Study on The Double Environmental Effects of Trade in Services: Mathematical Analysis of Cross-National Panel Data From 129 Countries

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Abstract

Under the background of the rapid development of trade in services, the double effects of trade in services on environmental quality are studied. This paper constructs the fixed effect panel models of the environmental equation and the economic growth equation, collects the cross-national panel data of 129 countries from 1995 to 2018, uses two-stage regression methods, empirically tests the double environmental effects of trade in services. The results show that the direct effect of trade in services on environmental quality is positive, the indirect effect is negative, and the overall effect of trade in services on environmental quality is positive. In countries with different income levels, the impact of trade in services on the environment is heterogeneous. The total effects of trade in services and services exports trade on environmental pollution are negative in low-income countries, lower middle-income countries and high-income countries, and positive in upper middle-income countries. The total effects of services imports trade on environmental pollution are negative in low-income countries, upper middle-income countries and high-income countries, and positive in lower middle-income countries.

Keywords-*trade in services; direct effect; indirect effect; total effect*

1. INTRODUCTION

Since the entry into force of the general agreement on trade in services on January 1, 1995, global trade in services has developed at an alarming rate. Trade in goods has always been dominant in global trade. However, compared with the growth rate of trade in goods and services since 2005, the growth rate of trade in goods has been 1% slower. In 1995, the total trade in services of 221 countries and regions in the world reached US $2226.3 billion, exceeding US $12071.9 billion in 2018. The average growth rate from 1995 to 2018 was 7.3%. In 2017, trade in services accounted for 23% of the global trade, which will continue to increase in the future. It is expected that the value will exceed 35% in 2040.

Figure 1 shows that the global trade in services (% of GDP) accounted for 15.91% in 1995 and 21.5% in 2018, the average value was 18.55%. The trade in services (% of GDP) of high-income countries is much higher than the world average value, which has exceeded 30% since 2014, and the growth rate is also the fastest, which is related to the relatively developed service industry in high-income countries. The trade in services (% of GDP) of other countries is below the world average value. The growth rate of trade in services in upper middle-income countries is faster than that in lower middle-income countries. Generally speaking, the trade in services (% of GDP) increases with the increase of income level.

S. A. R. Khan et al. (Eds.): ICMSSE 2022, AHCS 12, pp. 81–95, 2023.
https://doi.org/10.2991/978-94-6463-056-5_13

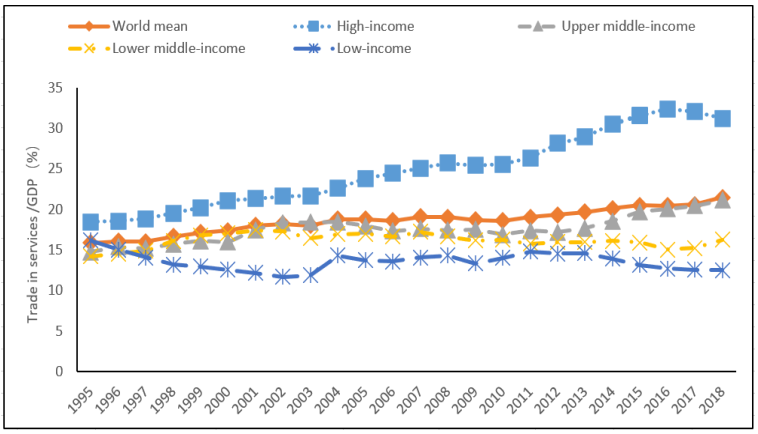

Figure 1. Trade in services (% of GDP) of different income countries

In 1995, the global CO_2 emission was 21.794 billion tons, and then increased year by year, reached 33.143 billion tons in 2018. Figure 2 shows that the CO_2 emissions of high-income countries are much higher than the world average of 4.18 per capita metric tons, the average value was 9.83 per capita metric tons. The average carbon dioxide emissions of upper middle-income countries, lower middle-income countries and low-income countries are 3.62, 1.12 and 0.31 metric tons per capita, there is a positive correlation between CO_2 emissions and per capita income.

The economic growth level is closely related to trade in services. Countries with high per capita income also have a high trade in services (% of GDP). Countries with higher income levels also have higher CO_2 emissions. What is the relationship between trade in services and CO_2 emissions? What role does income level play between trade in services and CO_2 emissions? Based on the above problems, it is of great practical significance to empirically test the relationship between trade in services, economic development and CO_2 emissions.

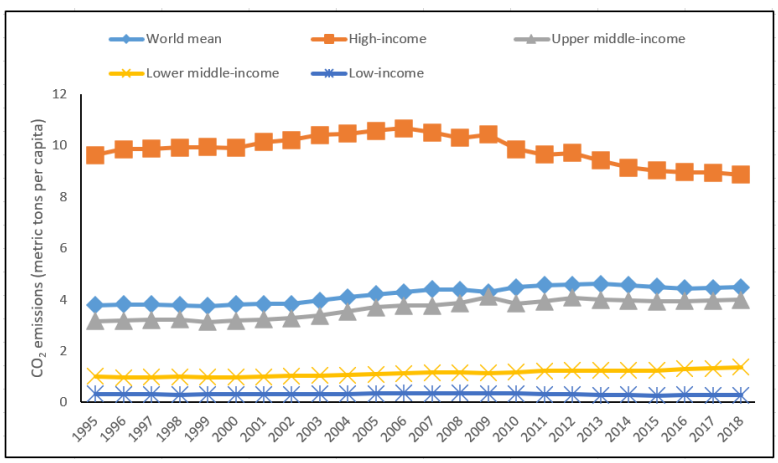

Figure 2. CO_2 emissions of different income countries

2. LITERATURE REVIEW

Scholars at home and abroad have not reached a consensus on the relationship between trade in services and environmental pollution. Different service sectors have different impacts on the environment by assessing the environmental effects of trade in services [1]. The reason why U.S. trade in services helps to reduce its pollutant emissions is that U.S. trade in services itself is concentrated in less polluting industries [2]. Trade in services is not necessarily concentrated in environmentally friendly sectors. Furthermore, they conducted an empirical test using the data of Spanish service sector and carbon dioxide emissions in 2007, and found that carbon dioxide emissions mainly came from the transportation sector, and the environmental effects of hotel catering, wholesale and retail, maintenance and other departments were related to their final demand [3]. The positive correlation between the service sector and carbon dioxide emissions is not caused by the service sector itself, but closely related to the final demand of non-service sectors for the service sector [4]. Domestic scholars Ni Xiaoqian et al. used the panel data of 10 European countries from 1997 to 2007 to evaluate the environmental effects of U.S. trade in services exports, and found that the impact of U.S. trade in services exports on the environment is related to the selected pollutants, and the impact of various service departments on the environment is also different [5]. Li Xiaofeng et al. empirically tested the relationship between trade in

services and carbon dioxide emissions based on the panel data of 50 countries from 1995 to 2009, and found that there was an inverted U-shaped relationship between trade in services and carbon dioxide emissions, but not all countries with different income levels passed the significance test [6].

Whether trade in services can promote economic growth, there are differences in the research conclusions of scholars at home and abroad. Economists have been exploring the relationship between trade and economic growth since the viewpoint of "trade is the engine of economic growth " (Robertson) was put forward. Nurkes affirmed that trade promotes economic growth. He believes that trade promotes the economic growth of some countries because it not only creates short-term static benefits, but also serves as a channel to other sectors, which helps to promote the overall economic prosperity of the region. Some scholars are skeptical about trade promoting economic growth. For example, Bhagwati put forward the view of "Immiserising Growth"[7], and Kravis also believes that "trade is just a maid of economic growth". The above views have been demonstrated in some developing countries, because developing countries are often at a disadvantage in the international division of labor, and trade may not promote their own economic growth [8]. Mazumdar believes that the expansion of trade scale does not necessarily promote economic growth, but also depends on the specific trade structure [9]. In trade in services, enterprise competitiveness is reflected in service industries such as finance, telecommunications and transportation [10]. Dennis R et al. found that foreign trade does not always promote economic growth, but must meet certain conditions [11]. The research conclusions of Chinese scholars all support that trade in services can promote economic growth [12-14].

Environmental economists have long focused on the relationship between economic growth and the environment. Grossman and Krueger concluded that the per capita income level and environmental pollution showed an "inverted U-shape", which was later called EKC by scholars [15]. Other experts who use different theoretical models to prove that the relationship between environmental pollution and economic growth shows an "inverted U-shaped" curve [16-18]. Lindmark analyzed the main reasons why economic activities affect environmental pollution (scale effect, structure effect and technology effect in economic development) [19]. When measuring environmental quality with carbon dioxide emissions, Chinese scholars supported the existence of EKC curve [20-21]. The existence of EKC curve is conditional, which is related to the research area and the selected measurement method [22].

Scholars at home and abroad have discussed the environmental and economic effects of trade in services from trade in services—environmental pollution and trade in services—economic growth, and achieved fruitful results. However, trade in services not only directly affects the environmental quality, but also affects the economic level, which indirectly affects the environment through the EKC. At present, no research has focused on the double effects of "trade in services—environmental pollution" and "trade in services—economic development—environmental pollution". This paper will explore the double effects of trade in services on environmental pollution from the above two paths. At the same time, few scholars study the double effects of trade in services on environmental pollution from the three aspects of trade in services, services imports trade and services exports trade. This paper collects the relevant data of trade in services, economic development level and carbon dioxide emissions of 129 countries from 1995 to 2018, investigates the double effects of trade in services on environmental quality, empirically tests the effects of trade in services, services imports trade and services exports trade on environmental quality through transnational panel data, and puts forward corresponding suggestions.

3. TRADE IN SERVICES, ECONOMIC GROWTH AND ENVIRONMENTAL QUALITY: MECHANISM

It is generally believed that compared with the trade in goods, trade in services belongs to the clean industry and will not produce pollutants such as carbon dioxide that cause damage to the environment. In fact, the scope of the service industry is much more complex than we thought, and the service products themselves will indirectly and potentially affect the environment. For example, the mercury content in San Francisco Bay exceeds the standard seriously. The serious pollution in this area is caused by the waste containing high mercury discarded by dental clinics. WTO divides trade in services into 12 industries, the first is the transportation industry, which will produce harmful gases, air pollution and noise pollution in the process of vehicle transportation. The second is the tourism industry. The construction of tourism facilities will break the ecological balance and cause environmental damage. Harmful products will be used in cleaning and maintenance. Thirdly, construction services, environmental services and other industries, involving the use and disposal of harmful products, water, air and soil pollution to waste disposal sites, etc. Finance, insurance, telecommunications, education and other industries will have an impact on customer behavior, and then have an indirect impact on the environment.

Endogenous economic growth theory holds that the direct variables affecting economic growth include capital, labor, technological progress and institution. The services exports trade will lead to the increase of domestic and foreign investment and the rapid formation

of capital. The change of service trade scale and structure will also have an impact on capital accumulation; With the cross-border flow of factors in international service trade, the structure of service trade will change from labor-intensive services to technology and knowledge intensive services. In order to enhance the competitiveness of international services, a country or region will continue to expand human capital investment. Technical consultation and service, licensing trade and cooperative production are the three main trade modes in the international technology market. Technology transfer has multiplier effect. Trade in scientific and technological services affects technological progress through market transactions. Service trade changes the incentive structure between people by affecting the relative price of factors, forming a positive learning mechanism. At the same time, communication services, education services and tourism services affect values and business philosophy to a certain extent. Trade in services can also affect economic growth by affecting employment. The surplus of trade in services will increase employment opportunities in the service industry, while the deficit countries are just the opposite. In short, trade in services plays an important role in economic growth by affecting capital, labor, technological progress, institution and employment.

Economic growth mainly acts on environmental quality through environmental Kuznets curve, in which the scale, structure and technology of economic growth are the main mechanism of economic growth acting on environmental quality. To sum up, trade in services not only has a direct effect on environmental quality, but also indirectly affects environmental quality through economic growth.

4. METHODS AND MATERIALS

4.1.Methods

In order to empirically study the double effects of trade in services on environmental pollution, the following equation models are proposed: firstly, the environmental equation including service trade factors is introduced; secondly, this paper constructs the equation of service trade and other factors affecting the level of per capita income.

$$co_{2it} = \beta_0 + \beta_1 ser_{it} + \beta_2 ser_{it}^2 + \beta_3 \ln GDP_{it} + \beta_4 ind_{it} + \beta_5 tech_{it} + \beta_6 fdi_{it} + \alpha_i + \varepsilon_{it} \quad (1)$$

$$\ln GDP_{it} = \gamma_i + \varepsilon_t + \alpha_1 ser_{it} + \alpha_2 K_{it} + \alpha_3 \ln L_{it} + \alpha_4 fdi_{it} + \nu_{it} \quad (2)$$

Formula (1) is the emission equation of environmental pollutants, *i, t* represent the country and year respectively, α_i , ε_{it} are the unobservable individual effect and "white noise". co_2 is carbon dioxide emission and represents environmental quality. ser , GDP , ind , $tech$, fdi are the trade in services, economic development level, industrial structure, technological innovation and foreign direct investment. The square term of ser is added to test whether there is a nonlinear relationship between trade in services and carbon dioxide emissions.

Formula (2) draws from Barro et al. [23] solo model which was widely used in the field of economic growth, and economic growth is expressed as a function of trade in services and other economic variables. Where ser is trade in services, K , L, fdi are the total fixed capital formation, human capital and foreign direct investment. γ_i is the national fixed effect, ε_t is the time fixed effect and ν_{it} is the interference term.

Combined with equations (1) and (2) and referring to the empirical technology of Halkos and Paizanos [24], the total, direct and indirect effects of trade in services on environmental pollution are expressed as follows

$$\frac{d(co_2)}{d(ser)} = \frac{\partial(co_2)}{\partial(ser)} + \frac{\partial(co_2)}{\partial(GDP)} \cdot \frac{\partial(GDP)}{\partial(ser)} \quad (3)$$

The left side of the equation is the total effect of trade in services on environmental pollution, and the first part on the right side of the equation is the direct effect of trade in services on environmental pollution, corresponding to the coefficient $\beta_1 + 2\beta_2 ser$ in equation (1). The second part on the right side of the equation is the indirect effect of trade in services on environmental pollution, which is equal to $\alpha_1 \cdot \beta_3$. It can be seen that the direct effect is related to the trade in services, the indirect effect is a constant, and the total effect is equal to the sum of direct effect and indirect effect.

4.2.Variables and Data Source

4.2.1.Explained variables: CO_2 emission and economic development level.

This paper selects carbon dioxide emissions of various countries to measure environmental quality and chooses per capita GDP to measure the level of economic development.

4.2.2.Explanatory variables: trade in services, services imports trade and services exports trade.

Trade in services is generally expressed by trade in services (% of GDP), the services imports trade is expressed by trade in services imports (% of GDP), and the services exports trade is expressed by trade in services

exports (% of GDP). The higher the trade in services, the higher the proportion of the tertiary industry. It is generally considered that the tertiary industry has little impact on environmental pollution. However, the means of transportation required for transportation services will produce carbon dioxide, which will cause a certain degree of damage to the environment. Other services such as finance, computer and communication can also affect the environment by affecting customer behavior. Therefore, the impact of trade in services on environmental pollution remains to be observed.

4.2.3.Other variables.

According to the EKC model, the control variables including industrial structure, economic development level, technological innovation, foreign direct investment are selected to test the impact of trade in services on environmental quality. When testing the impact of trade in services on economic growth, total fixed capital formation, foreign direct investment and the number of labor force are control variables. Table 1 shows the type, name, symbol and definition of each variable.

TABLE 1. NAME AND DEFINITION OF EACH VARIABLE

Type	Name	Symbol	Definition
Explained variable	Carbon dioxide emissions	CO_2	Carbon dioxide emissions, metric tons per capita
	Economic development level	GDP	Per capita GDP, natural logarithm
Explanatory variables	Trade in services	ser	Trade in services / GDP
	Services imports trade	imp	Services imports /GDP
	Services exports trade	exp	Services exports /GDP
Other variables	Industrial structure	ind	Added value of industry (including construction) /GDP
	Technological innovation	tech	GDP per unit of energy use (constant 2011 PPP $ per kg of oil equivalent)
	Foreign direct investment	fdi	Foreign direct investment (net inflow)/GDP
	Capital	K	Total fixed capital formation /GDP
	Labor force	L	Number of labor force, natural logarithm

Excluding some countries with more missing data, we finally selected the transnational panel data of 129 countries from 1995 to 2018, the number of high-income countries, upper middle-income countries, lower middle-income countries and low-income countries are 45, 42, 32 and 10. The data are from the world bank website (https://data.worldbank.org/).

5. RESULTS AND DISCUSSION

5.1.Direct Effect of Trade in Services on Environmental Pollution

The direct relationship between trade in services and CO_2 emissions is tested by continuously adding control variables. The regression results are shown in table 2. Trade in services is significantly negatively correlated with CO_2 emissions. Compared with trade in goods, trade in services generally belongs to clean industry, which has little impact on environmental pollution. The development of trade in services helps to improve environmental quality. The square term coefficients of the trade in services are positive in the regression model, and pass the significance test at the 1% level, trade in services has a U-shaped relationship with CO_2 emissions, but the coefficient value is very small and almost negligible. Industrial structure, economic growth and *fdi* are significantly positively correlated with CO_2 emissions. It can be seen that the scale of economic growth, the industrial structure dominated by the secondary industry and *fdi* are all important reasons to boost the increase of CO_2 emissions, and technological innovation is significantly negatively correlated with CO_2 emissions, continuously strengthening technological innovation will help to reduce CO_2 emissions and improve environmental quality.

TABLE 2. RESULTS OF DIRECT EFFECT OF TRADE IN SERVICES ON ENVIRONMENTAL POLLUTION

	①	②	③	④	⑤	⑥
ser	-0.012***	-0.032***	-0.034***	-0.033***	-0.025***	-0.028***
	(-5.19)	(-6.29)	(-7.10)	(-6.94)	(-5.38)	(-5.70)
ser^2		0.000***	0.000***	0.000***	0.000***	0.000***
		(4.43)	(4.53)	(4.68)	(3.89)	(4.18)
lnGDP			0.557***	0.519***	0.690***	0.690***
			(14.66)	(13.51)	(17.55)	(17.58)
ind				0.024***	0.044***	0.044***
				(5.32)	(9.45)	(9.52)
tech					-0.109***	-0.109***
					(-13.22)	(-13.28)
fdi						0.003***
						(2.26)
_cons	5.002***	5.355***	0.784***	0.367	-0.731**	-0.703**
	(92.26)	(55.57)	(2.41)	(1.10)	(-2.20)	(-2.12)
N	3096	3096	3096	3096	3096	3096
r^2	0.011	0.019	0.098	0.108	0.168	0.170
F	26.925***	23.366***	88.573***	74.255***	98.565***	83.516***

NOTE: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.025$，values in parentheses are t or Z statistic, the same below.

Columns ① ~ ④ in table 3 show the regression results from low to high-income countries. There is a significant U-shaped relationship between the trade in services and CO_2 emissions in low-income and high-income countries, and the value of square term coefficient is still very small. However, the regression coefficient between the trade in services and CO_2 emissions in middle-income countries is not significant. It can be seen that further improving trade in services helps to reduce environmental pollution, and plays the largest role in high-income countries. Because the upstream of the trade in services chain are high-income countries, which mainly export technology and capital, it has little impact on environmental pollution, but helps to alleviate the increase of CO_2 emissions and improve environmental quality.

TABLE 3. RESULTS OF DIRECT EFFECTS OF TRADE IN SERVICES ON ENVIRONMENTAL POLLUTION IN DIFFERENT INCOME COUNTRIES

	①	②	③	④
ser	-0.009**	-0.003	0.000	-0.020**
	(-2.16)	(-0.31)	(0.04)	(-2.10)
ser^2	0.000**	-0.000	-0.000	0.000***
	(2.00)	(-0.37)	(-0.33)	(2.61)
lnGDP	0.098***	0.374***	0.918***	1.345***
	(8.28)	(9.92)	(19.65)	(10.91)
ind	-0.003***	-0.003	-0.011	0.127***
	(-3.20)	(-0.93)	(-1.53)	(7.54)
tech	-0.044***	-0.010*	-0.128***	-0.467***
	(-7.45)	(-1.91)	(-7.21)	(-12.12)
fdi	0.002*	0.037***	-0.005	0.004*
	(1.88)	(6.85)	(-1.38)	(1.89)
_cons	-0.045	-1.483***	-2.044***	-2.866***

	(-0.65)	(-5.46)	(-5.07)	(-2.59)
N	240	768	1008	1080
r^2	0.354	0.228	0.359	0.357
F	16.831***	29.709***	88.643***	78.538***

5.2.Direct Effect of Services Imports Trade on Environmental Pollution

The regression results of the direct effect of trade in services imports on environmental pollution are shown in table 4. The full sample regression results show that (column①) there is a significant negative linear relationship between trade in services imports and carbon dioxide emissions. It can be seen that services imports trade helps to improve domestic environmental quality. In low-income countries (column②), trade in services imports helps to reduce carbon dioxide emissions. In the lower middle-income countries (column③), the relationship between services imports trade and carbon dioxide emissions presents an inverted U-shaped relationship. In upper middle-income countries (column④), the regression coefficient between trade in service imports and carbon dioxide emissions failed to pass the significance test. In high-income countries (column⑤), there is a U-shaped relationship between services imports trade and carbon dioxide emissions, but the square term coefficient is still very small and the first-order coefficient is large. It can be seen that trade in services imports still helps to reduce carbon dioxide emissions of high-income countries. It is estimated that the average of trade in service imports in transportation and tourism industries with heavy environmental pollution in service imports is 44.56% and 51.68% in low-income countries and lower middle-income countries respectively, and 35.58% in high-income countries. It can be seen that in lower middle-income countries, the proportion of transportation and tourism imports in imported service trade exceeds 50%, and the structure of imported service trade is unreasonable, this is also the main reason for its promoting effect on carbon dioxide emissions.

TABLE 4. RESULTS OF DIRECT EFFECTS OF SERVICES IMPORTS TRADE ON ENVIRONMENTAL POLLUTION IN DIFFERENT INCOME COUNTRIES

	①	②	③	④	⑤
imp	-0.029***	-0.012**	0.026*	0.012	-0.045**
	(-3.01)	(-2.04)	(1.79)	(0.74)	(-2.13)
imp^2	0.000	0.000	-0.001*	-0.000	0.000***
	(1.62)	(1.47)	(-1.69)	(-0.07)	(2.43)
lnGDP	0.685***	0.102***	0.384***	0.919***	1.370***
	(17.38)	(8.37)	(9.74)	(19.52)	(11.02)
ind	0.045***	-0.003***	-0.004	-0.010	0.124***
	(9.83)	(-3.36)	(-1.02)	(-1.46)	(7.33)
tech	-0.112***	-0.045***	-0.011**	-0.128***	-0.473***
	(-13.56)	(-7.66)	(-2.09)	(-7.22)	(-12.44)
fdi	0.002	0.003**	0.035***	-0.006	0.004**
	(1.60)	(1.99)	(6.37)	(-1.63)	(1.97)
_cons	-0.919***	-0.072	-1.770***	-2.232***	-2.963***
	(-2.75)	(-1.15)	(-6.38)	(-5.38)	(-2.68)
N	3096	240	768	1008	1080
r^2	0.163	0.357	0.230	0.360	0.356
F	79.081***	17.003***	29.979***	74.056***	78.066***

5.3.Direct Effect of Services Exports Trade on Environmental Pollution

The regression results of the relationship between services exports trade and carbon dioxide emissions are reported in table 5. The full sample regression results (column①) show that there is a significant U-shaped relationship between services exports trade and carbon dioxide emissions, and the square term coefficient is very small and negligible. Compared with the emission reduction effect of services imports trade, it plays a greater role in services exports trade. In low-income countries (column②) and high-income countries (column⑤), the relationship between services exports trade and carbon dioxide emissions is U-shaped, but the square term coefficient is small. In lower middle-income countries (column③), the relationship between services exports trade and carbon dioxide emissions is significantly negative linear. It can be seen that services exports trade helps to improve domestic environmental quality. From the coefficient value, in lower middle-income countries, the role of services exports trade in pollution reduction is the most prominent. In upper middle-income countries (column④), the relationship between services exports trade and carbon dioxide emissions has not passed the significance test. The average proportion of transportation and tourism services exports trade in services exports trade in high-income countries, upper middle-income countries, lower middle-income countries and low-income countries are 41.01%, 57.19%, 49.29% and 38.86% respectively.

TABLE 5. RESULTS OF DIRECT EFFECTS OF SERVICES EXPORTS TRADE ON ENVIRONMENTAL POLLUTION IN DIFFERENT INCOME COUNTRIES

	①	②	③	④	⑤
exp	-0.058***	-0.008*	-0.034***	-0.023	-0.027*
	(-6.97)	(-1.66)	(-2.72)	(-1.26)	(-1.65)
exp^2	0.000***	0.000*	0.000	0.000	0.000***
	(5.31)	(1.81)	(1.15)	(0.48)	(2.38)
lnGDP	0.702***	0.096***	0.381***	0.919***	1.319***
	(17.92)	(8.12)	(10.41)	(19.69)	(10.75)
ind	0.043***	-0.003***	-0.004	-0.011	0.131***
	(9.32)	(-3.38)	(-1.10)	(-1.56)	(7.81)
tech	-0.110***	-0.041***	-0.011**	-0.125***	-0.468***
	(-13.44)	(-6.88)	(-1.99)	(-7.03)	(-11.99)
fdi	0.003**	0.002*	0.037***	-0.005	0.003*
	(2.18)	(1.72)	(7.13)	(-1.37)	(1.65)
_cons	-0.758***	-0.101	-1.378***	-1.936***	-2.856***
	(-2.33)	(-1.54)	(-5.51)	(-4.82)	(-2.58)
N	3096	240	768	1008	1080
r^2	0.175	0.353	0.240	0.361	0.357
F	86.420***	16.738***	31.625***	74.441***	78.570***

Comparing the impact of trade in services, services imports trade and services exports trade on environmental quality, we find that trade in services generally helps to improve environmental quality. From the value of regression coefficient, services exports trade is more conducive to pollution reduction. Comparing the relationship between trade in services and environmental quality in countries with different income levels, low-income countries and high-income countries mainly play a positive role, the relationship between services in trade and environmental pollution in upper middle-income countries is not significant, the relationship between services imports trade and environmental pollution in lower middle-income countries shows an inverted U-shaped relationship, and services exports trade helps to improve environmental quality. The relationship between services imports and services exports trade and environmental pollution in upper middle-income countries is not significant.

5.4. Economic Growth Effect of Trade in Services

The empirical results of the relationship between trade in services and economic growth are shown in table 6. Firstly, all samples are regressed (column①). The results show that there is a significant positive correlation between economic growth and the trade in services. However, in low-income countries (column②) and lower middle-income countries (column③), the relationship between economic growth and trade in services is significantly negatively correlated. In upper middle-income countries (column④) and high-income countries (column ⑤), there is a significant positive correlation between trade in services and economic growth. Among them, in high-income countries, the trade in services contributes the most to economic growth. The possible explanation is that low-income or lower middle-income countries are at the end of the trade in services industrial chain, mainly exporting labor, there is an "Immiserising Growth" situation, so the trade in services not only does not promote but also inhibits economic growth.

TABLE 6. RESULTS OF THE RELATIONSHIP BETWEEN TRADE IN SERVICES AND ECONOMIC GROWTH

	①	②	③	④	⑤
ser	0.001*	-0.012***	-0.013***	0.001*	0.003***
	(1.73)	(-2.43)	(-3.96)	(1.66)	(3.92)
K	0.012***	0.010***	0.002	0.036***	0.003
	(6.77)	(3.26)	(0.49)	(9.53)	(1.04)
lnL	2.436***	2.165***	2.896***	2.509***	1.751***
	(39.07)	(21.10)	(25.24)	(19.34)	(17.35)
fdi	-0.000	0.002	0.009**	-0.015***	0.001
	(-0.83)	(0.40)	(2.01)	(-6.32)	(1.12)
_cons	-29.223***	-27.761***	-38.263***	-30.589***	-16.632***
	(-30.88)	(-17.57)	(-21.30)	(-15.57)	(-11.06)
N	3096	240	768	1008	1080
r^2	0.415	0.747	0.535	0.437	0.332
F	426.287***	137.065***	173.386***	150.048***	103.524***

5.5. Economic Growth Effect of Services Imports Trade

The regression results of the relationship between services imports trade and economic growth are shown in table 7. In lower middle-income countries (column③) and upper middle-income countries (column④), services imports trade inhibits economic growth, and in high-income countries (column⑤), services imports trade significantly promotes economic growth. In low-income countries (column②) and full sample (column①), the regression results show that the relationship between services imports trade and economic growth does not pass the significance test.

TABLE 7. RESULTS OF THE RELATIONSHIP BETWEEN SERVICES IMPORTS TRADE AND ECONOMIC GROWTH

	①	②	③	④	⑤
imp	0.001	-0.007	-0.018***	-0.015**	0.008***
	(0.28)	(-0.82)	(-3.33)	(-2.17)	(4.23)
K	0.012***	0.009***	0.001	0.038***	0.003
	(6.74)	(3.09)	(0.23)	(10.02)	(1.06)
lnL	2.443***	2.161***	2.847***	2.471***	1.750***
	(39.33)	(20.68)	(24.23)	(19.11)	(17.48)
fdi	-0.000	-0.000	0.010**	-0.014***	0.001
	(-0.67)	(-0.02)	(2.10)	(-5.95)	(1.06)

_cons	-29.310***	-27.808***	-37.526***	-29.911***	-16.624***
	(-31.07)	(-17.32)	(-20.34)	(-15.29)	(-11.13)
N	3096	240	768	1008	1080
r^2	0.414	0.740	0.531	0.440	0.334
F	425.865***	132.077***	170.974***	152.108***	104.462***

5.6. Economic Growth Effect of Services Exports Trade

Table 8 reports the relationship between services exports trade and economic growth. The full sample regression results (column①) show that services exports trade significantly promotes economic growth, but in low-income countries and lower middle-income countries (columns ②-③), services exports trade inhibits economic growth, and lower middle-income countries perform more significantly than low-income countries, especially in upper middle-income and high-income countries (columns④-⑤). There is a significant positive correlation between services exports trade and economic growth, indicating that services exports trade helps to promote economic growth and plays a greater role in upper middle-income countries.

TABLE 8. RESULTS OF THE RELATIONSHIP BETWEEN SERVICES EXPORTS TRADE AND ECONOMIC GROWTH

	①	②	③	④	⑤
exp	0.003**	-0.017**	-0.021***	0.020***	0.006***
	(1.98)	(-2.21)	(-3.52)	(3.15)	(3.51)
K	0.013***	0.010***	0.002	0.035***	0.003
	(6.84)	(3.27)	(0.56)	(9.44)	(0.97)
lnL	2.427***	2.127***	2.972***	2.551***	1.760***
	(38.83)	(20.58)	(25.76)	(19.81)	(17.35)
fdi	-0.001	-0.003	0.006	-0.015***	0.001
	(-0.99)	(-0.68)	(1.45)	(-6.45)	(1.23)
_cons	-29.090***	-27.245***	-39.510***	-31.365***	-16.751***
	(-30.69)	(-17.05)	(-21.97)	(-16.10)	(-11.08)
N	3096	240	768	1008	1080
r^2	0.415	0.745	0.532	0.444	0.330
F	427.504***	136.098***	171.633***	154.432***	102.413***

5.7. Double Effects of Trade in Services on Environmental Pollution

Since the total effect and direct effect are related to the trade in services, the results in table 10-12 are calculated according to the average value of trade in services in the sample period.

On the whole, the trade in services helps to reduce carbon dioxide emissions (table 9), in which the direct effect is -0.028, the indirect effect is 0.001, and the total effect is -0.027. However, in countries with different income levels, the impact of trade in services on environmental pollution is heterogeneous. It has both direct and indirect effects in low-income and high-income countries, and the total effect is negative. It can be seen that the trade in services in low-income and high-income countries will help reduce carbon dioxide emissions, it plays the most important role in high-income countries. In lower middle-income countries and upper middle-income countries, the direct effect of trade in services on environmental pollution is not significant, mainly manifested in indirect effects. In lower middle countries, vigorously developing trade in services helps to reduce carbon dioxide emissions, but in upper middle-income countries, the conclusion is the opposite, because the direct effect of service trade in upper middle-income countries needs to be observed, However, trade in services has significantly promoted economic growth. Economic growth has promoted the increase of carbon dioxide emissions through scale effect, so it is generally positive.

TABLE 9. DOUBLE EFFECTS OF TRADE IN SERVICES ON ENVIRONMENTAL POLLUTION

	Full sample	Low-income	Lower middle-income	Upper middle-income	High-income
Direct effect	-0.028 ***	-0.009**	-0.003	0.000	-0.020 **
Indirect effect	0.001	-0.001	-0.005	0.001	0.004
Total effect	-0.027	-0.010	-0.005	0.001	-0.016

The calculation results of the double effects of services imports trade and services exports trade on environmental pollution are shown in table 10-11. Both services imports trade and services exports trade help to reduce carbon dioxide emissions. Services exports trade has the greatest effect on carbon dioxide emission reduction. Especially in low-income and high-income countries, the import and export of services will significantly improve their environmental quality. However, in lower middle-income countries, the relationship between services imports trade and export service trade and carbon dioxide emissions is opposite. Among them, services imports trade is not conducive to improving environmental quality, and only services exports trade helps to reduce environmental pollutant emissions. On the contrary, in upper middle-income countries, services imports trade will help to reduce environmental pollutant emissions, while services exports trade will exacerbate domestic environmental pollution.

TABLE 10. DOUBLE EFFECTS OF SERVICES IMPORTS TRADE ON ENVIRONMENTAL POLLUTION

	Full sample	Low-income	Lower middle-income	Upper middle-income	High-income
Direct effect	-0.029***	-0.012**	0.026*	0.012	-0.045**
Indirect effect	–	–	-0.007	-0.014	0.011
Total effect	-0.029	-0.012	0.019	-0.014	-0.034

TABLE 11. DOUBLE EFFECTS OF SERVICES EXPORTS TRADE ON ENVIRONMENTAL POLLUTION

	Full sample	Low-income	Lower middle-income	Upper middle-income	High-income
Direct effect	-0.058***	-0.008*	-0.034***	-0.023	-0.027*
Indirect effect	0.002	-0.002	-0.008	0.018	0.008
Total effect	-0.056	-0.010	-0.042	0.018	-0.019

5.8.Robustness Test

This paper uses placebo to test the environmental and economic effects of trade in services. Firstly, we keep the control variables corresponding to carbon dioxide emissions, and randomly assign the core explanatory variables including trade in services, services imports trade and services exports trade to each country for re estimation. The randomly assigned trade in services, services imports trade and services exports trade regression coefficients are not significant (table 12, equations①-③). Secondly, we test the economic growth effect of trade in services in the same way. The results show that the regression coefficients of the randomly distributed trade in services, services imports trade and services exports trade are still not significant (equation④-⑥), the research results are stable.

TABLE 12 ROBUSTNESS TEST RESULTS OF ENVIRONMENTAL AND ECONOMIC EFFECTS OF TRADE IN SERVICES

	①	②	③	④	⑤	⑥
Explained variable	CO_2	CO_2	CO_2	lnGDP	lnGDP	lnGDP
ser	-0.002			0.000		

	(-1.07)			(1.27)		
ser^2	0.000					
	(0.58)					
imp		-0.000			0.001	
		(-0.12)			(0.99)	
imp^2		-0.000				
		(-0.26)				
exp			-0.004			0.001
			(-1.24)			(1.35)
exp^2			0.000			
			(0.66)			
lnGDP	0.686***	0.685***	0.687***			
	(17.40)	(17.38)	(17.41)			
ind	0.047***	0.047***	0.047***			
	(10.35)	(10.36)	(10.33)			
tech	-0.118***	-0.117***	-0.117***			
	(-14.36)	(-14.35)	(-14.36)			
fdi	0.001	0.001	0.001	-0.000	-0.000	-0.000
	(0.58)	(0.60)	(0.58)	(-0.62)	(-0.62)	(-0.61)
K				0.012***	0.012***	0.012***
				(6.72)	(6.73)	(6.72)
lnL				2.444***	2.445***	2.443***
				(39.51)	(39.52)	(39.49)
_cons	-1.182***	-1.204***	-1.188***	-29.322***	-29.336***	-29.309***
	(-3.66)	(-3.72)	(-3.68)	(-31.17)	(-31.18)	(-31.15)
N	3096	3096	3096	3096	3096	3096
r^2	0.158	0.158	0.158	0.415	0.415	0.415
F	76.596***	76.391***	76.704***	426.524***	426.254***	426.611***

6. CONCLUSIONS AND ENLIGHTENMENT

6.1.Conclusions

The results show that for every 1% increase in trade in services (% of GDP), carbon dioxide emissions will be reduced by 0.028 per capita metric tons, for every 1% increase in services imports trade (% of GDP), carbon dioxide emissions will be reduced by 0.029 per capita metric tons, and for every 1% increase in services exports trade (% of GDP), carbon dioxide emissions will be reduced by 0.058 per capita metric tons. The development of trade in services helps to reduce the emission of environmental pollutants, and the expansion of trade in services has a positive direct effect on the improvement of environmental quality.

In countries with different income levels, the impact of trade in services on the environment is heterogeneous. In terms of direct impact, for each 1% increase in trade in services (% of GDP), the carbon dioxide emissions of low-income and high-income countries will be reduced by 0.009 and 0.020 per capita metric tons, while that is not significant in middle-income countries. In terms of indirect impact, for every 1% increase in trade in services (% of GDP), the economic level of low-income and lower middle-income countries will decrease by 0.012% and 0.013%, while the economic level of upper middle-income and high-income countries will increase by 0.001% and 0.003%. Economic growth has a positive effect on the emission of environmental pollutants in countries with different income levels. The elastic value of income level on the emission of environmental pollutants is 1.345, 0.918, 0.374 and 0.098 from high-income countries to low-income countries. Considering the direction and value of direct and indirect double effects, the total effect of trade in services on

environmental pollution in low-income, lower middle-income, upper middle-income and high-income countries are -0.010, -0.005, 0.001 and -0.016 respectively. The total effect of services imports trade on environmental pollution in the above four categories of countries are -0.012, 0.019, - 0.014 and -0.034. The total effect of services exports trade on environmental pollution in the above four categories of countries are -0.010, - 0.042, 0.018 and -0.019.

6.2.Enlightenment

First of all, compared with the traditional trade in goods, trade in services itself belongs to the clean industry, but trade in services can not only have a direct impact on the environment by generating harmful gases, but also affect the level of economic development, and then have an indirect impact on the environment, and the latter plays a more important role. Although trade in services can improve environmental quality, the fact that economic development has a destructive effect on the environment cannot be reversed, so the positive effect of trade in services on the environment has been reduced or squeezed out.

Secondly, the total environmental effects of trade in services and trade in services exports in upper middle-income countries are positive, indicating that the development of trade in services does not help to reduce the emission of environmental pollutants. China is one of the upper middle-income countries. We vigorously develop trade in services, especially services exports trade, at the expense of our own environment. We need to think about whether the product structure of services exports trade is reasonable? What is the negative impact of services exports trade on our consumption behavior? According to the data of China Business Data Center in 2020, China's total services exports trade was 280.6 billion US dollars, a decrease of 1% over the previous year. In terms of industry distribution, other business services ranked first, the value was $74.81 billion, followed by tourism and transportation services. Its total trade volume was $73.14 billion, which accounted for 26.06% in trade in services. These are the two major departments that have an important impact on environmental pollution. Low pollution industries with high-tech content, such as finance, account for less than 2%. From the perspective of sustainable development, the structure of services exports trade is weak, which is closely related to many problems in the fields of environment, education and so on. Only by adjusting the structure of services exports trade and changing the wrong orientation of vigorously developing the scale of trade in services can we help alleviate and improve the problem.

ACKNOWLEDGMENT

This research has been supported by the Science and Technology Research Program of Chongqing Municipal Education Commission (Grant No. KJQN202101509)

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