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Does the Double Dividend of Environmental Tax Really Play a Role in OECD Countries? A Study Based on the Panel ARDL Model

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Abstract

Based on the Panel ARDL model, this paper reports the economic and environmental performance of environmental tax levied in 36 countries of OECD from 1994 to 2014. According to the double dividend theory of environmental tax, the following six variables are selected to establish the Panel ARDL model: environmental tax, GDP, unemployment rate, greenhouse gas emissions, nitrogen oxides emissions and sulfur oxides emissions. After a series of econometric methods such as unit root test, cointegration test and Granger causality test, the conclusion is as followed. It is found that there is a long-term cointegration relationship between the environmental tax and the other five variables. We can also conclude that the environmental tax significantly reduces nitrogen oxides emissions in the long run, while it also significantly reduces sulfur oxides emissions in the short run, then from this perspective, the green dividend effect is obvious. But in fact, we cannot prove that environmental taxes have a significant positive effect on reducing greenhouse gas emissions. In addition, we have confirmed that for 36 countries of OECD, environmental taxes can achieve the blue dividend of economic growth, but there is no evidence that environmental taxes have a positive effect on reducing unemployment.

Keywords: panel-ARDL, environmental tax, double dividend, OECD countries

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INTRODUCTION

Environmental tax is an economic concept that emerged in the late 19th century. It originated from the welfare economics proposed by the economist Marshall in the 1920s. After World War II, the world's major capitalist countries, led by the United States and Japan, embarked on the path of rapid revival. However, with the rapid development of economy, environmental problems are becoming more and more serious, which has seriously affected the comprehensive development of social economy. In this context, environmental taxes came into being. On the basis of Marshall's study, Pigou, the British economist, put forward the theory of "externalization of internal cost", and he also advocated that the government should control pollution with the use of tax. In this sense, he is indeed the pioneer of environmental tax. OECD defines environmental tax as a price tool of broader tax collection basis aimed at reducing environmental pollution, which is the main pillar of green development policy. It is believed that the environmental tax can provide incentives for long-term and effective development, green innovation investment and consumption mode transformation.

The development of environmental tax in OECD countries has gone through three stages. The first stage: from the 1970s to the early 1980s. In 1972, the OECD proposed the polluter pays principle, requiring the polluters to assume the cost of regulating and monitoring emissions and then internalize external costs. The second stage: from 1980s to the middle of 1990s. During this period, more and more OECD countries have adopted some taxes such as pollution tax, product tax and energy tax to protect the ecological environment and guide people's consumption behavior. The third stage: since the mid-1990s.In this period, the environmental tax policy of OECD countries has developed further. From scattered and individual

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environmental taxes, it has gradually developed into an environmental tax system. In addition to increasing various environmental taxes, the original tax has been adjusted to have the function of environmental protection, so as to achieve the goal of a comprehensive environmental tax system. Nowadays, many OECD countries have established the environmental tax system generally, at the time, the environmental tax has become the main means of environmental policy in many countries. From the perspective of the conventional composition of OECD environmental tax revenue, it mainly includes the following five aspects: (1) Energy tax. It is the leading source of environmental tax revenue for OECD countries, mainly from transportation, heating, industrial, and power generation. For example, diesel tax in the United States, mineral oil tax and electricity tax in Britain, etc. (2) Transportation tax (motor vehicles and vessel tax). It is the second largest component of the OECD's environmental tax, mainly from taxes on transportation, such as the vehicle tax and airplane tax in Germany, Vehicle acquisition tax in Japan. (3) Pollution tax. It is mainly composed of taxes on waste water, waste gas and garbage produced by industry, agriculture and so on, such as Levies on water pollution in Netherlands, tax on wastes in Sweden and the carbon tax in Ireland. (4) Others. It refers to the tax on other products and services. Such as the charges for groundwater extraction in Netherlands and Natural gravel tax in Sweden and so on. (5) Environmental measures in direct tax. According to the characteristics of direct tax, various incentive measures are designed to improve the environment and curb pollution.

In the early days, the welfare economists, represented by Pigou, mainly focused on the correction of environmental tax on negative externalities, ignoring the recycle of the environmental revenue. As people pay more attention to environmental problems, the study on environmental tax is becoming deeper and deeper. Some scholars in OECD countries, such as Bovenberg and De Mooij (1994), point out that the existence of double dividend depends on the relative size of the revenue recycling effect (RRE) and the relative size of the tax interaction effect (TIE). These scholars not only affirmed the effect of environmental tax on improving environmental quality, but also conducted a further study on the double dividend hypothesis of environmental tax by considering the recycling of environmental tax revenue. According to the double dividend theory, OECD countries have carried out environmental tax reforms in the 1990s, and the reforms have achieved remarkable results. However, whether the double dividend hypothesis has been realized has yet to be verified.

Therefore, the purpose of this paper is to explore the relationship between environmental tax (ET), gross domestic product (GDP), unemployment rate (UNE), greenhouse gas emission (GHE), nitrogen oxide emission (NOE) and sulfur oxide emission (SOE) in 36 countries and regions of OECD, and then analyze whether the environmental tax reform in OECD countries has realized the double dividend hypothesis. The study findings are as follows: First, there is a long-term relationship between environmental tax and economic growth. In the long run, the implementation of the environmental tax has significantly promoted economic growth. Secondly, there is a long-term relationship between environmental tax and unemployment rate, but the correlation between the two is positive, which shows that environmental tax does not play a role in reducing the unemployment rate. So the blue dividend is not fully realized. Third, there is a long-term relationship between environmental tax and greenhouse gas emissions, but environmental tax has not played a significant role in reducing greenhouse gas emissions. Green dividends have also not been fully realized. Therefore, it is reasonable to believe that the double dividend of the environmental tax studied in this paper has not been fully realized. The structure of this paper contains five parts. The first part is the introduction, the second part is the literature review, the third part is theoretical basis and model framework, the fourth part is the analysis of the experimental process, and the last part is the conclusion.

LITERATURE REVIEW

The double dividend effect of environmental tax can be understood in the following two ways:

First, the tax on the behavior of pollution can increase the cost of the polluter, inhibit or reduce the behavior of the polluter in production or consumption, promote environmental protection, and help to improve the environment, this is what we call "green dividend". Second, environmental tax reform can increase output, promote employment and improve economic efficiency, this is what we call "blue dividend". Pigou (1920) was the first one to propose to reduce environmental pollution by using tax. He proposed that one of the methods to control pollution is to levy taxes on polluters based on the degree of pollution, which can further inhibit pollution. Amundsen (1999) has pointed out in his study that the

Pigou tax is the best choice for small countries. Due to the differences of tax systems in various countries, the implementation effect of environmental tax is also very different. Economists generally believe that environmental tax can reduce the damage to the environment. Many economists have conducted literature integration studies on existing study in order to obtain stronger evidence of whether the environmental tax has a double dividend. Bosquet (2000) integrates 56 studies on double dividend of environmental tax before April 2000, extracts 139 variables from them and distinguished macroeconomic models from CGE models. It is found that environmental tax can improve the environment and there is a green dividend. And from the perspective of "blue dividend", for employment, 73% of studies believe that environmental tax can promote employment, while using macroeconomic models have more positive results than CGE models. For economic growth, about 49% of studies using macroeconomic models believe that environmental tax has a positive effect on economic growth, compared with 58% in CGE models. Patuelli et al. (2005) integrates 61 studies on double dividend of environmental tax during 1992-2000, and carries out the study on the variables used by them. His study distinguishes different periods and regions, and carries out multivariate analysis from CGE model and macro-economic model respectively. The results show that the green dividend of environmental tax is more significant than blue dividend. And when the implementation of environmental tax is combined with the reduction of social security contributions, it will have a positive effect on employment, but the impact on economic growth is not obvious. Jaume (2018) integrates 40 studies related to the effects of environmental tax from 1993 to 2016, and selects 69 variables to carry out his study. Finally, the study shows that about 44.9% of the studies believes that environmental tax has an improvement effect on the environment, which is also the main effect of the implementation of environmental tax. And 55.1% of the studies believes that the blue dividend effect of environmental tax is not obvious.

In recent years, more and more attention has been paid to environmental problems. Many countries have implemented environmental tax to reduce pollution, hoping to achieve the goals of the Kyoto Protocol. In particular, some European countries have introduced various environmental taxes, and recycle environmental tax revenue by reducing the individual income tax or social security contributions. Some people believe that environmental tax is an effective way to solve the problems of carbon emission and energy consumption. The double dividend hypothesis also suggests that environmental tax can reduce environmental pollution by raising private cost. Meanwhile, with the increase of income, environmental tax can reduce some direct tax and reduce people's burden. Many studies also support the double dividend effect of environmental tax. For example, Barker et al. (1993) carries out study on the UK's carbon tax/energy tax, and focuses on the power industry to explore the impact of this tax on carbon emissions, economic growth, industrial structure and energy consumption. This study conducts comparative analysis on some existing studies, it is found that the carbon tax/energy tax in the UK can not only reduce carbon dioxide emissions, but also produce good macroeconomic consequences, and then, increase GDP. So, there's a double dividend. However, from the perspective of tax shifting and tax neutrality, it is still necessary to discuss whether there will be inflation. Bossier and Bréchet (1995) conducts a study on the whole of Germany, France, Britain, Italy, Netherlands, Belgium and the above six countries, by using the HERMES model. The study confirms the existence of the double dividend, and also proposes that when the environmental tax is combined with the reduction of social security contributions, the labor cost can be reduced, and the enterprise may replace other production factors with the labor factor, thereby stimulating employment. Takedaa (2007) uses a multi-sectoral dynamic CGE model to study economic data, carbon source data, and various tax data for 27 sectors in Japan. This study selects 1995 as the base year and divides the double dividend into two categories: "strong" and "weak". The results show that the double dividend of Japan's carbon emission control mechanism is weak. Furthermore, since Japan's carbon emission control mechanism can lead to a reduction in capital tax, a strong double dividend also exists. Fraser and Waschik (2013) conducts a study of Australia using the general equilibrium model and the GTAP-EG model. The study results show that Australia has a double dividend effect. In Australia, the environment tax is levied by reducing the consumption tax. With the increase of emission reduction, the increase in carbon taxes has led to higher levels of welfare. Rivera et al. (2016) conducts a study of Mexico from the perspective of economics using the Three-ME model. It is found that there is a double dividend in Mexico. He also believes that the carbon tax will promote the low emission development of Mexico's economy, and at the same time, a higher

level of social welfare can be achieved through a proper carbon tax income distribution policy.

In addition, there are many studies that hold a query or even a negative attitude towards the existence of double dividends. Carraro et al. (1996) conducts a study of data from 12 EU countries during the period 1978-1989.In this study, the WARM model is used to establish regression equations for production, household, government, and foreign agencies. The results show that the double dividend exists only in the short term, and in the long term, it will not only lead to the disappearance of "employment dividend", but also lead to the gradual weakening or even disappearance of green dividend due to the change of energy demand structure. Rapanos and Polemis (2005) studies the energy tax on Greece. The result shows that the total amount of carbon dioxide emissions will increase by 6% every year when the energy tax is in line with the EU average. Only when the environmental tax is raised to the highest level of the European Union can it be able to limit the carbon dioxide emissions and produce a green dividend. He also points out that the environmental tax can not be the only tool to prevent pollution. Glomm et al. (2008) uses the United States as the research object and expresses the environmental tax by fuel tax. After the definition of the function of each economic variable, the Newton-Raphson method is used to obtain the steady state, and then the dynamic general equilibrium model is used for the study. The result shows that, on the economic side, environmental tax can reduce the deadweight loss caused by the existence of capital tax, thus producing a blue dividend. Although the green dividend exists theoretically, it will become very small in the context of the reality of the United States, when considering the expenditures that the family is willing to pay for environmental quality. Lin and Li (2011) uses the DID difference method to study certain European countries. The results show that the carbon tax in Finland has a significant negative impact on the growth of carbon dioxide emissions per capita. But in Norway, carbon tax does not actually achieve the effect of reducing the emission. Ekins et al. (2011) studies the environmental tax reform in the UK by using the mdm-e3 model. This study selects 7 specific scenarios and distinguishes the "strong" and "weak" double dividends. It is found that environmental taxes can reduce greenhouse gas emissions and greatly increase employment, but the impact on economic output is small, so the support for double dividends is insufficient. Ciaschini et al. (2012) believes that environmental tax is usually an effective means of controlling pollution. Using the tax model, it is found that there is a green dividend in the entire Italian economy, but the blue dividend exists only in the northern central city and the southern peninsula. Orlov et al. (2013) finds that Russia's environmental tax has reduced the demand for imported energy to a certain extent, which has led to a reduction in carbon dioxide emissions. However, it is worth noting that only when capital does not have international liquidity will there be a double dividend, otherwise, it will cause welfare losses. The study by Danuše Nerudová and Dobranschi (2014) finds that for 15 EU countries, the environmental tax has increased energy consumption, and the green dividend is negative, which means that environmental tax has a negative effect on environmental protection. Abdullah (2014) conducts a study of the EU and OECD countries, and it is found that the increase in environmental tax does not seem to have any substantial impact on the economy. In addition, the increase in environmental tax has not affected the goal of reducing emissions in various countries. Therefore, environmental taxes and the use of related renewable energy should continue to be implemented, but these actions must be linked to economic development, which is essential for the transition economies to improve their environment. For example, in some OECD countries, taxes on motor fuels and electric vehicles are used to build or maintain roads and other activities, such as installing soundproof walls, developing bicycle lanes, and improving public transportation. The study of Oueslati (2014) finds that no matter how the environmental tax system reform, its short-term welfare effect is negative, and the existence of its long-term welfare effect depends on the adjustment of capital. Arbolino (2014) finds that environmental taxes have a positive effect on environment through the comparative study of the effects of environmental taxes before and after implementation, but the effect on the improvement of unemployment rate is not obvious, showing a negative effect. Radulescu (2017) finds that the double dividend of environmental taxes does not exist neither in the EU nor Romania. The blue dividend of the study is represented by economic growth and unemployment rate. The green dividend is expressed by greenhouse gas emissions. And in his study, the VECM model and the OLS regression method are used to explore the double dividend of environmental tax. The results prove that the environmental tax has only a green dividend for Romania, which can reduce greenhouse gas emissions, and there is a negative correlation between GDP and environmental tax; due to the great differences in

environmental tax among various EU countries, environmental tax has a certain effect on the improvement of the environment and economic growth, but there is no blue dividend in achieving the employment rate. Mardones (2018) conducts a study on Brazil, Mexico and Chile, and his findings are similar to those of Rapanos and Polemis (2005). He further points out that even if the environmental tax is determined to be the highest rate, the role of environmental tax will be weakened if no other measures are supplemented to help reduce CO_2 emissions.

In addition, obsolete technology and low energy costs are also the causes of carbon dioxide emissions, and the capital invested in production equipment has evolved into sunk costs, which has also hindered technological progress. Orlov et al. (2013) points out that in the short and medium term, environmental tax can reduce the emissions of carbon dioxide and other greenhouse gases and encourage the adjustment of existing capital equipment. In the long run, environmental tax will accelerate the promotion of more energy-saving technologies and stimulate technological progress. Gemechu (2012) points out that it will greatly affect agriculture, coal mining, soybean oil production and food industry if the environmental tax is imposed on no carbon dioxide greenhouse gases instead of taxing carbon dioxide separately.

The methods and results are summarized in **Table 1**.

It can be seen from **Table 1** that the existing studies on double dividend of environmental tax mainly focus on the relationship between CO_2 emissions, economic growth and unemployment rate, and the models commonly used are macroeconomics model, CGE model or time series analysis model.

The marginal contributions of this paper can be summarized as follows: Firstly, this paper quotes two special indexes, that is, the proportion of nitrogen oxides to GDP and the proportion of sulfur oxides to GDP, which can more fully reflect the degree of environmental pollution. However, most previous studies only take carbon dioxide emissions as the measurement index of green dividend, which is rather one-sided. Therefore, the variable selection in this paper can make up for the shortcomings of previous studies to a certain extent; Secondly, the model used in this paper is panel ARDL, which is more suitable for the study of Multi Country and multi variable in a long time period. Research on the policy consequences of environmental taxes based on panel ARDL model is relatively rare at present.

THEORETICAL BASIS AND MODEL FRAMEWORK

Double Dividend Theory

The double dividend theory of environmental tax was formally proposed by Pearce (1991) when studying the carbon tax reform. Its basic connotation includes two dividends as followed: The first dividend is that the environmental tax can effectively reduce the emission of pollutants, thus improving the environmental quality that is what we call “green dividend”. The second dividend is that the increase of environmental tax revenue can reduce the burden of distorting taxes, such as income tax and capital tax through the tax shifting, then promote employment and improve the efficiency of economic growth that is what we call “blue dividend”.

The proposal of the double dividend theory has aroused the extensive debate in academic. With the deepening exploration and study of the hypothesis by scholars such as DE Mooij (1994), Goulder (1995) and Bovenberg (1999), the double dividend hypothesis of environmental tax has also been further developed. The double dividend theory of environmental tax can be roughly explained as follows: First, the “weak double dividend theory”, which refers to the use of environmental tax revenue to reduce the original distorted tax revenue burden, which is conducive to stimulating labor and capital investment, thus promoting economic benefit growth; Second, the “strong double dividend theory”, that is, the environmental tax reform can improve the efficiency of the current tax system while realizing the environmental benefits, thus improving the social welfare level. Third, the “double dividend theory of employment”, which means that environmental tax reform can not only improve the quality of the environment, but also promote the growth of employment.

Environmental tax is an economic means to internalize the social cost of environmental pollution and ecological destruction into production cost and market price, and then distribute environmental resources through market mechanism. It is mainly to levy taxes on direct pollutants and some products that may produce pollution, the former includes carbon tax, sulfur tax, sewage treatment tax, garbage tax and so on. The latter includes tax on coal, oil, energy and automobiles. In theory, using tax tools to internalize the

Table 1. Summary of methods and conclusions of some studies on double dividend

Author	Period	Object	Variables	Methods	Conclusion
Bosquet B	2000	139 variables from 56 studies on double dividend of environmental tax before April 2000	CO_2 emissions, employment, economic growth	Integration, summary and contrast	There is a green dividend; 73% of the studies believe that there is a double dividend for employment;49% of studies using macroeconomic models believe that there is a blue dividend for economic, compared with 58 percent in general economic models.
Patuelli R, Nijkamp P, Pels E	2005	variables from 61 studies on double dividend of environmental tax during 1992-2000	CO_2 emissions, employment	Comparison of CGE model and Macroeconomic model	There is a green dividend and a blue dividend for employment, but the effect on economic growth is not obvious.
Jaume Freire-González	2018	69 variables from 40 studies on double dividend of environmental tax during 1993-2016	CO_2 emissions, economic growth	CGE model	44.9% of the studies believe that double dividend has not been realized, and 55.1% of the studies believe that there is a double dividend.
Barker T, Baylis S, Madsen P	1993	electric power industry in UK	CO_2 emissions, economic growth, Industrial structure, energy consumption	Comparison and analysis of multiple models	There is a double dividend, but the effect of inflation also needs to be considered.
Bossier F, Bréchet T	1995	Germany, France, Britain, Italy, the Netherlands, Belgium and the whole formed by the above six countries	employment	Combination of simple incremental contrast and HERMES model	there is a blue dividend for employment.
Takedaa S	2007	Japan	economic data, carbon emission data, various tax data	Multi sector dynamic CGE model	Both weak and even strong dividends exist.
Iain Fraser	2013	Australia	CO_2 emissions, output, import and export trade, welfare level	CGE model, GTAP-EGmodel	There is a double dividend.
Gissela LandaRivera	2016	Mexico	CO_2 emissions, economic growth	Three-ME model	There is a double dividend.
Carraro C, Galeotti M, Gallo M	1996	12 countries of EU	employment, energy consumption demand, CO_2 emissions	WARM model	There is a short-term double dividend, and the long-term green dividend disappears.
Vassilis T. Rapanos	2005	Energy tax in Greece	CO_2 emissions, energy consumption, economic growth	Single equation model, cointegration test, error correction model	When the environmental tax rate is raised to the highest level in the European Union, carbon dioxide emissions can be curbed and there is a green dividend.
Glomm G, Kawaguchi D, Sepulveda F	2008	The US	fuel tax, environmental quality, economic growth, social welfare	dynamic CGE model	There is a blue dividend, and the green dividend will gradually disappear due to family factors.
Boqiang Lin, Xuehui Li	2011	Denmark, Finland, Sweden, Holland, Norway and other European countries.	CO_2 emissions, per capita GDP, energy consumption, industrial structure	DID difference method	There is a negative green dividend in Finland, and there is no green dividend in Norway.
Ekins P, Summerton P, Thoung C	2011	The UK	economic growth, CO_2 emissions, employment, etc.	MDM-E3 model	There is a green dividend, but it has little impact on the economy, and the blue dividend is not obvious.
Maurizio Ciaschini	2012	Italy	economic growth, price level, employment rate, output level, CO_2 emissions	bi-regional CGE model	There is a green dividend in the entire Italy, but the blue dividend exists only in the northern central city and the southern peninsula.
Anton Orlov	2013	Russia	CO_2 emission, production level, import energy demand	STAGE model	When capital does not have international liquidity, there is a double dividend; otherwise, it will cause welfare losses.
Danuše Nerudová	2014	15 countries of EU	Income tax, energy consumption, production and consumption	Granger causality test	The green dividend is negative, aggravating environmental pollution.
Sabah Abdullah	2014	EU and OECD countries	economic growth, the proportion of various taxes, the level of environmental pollution	Granger causality test, panel cointegration test	There is no green dividend.
Walid Oueslati	2014	Some cases of environmental tax reform	economic growth, welfare level	Endogenous growth model	There is no double dividend in the short term.
Arbolino R	2014	26 European countries	environmental quality level, employment rate, innovation ability	Comparative analysis, hierarchical cluster analysis, quantitative SWOT analysis	There is a green dividend, but the blue dividend for employment does not exist.
Magdalena Radulescu, Crenguta Ileana Sinisi	2017	Romania and EU	economic growth, unemployment rate, greenhouse gas emissions	Johansen cointegration test, VECM model, OLS regression	Neither Romania nor the EU has a double dividend.
Cristian Mardones	2018	Brazil, Mexico and Chile	CO_2 emissions, CPI, power generation	Leontief pricing model	When the environmental tax rate reaches the highest, there is a green dividend. But without other support measures, the green dividend will weaken

negative external cost requires that the optimal level of environmental tax designed should be equal to the marginal cost of damage caused by pollution, and the marginal cost of damage in practice is almost impossible to accurately determine. As a result, the OECD (1972) proposed the "polluter pays principle" by partially adjusting the optimal tax rate calculation model in order to seek more efficient environmental policies to cope with the increasing environmental pressure. The polluter pays principle clearly defines the subject of environmental negative externalities cost, and requires the tax burden design to achieve an "acceptable state" of the environment based on the environmental protection target set by the government. For example, the Danish government implemented the energy tax reform as early as 1993, and raised the energy tax rate year by year from 1993 to 1997 based on economic development and ecological environment change. The total cost of environmental tax can be regarded as "basic welfare loss". When the pollution is reduced, the degree of negative externality damage is reduced, and the social benefits can be called "pollution correction income". The difference between "pollution correction income" and "basic welfare loss" generates net income from the environment, which can be called the "basic welfare effect" (the first dividend). Based on the above analysis, hypothesis 1 is proposed in this paper:

H1: under the same conditions, the environmental tax of OECD countries can inhibit the emission of pollutants, improve the ecological environment and realize the green dividend.

The imposition of environmental taxes (such as carbon dioxide, sulphur dioxide and energy taxes) can increase national fiscal revenue, but in turn increases the tax burden on the taxpayer and increases the production cost of the product. If the amount of the increased tax revenue can be used to reduce the distorting taxes related to the labor force (such as income tax, labor tax, etc.), it will increase the employees' disposable income after tax and mobilize their enthusiasm for labor, thus increasing the supply of labor, promoting the growth of employment and economic Development (Andre 2003, Shir O Takeda 2006). At the same time, this is consistent with the "income cycle effect" (Parry 1995). In practice, developed countries generally adopt structural tax cuts, such as the UK's landfill tax in 1996, and a 0.1 per cent reduction in national insurance premiums paid to employees by registered landfill employers.

Further research has shown that the employment dividend is more likely to hold if there is imperfect competition in the Labour market. Strand (1998) pointed out that when an enterprise is in an environment where it is free to enter and leave, and there is a mechanism for workers to bargain with the enterprise about the residual value, increasing the environmental tax without subsidy will lead to an increase in the unemployment rate. However, when the increased environmental tax is used to compensate employees' wages or capital, the employment dividend can be obtained. At the same time, structural tax cuts driven by environmental taxes can not only encourage labor and capital investment, but also stimulate the consumption of total products in the market and promote the improvement of the efficiency of economic development (Glomm et al., 2008). In view of the above analysis, hypothesis 2 is proposed in this paper:

H2: under other conditions, the environmental tax of OECD countries can promote employment growth and improve the efficiency of economic development and achieve blue dividends.

Model Design

According to the characteristics of selected variable data, this paper adopts Panel ARDL model for testing. Panel ARDL can solve the problem of insufficient sample size and is suitable for the study of small sample. In addition, it is helpful to correctly analyze the relationship between the panel data of various economic variables. It is worth noting that Panel ARDL is more effective than other linear regression models in avoiding the endogeneity of interpreted variables and explanatory variables. Therefore, in order to test the above hypothesis 1, we set the following research model (1):

$$\begin{aligned}\Delta GHE_{it} = {} & \alpha_i + \sum_{j=1}^{m-1} \beta_{ij}\, \Delta GHE_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il}\, \Delta ET_{i,t-l} \\ & + \sum_{k=0}^{q-1} \mu_{ik} \Delta UNE_{i,t-k} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta GDP_{i,t-r} \\ & + \sum_{s=0}^{u-1} \gamma_{is} \Delta SOE_{i,t-s} + \sum_{x=0}^{v-1} \gamma_{ix} \Delta NOE_{i,t-x} \\ & + \delta_1 GHE_{i,t-1} + \delta_2 ET_{i,t-1} + \delta_3 UNE_{i,t-1} \\ & + \delta_4 GDP_{i,t-1} + \delta_5 SOE_{i,t-1} + \delta_6 NOE_{i,t-1} + \varepsilon_{1i,t}\end{aligned} \quad (5)$$

The explained variable in model (1) is the ratio of greenhouse gas emissions to GDP. In order to simplify the description of the model in this paper, NOE and SOE can replace GHE as the explained variable respectively. The explanatory variable is ET (the ratio of environmental tax revenue to total tax revenue). In other words, in order to verify the inhibitory effect of environmental tax on the emission of pollutants and the optimization of the environment, the pollution targets

Table 2. Descriptive statistics

variables	Mean	Median	Max	Min	Std.Dev	Skewness	Kurtosis	Sum	Sum Sq. Dev	Speicific figure
GDP	2.737	2.834	11.889	-14.724	3.143	-0.755	6.398	2061.169	7427.514	GDP year growth rate
ET	7.081	6.950	16.980	-7.500	2.450	-0.181	7.528	5084.400	4303.510	Tax revenue, % of total tax revenue
GHE	0.399	0.350	1.483	0.110	0.172	1.569	7.398	297.203	22.112	Greenhouse emission/GDP
NOE	1.091	0.920	4.280	0.150	0.673	1.574	5.831	778.620	322.509	Nitrogen Oxides emission/GDP
SOE	1.046	0.510	10.110	0.020	1.328	2.292	9.843	746.500	1257.487	Sulphur Oxides emission/GDP
UNE	7.704	7.242	28.371	2.007	3.951	1.607	7.402	5562.357	11253.940	unemployment rate

Note: ET is the environment tax, Tax revenue, % of total tax revenue. GDP is the gross domestic price, GDP year growth rate. GHE is the greenhouse emission, Greenhouse emossion per GDP, and UNE is the unemployment rate, SOE is Sulphur Oxides Emissions, Sulphur Oxides Emissions per GDP, NOE is Nitrogen Oxides Emissions, Nitrogen Oxides Emissions per GDP.

of 3 high energy high energy consumption enterprises, such as greenhouse gas emissions, sulphide emissions and nitrogen oxides emissions, have been concretely discussed in this paper. At the same time, in order to explore the effect of environmental tax on emission reduction, the relative number of the 3 common pollution indicators, rather than absolute numbers, was used to compare the longitudinal comparison of the different national time series. In order to test hypothesis 2, we set the following research models (2) and (3):

$$\begin{aligned}\Delta GDP_{it} &= \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta GDP_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} \Delta ET_{i,t-l} \\ &+ \sum_{k=0}^{q-1} \mu_{ik} \Delta UNE_{i,t-k} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta GHE_{i,t-r} \\ &+ \sum_{s=0}^{u-1} \gamma_{is} \Delta SOE_{i,t-s} + \sum_{x=0}^{v-1} \gamma_{ix} \Delta NOE_{i,t-x} \\ &+ \delta_1 GDP_{i,t-1} + \delta_2 ET_{i,t-1} + \delta_3 UNE_{i,t-1} \delta_4 GHE_{i,t-1} \\ &+ \delta_5 SOE_{i,t-1} + \delta_6 NOE_{i,t-1} + \varepsilon_{1i,t}\end{aligned} \quad (2)$$

$$\begin{aligned}\Delta UNE_{it} &= \alpha_i + \sum_{j=1}^{m-1} \beta_{ij} \Delta UNE_{i,t-j} + \sum_{l=0}^{n-1} \varphi_{il} \Delta ET_{i,t-l} \\ &+ \sum_{k=0}^{q-1} \mu_{ik} \Delta GDP_{i,t-k} + \sum_{r=0}^{p-1} \gamma_{ir} \Delta GHE_{i,t-r} \\ &+ \sum_{s=0}^{u-1} \gamma_{is} \Delta SOE_{i,t-s} + \sum_{x=0}^{v-1} \gamma_{ix} \Delta NOE_{i,t-x} \\ &+ \delta_1 UNE_{i,t-1} + \delta_2 ET_{i,t-1} + \delta_3 GDP_{i,t-1} \\ &+ \delta_4 GHE_{i,t-1} + \delta_5 SOE_{i,t-1} + \delta_6 NOE_{i,t-1} + \varepsilon_{1i,t}\end{aligned} \quad (3)$$

The explanatory variables in models (2) and (3) are GDP growth rate and unemployment rate respectively, while the explanatory variables are still ET (the ratio of environmental tax revenue to total tax revenue). GDP growth rate and unemployment rate respectively represent the economic growth rate and social employment situation of OECD countries, while ET said the structural ratio of environmental tax related taxes in OECD countries in total fiscal revenue is a kind of tax pressure for taxpayers. Considering that the ratio of environmental tax revenue to GDP growth rate and unemployment rate may have hysteresis, in order to avoid the problem of endogeneity of variable data, this paper treats all variables with a lag of one period. Δ and $\varepsilon_{ki,t}$ (k=1,2,3) is the first order difference of all variables and white noise. In addition, α_i represents the intercept of different countries, and the internal regression coefficients in different countries are the same as α and $\beta, \varphi, \mu, \gamma$ and τ, and the subscript i is a specific unit and varies from 1 to N. At the same time, this article will determine the optimal lag time for each variable based on the minimization of the Schwarz information criterion (SBIC).

Data

In this paper, 36 OECD countries from 1994 to 2014 were selected as research samples, and ET (the proportion of environmental tax revenue in total tax revenue), GHE (the proportion of greenhouse gas emissions in GDP), SOE (the proportion of sulfur oxides in GDP), NOE (the proportion of nitrogen oxides in GDP), annual GDP growth rate and UNE (unemployment rate) were used as research variables. All of these variables are from the OECD database. All of these variables are from the OECD database. At the same time, in order to avoid the influence of the measurement units of the above variables on the experimental results, this paper standardized them in the form of ratio. The OECD countries included in this paper include 36 countries including Australia, Austria, Belgium, Canada, Chile, Czech republic and Denmark.

From the descriptive statistics in **Table 2**, it can be seen that the average level of environmental tax in OECD countries is about 7% of total tax revenue, and the intensity of environment-related tax collection is generally large. However, there are still a few countries whose proportion distribution is skewed towards the poles with significant differences. Further observation shows that the proportion of greenhouse gas emissions in pollution-related indicators is more evenly distributed than that in other countries, concentrated at about 0.5%. However, the distribution level of sulfur oxidation and nitrogen oxides in OECD countries is different, especially in the proportion of nitrogen oxides, the highest level in each country is above 10%, and the lowest is close to 0.

EMPIRICAL RESULTS AND ANALYSIS

It is necessary to know the dynamic characteristics of data before making regression estimates based on panel data used in this paper. In order to verify the stationary of the data, the unit root test should be performed at first. In this paper, the first-generation

Table 3. Unit root tests results

variable	Levin, Lin & Chu t*		Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	level	first difference	level	first difference	level	first difference	level	first difference
ET	-2.771**	-20.379***	-0.242	-17.422***	72.174	388.225***	85.636*	428.290***
	(0.003)	(0.000)	(0.404)	(0.000)	(0.406)	(0.000)	(0.099)	(0.000)
GDP	-13.617***	-30.508***	-10.541***	-25.683***	241.056***	583.850***	254.852***	1913.260***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
UNE	0.823	-11.777***	1.562	-6.861***	65.415	160.458***	84.652	167.735***
	(0.795)	(0.000)	(0.941)	(0.000)	(0.633)	(0.000)	(0.112)	(0.000)
GHE	-5.885***	-22.093***	2.037	-20.554***	77.256	464.551***	300.991***	528.092***
	(0.000)	(0.000)	(0.979)	(0.000)	(0.315)	(0.000)	(0.000)	(0.000)
NOE	-12.912***	-17.466***	-2.665**	-15.135***	140.887***	338.486 ***	483.233***	394.983***
	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SOE	-20.699***	-20.069***	-12.680***	-18.616***	398.627***	422.391 ***	1067.300***	426.452***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: The value in parentheses is the *P*-value of the statistic, ***, **, and *indicates statistical significance at the 1%, 5% and 10% level.

Table 4. Pedroni &Kao& Johansen Fisher Panel Cointegration Test Results

Pedroni Residual Cointegration Test			
Alternative hypothesis: individual AR coefs. (between-dimension)			
		Statistic	**Prob.**
Group PP-Statistic		-24.310***	(0.000)
Group ADF-Statistic		-5.962***	(0.000)
Alternative hypothesis: common AR coefs. (within-dimension)			
		Statistic	Prob.
Panel PP-Statistic		-7.815***	(0.000)
Panel ADF-Statistic		-3.971***	(0.000)
Kao Residual Cointegration Test			
ADF		-6.495	0.000
Johansen Fisher Panel Cointegration Test			
Hypothesized	**Fisher Stat.***		**Fisher Stat.***	
No. of CE(s)	**(from trace test)**	**Prob.**	**(from max-eigen test)**	**Prob.**
None	1124.000***	(0.000)	631.900***	(0.000)
At most 1	866.700***	(0.000)	586.000***	(0.000)
At most 2	424.900***	(0.000)	239.500***	(0.000)
At most 3	237.200***	(0.000)	163.500***	(0.000)
At most 4	128.200***	(0.000)	110.400***	(0.000)
At most 5	91.620**	(0.002)	91.620***	(0.002)

Note: The value in parentheses is the p-value of the statistic, ***, **, and *indicates statistical significance at the 1%, 5% and 10% level.

panel unit root test methods, such as Levin et al (2002), Im et al (2003), ADF (1979), and PP (1988), are adopted. The development of the panel unit root test is similar to the traditional ADF test. **Table 3** shows the panel unit root test results. It can be inferred from the **Table 3**, the variables including environmental tax (ET), gross domestic product (GDP), greenhouse gas emission (GHE), nitrogen oxide emission (NOE) and sulfur oxide emission (SOE) are stationary at levels and hence of order I(0) in 1% critical level. And the unemployment rate (UNE) is integrated at first difference and hence of order I(0).Thus, it indicates that the order of integration is a mixture of I(0) and I(1), making it valid to use ARDL model in this study.

In order to further understand the long-term dynamic relationship between variables, and to analyze the dynamic relationship between variables both in long term and short term, a long-term cointegration test is introduced. **Table 4** reports the cointegration estimation results using the method of Pedroni (1999, 2004), Kao (1999) and Johansen Fisher cointegration Test. The null hypothesis of the above three tests is that there is no cointegration relationship between ET, GDP, GHE, NOE, SOE and UNE. The results of the Pedroni test show that the null hypothesis of no cointegration is rejected at the 1% level. The results of the Kao test show that the coefficient of the t-statistic is significant, rejecting the null hypothesis of no cointegration, so the variables are cointegrated. The results of the Johansen Fisher Panel Cointegration Test reject the null hypothesis that there are at most five cointegration relationships at the 1% level. Therefore, it can be concluded that economic growth, unemployment rate, environmental tax, greenhouse gas emissions, nitrogen oxide emissions, and sulfur oxide emissions are synchronized in the long-term, and have a long-term cointegration relationship.

The results of the cointegration test in this paper are consistent with the literature conclusions of several related variables in different countries, such as Barker

Table 5. Long-term and short-term panel ARDL dynamic estimate results

Long Run Estimate						
dependent variable	**D(ET)**	**D(GDP)**	**D(UNE)**	**D(GHE)**	**D(NOE)**	**D(SOE)**
D(GDP)	0.188***		-0.006	0.917	0.493*	-0.083
	(0.000)		(0.755)	(0.245)	(0.082)	(0.592)
D(UNE)	3.075**	-15.679***		0.658	44.441**	-13.583**
	(0.001)	(0.000)		(0.966)	(0.001)	(0.004)
D(GHE)	0.013***	-0.018***	0.002*		0.391***	-0.033***
	(0.000)	(0.000)	(0.062)		(0.000)	(0.000)
D(NOE)	-0.025***	0.014***	-0.004**	2.166***		0.075***
	(0.000)	(0.000)	(0.006)	(0.000)		(0.000)
D(SOE)	0.037***	0.022**	-0.009*	-1.633***	1.031***	
	(0.000)	(0.023)	(0.079)	(0.000)	(0.000)	
ECTt-1		-1.056***	-0.023***	-0.056**	-0.148 ***	-0.101***
		(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Short Run Estimate						
D(GDP)	-0.391		-1.847***	-36.146**	-0.691	4.213
	(0.206)		(0.000)	(0.027)	(0.885)	(0.257)
D(UNE)	0.243	0.099***		-8.091	1.596	2.793***
	(0.120)	(0.000)		(0.147)	(0.233)	(0.025)
D(GHE)	0.001	-0.00004	-0.0004		0.152***	0.048**
	(0.718)	(0.905)	(0.654)		(0.000)	(0.030)
D(NOE)	0.016*	-0.002*	0.005 **	1.296***		0.106**
	(0.077)	(0.061)	(0.032)	(0.000)		(0.076)
D(SOE)	-0.041*	-0.004	0.002	2.034**	0.458***	
	(0.067)	(0.192)	(0.683)	(0.002)	(0.007)	

Note: The value in parentheses is the p-value of the t-statistic of the coeffecient, ***, **, and *indicates statistical significance at the 1%, 5% and 10% level.

(1993), Orlov et al. (2013) and so on. At the same time, it is contrary to the results of some literature, such as Abdullah (2014). This difference is related to the individual, the number of research objects and the methods of research. The results of this paper can represent the commonness of the OECD countries in the long run.

The ARDL method can not only estimate the long-term relationship between the common regression variables, but also provide the coefficient of the error correction term, proving the existence of the long-term relationship and supporting the applicability and robustness of this model. The coefficient of the error correction term measures the adjustment of equilibrium path from short-run to long-run for the dependent variable (Apostolidou et al. 2015). When the coefficient of the error correction term is negative, the model is stable and we can also conclude that there is a long-term relationship. **Table 5** reports the results of the long-term and short-term regression of the ARDL model. In the long run, the coefficient between environmental tax and GDP is 0.188, that is to say, if the environmental tax changes by one unit, GDP will change by 0.188 units in the same direction. This result is significant at the 1% level. This conclusion is consistent with the Barker (1993). Therefore, we affirm the positive role of the implementation of environmental tax for economic development. The long-term coefficient between environmental tax and unemployment rate is 3.075, that is to say, when the unit environmental tax increases or decreases, the unemployment rate will change by 3.075 units in the same direction. This result indicates that the environmental tax plays a negative role in promoting employment, and the negative effect is very significant at the 5% level. This result is consistent with Arbolino (2014), which holds that there is a negative correlation between environmental tax and employment. Therefore, this paper believes that the environmental tax has not played a role in reducing the unemployment rate for the OECD countries. The long-term coefficient between the environmental tax and the greenhouse gas emissions is 0.013, that is to say, the increase or decrease of unit environmental tax will cause the same change of greenhouse gas emissions by 0.013, which is significant at the confidence level of 1%.This means that environmental tax plays a negative role in reducing greenhouse gas emissions, and the negative impact is also significant. This conclusion is consistent with the view of Lin and Li (2011). The long-term coefficient of environmental tax and nitrogen oxides is -0.025, while the long-term coefficient of environmental tax and sulphur oxide is 0.037, and both of the two coefficient are significant at 1% confidence level. Therefore, we believe that for OECD countries, the green dividend of environmental tax on greenhouse gas emission indicators may not have been shown yet, but it has played a significant role in controlling the emission of nitrogen oxides. An increase in the unit environmental

Table 6. Long-term and short-term results of the Granger causality test

Short run causalities		Wald-value			Long run causalities	ECT_{t-1}
D(ET) ⇔D(GDP)	11.391**	(0.003)	4.940*	(0.085)	$f(ET\|GDP,UNE,GHE,NOE,SOE)$	—
D(SOE) ⇔ D(NOE)	30.482***	(0.000)	15.385**	(0.001)	$f(GDP\|ET,UNE,GHE,NOE,SOE)$	-1.056***
D(UNE) ⇔ D(ET)	5.631*	(0.060)	4.876*	(0.087)	$f(UNE\|ET,GDP,GHE,NOE,SOE)$	-0.023***
D(NOE) ⇔ D(GHE)	7.100**	(0.029)	5.110*	(0.078)	$f(GHE\|ET,UNE,GDP,NOE,SOE)$	-0.056***
D(SOE) ⇒ D(GHE)	5.852*	(0.054)			$f(NOE\|ET,UNE,GHE,GDP,SOE)$	-0.148***
D(UNE) ⇒ D(GHE)	5.755*	(0.056)			$f(SOE\|ET,UNE,GHE,GDP,NOE)$	-0.101***
D(ET) ⇒ D(NOE)	6.636**	(0.036)				
D(NOE) ⇒ D(GDP)	6.032**	(0.049)				
D(UNE) ⇒ D(NOE)	8.885**	(0.012)				
D(GDP) ⇒ D(UNE)	37.142***	(0.000)				

tax can reduce nitrogen oxide emissions by 0.025. In this paper, the green dividend effect of the environmental tax is partially affirmed, and the environmental tax has indeed played a role in reducing nitrogen oxides in the long term.

Table 5 shows that in the short term, the environmental tax is only significantly related to NOE and SOE. The short-term coefficient of environmental tax and nitrogen oxide is 0.016, while the short-term coefficient of environmental tax and sulfur oxide is -0.041, both of which are significant at the confidence level of 10%. It can be seen that in the short term, the green dividend of environmental tax has played a significant role in controlling the emission of sulfur oxides. The increase in unit environmental tax will reduce sulfur oxide emissions by 0.041. The conclusions in this paper represent the common features of the OECD countries studied. The conclusion that environmental tax can reduce pollutant emission is consistent with the research results of Hu (2018) and Wang (2018). In this paper, the effect of environmental tax on the green dividend is partially affirmed, environmental taxes do have a role in reducing sulfur oxides.

In addition, the empirical results in **Table 5** show that the coefficient of unemployment rate and GDP are -0.006 and -1.847 in the long-term and short-term respectively, which means that the increase of unit unemployment rate will reduce GDP growth rate by 0.006 units in the long term and 1.847 units in the short term. This conclusion is consistent with Mohseni (2016), and they jointly affirm that the increase in unemployment rate will have a negative effect on economic growth. At the same time, it is found in this paper that the long-term coefficient of nitrogen oxides and GDP is 44.441, which means that the unit nitrogen oxide emissions will increase by 44.441 with the unemployment rate. Thisreflects the relationship between environmental pollution and employment.

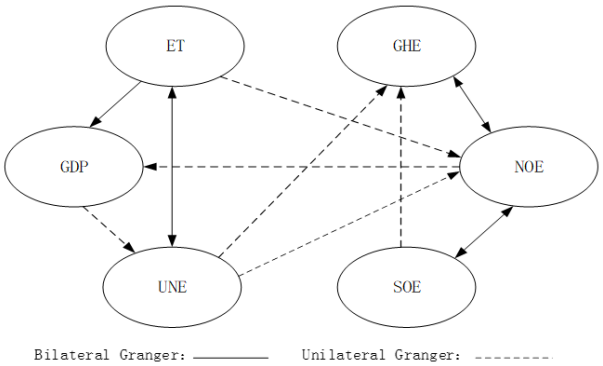

Fig. 1. Short-run Granger causality relationship

Table 6 shows the long-term and short-term results of the Granger causality test. The long-term and short-term direction of granger causality is shown in **Fig. 1**. In the long term, all variables are granger causality relation to each other, and all variables have the function of predicting other variables. In the short term, we have found the existence of a bi-directional causality between environmental tax and GDP. There is a bilateral granger relationship between environmental taxes and unemployment, between sulfur oxides and nitrogen oxides, and between nitrogen oxides and greenhouse gas emissions. In addition, we have found the existence of a uni-directional causality running from sulfur oxides and unemployment rate to greenhouse gas emissions, and from environmental tax and unemployment rate to nitrogen oxides. Nitrogen oxides are the granger cause of economic growth, and economic growth is the granger cause of unemployment.

CONCLUSION

According to the double dividend theory of environmental tax, this paper selects indicators that can reflect green dividend including greenhouse gas emissions, nitrogen oxides and sulfur oxides. This paper also selects indicators that can reflect the blue dividend of environmental taxes including gross domestic product and unemployment rate. Through a series of econometric methods such as unit root test, cointegration test, Granger causality test, this paper then

establishes the panel ARDL model for the corresponding data of 36 countries and regions of OECD, and obtains a series of results. This paper finds that for 36 OECD countries, there is a long-term cointegration relationship between environmental tax and other variables used in this paper. In terms of the green dividend, the environmental tax has not played an active and significant role in reducing greenhouse gas emissions, but it has played a significant role in reducing nitrogen oxides in the long term and a significant role in reducing sulfur oxides in the short term. The traditional analysis of environmental tax mainly focuses on the role of environmental tax on greenhouse gas emissions. Traditional research on the role of environmental tax reduction has focused on the study of reducing the greenhouse gas emissions. Previous studies on the green dividends of environmental taxes generally use greenhouse gas emissions to measure the improvement of the environment. This study found that greenhouse gas emissions may not be sufficient to reflect the green dividend of environmental taxes to reduce pollution and protect the environment. Greenhouse gases such as carbon dioxide emissions are not enough to be defined as pollutants, but sulfur oxides and nitrogen oxides are strictly environmental pollutants that affect air quality, soil quality and water resources. From this perspective, this paper holds that the green dividend of environmental tax has a significant effect in 36 countries and regions of OECD, and the environmental tax has played a positive role in improving the environment. This conclusion is consistent with the hypothesis of the initial study in this paper and confirms the green dividend effect of environmental tax. In terms of blue dividend, environmental tax has already played a significant role in promoting economic growth, which is completely consistent with hypothesis 2 in this paper. The results of dividends in pulling employment and controlling unemployment have not been realized. The conclusion of this study is contrary to the hypothesis of the initial study of this paper. It is speculated that the impact of the employment policy and environment on the employment rate is more significant than the environmental tax on it, and on the other hand, the environmental tax in OECD countries is different from each other. The study can only represent the general commonality of the 36 countries, and the blue dividends of various countries may be different.

The environmental tax of the OECD countries is mature and perfect around the world. It is the earliest practice to compensate the cost based on the "polluter pay" principle (the OECD proposed that polluters have to undertake the cost of reducing pollution facilities in 1972). At present, most of the environmental tax in OECD countries take the pollutants directly discharged to the environment as the object of environmental taxes. At the same time, a number of preferential tax policies are set. First, the public sector and agriculture and other industries implement tax reduction and exemption; Second, we will give preferential treatment to domestic sewage and municipal sewage that are closely related to the lives of ordinary residents. Third, the reduction of pollutant emissions are generally given tax incentives; Fourth, we will encourage tax incentives for waste recycling. The initial manifestation of environmental tax dividend in OECD countries is due to the commonality between the improvement of environmental tax and long-term practice. However, combined with **Fig. 2**, it can be seen that the proportion of environmental tax revenue in the total tax revenue of OECD countries is quite different, which is related to the national conditions of environmental tax collection. For example, resource tax is a tax on the exploitation and use of domestic natural resources. The Nordic countries Denmark and Finland have fishery license tax and hunting license tax. The United States mainly imposes resource tax on oil and natural gas, while France has a water resource exploitation tax, which also imposes corresponding taxes on air pollution, noise pollution, agricultural fertilizers and pesticides. Therefore, in the process of learning from the setting of environmental tax in OECD countries, countries should combine their national conditions. Finally, this paper studies some commonalities in the implementation of environmental tax performance in 36 countries of OECD. The research results only represent the overall situation in 36 countries, which is not enough to represent individuals. In subsequent studies, we will conduct grouping and other treatment methods to promote further research.

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