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Can Environmental Protection Taxes Promote New Quality Productivity Improvement in the Transport Sector?

-- Empirical Evidence based on Data from Chinese A-share Listed Firms

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Abstract

New quality productivity is a brand-new exploration of emerging and future industries, a key hand in solving the main social contradictions in the new era, and a necessary way to transform from rough development to high-quality development. As an important cornerstone of the national economy, the transport industry suffers from excessive consumption of energy leading to environmental degradation, which is not conducive to the enhancement of China's new quality productivity. Based on the financial statement data of listed transport industry enterprises from 2012 to 2022, the article explores the impact of environmental protection tax on the new quality productivity of transport industry enterprises, and the results show that environmental protection tax significantly improves the new quality productivity of the transport industry; the mechanism study shows that environmental protection tax improves the new quality productivity of the transport industry by forcing the transport industry enterprises to carry out technological innovation, optimise the human capital structure, and improve the human capital structure of the enterprises. The mechanism study shows that the environmental protection tax enhances the new productivity of enterprises in the transport industry by forcing them to make technological innovation and optimize human capital structure; the heterogeneity test finds that the environmental protection tax significantly promotes the new productivity of non-state-owned enterprises, non-large enterprises and labour-intensive enterprises. The results of the study provide favourable empirical evidence for promoting new productivity in the transport industry, improving the tax system and promoting high-quality economic development.

Keywords

Environmental Protection Tax; Transport Industry; New Quality Productivity; Technological Innovation; Human Capital Structure.

1. Introduction

The new quality of productivity, as a concentrated manifestation of contemporary advanced productive forces, stems from revolutionary breakthroughs in technology, innovative allocation of factors of production, and in-depth transformation and upgrading of industries, and its core mark lies in the significant increase in total factor productivity. The transport industry, as an important cornerstone supporting socio-economic development, not only has strong profitability and agglomeration capacity, but also plays a pivotal role in promoting economic growth and facilitating the process of globalisation. However, with the acceleration of urbanisation and the booming development of e-commerce, China's transport industry has achieved rapid development, but the ensuing problems should not be ignored, such as excessive

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energy consumption and continuous environmental degradation. According to relevant statistics, the energy consumption of China's transport industry has accounted for 9% of the country's total energy consumption in 2019. With the rapid growth of energy consumption and the increasingly serious problem of carbon emissions, the transport industry has become a high-carbon emission industry second only to energy and industry. It is worth noting that the enhancement of the new quality productivity of the transport industry is not only affected by the factors of the transport system itself, but also profoundly influenced by the socio-economic environment system. Therefore, in-depth analysis of the influence mechanism of socio-economic environmental and institutional factors on the new quality productivity of the transport industry and identification of effective paths to enhance the new quality productivity of the transport industry are of great policy guidance and practical value for effectively enhancing the new quality productivity of the transport industry and promoting its green and high-quality transformation and development. This is not only the key to enhancing the competitiveness of the transport industry, but also an important measure to promote sustainable economic and social development. In the transport sector, the implementation of the environmental protection tax has pushed enterprises to increase the research and development and application of environmentally friendly technologies, promoting the transformation of the transport industry into a green, low-carbon and intelligent one. For example, measures such as encouraging the use of clean energy vehicles, optimising logistics and transport routes and improving transport efficiency not only help to reduce environmental pollution, but also enhance the new quality of productivity in the transport industry. In addition, the environmental protection tax also encourages enterprises to save and recycle resources, and promotes the transport industry to achieve sustainable development. The guidance of tax policy makes enterprises pay more attention to green supply chain construction, energy saving and emission reduction as well as environmental protection technology innovation, thus enhancing the overall efficiency of the transport industry. Therefore, environmental protection tax not only helps to improve environmental quality, but also effectively promotes the enhancement of new quality productivity in the transport industry.

At present, the research on the impact of environmental protection tax policy on the new productivity of enterprises is still insufficient, mainly focusing on the theoretical level, and there is a relative lack of empirical research. In view of this, this paper empirically examines the impact and transmission mechanism of environmental protection tax on the new quality productivity of enterprises by using financial statement data of listed enterprises, and puts forward policy recommendations based on the findings in order to promote high-quality economic development. Compared with the existing literature, the contribution of this paper lies in the following: firstly, new quality productivity is an emerging concept and there is a lack of quantitative research models. Second, as an important driving force for enterprise development, new quality productivity has many influencing factors, but existing studies are mostly based on qualitative analysis. Through the empirical method, this paper discusses in depth the impact of environmental protection tax on the new quality productivity of enterprises and its transmission mechanism from the perspective of enterprise stakeholders, which enriches the relevant theoretical research. Finally, through heterogeneity analysis, this paper compares the impact of different environmental protection tax policies on the change of new quality productivity at both micro and macro levels, which provides empirical evidence for improving environmental protection tax policies, promoting enterprise development and accelerating the formation of new quality productivity.

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2. Literature Review and Research Hypotheses

2.1. Literature Review

While promoting economic growth, China's long-standing crude mode of production has also had a greater negative impact on the environment, and the problems of ecological deterioration and tightening resource constraints have continued to come to the fore. In order to alleviate the deterioration of the ecological environment, China enacted the Environmental Protection Law (for Trial Implementation) in 1979, which established a sewage charge system, and promulgated the Regulations on the Administration of the Collection and Use of Sewage Charges in 2002, which strengthened the collection and management of sewage charges. However, in fact, China has not established a real market-based environmental protection system (Wang Jinnan et al., 2009)0. The fundamental reason for this is that the sewage fee system is not sufficiently standardised and mandatory in collection and management, and suffers from excessive administrative intervention as well as insufficient enforcement (Bi Xi and Yu Lianchao, 2021)[2][3]. Precisely because of the lax supervision in the implementation process of the sewage right system and the unfavourable role of the market mechanism, China began to implement the Environmental Protection Tax Law in 2018, establishing the environmental protection tax system in the form of law. In recent years, the research literature on environmental protection tax has become increasingly rich. Many scholars have started from the micro level of enterprises to study the impact of environmental protection tax on the innovation level, profitability and total factor productivity of enterprises, but a unified conclusion has not yet been formed. First of all, from the perspective of the innovation level of enterprises, Bi Xi and Yu Lianchao (2016)[3], Niu Meichen and Liu Ye (2021)[4] believe that the impact of environmental protection tax on the green technological innovation of enterprises presents a "U" relationship of inhibition followed by facilitation (Jiangetal., 2022)[5], and there is a certain degree of lag in this impact. However, Li Xiangju and He Na (2018)[6] believe that the relationship between environmental protection tax and enterprise technological innovation is an "inverted U" type. Liu, Jinke and Xiao, Yiyang (2022) [7] find that environmental protection tax reform promotes green innovation by improving energy efficiency and end-of-pipe green innovation, but this green innovation crowds out other technological innovations. Second, from the point of view of the profitability of enterprises, Liu Xiaoguang and Shao Runxin[8] (2021) use the double difference method to find that the introduction of environmental protection tax can force enterprises to increase the investment in innovation, which in turn improves the profitability of enterprises. Some scholars believe that the introduction of environmental protection tax will increase the tax burden of enterprises in the initial period, and in the short term, enterprises will face higher production costs and environmental management expenses, which will ultimately lead to a decline in competitiveness and performance (Jin Youliang et al., 2020; Lu Hongyou et al., 2019)[9][10], but in the long term, under the pressure of the environmental protection tax, enterprises will carry out cleaner production in order to reduce the pollution emissions, and through the production of green products ultimately obtaining sustainable profit points thus enhancing their profitability (Abdullah & Morley, 2014)[11]. Finally, for the total factor productivity of enterprises, China has long implemented the sewage fee system, although it can achieve environmental dividends, but it harms the total factor productivity of enterprises, while the implementation of environmental protection "fee to tax" can make up for the shortcomings of the sewage fee system, and significantly improve the total factor productivity of enterprises, which helps to promote the high-quality development of enterprises (Yang Jie et al., 20)[12]. high-quality development (Yang Yang et al., 2022)[13]. Specifically, environmental protection tax can improve the capacity utilisation rate of enterprises by suppressing over-investment of heavily polluting enterprises and promoting technological innovation (Yu Lianchao et al.,

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2021)[14], and in the process of dissolving excess capacity, the allocation of resources of enterprises can be optimised, which will ultimately achieve the enhancement of total factor productivity (Yang Wenju and Wang Qi, 2022)[15].

The theoretical basis for the discussion of the new quality of productivity can be traced back to the classical British economist William Gaddie, whose view that "land is the mother of wealth, and labour the father and dynamic element of wealth" (William Gaddie, 1962) [16]laid the cornerstone for the development of productivity theory. In China, the assertion that "science and technology are the first productive forces" has injected new vigour into productivity theory. Subsequently, the decisive role of science and technology in economic development was profoundly elucidated. In the new historical stage, it is clearly stated that "science and technology innovation is the first driving force", which marks a new stage of development of China's productivity theory, representing a leap and qualitative change in productivity. The core of new productivity lies in innovation, and its main carrier is the industrial field. By nature, new quality productivity is reflected in the emergence of a large number of disruptive innovative technologies and the release of enormous kinetic energy through the industrialisation process. At the qualitative level, the new quality of productivity is manifested in the rapid rise of new industries, which possess higher technological level, better economic efficiency and more friendly environmental characteristics, thus promoting the economy to achieve high-quality development.

In the continuous evolution of productivity theory, several terms have emerged around this core concept, such as labour productivity, productivity and labour productivity, which together constitute an important part of the theoretical system of historical materialism and Marxist political economy. However, the relationship between these concepts has been controversial in economics. In his study, Lin Jian (1985) [17]pointed out that productivity and labour productivity are both interrelated and differentiated in Marxist productivity theory. Productivity, as the key factor constituting labour productivity, reflects the ability of human beings to conquer and transform nature. Labour productivity, on the other hand, is similar to labour productivity, which measures the value and efficiency created by workers in the labour process.

Liu Yixiang (2001) [18]further explains the relationship between productivity and productivity. According to him, productivity represents the productive capacity of people, while productivity is concerned with the efficiency and scale of production. In practical applications, the two are often intertwined and productivity is often constrained by productivity. In daily life, we can easily find the concept of "productivity" widely used, and very often it actually refers to productivity. When Mao Zedong talked about "developing production and ensuring supply", although it literally refers to productivity, its actual meaning is closer to productivity. although the two can be regarded as equivalent in some cases from an economic point of view, productivity is not the whole meaning of productivity. It should also cover the economic and social meanings embedded in productivity. Yang Yanjiang (2012)[19], after studying Capitalism, points out that labour productivity and labour productivity can be substituted for each other in most cases. When the potential of labour productivity is fully released, labour productivity and labour productivity converge. A similar view is held by Ma Yun and Wei Xinghua (2013),[20] who argue that labour productivity is an external manifestation of productivity or labour productivity, and that the level of development of productivity or labour productivity can be measured through labour productivity. Yang Chengxun (2020)[21], after studying the Complete Works of Lenin, emphasised that the development of productivity is mainly reflected in the improvement of production efficiency, and that although productivity and production efficiency overlap in some aspects, they still have different meanings in essence. These studies provide valuable ideas and directions for a deeper understanding of the new quality of productivity and its relationship with traditional productivity.

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After exploring the relevant literature in depth, we can draw the following conclusions: firstly, as an advanced form of traditional productivity development, new-quality productivity is a significant leap achieved through the incorporation of new technologies; secondly, despite the subtle conceptual differences between productivity and productivity, in the field of economics they are often regarded as interchangeable terms; furthermore, the impact of environmental protection tax on enterprise development is not monolithic; it both may promote business development or have a dampening effect. These findings provide new perspectives and directions for the research in this paper.

2.2. Research Hypotheses

2.2.1. Environmental Protection Tax, Technological Innovation and New Quality Productivity of Enterprises

After the implementation of environmental protection tax, the production cost of transport enterprises has increased significantly, which in turn has compressed their profit margins. In order to widen their profit margins, enterprises often choose to upgrade their technology to improve their productivity to cope with the pressure brought by the environmental tax. According to the Porter's Hypothesis, environmental taxes can stimulate the innovation drive of enterprises, and offset the additional costs incurred by environmental taxes through innovative activities, thus enhancing the competitiveness of enterprises in the market. The path of environmental regulation on enterprise innovation is quite rich, mainly including the following six points: first, environmental regulation sends a signal of inefficiency to enterprises, prompting them to self-examination and improvement; second, environmental regulation enhances the enterprise's awareness of innovation, and pushes them to actively seek for new technologies and methods; third, environmental regulation mitigates the possible negative impacts of green investment on enterprises; fourth, environmental regulation increases the cost pressure on enterprises, thus stimulating the enterprise's market competitiveness; and fourth, environmental taxation increases the cost pressure on enterprises, thus stimulating the enterprises to innovate. Fourth, environmental regulations increase the cost pressure on firms, thus stimulating them to look for ways to save costs; fifth, environmental regulations improve the competitive environment in the market, prompting firms to pay more attention to innovation in order to enhance their competitiveness; and sixth, environmental regulations may have an imperfectly compensating effect, but they still have a driving force for firms to innovate on the whole. The reason why environmental regulation can effectively drive enterprise technological innovation mainly stems from the compensation effect brought by technological innovation. This compensation effect includes product compensation effect and process compensation effect. The product compensation effect is reflected in the environmental regulation to encourage enterprises to provide higher quality and safer products, while reducing the environmental cost of the product, so as to compensate for the increase in production costs due to environmental taxes. The process compensation effect is reflected in the fact that environmental regulation improves productivity, reduces energy consumption and optimises the production process, which also helps to compensate for the increased costs of environmental taxes.

As a market-based environmental regulation tool, the innovation compensation effect triggered by environmental taxes is mainly manifested in the two aspects of enterprises' products and production processes. On the one hand, by improving the quality, safety and environmental friendliness of their products, firms are able to compensate for the increase in production costs due to environmental taxes; on the other hand, by reducing the energy consumption of their production processes, optimising their production processes, and improving their greenness, firms are able to cope with the cost pressures brought about by environmental taxes. Therefore, the hypothesis is proposed:

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H1: Environmental protection tax will increase the productivity of transport enterprises by forcing them to carry out technological innovation.

2.2.2. Environmental Protection Tax, Human Capital Structure and New Productivity of Enterprises

After the implementation of environmental protection tax, enterprises face the challenge of rising costs and squeezed profit margins, and this pressure will force enterprises to seek ways to improve productivity. In this process, enterprises need to invest in a variety of production factors in order to enhance productivity; however, they have limited resources, which requires them to optimise the allocation of existing factor resources and thus enhance resource allocation efficiency (Li Xinyang, 2023). When upstream enterprises are subject to environmental regulations and pass the tax burden to downstream affiliates through the price-tax linkage mechanism, the operating costs of downstream enterprises will rise. In order to maintain product comparative advantages in the market, enterprises will actively improve the efficiency of factor resource allocation to regain the factor cost advantage. The implementation of the environmental protection tax policy will promote industrial upgrading and elimination of outdated production capacity by enterprises in the transport industry, which in turn will enhance the demand for high-quality human capital structure (Zhu Lan et al., 2024). Based on the above analysis, this paper puts forward the following hypothesis.

H2: Environmental protection tax optimises the allocation of human capital elements by forcing transport industry enterprises to optimise their new quality productivity.

3. Data Processing and Empirical Design

3.1. Model Setting

Equation (1) is the baseline regression model, “Npro”it is the new quality productivity of transport enterprises in period t, γ_i and ν_t are the individual and time fixed effects ε_it is the random disturbance term, and “Control”_mit is a series of control variables. In this paper, we will use the above sub-model to examine the impact of environmental regulation on the new quality productivity of enterprises in the transport industry.

$$Npro_{it} = \alpha_0 + \alpha_1 LnET + \sum_{m=2}^{n} \alpha_m \, Control_{mit} + \gamma_i + \nu_t + \varepsilon_{it} \quad (1)$$

3.2. Explanation of Variables

Explained variable: new quality productivity (Npo). Referring to Lu Jiang, Guo Ziang and other scholars[22], the evaluation of new quality productivity is built on three first-level indicators: science and technology productivity, green productivity and digital productivity. For science and technology productivity, it is portrayed in terms of innovation productivity and technology productivity; regarding green productivity, it is measured from the perspectives of resource-saving productivity and environmentally friendly productivity; and for digital productivity, it is considered from the levels of digital industry productivity and industrial digital productivity.

Explanatory variable: environmental tax (LnET). Referring to the study of Bao Jian and Guo Baoqi (2023) [23]this paper adopts Yong narrow environmental tax as the explanatory variable, i.e., the amount of environmental protection tax paid by listed companies (replaced by sewage charges from 2012 to 2017), which is logarithmised.

Control variables: the internal characteristics of listed companies may affect the factors of new quality productivity of enterprises, drawing on the research of Sun Yupeng et al and Guo Feng et al , this paper selects the size of the enterprise (Size), the equity ratio (DER), the return on assets (ROA), the return on equity (ROE), the growth rate of operating income (Growth), the growth rate of total assets (AssetGrowth), financial leverage (FL), the proportion of shares held

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by the first largest shareholder (Top1), separation of powers (Seperate) Listed years (ListAge), total asset turnover (ATO) Ben as a control variable. The specific definitions and descriptions of each variable are detailed in Table 1; Table 2 presents the results of descriptive statistical analysis of each variable.

Table 1. Definitions and descriptions of variables

Variable type	variable name	Variable symbol	Description of variables
explanatory variable	New Quality Productivity	Npro	New Quality Productivity
explanatory variable	environmental taxation	LnET	Payment of environmental protection tax takes logarithms
control variable	Enterprise size	Size	Total assets in logarithms
	equity ratio	DER	Total liabilities/total owners' equity
	return on assets	ROA	Net profit/total assets
	return on net assets	ROE	Return on shareholders' equity/return on net worth
	Revenue growth rate	Growth	Growth in operating income/total operating income of the previous year
	Total asset growth rate	AssetGrowth	Growth in total assets for the year/total assets at the beginning of the year
	financial leverage	FL	Assets/liabilities
	Percentage of shares held by the largest shareholder	Top1	Percentage of shares held by the largest shareholder/total number of shares
	separation of powers	Seperate	Separation of business ownership and control
	Number of years listed	ListAge	Current year - previous year +1
	Total asset turnover	ATO	Total sales revenue/average total assets

Table 2. Descriptive statistics of main variables

VarName	variable name	observed value	Mean	SD	Min	Median	Max
Npro	New Quality Productivity	888	6.316	2.688	1.045	6.156	14.945
LnET	environmental taxation	888	14.057	1.535	10.797	14.013	17.594
Size	Enterprise size	888	23.164	1.393	20.260	23.102	26.381
DER	equity ratio	888	1.037	0.901	0.073	0.761	4.969
ROA	Net profit/total assets	888	0.044	0.041	-0.107	0.040	0.177
ROE	return on net assets	888	0.074	0.079	-0.318	0.077	0.267
Growth	Revenue growth rate	888	0.132	0.328	-0.518	0.078	1.874
AssetGrowth	Total asset growth rate	888	0.116	0.187	-0.204	0.070	1.021
FL	financial leverage	888	1.322	0.755	-0.793	1.134	5.912
Top1	Percentage of shares held by the largest shareholder	888	42.386	14.066	13.894	41.319	75.458
Seperate	separation of powers	888	5.024	8.114	0.000	0.000	27.171
ListAge	Number of years listed	888	2.438	0.699	0.693	2.639	3.332
ATO	Total asset turnover	888	0.522	0.539	0.041	0.322	3.015

Source of data for this paperThe time interval for the article to select the micro-sample data of listed companies is 2012-2022, and the data used is from WIND database. In this paper, the micro-sample data are treated as follows: (1) The samples of ST and ST* companies are excluded. (2) In order to prevent the influence of outliers on the estimation results, this paper

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treats all continuous variables with 1% and 99% winsor. (4) The samples of firms with serious missing data are excluded. Finally this paper obtains 888 valid observations. The definitions of the main variables are shown in Table 1 below and the descriptive statistics are shown in Table 2.

4. Analysis of Empirical Results

4.1. The Impact of Environmental Protection Tax on the New Quality Productivity of Enterprises in the Transport Industry

Table 3. Benchmark model regression results

	(1)	(2)
variable name	Npro	Npro
LnET	0.0966*	0.1512**
	(1.79)	(2.07)
Size		0.4799*
		(1.93)
DER		-0.1655**
		(-2.35)
ROA1		-0.7281***
		(-4.03)
ROE		-1.6986***
		(-3.13)
Growth		0.1068
		(0.63)
AssetGrowth		-0.2296
		(-0.77)
FL		-0.0007
		(-0.33)
Top1		0.0063
		(0.52)
Seperate		0.0156
		(1.34)
ListAge		0.2931
		(1.12)
ATO		0.0725
		(0.25)
_cons	4.9833***	-7.6235
	(6.58)	(-1.34)
Individual fixation	YES	YES
fixed time	YES	YES
N	882	848
adj.R^2	0.7718	0.7719

Note: ***, **, * denote significance levels of 1 per cent, 5 per cent, and 10 per cent, respectively, and t-statistic values in parentheses, with t-values calculated with robust standard errors, below.

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This paper starts with the new quality productivity of enterprises in the transport industry and analyses the impact of environmental protection tax on the new quality productivity of transport enterprises. Table 2 shows the regression results of model (1), i.e. the baseline model regression results, which reflect the impact of environmental protection tax on the new quality productivity of transport enterprises. According to the results in column (1), the regression coefficient of the interaction term without the addition of control variables is 0.0966, which is significant at the 10 per cent level; in column (2), the regression coefficient of the interaction term with the further addition of enterprise control variables is 0.1512, which is significant at the 5 per cent level; the adjusted R2 in column (2) is superior to that in column (1), and thus the regression results with the addition of control variables, such as the enterprise's region are more robust, and the following section will carry out the robustness test to enhance the credibility of the empirical results. The regression results show that the environmental protection tax has a significant positive effect on the new quality productivity of the transport industry and promotes the new quality productivity of enterprises.

4.2. Robustness Test

4.2.1. Replacement of Explanatory Variables.

In the field of economics, productivity and productivity are often replaceable, so in this paper total factor productivity is used as a replacement explanatory variable to measure the level of new quality productivity of enterprises. Total factor production (TFP) is selected as the explanatory variable, and the current methods of measuring total factor productivity at the enterprise level mainly include the OP method and the LP method, but because the OP method results in the samples with zero investment not being estimated, so there will be a large number of samples missing, so this paper adopts the LP method to estimate the total factor productivity of the enterprise. From the regression results in columns (1) and (2) of Table 4, the coefficients of environmental protection tax are significantly positive at the level of 1% and 5%, respectively, indicating that after replacing the explanatory variables, environmental protection tax has a positive effect on the level of new quality productivity of enterprises, and the hypothesis H1 of this paper has been preliminarily verified.

Table 4. Replacement of explanatory variables regression results.

variable name	(1)	(2)
	TFP_LP	TFP_LP
LnET	0.3158***	0.1182**
	(5.07)	(2.39)
_cons	3.9456***	-4.7208***
	(4.47)	(-5.67)
control variable	YES	YES
Individual fixation	YES	YES
fixed time	YES	YES
N	770	741
adj.R^2	0.9392	0.9704

4.2.2. Excluding Anomalous Cities

In China, municipalities and provincial capitals have greater economic specificity, and in order to reduce the impact of the above cities on the results of the study, the regression after deleting the sample enterprises in the four cities of Beijing, Shanghai, Guangzhou and Shenzhen. From

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the regression results in columns (1) and (2) of Table 4, the coefficient of environmental protection tax is significantly positive at the 1% and 5% levels, indicating that environmental protection tax promotes the new quality productivity level of enterprises in all regions of China, and the conclusion of hypothesis H1 of this paper is valid.

Table 5. Regression results excluding outliers

variable name	(1)	(2)
	Npro	Npro
LnET	0.3153***	0.1160**
	(4.62)	(2.19)
_cons	3.9703***	-4.6640***
	(4.12)	(-4.50)
control variable	YES	YES
fixed time	YES	YES
Individual fixation	YES	YES
N	666	639
adj.R^2	0.9321	0.9664

4.2.3. Removal of Anomalous Years

During the sample period, the new crown epidemic after 2020 has a very significant impact on the development of enterprises, in order to reduce the uncertainty of the results of the study in abnormal years, the regression is conducted after removing the three years of data from 2020-2022. From the regression results in columns (1) and (2) of Table 4, the coefficients of the environmental protection tax are significantly positive at the 1% and 5% levels, indicating that the environmental protection tax promotes the level of firms' new-quality productivity after the exclusion of the anomalous years, and Hypothesis H1 of this paper is verified once again.

Table 6. Regression results for deletion of anomalous years

variable name	(1)	(2)
	TFP_LP	TFP_LP
LnET	0.3158***	0.1182**
	(5.07)	(2.39)
_cons	3.9456***	-4.7208***
	(4.47)	(-5.67)
control variable	YES	YES
Individual fixation	YES	YES
fixed time	YES	YES
N	770	741
adj.R^2	0.9392	0.9704

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5. Further Analysis

5.1. Heterogeneity Analysis

5.1.1. Heterogeneity of Enterprise Property Rights

Given the differences in enterprise property rights, their business models and objectives are distinctive. In order to deeply analyse the impact of enterprise property rights heterogeneity on the research findings, this paper divides the sample into the central and local state-owned enterprise group (collectively referred to as state-owned enterprises) and the other property rights enterprise group (collectively referred to as non-state-owned enterprises). Observing the regression results of column (1) and column (2) in Table 7, it is easy to find that the coefficients of environmental protection tax for both state-owned enterprises and non-state-owned enterprises show positive values at the 10% significance level. This means that with the increase in the amount of environmental protection tax payment, the level of new quality productivity of enterprises with different property rights shows an upward trend.

Further analysis reveals that the increase in new quality productivity level of non-state-owned enterprises is more significant than that of state-owned enterprises under the impetus of the environmental protection tax policy. This is mainly attributed to the fact that SOEs have long carried the political and social responsibilities entrusted by the state, and many of them are in high-energy-consuming and high-polluting industries, such as coal, electricity and energy. After the implementation of the environmental protection tax policy, these enterprises need to invest a large amount of money in rectification to meet the state's environmental protection requirements. In contrast, non-state-owned enterprises, especially private ones, face less pressure to rectify and require less capital, and are therefore more likely to meet the national environmental standards. In addition, non-state-owned enterprises tend to pay more attention to corporate image, so after the implementation of the environmental tax policy, they are more inclined to promote the innovative development of enterprises in order to enhance the level of new quality productivity. On the other hand, the production activities of state-owned enterprises tend to have more administrative colours, and their motivation comes more from the requirements of national policies than from the development needs of the enterprises themselves. Therefore, after the implementation of the environmental protection tax policy, state-owned enterprises may have relatively weaker incentives to enhance new quality productivity.

Table 7. Results of the regression of firms' property rights heterogeneity

variable name	(1)	(2)
	state enterprise	non-state enterprise
LnET	0.1127*	0.4123*
	(1.75)	(1.68)
_cons	-10.1376	-9.7319
	(-1.47)	(-0.92)
control variable	YES	YES
Individual fixation	YES	YES
fixed time	YES	YES
N	695	153
adj.R^2	0.7678	0.6755

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5.1.2. Heterogeneity in Firm Size

Given the different sizes of enterprises, their operating capabilities also vary. In order to explore the specific impact of enterprise size heterogeneity on the findings of the study, this paper groups large enterprises into one category (Size=1), while MSMEs are uniformly classified as non-large enterprises (Size=0). By carefully analysing the regression results in columns (1) and (2) of Table 8, we observe that the coefficients of environmental protection tax for non-large firms show positive values at the 5% significance level. This finding implies that after the implementation of the environmental protection tax, non-large firms are more significant in promoting new quality productivity gains as compared to large firms. Delving deeper into the reasons behind this, we find that firm size plays a pivotal role in the financing process. Before the promulgation of the new environmental protection law, the size of the enterprise is often proportional to the number of assets that can be used as collateral or guarantee for loans. The larger the size of the firm, the more secure its repayment ability usually is, and therefore faces relatively lower financing constraints. In particular, before the implementation of the new environmental protection law, those large and heavily polluting enterprises were often able to obtain more bank credit support. However, these large enterprises were often accompanied by more serious pollution emission problems. Therefore, with the implementation of the new environmental protection law, banks may gradually tighten their credit restrictions on larger polluting enterprises. This also explains to some extent why non-large enterprises are able to promote new quality productivity more actively after the implementation of the environmental protection tax policy.

Table 8. Regression results for firm size heterogeneity

variable name	(1)	(2)
	major industry	Non-Large Enterprises
LnET	0.1579	0.1838**
	(0.78)	(2.20)
_cons	18.3103	-23.0983***
	(1.43)	(-2.76)
control variable	YES	YES
Individual fixation	YES	YES
fixed time	YES	YES
N	423	414
adj.R^2	0.8035	0.7206

5.1.3. Heterogeneity of Firm Attributes

In this paper, we classify manufacturing industry segments into three broad categories: labour-intensive, capital-intensive and technology-intensive. From the data in columns (1) and (2) of Table 9, we can observe that among the labour-intensive industries, especially the transportation industry, the implementation of environmental protection tax has a significant positive impact on its new quality productivity. The reason for this phenomenon may lie in the fact that the implementation of environmental protection tax has prompted downstream enterprises to have to carry out industrial upgrading in order to eliminate those backward production capacities. The process of industrial upgrading, in turn, increases the demand for high-quality human capital by enterprises. In other words, in order to achieve sustainable and healthy economic development, the human capital structure of enterprises must be in line with the industrial structure. Therefore, when the environmental protection tax can be implemented,

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the performance of labour-intensive transport industry enterprises in terms of new quality productivity improvement is particularly significant.

Table 9. Results of the regression of heterogeneity of enterprise property rights

variable name	(1)	(2)
	Labour-intensive enterprises	Non-labour intensive enterprises
LnET	0.4042**	0.0672
	(2.06)	(0.98)
_cons	5.4800	-19.0925*
	(0.61)	(-1.83)
control variable	YES	YES
Individual fixation	YES	YES
fixed time	YES	YES
N	461	367
adj.R^2	0.8303	0.6400

5.2. Mechanism Testing

According to the previous empirical results, environmental protection tax reform has a significant positive effect on the new quality productivity of transport industry enterprises, and the following section will explore the transmission mechanism of environmental protection tax affecting the new quality productivity of transport industry enterprises. According to Jiang Boat (2022), the traditional three-step mediation effect model may have an impact on the analysis of the intermediate mechanism, so this paper mainly examines the mechanism of environmental protection tax on the new quality productivity of enterprises by observing the effect of environmental protection tax on the intermediate variables. The following model is constructed:

$$M_{it} = \gamma_0 + \gamma_1 \mathrm{LnET} + \sum_{m=2}^{n} \gamma_m Control_{mit} + \lambda_i + \nu_t + \varepsilon_{1it} \quad (2)$$

$$NPro_{it} = \delta_0 + \delta_1 \mathrm{LnET} + \delta_2 M_{cit} + \sum_{m=3}^{n} \gamma_m Control_{mit} + \lambda_i + \nu_t + \varepsilon_{2it} \quad (3)$$

M_{cit} represents the mediating variable in the model, as the factors affecting new quality productivity are mainly influenced by innovation inputs and outputs and human capital accumulation. Moreover, environmental regulations can affect the new quality productivity of enterprises by influencing their R&D inputs and endowment structure. Therefore, the mediating variables in this paper are PatentAcq and HC. At the same time, it is also necessary to pay attention to the problem of endogeneity of the mediating variables, Jiang Boat (2022) believes that the problem of endogeneity of the mediating variables is the reason for the bias in the judgement of the traditional mediation effect model. Therefore, this paper explores the relationship between the mediating variables and the new quality productivity, specifically, it is because the new quality productivity is affected by the level of technological innovation and the allocation of resource factors, so the R&D investment and human capital structure selected in this paper are exogenous, which ensures that the conclusions of the study will not be interfered by the endogeneity of the mediating variables.

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Table 10. Mechanism Tests

	(1)	(2)	(3)	(4)
	HC	Npro	*PatentAcq*	Npro
LnET	0.2874*		0.1556*	
	(1.69)		(1.78)	
HC		0.0208**		
		(2.16)		
PatentAcq				0.1212**
				(2.34)
_cons	27.4458***	-7.1902*	-0.2131	1.8400
	(6.66)	(-1.66)	(-0.17)	(1.41)
control variable	YES	YES	YES	YES
Individual fixation	YES	YES	YES	YES
fixed time	YES	YES	YES	YES
N	799	799	848	848
adj.R^2	0.8708	0.8961	0.7023	0.8887

6. Conclusion and Implications

Based on the data of listed Chinese companies in the transport industry from 2012 to 2022, this paper finds through empirical analysis that environmental protection tax significantly promotes the improvement of new quality productivity in the transport industry. This positive effect mainly stems from the incentive effect of environmental protection tax on technological innovation and human capital structure optimisation of enterprises. Further heterogeneity tests reveal that environmental protection tax has a more significant effect on the new productivity of non-state-owned enterprises, small transport enterprises and labour-intensive transport enterprises.

Based on the above findings, this paper proposes the following policy implications:

Firstly, deepening environmental tax reform is the key to promoting the "quantity and quality" of green technological innovation. China's environmental tax originates from the sewage fee system, and most of the provinces have not adjusted the tax standard for the sake of tax stability, and only a few provinces have made small adjustments. However, with the changes in economic development and environmental protection needs, the current environmental tax rate and tax scope have lagged behind the pace of economic and social development. Therefore, on the one hand, the environmental tax rate should be increased appropriately, and consideration should be given to shifting from proportional tax rate to progressive tax rate, and the corresponding tax rate gradient should be set according to the pollutant emissions; on the other hand, the taxing scope of the environmental tax should be expanded to include pollutants such as carbon dioxide, so as to stimulate the vitality of the enterprises' green technological innovation in a more effective way.

Second, focus on the synergistic effect of factor inputs, especially human capital factors. Factor inputs have a synergistic effect on the impact of new quality productivity in the transport sector. Therefore, regional governments should accurately grasp the effect of factor combinations

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according to local realities, and rationally plan and adjust the levels of factor inputs in order to enhance the driving force of new quality productivity in transport.

Once again, it is indispensable to stimulate economic vitality and increase pollution control. Improve the level of economic development, enhance economic vitality to help promote technological innovation, and thus enhance the technical level of the transport system, improve the efficiency of resource use. At the same time, increasing investment in pollution control and effectively controlling traffic pollution emissions is the only way to achieve green and sustainable development of the transport industry.

Finally, differentiated environmental policies should be implemented for enterprises of different sizes and types. The impact of environmental protection tax on enterprise green technology innovation exists in the heterogeneity of enterprise scale and enterprise type. For heavily polluting non-large enterprises, while raising the environmental tax rate, fiscal R&D subsidies should be increased, and their financial pressure should be eased through green special debt and green credit policies, so as to increase their willingness and ability to innovate in green technology. For labour-intensive transport enterprises, while raising the environmental tax rate, environmental regulation should be strengthened to force them to carry out technological innovation, thereby enhancing the quality of green technological innovation.

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