrated around 0, normally distributed, and significantly deviate from their true values, i.e., most of the estimated coefficients are not significant. The horizontal dashed line is P = 0.1, and the scatter is concentrated above this dashed line, indicating that the coefficients are not significant at least at the 10% level. This implies that the policy effect of the implementation of the environmental protection tax policy on both quantitative and qualitative economic growth is not influenced by other unobserved factors.




*Group A Lpgdp*




*Group B Score*

*Figure 2: Scatterplot of P-value-coefficients of economic quantity and quality effects.*

## 5. Research Summary and Policy Advice

### *5.1 Research Summary*

This study uses the double difference model to theoretically and empirically analyse China's environmental protection tax policy on urban macroeconomic growth. The increase in environmental protection tax charge standard has promoted economic growth quality but not quantity. Environmental protection tax collection standard increases are small, the "cost effect" and "compensation effect" are similar, and policy implementation conditions are not perfect, so environmental protection tax has no obvious impact on economic growth in quantity. Environmental protection tax promotes regional industrial structure adjustment and upgrading, and enterprises gather to tertiary industry with low pollution and energy consumption, which reduces emissions and pollution and improves environmental quality, which boosts economic growth.

### *5.2 Policy Advice*

This paper recommends the following policies based on the aforementioned analysis and research. First, environmental protection tax does not promote economic quantity growth, so it should promote the local combination of the local actual situation, actively study the tax standard adjustment, and guide the tax to promote economic quantity growth. Second, environmental protection tax policy can boost economic growth quality. Half of China's provinces have not raised the tax standard, which should be done in phases and at the correct time to support local economic growth. Thirdly, the promotional effect on the quality of economic growth is stronger in regions with a more standardized environmental protection tax collection mechanism and a relatively well-developed institutional environment and supporting facilities. Thus, environmental protection tax collection management collaborative mechanisms and capacity building should be improved.

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