Research on the Implementation Effect of American Environmental Tax-And Its Enlightenment to China

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Abstract*:* This paper reviews the US environmental tax from 1994 to 2016 and examines the economic and environmental dividend effects of its environmental tax implementation. Based on the five variables of carbon dioxide density, unemployment rate, environmental tax, GDP growth rate, income tax, profit tax and capital gains tax, the ARDL model was established. It was found that the environmental tax was not collected in the United States in both long-term and short-term situations. The green dividend will bring a certain blue dividend in the long-term and short-term, and it will play a role in reducing the distortion tax in the short term. In the long run, it will promote economic growth and reflect the blue dividend.

Keywords: GDP; environmental tax; ARDL model; double dividend

1. Introduction

As the world's largest economy, the United States has developed its industry and has created many environmental problems in the process of rapid economic development. The implementation of the US environmental tax policy started earlier, but it is the path of "first pollution after governance". The US Congress proposed a bill to levy taxes on sulphides throughout the United States in 1971, and in 1987 recommended taxation of sulphur monoxide and nitrogen monoxide emissions [1]. After that, the US government introduced taxation measures throughout the environmental protection field and formed a unique US environmental tax system. At present, the US environmental tax categories mainly include consumption tax, gasoline tax, tire tax, mining product mining tax, solid waste treatment tax, sulfur dioxide tax, etc. imposed on chemicals that pollute the environment. In order to reduce the tax burden, the US government has also introduced relevant environmental tax incentives.

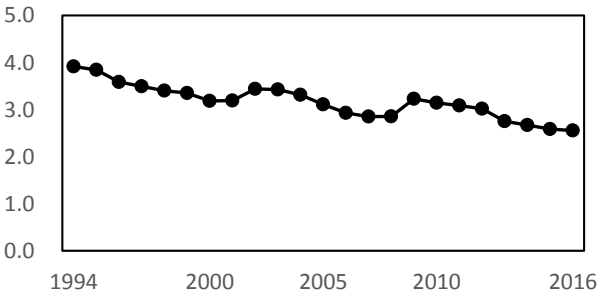

Figure 1. The US environmental tax as a general tax.

Figure 1 shows the proportion of total environmental tax revenue in the United States in 1994-2016 as a percentage of total tax revenue. We can see that the proportion of US environmental tax in total taxation has generally declined, reaching a minimum in 2016.

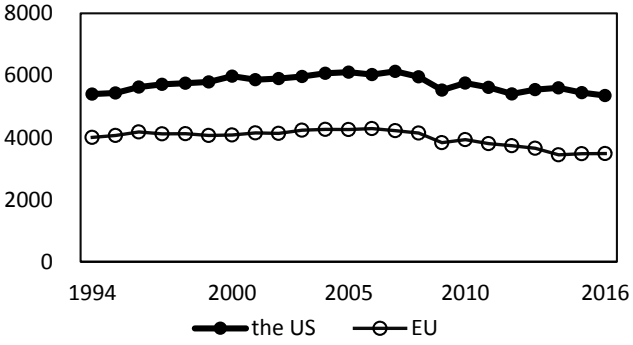

Figure 2. US and EU emissions trends from1994 to 2016.

Figure 2 shows the trend of CO2 emissions in the United States and the European Union from 1994 to 2016. It can be seen from the figure that the US emissions are much higher than those of the EU countries. In recent years, there has been a downward trend, while the EU carbon dioxide the emissions have remained basically steady. According to the 2018 edition of the BP World Energy Statistical Yearbook, the United States' carbon dioxide emissions in 2016 accounted for 16% of the world's carbon dioxide emissions, while the EU is about 10%. The US carbon dioxide emissions in 2016 were about 48.57 million tons lower than in 1994. The EU fell by about 52.75 million tons, which indicates that the

United States has not effectively controlled carbon dioxide emissions during the economic development process. In 2017, the United States withdrew from the Paris Agreement as the world's second largest emitter of carbon dioxide. (China is the largest country), and the United States still has an obligation to actively reduce carbon dioxide emissions.

As the world's second largest economy, China also has serious environmental pollution problems. According to the 2018 edition of BP World Energy Statistical Yearbook, China's carbon dioxide emissions in 2016 accounted for 27.3% of the world's carbon dioxide emissions. This paper uses ARDL model to empirically analyze this paper. US environmental tax (ENT), carbon dioxide density (CO2), GDP growth rate (GDP), unemployment rate (UNR) and income tax, profit tax and capital gains tax share (IPT) and US environmental tax implementation The effect is to provide relevant enlightenment for the implementation of environmental tax in China. The subsequent structural arrangement of this paper is the second part of the literature review of the double dividend of green tax; the third part is the theoretical analysis and research design; the fourth part is the empirical result and analysis; the fifth part is the research conclusion and enlightenment.

2. Literature Review

The double dividend effect of green tax can be understood as the fact that the taxation of environmental pollution can increase the cost of polluters, inhibit or reduce the behavior of polluters' production or consumption, promote environmental protection, and help improve the environment, that is, "green dividend". The second is to reform the tax system, increase output, promote employment, and improve economic efficiency, that is, "blue dividend." EU countries implement environmental taxes to reduce environmental pollution, and expect to reach the goal of the "Kyoto Agreement". It is widely believed that developed countries that are the first to implement green taxes have a double dividend effect, but Magdalena Radulescu (2017) finds a double dividend for green taxes [1]. The effect does not exist in the EU and Romania. The green tax has only a "green dividend" for Romania, which can reduce greenhouse gas emissions. Because of the large differences in green taxes between EU countries, the green tax is for the EU environment. The improvement effect is small, but it has a certain improvement effect on economic growth. Maurizio Ciaschini (2012) believes that environmental taxes are often an effective means of controlling pollution [2]. Using tax model studies, 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. Walid Oueslati (2014) found that regardless of the environmental tax reform, its short-term welfare effect is negative, and the long-term welfare effect depends on capital adjustment [3]. Arbolino (2014) found that environmental taxes have a positive effect on environmental improvement by comparing the effects of environmental taxes, but the effect on the improvement of unemployment rate is not obvious, showing a negative effect [4].

The earliest proposed use of taxes to reduce environmental pollution was Pigou (1920). Eirik S. Amundsen (1999) pointed out that the taxation of Pigou is the best choice for small countries [5]. Due to the differences in tax systems in various countries, green taxes are the implementation effects of different countries are also very different. Economists generally believe that environmental taxes reduce the impact on the environment. Jaume Freire-González (2018) found out that environmental tax pairs were found in some 44.9% of the studies by combing the previous studies [6].The environment has an improvement effect, which is also the main role of environmental taxation. 55.1% of the studies found that the "blue dividend" of environmental taxes is not obvious. Iain Fraser6 (2013) found that Australia has a double dividend effect, and the environmental tax is levied by reducing the consumption tax [7]. As the emission reduction level increases, the increase in carbon tax makes it more effective at higher emission reduction levels. A high level of welfare improvement. From the perspective of economics, Gissela Landa Rivera (2016) found that there is a double dividend effect in Mexico [8]. The carbon tax will provide a driving force for the low-emission development of the Mexican economy, while achieving a higher level of social welfare through an appropriate carbon tax income distribution policy.

Some European countries have introduced various environmental taxes to compensate by reducing the collection of personal income tax or social security contributions. Some people think that environmental taxes are an effective way to solve the carbon emissions and energy intensity. The double dividend hypothesis suggests that environmental taxes can reduce environmental pollution by increasing private costs, and as incomes increase, environmental taxes can reduce some of the direct taxes and reduce people's burdens. Bosquet (2010) found that environmental taxes can achieve both environmental and economic improvements through the study of 139 variables [9]. When environmental tax revenue is used to reduce payroll taxes and to prevent wage increases, then pollutants will be significant in the short to medium term. Decrease, small increases in employment and marginal gains or losses in production can occur. Anton Orlov (2013) found that the collection of environmental taxes in Russia reduced the demand for domestically produced and imported energy, although the reduction in demand for imported energy was more pronounced and led to a reduction in carbon dioxide emissions [10]. However, Danuše Nerudová (2014) found that environmental taxes were collected in 17 countries of the European Union, which in turn increased energy consumption, while the reduction of income tax had a negative effect on environmental protection [11]. Sabah Abdullah (2014) conducted a study of the EU and OECD countries and found that increasing environmental taxes does not seem to have any material impact on the economy [12]. In addition, the increase in environmental taxes does not affect the achievement of emission

reduction targets in individual 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 environmental standards, for example, in some OECD countries, automotive fuels and electric Car taxes are used to build or maintain roads and other activities such as installing soundproof walls, developing bicycle lanes and improving public transport (OECD, 2006). Vassilis T (2005), based on the Greek energy tax, found that when the energy tax is consistent with the EU average, the total annual carbon dioxide emissions increase by 6% [13]. However, if the environmental tax is raised to the highest level in the EU, carbon dioxide emissions will be severely limited. At the same time, he also pointed out that environmental taxes cannot be the only tool to prevent pollution. Cristian Mardones (2018) also holds the same view that even if the environmental tax is determined to be the highest tax rate, the environmental tax will be weakened if it is not supplemented by other measures that help reduce CO2 emissions [14].

Outdated technology and low energy costs have caused society to emit large amounts of carbon dioxide, and the capital invested in production equipment has evolved into sunk costs that have also hampered technological advances. Anton Orlov (2013) pointed out that in the short to medium term, environmental taxes can reduce greenhouse gas emissions such as carbon dioxide and encourage adjustments to existing capital equipment [10]. In the long run, environmental taxes will accelerate the promotion of more energy-efficient technologies and promote technological advancement. E.D. Gemechu (2012) pointed out that if an environmental tax is imposed on non-CO2 greenhouse gases instead of taxing carbon dioxide separately, taxes will greatly affect agriculture, coal mining, soybean oil and food industries [15].

3. Theoretical Basis and Research Design

3.1. Double Dividend Theory

Pearce (1991) first proposed a dual dividend theory to explain the environmental and economic impacts of green taxes. The first bonus of the double dividend means that the environmental tax can suppress the emission of pollutants and improve the environment, which is called the green dividend; the second dividend of the double dividend is the blue dividend, and the environmental tax is introduced, which can drive the environmental protection industry. The development has brought new economic growth points, provided labor positions, and promoted employment. On the other hand, it reduced the taxation of tax distortions such as income tax and capital tax by reducing the tax burden, reducing the burden on enterprises and residents. In order to better study the role of environmental tax, this paper proposes the following two hypotheses based on the double dividend theory:

H_1: Under the same conditions, environmental taxes can reduce carbon dioxide emissions, improve the ecological environment, and achieve a green dividend.

H_2: Under the same conditions, environmental taxes can promote economic growth, reduce the tax burden of distorted taxes, reduce unemployment, and achieve a blue dividend.

3.2. Model Design

According to the characteristics of the variables selected in this paper, this paper uses the ARDL model for research. In order to test hypothesis 1, the following research model is set (1)

$$\Delta CO_{2t} = \sum_{i=1}^{n} \alpha_1 \Delta CO_{2,t-i} + \sum_{i=1}^{n} \alpha_2 \Delta ENT_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta IPT_{t-i} + \sum_{i=1}^{n} \alpha_4 \Delta GDP_{t-i} + \sum_{i=1}^{n} \alpha_5 \Delta UER_{t-i} + \pi_1 CO_{2,t-i} + \pi_2 ENT_{t-i} \pi_3 IPT_{t-i} + \pi_4 GDP_{t-i} + \pi_5 UER_{t-i} + C_0 + \varepsilon_{1,t} \quad (1)$$

The explanatory variable in model (1) is carbon dioxide density, and the explanatory variable is the proportion of environmental tax revenue in total tax revenue. The ARDL model can test the long-term relationship between variables based on F statistic. If there is a long-term relationship, H_0: $\pi_1 \neq \pi_2 \neq \pi_3 \neq \pi_4 \neq \pi_5 \neq 0$ To test hypothesis 2, we set the following research models

$$\Delta GDP_t = \sum_{i=1}^{n} \beta_1 \Delta CO_{2,t-i} + \sum_{i=1}^{n} \beta_2 \Delta ENT_{t-i} + \sum_{i=1}^{n} \beta_3 \Delta IPT_{t-i} + \sum_{i=1}^{n} \beta_4 \Delta GDP_{t-i} + \sum_{i=1}^{n} \beta_5 \Delta UER_{t-i} + \tau_1 CO_{2,t-i} + \tau_2 ENT_{t-i} \tau_3 IPT_{t-i} + \tau_4 GDP_{t-i} + \tau_5 UER_{t-i} + C_0 + \varepsilon_{2,t} \quad (2)$$

$$\Delta IPT_t = \sum_{i=1}^{n} \gamma_1 \Delta CO_{2,t-i} + \sum_{i=1}^{n} \gamma_2 \Delta ENT_{t-i} + \sum_{i=1}^{n} \gamma_3 \Delta IPT_{t-i} + \sum_{i=1}^{n} \gamma_4 \Delta GDP_{t-i} + \sum_{i=1}^{n} \gamma_5 \Delta UER_{t-i} + \eta_1 CO_{2,t-i} + \eta_2 ENT_{t-i} \eta_3 IPT_{t-i} + \eta_4 GDP_{t-i} + \eta_5 UER_{t-i} + C_0 + \varepsilon_{3,t} \quad (3)$$

$$\Delta UER_t = \sum_{i=1}^{n} \theta_1 \Delta CO_{2,t-i} + \sum_{i=1}^{n} \theta_2 \Delta ENT_{t-i} + \sum_{i=1}^{n} \theta_3 \Delta IPT_{t-i} + \sum_{i=1}^{n} \theta_4 \Delta GDP_{t-i} + \sum_{i=1}^{n} \theta_5 \Delta UER_{t-i} + l_1 CO_{2,t-i} + l_2 ENT_{t-i} l_3 IPT_{t-i} + l_4 GDP_{t-i} + l_5 UER_{t-i} + C_0 + \varepsilon_{4,t} \quad (4)$$

The explanatory variables in models (2)-(4) are GDP growth rate, income tax, profit tax and capital gains tax ratio and unemployment rate, respectively. The explanatory variable is still the ratio of environmental tax revenue to total tax revenue. Considering that the impact of environmental tax revenue ratio on other variables may be lagging, and in order to avoid the endogeneity of variable data, this paper will lag the variables in the first

phase. This paper will determine the optimal lag period for each variable based on the minimization of AIC and SC information criteria.

3.3. Variables and Data

Table 1. Descriptive statistics table

the US	CO2	ENT	GDP	IPT	UER
Mean	2.4616	3.1711	2.4912	53.069	5.9341
Median	2.4829	3.1854	2.6666	53.5417	5.5333
Maximum	2.5152	3.9147	4.6852	57.4623	9.6167
Minimum	2.3545	2.5555	-2.775	45.5014	3.9917
Std.dev.	0.0521	0.3674	1.6967	2.8821	1.6236
Skewness	-0.9698	0.1512	-1.286	-0.8418	1.109
Kurtosis	2.5251	2.4580	5.2157	3.4862	3.0997
Sum	56.6171	72.9349	57.298	1220.589	136.483
Sum Sq. Dev.	0.0598	2.9691	63.331	182.741	57.9935

This paper selects five US environmental taxes (ENT), carbon dioxide density (CO2), GDP growth rate (GDP), unemployment rate (UNR) and income tax, profit tax and capital gains tax (IPT) from 1994 to 2016. The variables were studied. In order to avoid the influence of the unit of measurement of the above variables on the experimental results, this paper standardized the ratio in the form of ratio.

Table 1 shows the descriptive statistics for the five variables. The US environmental tax accounts for an average of 3.17% of the total tax revenue, indicating that the US government's environmental tax revenue is not the main source of tax revenue. Compared with the reality of US carbon dioxide emissions, the environmental tax rate should be increased or the environmental tax should be increased. Tax incentives. Income tax, profit tax and capital gains tax account for an average of 53.07% of the total US government tax revenue. Most of the US government tax revenue comes from this part, and the effect of tax shift is verified in the next experiment.

4. Empirical Results and Analysis

4.1. Unit Root Test

In order to avoid the phenomenon of false regression caused by regression analysis, the unit root test is first performed. In this paper, the ADF unit root test is used. If the original sequence is non-stationary, the sequence is determined after smoothing. Conversely, if the original sequence is stable, the original sequence is used for analysis.

Table 2. ADF unit root checklist

CO2	ENT	GDP	IPT	UER
-3.43**	-3.93**	-1.63*	-3.74***	-2.65*
（0.022）	（0.031）	（0.09）	（0.01）	（0.09）

Note: ***, **, * represent the level of significance of 1%, 5%, and 10%, respectively.

According to the results of the Table 2, it is shown that the stationary orders are the same between the variables, satisfying the cointegration test and the conditions for establishing the ARDL model.

4.2. ARDL-bound Test

The ARDL model can test the long-term relationship between variables based on F statistic. The F statistic used for hypothesis testing is not a standard F statistic, but two sets of thresholds based on I(0) and I(1) variables. . If the calculated F statistic is lower than the lower bound threshold given, there is no long-term cointegration relationship between the variables in the model; otherwise, there is a long-term cointegration relationship between the variables. If the F statistic is between the critical values, no definitive conclusion can be given. Once it is determined that there is a cointegration relationship between the variables, the ARDL model can be used to study the long-term relationship and short-term dynamic analysis of the variables. The results of the ARDL-bound test are shown in the following table 3:

Table 3. ARDL bound test

Long Run Estimate					
US	ENT	CO2	GDP	IPT	UER
F-statistics	6.0729***	24.3500***	6.7858***	10.8810***	3.9378*
Critical values	1%	5%	10%		
Lower bounds	3.74	2.86	2.45		
Upper bounds	5.06	4.01	3.52		
R2	0.983544	0.9947	0.926240	0.9990	0.998046
Adj-R2	0.895780	0.9668	0.886522	0.9815	0.981435

Note: ***, **, * represent the level of significance of 1%, 5%, and 10%, respectively.

From the Table 3, the US environmental tax (ENT), carbon dioxide density (CO2), GDP growth rate (GDP), unemployment rate (UNR) and income tax, profit tax and

capital gains tax share (IPT) and other five variables There is a long-term cointegration relationship between them.

4.3. ECM-ARDL Cointegration Analysis

The previous ARDL-bound test has shown that there is a long-term relationship between variables in the United States, and an error correction model (ECM-ARDL) can be established to test whether there is a short-term relationship.

Table 4. Results of ECM-ARDL cointegration analysis

the US	ENT	CO2	GDP	IPT	UER
Long Run Estimate					
ENT		0.1071	4.2558***	-6.0228	4.0896***
		（0.0016）	（0.0018）	（0.1905）	（0.0001）
CO2	6.6105***		-20.8588**	29.6499	-17.5207***
	（0.0117）		（0.0685）	（0.2568）	（0.0009）
GDP	0.1188	-0.0090		1.4687	-1.1203***
	（0.1479）	（0.3407）		（0.1362）	（0.0001）
IPT	0.0367	-0.0051	-0.0197		-0.0349
	（0.3431）	（0.1404）	（0.8414）		（0.6796）
UER	0.2903***	-0.0377	-0.9818***	0.1567	
	（0.0074）	（0.0002）	（0.0100）	（0.8637）	
Short Run Estimate					
ENT		0.1156***	3.4048	-4.1465*	1.5514***
		（0.0056）	（0.0000）	（0.0724）	（0.0000）
CO2	3.3958**		-16.6880***	20.4131	-6.6466***
	（0.0259）		（0.0139）	（0.1557）	（0.0094）
GDP	0.0977**	-0.0233**		1.0111**	-0.4250***
	（0.0380）	（0.0153）		（0.0150）	（0.0000）
IPT	-0.0084	-0.0008	-0.0158		-0.0132
	（0.6159）	（0.8033）	（0.8382）		（0.6781）
UER	0.2485	-0.0545	-2.1115***	0.1079	
	（0.0173）	（0.0105）	（0.0000）	（0.8576）	
ECM(-1)	-0.4864**	-1.0794***	-0.8000***	-0.6884***	-0.3793***
	（0.0176）	（0.0002）	（0.0007）	（0.0063）	（0.0000）

As shown in Table 4, in the long run, when the environmental tax is an explanatory variable, both GDP and unemployment rate are significantly at a confidence level of 1%. The collection of environmental taxes brings GDP to a growth rate of 4.25. However, it did not bring about a drop in the unemployment rate. Instead, it increased at a rate of 4.09, indicating that the environmental tax levy caused the heavy polluting industry to withdraw, and the environmentally friendly industry did not keep up. In the long run, the environmental tax levy has no obvious effect on carbon dioxide and distorted taxes, indicating that the US environmental tax levy does not bring significant green dividends, which is basically consistent with the trend of US carbon dioxide emissions, that is, with environmental taxes. The levy of the United States, the United States has not significantly reduced carbon dioxide emissions, and still faces significant emission reduction pressures in the long run. In the short term, the collection of environmental taxes reduces the burden of distorted taxes and adjusts the tax structure in the short term, but it does lead to an increase in the unemployment rate, which contradicts the blue dividend theory of double dividends; the collection of environmental taxes In the short term, carbon dioxide increased by 0.12 units and did not bring green dividends.

4.4. Granger Causality

Table 5. Granger causality test table

Short run causalities		
D(ENT) ⇒D(CO2)	3.1832*	(0.0744)
D(GDP) ⇒D(ENT)	3.9581**	(0.0466)
D(GDP) ⇒ D(IPT)	8.1732**	(0.0043)
D(GDP) ⇒ D(UER)	3.6323*	(0.0567)

Specifically in the Table 5, the long-term test results of the Granger causality test are: environmental tax is the Granger cause of carbon dioxide density; GDP is the Granger cause of distorted taxes, unemployment rate and carbon dioxide density.

5. Conclusions and Policy Implications

Table 6. US Double Dividend Effect

	variable	results	
		Long-term effect	Short-term effect
Green dividend	Carbon dioxide density	+ (Not obvious)	+ (***)
Blue dividend	GDP	+ (***)	+ (Not obvious)
	Twisted tax share	- (Not obvious)	- (*)
	Unemployment rate	+ (***)	+ (***)

In the Table 6, according to the "double dividend" theory of environmental tax, this paper selects carbon dioxide density as a variable in the green dividend index; in terms of blue dividend index, it chooses GDP growth rate, income tax, profit tax, capital gains tax ratio, and unemployment rate. Three variables. Through the use of the unit root test, cointegration test, Granger causality test and other econometric methods for the above variables, the experimental results show that neither the long-term nor the short-term environmental tax collection brings green dividends in the long-term and short-term. It will bring a certain blue dividend, which will play a role in reducing the distortion of taxes in the short term. In the long run, it can promote economic growth and reflect the blue dividend.

Through the research in this paper, our enlightenment for the design and improvement of China's environmental taxation system is: First, China, as the world's second largest economy, is the largest country in terms of carbon dioxide emissions, although it was implemented on January 1, 2018. The Environmental Protection Tax Law, but this is only the first step in China's environmental tax. In the future, it is still necessary to intensify efforts to continuously improve the Environmental Protection Tax Law. From the perspective of the implementation of the US environmental tax, this is a long one. The process requires the combination of government means and market means. Secondly, drawing on the experience of the United States, due to the failure of taxation means, government control measures cannot be completely replaced by environmental taxation means. Government control means is a useful supplement to environmental taxation means; Third, we should pay attention to the participation of the public and bring the concept of environmental protection to the hearts of the people. The environmental tax not only makes people more aware of environmental issues, but also raises funds for the construction of environmental protection projects, forming a bottom-up and government top-down environmental protection implementation mechanism for the implementation of environmental taxes. A good social environment.

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