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Study on the regulatory alienation effect of China's Environmental Protection Tax Law during the strict epidemic control period: based on a sample test of 1000 tax personnel

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Abstract

The enactment of the Environmental Protection Tax Law was a major event in the process of China's economic and social development. This law has achieved certain results in the first two years since enactment, but there have also been many problems. During the three-year strict pandemic control period, the normal process of Environmental Protection Tax Law implementation was impacted, causing alienation and reducing the quality of implementation. This study empirically reveals the alienation mechanism in the implementation of the Environmental Protection Tax Law by taking 1000 Chinese tax professionals, and randomly divides the sample equally into two parts, utilizing 500 samples for the initial test and another 500 samples for the robustness test. This research shows that pollutant emission monitoring (correlation coefficient is 0.07), preferential tax policies (correlation coefficient is 0.03) and the quality of tax personnel (correlation coefficient is 0.06) are not conducive to realizing the crowding-out effect of the Environmental Protection Tax Law, while preferential tax policies (correlation coefficient is 0.05), information-sharing platforms (correlation coefficient is 0.06) and the quality of tax personnel (correlation coefficient is 0.05) hinder the incentive effect, and the remaining elements passed the correlation coefficient test within certain confidence intervals. Therefore, the implementation of China's Environmental Protection Tax Law should be improved in the following ways: the accuracy of the environmental protection departments' supervision of pollutant emissions as well as the scientificity and rationality of preferential tax policies should be improved, the construction of environmental protection tax information-sharing platforms should be strengthened, and compound tax collection and management talent should be created.

Keywords Environmental Protection Tax Law, Strict pandemic control, Porter hypothesis, Crowding-out effect, Information-sharing platform

Introduction

On January 1, 2018, China's Environmental Protection Tax Law was formally enacted, marking the formal establishment of China's environmental protection tax system. Environmental protection and economic growth are the two current themes in the development of human society, and they are also two important objectives of the implementation of the Environmental Protection Tax Law. At the beginning of 2020, Chinese society suffered from COVID-19, which quickly spread around

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the world. To maximize the protection of people's lives, the Communist Party of China and the government of China took strict control measures, and by the end of 2022, to comply with the trend of the evolution of the global pandemic, strict pandemic control had ended, and the post-pandemic era began. In this special three-year period, China's economic and social development produced obvious alienation, deviating from the normal trajectory. This alienation manifested in the local government financial crisis, stagnation in many industries, an increase in unemployment, a decline in people's income, a disruption and transfer of the industrial chain, a reduction in social demand, shrinking social integrity, and turbulence in international relations. Therefore, since 2023, Chinese society has needed to gradually move past this alienating framework and rejuvenate the economy.

The Environmental Protection Tax Law was implemented in 2018, according to the normal promotion of the idea, the quality of implementation should be improved all the way. However, after the end of the control of the epidemic, there are still many problems. This paper defines this phenomenon as "alienation", that is, the implementation quality of the environmental protection tax law differs significantly from the expected goals. The implementation of the Environmental Protection Tax Law had an alienation effect during the period of strict pandemic control, but the mechanism and impact of this alienation effect are still unclear. In the wake of the normalization of China's economic and social development, to better realize the environmental protection and economy-driving functions of the Environmental Protection Tax Law, it is necessary to carry out a comprehensive analysis of the micro-mechanisms of the operation of the Environmental Protection Tax Law in this special three-year period to fully understand the alienation caused by the Environmental Protection Tax Law and to create good theoretical support for eliminating the constraints of alienation, which in turn will gradually improve the quality of Environmental Protection Tax Law implementation.

In the first 2 years after the implementation of the Environmental Protection Tax Law, certain results have been achieved, but there have also been many problems. The "Fiscal Policy Reform for Promoting Green Development in the New Era" group (2020) summarized the experience of implementing China's Environmental Protection Tax Law in the first two years and concluded that there are the following problems in the collection of the environmental protection tax in China. First, the scope of tax collection is narrow, failing to include volatile organic compounds within the scope.

Second, the tax exemption policy for sewage treatment plants is not conducive to water pollution control. Third, the levels of tax rates and preferential grades are unreasonable. Fourth, there are loopholes in the taxation system for solid waste. Fifth, there are differences in the identification of the objects of construction dust collection in different cities. Sixth, it is highly difficult to monitor pollutant emissions. Seventh, there is a lack of effective cooperation mechanisms between collection and management departments [44]. Ding noted that China's Environmental Protection Tax Law still has problems in terms of the scope of collection, tax rate setting, and tax incentives, and these problems are not conducive to the overall maintenance of public interests. Specifically, the scope of tax collection does not cover all pollutants that cause damage to the environment, the tax rate is low, the income scale is small, and preferential policies are not conducive to incentivizing enterprises to achieve more emission reductions [8]. The Beijing Municipal Taxation Bureau of the State Administration of Taxation group argued that the following problems still exist in the process of environmental protection tax collection in China. First, it is difficult to control the authenticity and accuracy of independent declarations. Second, cross-province construction project dust taxpayers are not unified. Third, there is a lack of compatibility between sewage discharge licences and the environmental protection tax. Fourth, the information-sharing mechanism between tax subjects is weak [45]. According to Wang, there are the following major problems in the tax collection and management of China's environmental protection tax. First, the tax-related information-sharing mechanism is imperfect. Second, the business quality of tax personnel needs to be improved, especially given the lack of knowledge reserves in the field of environmental protection. Third, it is difficult for tax authorities to obtain accurate information on sewage discharges, and it is difficult to include all polluters within the scope of environmental protection tax collection and management [50]. He et al. argued that the main problem facing the Environmental Protection Tax Law is the time lag of the policy, which has an inhibiting effect on the environmental governance ability of enterprises [17].

These studies were mainly conducted in the first two years after the implementation of China's Environmental Protection Tax Law, not during the three years of strict pandemic control. On the one hand, the situation indicates that before pandemic control, there were still some weak links in the implementation of China's Environmental Protection Tax Law that need to be addressed. On the other hand, the alienation mechanism of the Environmental Protection Tax Law during the

pandemic control period is still a black box and has not been revealed. Therefore, in the post-pandemic era, to give full play to the environmental regulation function of the Environmental Protection Tax Law, it is necessary to analyze in depth the alienation mechanism of the Environmental Protection Tax Law during the three years of the strict pandemic control period.

As the world attaches great importance to environmental issues, more countries have taken active measures to address environmental crises and seek coordinated economic and environmental development. As an important part of environmental regulatory policy, environmental protection taxes have become increasingly important. In a survey of South Africa, Iyke-Ofoedu et al. found that the environmental tax has a significantly greater effect on carbon emissions than does technological innovation and that the implementation of the environmental tax is conducive to realizing technological innovation [21]. Khaddage-Soboh et al. reached a similar conclusion in studies of G7 countries and reported that the implementation of environmental taxes is a key policy tool for reducing carbon emissions and achieving economic growth and environmental sustainability [27]. Strict environmental taxes can use tax rate tools to force enterprises to implement green technological innovation and achieve green transformation development, thus achieving sustainability [46]. Environmental taxes can also use incentive regulations to encourage enterprises to adopt environmental technologies rather than just using penalties to force enterprises to transform into green enterprises, which is also the basis for environmental taxes to achieve environmental goals [47]. The use of environmental taxes to achieve corporate green technological innovation and reduce the pressure on the environment brought by business activities has become an important environmental tool for Germany, France, Italy and the United Kingdom to achieve sustainable development [39]. The pressure brought by environmental crises and the difficulties due to unexpected shocks to the economy require enterprises to better comply with the environmental protection tax to maintain global sustainable development ability [1].

Existing research has verified the environmental regulatory effect of the Environmental Protection Tax Law, which plays an important role in improving the technological innovation ability of enterprises. However, there is no in-depth analysis of the crowding-out effect and incentive effect in the implementation of the Environmental Protection Tax Law, and the mechanism and influencing factors of these two effects are rarely discussed. There is no systematic analysis of whether the environmental regulatory effect of the Environmental

Protection Tax Law was effective under strict pandemic control. As enterprises faced the dual pressure of strict pandemic control and the environmental tax, the crowding-out effect and incentive effect of the existing environmental tax could not meet the needs of enterprises to carry out production and business activities. Therefore, in-depth discussion is needed to lay the foundation for the subsequent environmental regulatory effect of the environmental protection tax.

The contributions of this study are as follows. First, this study reveals the alienation mechanism of the Environmental Protection Tax Law during the period of strict pandemic control. The occurrence of this public crisis revealed the shortcomings in the implementation of China's Environmental Protection Tax Law, which means that the pandemic was not only a crisis, but also an opportunity to optimize the Environmental Protection Tax Law. By analyzing the alienation mechanism, the existing Environmental Protection Tax Law system is further optimized to better implement environmental regulation. Second, this study fills the gap in research on environmental regulation under the background of strong power. Environmental regulation makes greater use of entrepreneurs' initiative to complete environmental protection tasks, and government punishment cannot promote green technological innovation intentions. During the period of strict pandemic control, the way in which entrepreneurs obeyed strong power to change their production and operation plans can provide a reference for subsequent environmental system design. Finally, the validity of the Environmental Protection Tax Law is examined from the perspective of tax personnel. Most prior studies measured the effect of the Environmental Protection Tax Law from the perspective of entrepreneurs or the market, and fewer investigated the implementation subjects.

Literature review and design of the research model of the alienation effect

Implementation mechanism of the Environmental Protection Tax Law

Porter argued that the theory that environmental protection policies increase the production costs of enterprises and reduce their competitiveness, thus causing sluggish economic growth, was wrong. Based on this theory, the Porter hypothesis was proposed: economic entities will carry out innovation activities more actively when faced with environmental regulations to offset environmental costs and gain stronger market competitiveness and innovation benefits [41]. The Porter hypothesis considers the cost of environmental policy to be a driving force for promoting the technological innovation of enterprises and for optimizing production

efficiency in the long-term development stage, thus offsetting environmental and innovation costs. Based on the acquisition of competitive advantage, the realization of the Porter hypothesis can be divided into two categories, namely, the weak Porter hypothesis and the strong Porter hypothesis. The weak Porter hypothesis holds that enterprises realize technological innovation under environmental regulations; however, the production capacity obtained by technological innovation does not offset the extra costs that enterprises incur due to environmental regulations. Thus, the competitive advantage of enterprises is not realized. The strong Porter hypothesis holds that environmental regulation drives enterprises to realize technological innovation, and the performance increase obtained by technological innovation also offsets the cost of environmental regulation and significantly optimizes the market competitiveness of enterprises [22]. As a typical market-incentive environmental regulation, the Environmental Protection Tax Law applies the theory of the Porter hypothesis, that is, using an environmental tax to encourage the technological innovation of enterprises to achieve economic growth on the basis of environmental protection.

The collection mode of the environmental protection tax in China is "enterprise declaration, tax collection, environmental protection assistance and information sharing", and the subjects of tax collection include tax authorities and local environmental protection authorities. The collection of the environmental protection tax not only is conducive to strengthening environmental protection through modern financial and tax means, but also conforms to the general trend of changing fees and taxes around the world and improves the tax awareness of collection objects.

The concept of an environmental protection tax was first proposed by the British economist Pigou. Under the guidance of the concept of an environmental protection tax, European countries and the United States began to reduce direct government intervention in environmental protection policies, increasingly adopted a variety of taxes to maintain ecological balance, and imposed mandatory taxes on various pollutant emissions [55]. Internationally, environmental protection taxes are roughly divided into five types: carbon taxes, sulphur taxes, water pollution taxes, noise taxes, and solid waste taxes. The content of the environmental protection taxes in European countries and the United States generally includes the following. First, taxes are levied on enterprises that discharge pollutants, that is, levying taxes on wastewater, waste gas, waste residue emissions, and automobile exhaust emissions. Second, behavior involving high energy consumption and a high amount

of consumables is taxed. Third, taxes are levied to reduce the amount of natural resources extracted. Fourth, taxes are levied on polluting and destroying the urban living environment. Fifth, the behavior of polluting the rural ecological environment is taxed. Sixth, taxes are levied to prevent nuclear contamination [10]. The key to solving negative environmental externalities lies in the effective use of environmental regulatory policies. As a typical environmental policy, the Environmental Protection Tax Law is conducive to realizing the technological innovation of enterprises and reducing business risks under the background of green development [31].

Although environmental protection taxes are conducive to reducing environmental pollution and encouraging enterprises to enter the field of green development, the additional environmental cost prompts enterprises to seek more ways to reduce operating costs. Such ways include not only the active use of green technological innovation to reduce environmental taxes, but also the use of illegal activities to avoid environmental taxes [25]. As a typical environmental regulatory policy, the Environmental Protection Tax Law is a policy tool for forcing enterprises to complete green transformation and development [16]. However, whether the Environmental Protection Tax Law will achieve the expected effect is still being discussed. It is believed that while reducing pollution, environmental taxes also inhibit enterprises' investment in economic activities [43]. High environmental taxes bring more operating costs to enterprises, thus inducing them to engage in greenwashing, which is not only not conducive to the ecological environment, but also hinders the green technological innovation of enterprises [48]. Due to the long-term nature of technological innovation, high-polluting enterprises are more inclined to adopt greenwashing in the face of environmental protection taxes [20]. In the face of strict environmental policies, not only high-polluting enterprises, but also small and medium-sized enterprises tend to adopt tax avoidance strategies to reduce their operating costs. However, does the environmental protection tax actually fail to promote the technological innovation of enterprises to achieve the coordinated development of the economy and the environment? In a study of resource-based areas, Xue found that the realization of the environmental protection tax has effectively promoted the green transformation and upgrading of the industrial structure. Although it has an impact on the original industries, such negative effects are offset in long-term development and even result in green competitiveness [54]. Reasonable environmental protection taxes are the basis for promoting the ESG investment of enterprises and inducing enterprises to increase their green technological

innovation [52]. Therefore, it is necessary to evaluate the effect of the Environmental Protection Tax Law.

Under the current political, economic, and cultural systems of China, the implementation and deepening of the Environmental Protection Tax Law need to be continuously revised and improved in the following ways. First, local governments need to strengthen the implementation of the Environmental Protection Tax Law. The environmental tax system in developed regions has a history of more than 100 years, with rich experience. However, China's Environmental Protection Tax Law has just been implemented, with insufficient experience and many unknown areas. Thus, the law needs to be vigorously promoted by local governments during the implementation process [34]. Second, a reasonable tax rate should be set. China has a vast territory, and there are obvious imbalances in the economic, social, and cultural development of various regions. Therefore, the tax rate setting of the Environmental Protection Tax Law needs to be flexible and give local governments great discretion [5]. Third, the coordination between tax authorities and environmental protection departments should be improved. The collection of the Environmental Protection Tax Law is jointly undertaken by tax authorities and environmental protection departments, which is a special phenomenon in China's tax collection. Therefore, a high level of cooperation between tax authorities and environmental protection department is needed to achieve the purpose of the law [9]. Fourth, environmental protection departments need to accurately monitor the emission data of enterprises. In the collection of the Environmental Protection Tax Law, the main responsibility of environmental protection departments is to monitor the pollutant emissions of emitting enterprises and to then submit the data to the tax authorities. Therefore, monitoring by environmental protection departments is the premise of reasonable taxation [49]. Fifth, tax authorities need to make reasonable use of preferential policies. To tap the potential for enterprises to conserve energy and reduce emissions, the Environmental Protection Tax Law has formulated preferential tax policies to reward and encourage enterprises with excellent discharge treatment, which requires tax authorities to reasonably and flexibly use this policy to achieve the expected purpose of the law [18]. Sixth, it is necessary to attach importance to data integration construction. In the process of collecting environmental protection taxes, there is a large amount of data collection, transmission, filtering, and integration, including not only the official data of the government, environmental protection agencies, and tax authorities, but also the tax data of various enterprises. Therefore, it is necessary to build a data warehouse and organically

integrate these data to give full play to the data-sharing function [19]. Seventh, tax personnel should strengthen the cultivation of compound professional skills. The major difference between the collection of environmental protection taxes and other taxes is that the collector personnel have not only professional tax knowledge, but also certain knowledge of environmental protection to perform their job well. However, most tax personnel lack this compound knowledge [35]. Eighth, attention should be given to the cultivation of the tax-paying skills of tax-paying enterprises. In environmental protection tax collection, tax-paying enterprises' tax personnel also need to have compound professionalism. That is, they need to have tax knowledge and environmental protection knowledge, especially knowledge of the classification, testing, and accounting of pollutant emissions. However, in most enterprises in China, especially in small and medium-sized enterprises, such personnel are extremely scarce [36]. Ninth, the public should be guided to participate in supervision. The smooth implementation of the Environmental Protection Tax Law relies not only on the promotion of local governments, environmental protection agencies, and tax authorities, but also on the awareness and initiative of tax-paying enterprises. The supervisory role of the public should be fully brought into play to supervise not only the improper emission behaviors of tax-paying enterprises, but also the bad administrative behaviors of government departments [51].

Existing research has focused more on the environmental regulatory effect of the Environmental Protection Tax Law, but it has not studied the alienation effect of this law during the period of strict pandemic control. As a mandatory tax, the tax levied by the Environmental Protection Tax Law significantly increases the operating pressure on enterprises. It particularly did so during the period of strict pandemic control, when the externalities of green technology research and development were more significant [13], the production and operation activities of enterprises were difficult to carry out normally, and it was difficult for tax personnel to ensure the supervision of the Environmental Protection Tax Law. The reasonable control of enterprise tax payment costs and the pressure to ensure compliance costs need to be realized under the premise of determining the environmental regulatory effect of the Environmental Protection Tax Law.

Environmental regulatory effect of the Environmental Protection Tax Law

The Environmental Protection Tax Law is a typical environmental regulation characterized by command-and-control environmental regulation and market-incentive

environmental regulation. According to neoclassical economic theory, environmental regulation increases enterprises' investment in pollution control and their operating costs, thus exerting a negative impact on enterprise performance [29]. However, the Porter hypothesis proposed by Porter in the early 1990s holds that in the long run, reasonable environmental regulations can stimulate enterprises to carry out technological innovation, produce a compensation effect, and improve enterprise performance, thus achieving the dual goals of environmental protection and economic development [41]. In the Porter hypothesis, the effect is a compound effect consisting of the crowding-out effect and incentive effect.

The crowding-out effect of environmental regulation means that under the government's environmental regulation, enterprises have to increase their investment in pollution control or adopt advanced green production methods and introduce advanced cleaner production equipment, which will inevitably squeeze out the funds for technological innovation. Thus, there is a crowding-out effect on the technological innovation of enterprises. At the same time, environmental regulation makes environmental resources become economic goods. When enterprises consume environmental resources for production, they need to pay higher costs, which increases their production costs, leads to lower profits, and suppresses enterprises' motivation for innovation [11].

Under the incentive effect of environmental regulation, environmental regulation improves the public's awareness of environmental protection, reduces the information asymmetry between enterprises and individuals, and increases the public's attention to environmental protection issues. Therefore, under the supervision of the public, enterprises must increase the intensity of technological innovation. At the same time, the government's environmental regulatory policy can reduce various uncertainties in enterprises' process of technological innovation, reduce their innovation risks, and enhance their innovation awareness. Under environmental regulations, the cost of social resources increases, the cost of enterprises increases, and the survival pressure on enterprises increases accordingly, forcing enterprises to carry out technological innovation to enhance the market competitiveness of their products [59].

As an environmental regulation that has a significant impact on China's economic development and ecological protection, the Environmental Protection Tax Law also produces the Porter hypothesis effect, which includes the crowding-out effect and incentive effect. For a region, the result of the crowding-out effect is an

increase in environmental protection fiscal revenue, a reduction in the pollutant emissions of enterprises, and a strengthening of ecological environment governance, thus improving the quality of the regional ecological environment [6]. Similarly, for a region, the result of the incentive effect is an improvement in regional green technological innovation, the promotion of local economic growth, and stimulation of economic vitality, thus improving the level of regional economic development [42].

The environmental regulatory effect of the Environmental Protection Tax Law requires an incentive effect, but the crowding-out effect cannot be ignored. Existing research has mainly addressed the incentive effect, with little research exploring the crowding-out effect of environmental regulation. The incentive effect can significantly enhance green technological innovation ability [32], but the incentive effect of environmental protection taxes is not long term. Once environmental regulation cannot realize effective incentives for enterprises, they will lose the motivation to invest in research and development [61]. The crowding-out effect forces enterprises to increase their investment in technology and develop green technology under the pressure of environmental taxes, but the high environmental cost will damage the profit margin of enterprises, and they will ultimately face the dilemma of production difficulties. Existing studies show that it is difficult to accurately judge the effect of environmental regulation by simply discussing its positive or negative effects. As a complex consisting of the incentive effect and crowding-out effect, the environmental regulatory effect of the Environmental Protection Tax Law can be effectively evaluated only by discussing the two effects above at the same time.

Research model establishment

Due to the impact of three years of strict pandemic control, the normal process of implementing the Environmental Protection Tax Law was impacted. To reveal the nature of this impact, based on the analysis above, a research model of the regulatory alienation effect of the Environmental Protection Tax Law can be constructed as shown in the following two formulas. These formulas indicate the impact of the implementation mechanism of the Environmental Protection Tax Law on the crowding-out effect and incentive effect. Because the implementation process and intensity of the Environmental Protection Tax Law are different in different regions of China, it is necessary to consider the impact of the differences between the western, central, and eastern regions in the design of the research model:

Table 1 Variable characteristics

	Variable name	Symbol	Coefficient	Connotation
Main independent variables	Local government support	<i>zf</i>	β_1	Local governments vigorously promote the implementation, enforcement, and improvement of the Environmental Protection Tax Law
	Reasonable tax rate	<i>sl</i>	β_2	Setting tax rates helps to both protect the environment and promote economic development
	Collection agency coordination	<i>xt</i>	β_3	Tax departments and environmental protection departments are highly coordinated and in step with the process of taxation
	Pollution monitoring precision	<i>jj</i>	β_4	Environmental protection departments can accurately monitor and measure the pollutant emissions of enterprises
	Preferential tax fairness	<i>yh</i>	β_5	The preferential policy of environmental protection tax relief can be fairly applied to all enterprises
	Taxation information sharing	<i>xx</i>	β_6	Information on the environmental protection tax can be effectively shared by all parties
	Compound talent accomplishment	<i>fh</i>	β_7	Tax collectors have both professional tax knowledge and environmental protection knowledge
	Tax filing competence	<i>sb</i>	β_8	The environmental protection tax declaration personnel of enterprises can be competent in their work
	Social public supervision	<i>jd</i>	β_9	The public has a supervisory effect on the qualified behaviors of both sides of environmental protection tax collection
Control variables	Western region			The baseline variable does not participate in the model test
	Central region	<i>mi</i>	γ_1	This is a binary variable that takes the value of 1 when the region is Central China
	Eastern region	<i>ea</i>	γ_2	This is a binary variable that takes the value 1 when the region is Eastern China
Explained variables	Crowding-out effect	<i>JC</i>		The taxation behavior of the environmental protection tax enhances the quality of a region's ecological environment
	Incentive effect	<i>JL</i>		The taxation behavior of the environmental protection tax has increased a region's level of economic development

$$\begin{aligned}
 JC = & \beta_{01} + \beta_1zf + \beta_2sl + \beta_3xt + \beta_4jj \\
 & + \beta_5yh + \beta_6xx + \beta_7fh + \beta_8sb \\
 & + \beta_9jd + \gamma_1mi + \gamma_2ea + u_1
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 JL = & \beta_{02} + \beta_1zf + \beta_2sl + \beta_3xt + \beta_4jj \\
 & + \beta_5yh + \beta_6xx + \beta_7fh + \beta_8sb \\
 & + \beta_9jd + \gamma_1mi + \gamma_2ea + u_2
 \end{aligned} \tag{2}$$

The characteristics of variables, such as the variable name, variable symbol, variable coefficient, and variable connotation, are shown in Table 1.

Model test of the alienation effect

Sample survey

In pragmatic terms, the environmental regulatory effect of China's Environmental Protection Tax Law exists objectively, but it is difficult to measure and estimate subjectively. Among all types of economic entities, the tax personnel engaged in the collection of environmental protection taxes have the most scientific and reasonable identification and judgment of the crowding-out

effect and the incentive effect of the Environmental Protection Tax Law. At the same time, as first-line environmental protection tax collectors, these personnel's understanding of the status quo of various influencing factors is also more comprehensive and mature. Therefore, to explore the regulatory alienation mechanism of the Environmental Protection Tax Law as effectively as possible, this study adopts a 7-point scale and collects sample data from tax personnel engaged in environmental protection tax collection in China's tax departments. The question for the crowding-out effect was designed as follows: "To what extent do you think the Environmental Protection Tax Law promoted ecological environmental protection in the region during the three years of strict pandemic control? The question for the incentive effect was designed as follows: "To what extent do you think the Environmental Protection Tax Law contributed to the growth of the green economy in the region during the three years of strict pandemic control?".

Since the implementation of China's Environmental Protection Tax Law began in 2018, more relevant tax personnel have been transferred from other fields. To

better evaluate the regulatory effect of the Environmental Protection Tax Law, people with more than one year of experience were selected as objects of investigation as much as possible. The survey respondents of 1000 tax officers were selected from the dedicated departments of environmental protection tax collection to ensure the reliability of the survey data. To ensure the rationality of the sample distribution, the survey objects were selected from seven regions in China. As the scale of industry in Northeast China has declined significantly, the number of personnel in the region’s environmental protection tax collection department is relatively small; thus, the sample size for this region is reduced. Before selecting the sample selection and administering the survey, we confirmed that the respondents had experience in environmental protection tax collection through telephone calls and the

internet and explained the meaning of the questionnaire to them.

This data survey started on January 1, 2023, and ended on March 12, 2023. A total of 1213 samples were obtained nationwide, and 1000 valid samples were retained after removing questionnaires with missing items and a high repetition rate. The sample characteristics are shown in Table 2.

Research model testing

Based on data from a total of 1000 samples, this study aimed to conduct an initial model test with the data of 500 samples. Then, it conducted a robustness test with the data of the other 500 samples. Therefore, in the overall sample data, 500 samples were immediately drawn for model testing. Verifying whether there is multicollinearity between variables is the premise of model

Table 2 Sample characteristics

Attribute	Type	Sample size	Proportion%	Attribute	Type	Sample size	Proportion%
Age distribution	< =25	57	5.7	Region distribution	Central and Southern China region	156	15.6
	25 ~ 30	121	12.1		Northeastern China	80	8.0
	30 ~ 35	153	15.3		Northwest Region	152	15.2
	35 ~ 40	172	17.2		Southwest Region	152	15.2
	40 ~ 45	180	18.0		Southeast Region	150	15.0
	45 ~ 50	130	13.0		Eastern China	158	15.8
	50 ~ 55	111	11.1		North China	152	15.2
Years of practice	> =55	76	7.6	Profession distribution	Tax Administration	87	8.7
	< =5	133	13.3		Finance	77	7.7
	5 ~ 10	188	18.8		Finance and Accounting	102	10.2
	10 ~ 15	253	25.3		Business Administration	56	5.6
	15 ~ 20	289	28.9		Marketing	61	6.1
	> =20	137	13.7		E-commerce	44	4.4
	Rank distribution	Division Chief and above	16		1.6	Survey way	Industrial Engineering
Deputy Division Chief		32	3.2	Human Resource	67		6.7
Section Chief		61	6.1	Law	82		8.2
Deputy Section Chief		88	8.8	Chinese	77		7.7
Section Member		411	41.1	Foreign Language	34		3.4
Officer		386	38.6	Other	273		27.3
Other		6	0.6	Interview	44		4.4
Academic calendar	Doctor	17	1.7	Mail	82	8.2	
	Master	186	18.6	Electronic Survey	265	26.5	
	Undergraduate	392	39.2	Telephone Interview	67	6.7	
	Junior College	288	28.8	Paper Questionnaire	38	3.8	
	Secondary and High Schools	109	10.9	Mandatory Investigation	492	49.2	
	Junior High School and below	8	0.8	Other	12	1.2	

Table 3 Correlation coefficient matrix

	<i>zf</i>	<i>sl</i>	<i>xt</i>	<i>jj</i>	<i>yh</i>	<i>xx</i>	<i>fh</i>	<i>sb</i>	<i>jd</i>	<i>mi</i>	<i>ea</i>	<i>JC</i>	<i>JL</i>
Local government support (<i>zf</i>)	1.00												
Reasonable tax rate (<i>sl</i>)	0.13***	1.00											
Collection agency coordination (<i>xt</i>)	0.12***	0.00	1.00										
Pollution monitoring precise (<i>jj</i>)	0.14***	0.10**	0.16***	1.00									
Preferential tax fairness (<i>yh</i>)	0.06	0.03	0.03	0.07	1.00								
Taxation information sharing (<i>xx</i>)	0.10**	0.14***	0.10*	0.12**	0.02	1.00							
Compound talent accomplishment (<i>fh</i>)	0.08*	0.05	0.06	0.00	0.16***	0.07	1.00						
Tax filing competence (<i>sb</i>)	0.06	0.00	0.05	0.15***	0.05	0.05	0.02	1.00					
Social public supervision (<i>jd</i>)	0.15***	0.06	0.06	0.11**	0.08*	0.13***	0.00	0.06	1.00				
Central China (<i>mi</i>)	0.11*	0.00	0.03	0.04	0.09*	0.05	0.12**	0.00	0.01	1.00			
Eastern China (<i>ea</i>)	0.04	0.03	0.00	0.09*	0.11**	0.06	0.07	0.16***	0.06	0.05	1.00		
Crowding-out effect (<i>JC</i>)	0.14***	0.11*	0.13**	0.05	0.02	0.10*	0.05	0.10*	0.09*	0.12**	0.04	1.00	
Incentive effect (<i>JL</i>)	0.12**	0.10*	0.13***	0.11**	0.04	0.05	0.06	0.11*	0.09*	0.05	0.10*	0.12**	1.00

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; $N = 50$

Table 4 Test results of the research model (initial test)

Explanatory variable	Explained variable	
	Crowding-out effect (<i>JC</i>)	Incentive effect (<i>JL</i>)
<i>Main independent variables</i>		
Local government support (<i>zf</i>)	0.15***	0.13**
Reasonable tax rate (<i>sl</i>)	0.12**	0.10*
Collection agency coordination (<i>xt</i>)	0.14***	0.11*
Pollution monitoring precise (<i>jj</i>)	0.07	0.09*
Preferential tax fairness (<i>yh</i>)	0.03	0.05
Taxation information sharing (<i>xx</i>)	0.11**	0.06
Compound talent accomplishment (<i>fh</i>)	0.06	0.05
Tax filing competence (<i>sb</i>)	0.11**	0.12***
Social public supervision (<i>jd</i>)	0.08*	0.10*
<i>Controlled variable</i>		
Central China (<i>mi</i>)	0.13***	0.06
Eastern China (<i>ea</i>)	0.05	0.11**
<i>Statistic</i>		
R^2	0.69	0.72
ΔR^2	0.01	0.03
Adjusted R^2	0.70	0.75
Adjusted F value	82.19	129.19
P value	***	***

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; $N = 500$

Table 5 Test results of the research model (robustness test)

Explanatory variable	Explained variable	
	Crowding-out effect (<i>JC</i>)	Incentive effect (<i>JL</i>)
<i>Main independent variables</i>		
Local government support (<i>zf</i>)	0.13**	0.14***
Reasonable tax rate (<i>sl</i>)	0.11**	0.09*
Collection agency coordination (<i>xt</i>)	0.12**	0.10*
Pollution monitoring precise (<i>jj</i>)	0.05	0.10**
Preferential tax fairness (<i>yh</i>)	0.04	0.06
Taxation information sharing (<i>xx</i>)	0.12**	0.07
Compound talent accomplishment (<i>fh</i>)	0.08	0.06
Tax filing competence (<i>sb</i>)	0.10**	0.13***
Social public supervision (<i>jd</i>)	0.10*	0.12**
<i>Controlled variable</i>		
Central China (<i>mi</i>)	0.15***	0.04
Eastern China (<i>ea</i>)	0.06	0.12**
<i>Statistic</i>		
R^2	0.63	0.70
ΔR^2	0.02	0.01
Adjusted R^2	0.65	0.71
Adjusted F value	112.99	98.75
P value	***	***

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; $N = 500$

testing. If there is multicollinearity between variables, the results of model testing will lack credibility. This study used the correlation coefficient matrix to determine whether multicollinearity exists. If the correlation coefficient is -1 , there is a negative correlation between variables; if the correlation coefficient is 0 , there is no

correlation between variables; if the correlation coefficient is 1 , there is a positive correlation between variables. To better ensure the accuracy of the model test results, 0.25 was adopted as the standard correlation coefficient in this paper. If the value is lower than 0.25 , the correlation between variables is weak, and there is

no multicollinearity problem in the research model. The correlation coefficient matrix obtained with Stata 15.0 software is shown in Table 3. The correlation coefficient between the variables is generally low, and all values are lower than 0.25. Thus, there is no multicollinearity problem in the design of the research model.

Based on the multicollinearity test and the data of 500 samples, Stata 15.0 software was used to test the research model. The test results are shown in Table 4.

Based on the research model test, the data from the other 500 samples were utilized to conduct the robustness test. First, the correlation coefficient matrix was used to implement the multicollinearity test, and it is found that the research model does not have the problem of multicollinearity. Then, the research model test was carried out; the results of the robustness test are shown in Table 5. The robustness test results are highly consistent with the initial test results.

Based on the results of the initial test and the robustness test, the following conclusions can be drawn: (1) in terms of the crowding-out effect, the indicators of pollution monitoring precision, preferential tax fairness, and compound talent accomplishment did not pass the significance test, indicating that they did not affect the crowding-out effect. (2) In terms of the incentive effect, the indicators of preferential tax fairness, taxation information sharing, and compound talent accomplishment did not pass the significance test, indicating that they did not play a role in the incentive effect. (3) In terms of the overall environmental regulatory effect, pollution monitoring precision, preferential tax fairness, taxation information sharing, and compound talent accomplishment are not effective. (4) At the regional level, with the western region as the baseline variable, the crowding-out effect in Eastern China is not significant, while the incentive effect in Central China is not significant. Therefore, under different regional economic conditions, there are regional differences in the enforcement validity of Environmental Protection Tax Law, and different forms of environmental regulations have different effects on people and enterprises.

Discussion and policy implications

Discussion

This paper extends Porter hypothesis theory and explores the alienation mechanism of the crowding-out and incentive effects of environmental regulation in the post-pandemic era, providing theoretical support for further optimization of the environmental protection tax law. On the effects of environmental regulation on the enterprise's economic behavior [4, 30, 40] and environmental behavior [2, 23] have conducted more studies. However,

the incentive effect and crowding-out effect generated by environmental regulations are not discussed enough, and only one of them is involved [3, 14, 28], and did not discuss the alienating effect of environmental regulation in depth. Although existing studies have analyzed the various aspects of environmental regulation, including government behavior [24, 38, 53], market response [15, 33, 57], and technological change of enterprises [26, 56], but there is no in-depth analysis of the mechanism of its action, and there is a lack of discussion on how the incentive and crowding-out effects of environmental regulation work. This study highlights the mechanism of the alienation effect of environmental regulation on the crowding-out and incentive effects, and explores whether Porter hypothesis theory is still compatible with the Chinese management context after the alienation of the implementation effect of the environmental protection tax law, to provide reference for countries around the world to deal with the alienation phenomenon that exists in the process of environmental regulation.

The environmental regulatory effect of the Environmental Protection Tax Law is the key to promoting the green development of enterprises, but how to ensure the effectiveness of the environmental regulatory effect is still under discussion. Since the Environmental Protection Tax Law will force enterprises to increase their investment in the research and development of green technologies, it will significantly optimize innovation ability, but it will impose a great burden on enterprise performance [37]. Although environmental taxes can help control the amount of pollution, their crowding-out effect can hinder the financial ability of enterprises to engage in green activities [12]. There is a positive relationship between environmental taxes and economic growth, but the realization of this relationship requires a large amount of early investment by enterprises to stimulate their economic innovation ability [62]. This investment placed great financial pressure on the normal production and operation of enterprises during the period of strict pandemic control. A severe environmental situation requires governments to adopt more effective environmental regulatory policies to realize symbiosis between the economy and the environment [7]. How to find more effective environmental regulatory policies while ensuring the effectiveness of environmental regulation in emergencies [60] is a problem that needs to be solved in the wake of the COVID-19 outbreak. Whether the environmental regulatory effect of environmental protection taxes can be realized needs to be adjusted in accordance with the actual background to protect the environment, promote economic development, and avoid the occurrence of enterprises'

greenwashing behavior [58]. It is necessary to consider both the crowding-out effect of the Environmental Protection Tax Law and the incentive effect to more accurately judge the environmental regulatory effect of this law and then complete regulatory optimization.

The Environmental Protection Tax Law is an important policy tool for realizing environmental regulation, and it can provide policy support for enterprises to implement technological innovation strategies. However, the alienation effect of this law exposed during the period of strict pandemic control shows that the existing environmental protection tax is not well adapted to economic development. The implementation of the environmental protection tax law needs to be reformed to adapt to new economic and social development trend. Therefore, from the perspective of tax personnel, this paper studies the alienation mechanism of the Environmental Protection Tax Law to provide theoretical support for optimizing environmental regulations under the background of economic normalization in the post-pandemic era. Meanwhile, based on China's practical experience, this study provides a reference for countries worldwide to alleviate environmental pressure, promote the green technological innovation of enterprises, and optimize the global ecological environment.

According to the test results, local government support passed the significance test for both the crowding-out effect (correlation coefficient 0.15, $P < 0.001$) and the incentive effect (correlation coefficient 0.13, $P < 0.01$). These results indicate that even in the context of strict pandemic control, local governments were equally concerned with the implementation of the Environmental Protection Tax Law, especially after the establishment of the dual-carbon goal and after the local ecological environment became an important indicator of the government's management level. Therefore, local governments are more willing to strengthen environmental regulation to safeguard the co-development of the local economy and the environment. However, in the future, it is necessary for the government to supervise the implementation of the environmental protection tax law in accordance with the real conditions. Government support does not really guarantee the realization of the environmental regulation effect, but requires comprehensive supervision. A reasonable tax rate passes the significance test for both the crowding-out effect (correlation coefficient 0.12, $P < 0.01$) and the incentive effect (correlation coefficient 0.10, $P < 0.05$). These results indicate that the existing Environmental Protection Tax Law gives local governments a high degree of discretion in the tax rate design process. Due to economic imbalances and ecological differences, the economic conditions

of different regions require that the government's environmental policy be tailored to local conditions to better determine the environmental tax rate. However, this flexibility will bring opportunistic behavior, so the implementation process of environmental protection tax law needs to further strengthen information disclosure to avoid public tragedy.

Collection agency coordination passes the significance test for both the crowding-out effect (correlation coefficient 0.14, $P < 0.001$) and the incentive effect (correlation coefficient 0.11, $P < 0.05$). These results indicate that various administrative subjects can cooperate in the process of tax collection. The efficiency of good government management can guarantee the implementation of administrative orders, thus guaranteeing the smooth implementation of policies. Because the implementation of the environmental protection tax law involves many administrative departments, the cooperation dilemma arises when the participants with interests prefer to obtain a tax law that is more favorable to them. Therefore, coordination is an important part of maintaining environmental protection tax laws. Tax filing competence passed the significance test for both the crowding-out effect (correlation coefficient 0.11, $P < 0.01$) and the incentive effect (correlation coefficient 0.12, $P < 0.001$). These results indicate that corporate taxpayers already have a clear understanding of the Environmental Protection Tax Law, which can ensure a smooth tax payment process. This also means that enterprises generally accept the environmental protection tax and make adjustments in the course of business operations to meet the requirements of environmental regulations. Attention still needs to be paid to the fact that this link is a key link in the emergence of opportunistic behavior and that the concept of the rule of law needs to be strengthened among taxpayers. Social public supervision passed the significance test for both the crowding-out effect (correlation coefficient 0.08, $P < 0.05$) and the incentive effect (correlation coefficient 0.10, $P < 0.05$). These results indicate that public participation has become an important force in ensuring the implementation of the Environmental Protection Tax Law. Different from the rights and interests of other supervisory agencies, the public is more sensitive to the environmental behaviors of enterprises and more active in supervising illegal behaviors. This situation shows that environmental awareness has been deeply embedded in people's minds and that the national ecological supervision system has been completed. In the subsequent optimization of the environmental protection tax law, the role of public supervision should be strengthened, and the enthusiasm of the public to participate in supervision

should be enhanced while shaping the public's concept of environmental protection.

Pollution monitoring precision did not pass the significance test for the crowding-out effect (correlation coefficient 0.07), but passed the significance test for the incentive effect (correlation coefficient 0.09, $P < 0.05$). The reason is that the existing monitoring technology is not as accurate as expected. Effective monitoring more accurately measures corporate environmental behavior, thus reducing the tax ratio of enterprises and ensuring that funds are available for enterprise technological innovation to a certain extent. The breakthroughs obtained by technological innovation will reversely compensate for the R&D investment of enterprises. Precise monitoring means that companies are under more comprehensive supervision; thus, they must take steps towards green production or face penalties. The test results show that although the current pollution monitoring technology has made some progress, it still cannot meet the expected requirements. Not only are there deficiencies at the technical level, but there are also problems at the operational level, which also contribute to the alienation of environmental regulation due to the fact that the quality of the personnel involved is not sufficient to fulfill the requirements of accurate monitoring technology. The reason preferential tax fairness fails to pass the significance test for the crowding-out effect (correlation coefficient 0.03) and the incentive effect (correlation coefficient 0.05) is that enterprises perceive the unfairness of the government's preferential tax policies. Thus, the government's policies lose credibility, and enterprises have doubts about the authority of the Environmental Protection Tax Law. Therefore, enterprises will take a negative attitude towards dealing with the Environmental Protection Tax Law, causing the technological innovation of enterprises to lag. Not only has it brought a crisis to business innovation, it has also a devastating impact on the overall business environment. When government credibility is lacking, systemic social risks arise. Taxation information sharing passed the significance test for the crowding-out effect (correlation coefficient 0.11, $P < 0.01$) but failed to do so for the incentive effect (correlation coefficient 0.06). These results indicate that the construction of a tax information-sharing platform has not met the expected requirements. The establishment of an information-sharing platform can not only overcome the communication barriers between tax departments and enterprises, but also optimize the communication between government departments, between the government and enterprises, and even between enterprises to ensure the authority of tax payment. The imperfect construction of the platform has

created communication barriers between agencies and damaged the ability of the Environmental Protection Tax Law to fulfill its regulatory function. Compound talent accomplishment failed to pass the significance test for the crowding-out effect (correlation coefficient 0.06) and the incentive effect (correlation coefficient 0.05). These results indicate that existing taxpayer quality cannot meet the requirements of the Environmental Protection Tax Law. The lack of legal knowledge is more likely to produce speculative behavior, in order to seek private interests to hide the environmental behavior of enterprises, not only conducive to the implementation of environmental protection tax law, but also to the commercial ecology. Different from the traditional tax payment business, the implementation of the environmental protection tax combines the dual functions of environmental protection and tax punishment. Under strict pandemic control, it was difficult for enterprises and government departments to complete the training of taxpayers, resulting in deviation in the cognition of the taxpayers of most enterprises in regard to environmental protection taxes, which is not conducive to realizing the regulatory effect of the Environmental Protection Tax Law.

According to the model test results, during the period of strict pandemic control, the implementation of the Environmental Protection Tax Law exerted a positive effect. However, there were also many loopholes that caused this law to produce an alienation effect, which not only damaged the early environmental protection results, but also hampered follow-up work. To better adapt to the requirements of economic and social development under the economic normal, it is necessary to improve the Environmental Protection Tax Law to give full play to the environmental regulatory effect and optimize the green technological innovation ability of enterprises.

Policy implications

According to the results of the research model test, during the three years of strict pandemic control, the implementation effect of China's Environmental Protection Tax Law still existed. However, the implementation quality did not improve, and some implementation problems before strict pandemic control were not effectively solved. In fact, there were signs of aggravation. To give full play to the environmental regulatory effect of the Environmental Protection Tax Law, priority should be given to improvements in the following aspects:

First, environmental protection authorities should continue to improve the accuracy of pollutant emission monitoring. According to the test results, the failure of environmental protection departments' sewage monitoring to produce the crowding-out effect shows

that the lack of accuracy of pollution monitoring not only reduces the trust of enterprises, but also raises the alarm of tax departments. On the one hand, environmental protection departments should increase their investment in environmental monitoring equipment and introduce more advanced monitoring equipment to improve the real-time reliability of pollutant discharge monitoring. On the other hand, they should also improve the responsibility of monitoring personnel, overcome bureaucracy, and put an end to perfunctory work. At the same time, environmental protection departments need to strengthen communication with enterprises on the monitoring data confirmation and strengthen coordination with tax authorities on monitoring data transmission to minimize deviations in monitoring data.

Second, preferential tax policies should be made more scientific and rational. According to the test results, the preferential policies of the environmental protection tax not only fail to produce the crowding-out effect, but also fail to produce the incentive effect, indicating that there are still many problems in the implementation of preferential policies. Therefore, the experience of the United States and the Netherlands could help local governments increase their discretion in the selection and implementation of preferential tax policies. The experience of OECD countries could also be used to classify taxpayers and formulate different preferential policies for different types of tax-paying enterprises. China's Environmental Protection Tax Law currently lists only a limited number of tax incentives, despite the increase in sewage charges over the past. However, the preferential strength of some energy savings and emission reductions of more outstanding enterprises is not large enough. Preferential policies should take a comprehensive form, and efforts should be made to continue to improve the preferential strength of high-quality environmental protection enterprises. At the same time, tax authorities should listen to the feedback of tax-paying enterprises on the implementation of preferential policies, reflect on the shortcomings in the implementation of such policies, and avoid listening to biased beliefs and taking dogmatic actions.

Third, the construction of environmental protection tax information-sharing platforms should be strengthened to improve coordination between all sides. According to the test results, the failure of information sharing to produce the incentive effect indicates not only the failure to achieve effective information sharing between tax agencies and environmental protection agencies, but also the failure to achieve effective information sharing between tax agencies, environmental protection agencies and tax-paying enterprises, which is very detrimental to realizing the functions of the environmental protection

tax. Local governments have supported the construction of information-sharing platforms, which should continue to be vigorously promoted after in the wake of strict pandemic control. Tax agencies and environmental agencies should take the initiative in the construction of information-sharing platforms, vigorously participate in them, and actively seek directions for breakthroughs rather than staying out of the way. At the same time, local governments, environmental protection agencies, and tax agencies should communicate with tax-paying enterprises, understand their information needs, and create as much convenience as possible for their tax-paying behavior.

Fourth, the business quality of tax collectors should be improved, and composite tax personnel should be actively created. According to the test results, due to the lack of professional complexity of tax personnel, there is no obvious crowding-out effect or incentive effect, which hinders improving the quality of tax collection and achieving the goals of tax collection. In the current situation, tax departments should actively carry out primary environmental knowledge training for tax personnel, resume the training business from before the period of strict pandemic control, and continue to implement face-to-face teaching as much as possible so that the effect of the training can be improved more quickly. On the other hand, tax personnel also need to consciously strengthen their knowledge of environmental protection, especially by deepening their knowledge of environmental protection in terms of sewage monitoring and constantly improving their compound professionalism.

Limitations and future prospects

This paper takes 1000 tax personnel as samples for empirical testing and takes the crowding-out effect and the incentive effect of the Environmental Protection Tax Law as the dependent variables of the regulatory effect research model to explore the alienation mechanism of the Environmental Protection Tax Law under strict pandemic control. However, limited to the research horizon, this paper has the following limitations. (1) There is a lack of comparisons of the effects of environmental regulation between the period of strict pandemic control and the post-pandemic era. With the end of China's strict pandemic control, the implementation of the Environmental Protection Tax Law has also entered a new stage. It is necessary to conduct a comparative analysis of the Environmental Protection Tax Law in different periods to determine more accurate optimization strategies. (2) There is a lack of comparative analysis of international regions. Compared with the environmental protection regulations

of other countries, China's Environmental Protection Tax Law was introduced later, and after alienation under strict pandemic control, this law has many deficiencies. Therefore, deficiencies can be identified and addressed through comparative analysis with mature international environmental regulations.

Future research will focus on the collection of data on the implementation of the Environmental Protection Tax Law in the post-pandemic era to determine the differences in the environmental regulation of this law under different periods, improve the adaptive ability of this law to cope with crises through comparative analyses, and better utilize its regulatory effect. According to the research results, the regulatory effect of environmental protection taxes under strict pandemic control had a strong alienation effect. Therefore, it is necessary to continuously optimize the Environmental Protection Tax Law system to make it more adaptable to the conditions of social and economic development, to better exert the effect of environmental regulation and to promote the development of the green technological innovation ability of enterprises.

Author contributions

CMJ wrote the main manuscript text. ZJY responsible for study design. All authors reviewed the manuscript.

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Study data will be made available upon request.

Declarations

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The authors declare no competing interests.

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