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Analysis of the Impact of Green Trade Barriers on China's Fruit Exports to Japan, the United States and South Korea: A Trade Gravity Model

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Abstract: In 2021, China's Yali pear was rejectedby Japanese Customs due to a residue of 0.02ppm exceeding the standard of thiamethoxam, which instantly fermented in major Chinese social networks and sparked heated discussions. This incident exemplifies green trade barriers, particularly Japan's "positive list system." As a leading fruit exporter, China has been subject to green trade barriers due to environmental pollution and other problems, which has also led to fluctuations in China's fruit exports in recent years. Existing studies mostly focus on the overall study of green trade barriers on agricultural products, and there is almost no research on the impact of green barriers on fruits. Therefore, this paper expands the trade gravity model through statistical analysis to examine the impact of green trade barriers on China's fruit exports to the United States, Japan, and South Korea. The findings reveal that green trade barriers negatively affect China's fruit exports. Finally, according to the regression results, some practical suggestions are given based on the actual situation of each country.

Keywords: Green trade barriers, Trade gravity model, China's Fruit Exports, TBT/SPS

1. Introduction

As is widely known, President Trump launched a large number of tariffs on other countries as soon as he took office, which hindered the process of globalization. In today's context, in addition to traditional tariff barriers, green trade barriers have emerged as a new type of tariff barriers that can protect both the environment and domestic industries.

Now, China's agricultural products have often been constrained by green trade barriers. Previous studies have demonstrated that Green trade barriers have a significant negative impact on agricultural exports [1]. However, compared to other agricultural products (e.g., cereals, legumes, vegetables and other necessities), fruit is a non-essential agricultural product, and it has certain particularitie This paper aims to explore the impact of green trade barriers on the fruit.

China is a major fruit producer, with a total fruit production of 312 million tonnes in 2022, accounting for 30% of the woeld's total production[2]. At the same time, China's fruit export scale is 4.03 million tons, ranking fifth in the world[3]. Among the top 20 fruit export trading partners in China, only three countries have imposed a large number of green trade barriers against China, namely the United States, Japan and South Korea[4]. Therefore, this paper investigates the impact of

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green trade barriers on China’s fruit exports to these three countries through the extended model of the gravitational model.

In terms of research methodology, some scholar consider the green trade barrier as a dummy variable.[5]. However, this apporach can introduce errors, which is why this paper use Technical Barriers to Trade (TBT/SPS) (HS:08) to express the degree of green trade barriers. Additionally, in order to avoid multicollinearity, this article excludes Chinese per capita Gross Domestic Product. This approach provides a more detailed and intuitive research methodology.Based on the empirical results and the actual situation, this paper gives differentiated strategies to distinguish the fruit markets of the United States, Japan and South Korea, and provides data support for the government to formulate coping strategies and enterprises to adjust their export layout, which is of great significance for promoting the high-quality development of agriculture.

2. Literature review

In previous research, scholars have focused on the overall research on the impact of green trade barriers on agricultural products, and limited focus on the impact of green trade barriers on fruits. For example, Peihua Zhao explains the impact of green trade barriers and fiscal expenditure on the export volume of agricultural products, the impact varies from region to region.[1]. The earliest analysis of green trade barriers for a particular product in agricultural products dates back to 2007, when Gu et al. used a gravitational model to analyze the impact of green trade barriers on China's tea exports to Japan, the author mainly introduced green trade barriers into the model as a dummy variable [6-7]. Now there are many ways to study green trade barriers. Miao Miao used CMS to explain the impact of green trade barriers on China's aquatic exports [8]. JIANG Ling used pesticide residue limits (MRLs) in vegetables to represent green barriers to trade [9]. In this paper, we will use the TBT/SPS (HS:08) issued by foreign countries to measure the degree of green trade barriers, so as to make the regression results more accurate. At the same time, because the previous studies mostly focus on the overall agricultural products and ignore the particularity of the fruit category (high standards, seasonality), the degree of green trade barriers of fruits in this paper is complementary to the previous articles. The conclusions of this paper provide an important reference for the Chinese fruit market.

3. Methodology

3.1. Introduction to the experiment

This paper utilizes the fruit export data of Japan, the United States, and South Korea in the 20 years from 2004 to 2023. It makes assumptions based on the gravitational model, which was first introduced by Tinbergen, and has been widely used to analyze the trade flows of different products with varying levels of aggregation in different countries and regions[10]. In its simplest form, the gravity model posits that bilateral trade volumes are directly proportional to the GDP of the two countries and inversely proportional to the distance between them.

This paper expands on the traditional gravitational model. To avoid multicollinearity, the model excludes the domestic GDP of China, as it remains constant for the three countries under study in any given year. This simplifies the model by focusing solely on the impact of green trade barriers on China’s fruit exports to foreign markets.

Moreover, Jacob Wood et al. examined the negative impact of SPS on agricultural exports, finding that while the results were statistically insignificant, they triggered reactions from individual countries[11] Therefore, in order to avoid insignificant results, this paper selects the number of SPS/TBT standard documents on fruits (HS code 08) to measure the degree of green trade barriers, which is more accurate.

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In addition to green trade barriers, the paper also includes three variables: GDP per capita in foreign countries, the exchange rate of RMB against foreign currencies, and distance × oil prices (transportation costs). This makes the regression results of this paper more convincing.

$$\begin{aligned} \ln\ \text{export}_{ijt} &= \beta_0 + \beta_1 \ln\ \text{SPS}_{jt} + \beta_2 \ln\ \text{GDPper}_{jt} + \beta_3\ \text{REER}_{ijt} \\ &+ \beta_4 \ln\ \text{disoil}_{ijt} + \varepsilon_{ijt} \end{aligned} \tag{1}$$

Tips: i=China, j=Japan/United States/South Korea, t=time (years).

Table 1: Explanation

	Meaning	Explanation	Symbol	Data source
SPS_{jt}	The number of SPS and TBT issued by foreign countries regarding the HS code of 08 for fruits, which measures the degree of green trade barriers to fruits.	The higher the number of SPS/TBT releases, the stricter the control of foreign fruits, so it will discourage exports.	-	ePing SPS&TBT platform
$GDPper_{jt}$	GDP per capita of a foreign country	The higher the GDP per capita in a foreign country, the higher the level of consumption per capita, which can boost China's fruit exports.	+	World Development Indicators
$REER_{ijt}$	The exchange rate of the Chinese Yuan against foreign currencies	The RMB is based on the direct pricing method. The higher the exchange rate, the more expensive the goods exported by China and the less competitive Chinese fruit in the international market, which will hinder exports.	-	National Bureau of Statistics of China , IMF Data
$disoil_{ijt}$	(The distance from China to a foreign country)*(the price of oil)	DIS Oil measures the cost of transportation, the higher the cost of transportation, the lower the volume of fruit exported by China.	-	Statistics , FRED
$export_{ijt}$	The trade value of fruits exported from China to foreign countries (explanatory variable)		Data source: UN Comtrade (HS code 08)	

3.2. Experimental process

3.2.1. Summarize

Table 2: Summary statistics

VarName	Obs	Max	Min	Mean	SD
Export	60	19.356	17.052	18.312	0.727
SPS	60	3.638	0.000	1.992	1.040
REER	60	8.277	0.005	2.323	3.282
GDPper	60	11.324	9.711	10.565	0.354
Disoil	60	19.061	13.848	16.108	1.175

First, to prevent the variables from being too different from each other, the logarithm of export, GDPper, disoil, and SPS is taken. According to Table 2, the maximum value of China’s fruit exports is 19.356 and the minimum value is 17.052, which indicates that China’s total fruit exports fluctuates slightly. Meanwhile, the logarithmic distribution of the number of fruits published by SPS/TBT showed a change from 0 to 3.636, indicating considerable fluctuation in the number of SPS/TBT regulations.

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3.2.2. CorrelateTest and VIF test

Table 3: VIF test

Variable	VIF	1/VIF
Disoil	3.740	0.267
REER	3.410	0.293
GDPper	2.820	0.355
SPS	1.890	0.530
Mean VIF	2.970	

Before performing regression, the correlation test and multicollinearity test is taken. The correlation test results show that most variables do not exhibit a high degree of correlation (with absolute values less than 0.8). However, to further ensure the robustness of the results, a variance inflation factor (VIF) test is performed. As shown in Table 3, the VIF values are all below 10, indicating that there is no significant multicollinearity, and regression analysis can proceed.

3.2.3. Model selection

The conventional regression models are mixed-effect, random-effects, and fixed-effect. To determine the most appropriate model for this study, a Hausman test is performed. The test results showed a P value of 0.0000 (Prob >chi2 = 0.0000), leading to the rejection of the null hypothesis. Therefore, the fixed-effect model is chosen for the regression analysis.

3.3. Analysis of results

Table 4: Regression results

	(1) Fixed model	(2) Robustness test
VARIABLES	export	export
SPS	-0.138***	
	(0.0457)	
L.SPS		-0.126**
		(0.0532)
REER	-0.384***	-0.359***
	(0.0678)	(0.0845)
GDPper	0.680***	0.725***
	(0.137)	(0.152)
disoil	-0.0651*	-0.0562
	(0.0357)	(0.0387)
Constant	13.34***	12.65***
	(1.610)	(1.765)
Observations	60	57
Number of id	3	3
R-squared	0.659	0.573

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

From the regression results, at the 1% significance level, there is a significant negative relationship between the number of SPS/TBT documents on fruit H S code 08 and the export value of Chinese fruits to the three countries, and its parameter is negative -0.138, which proves that for every 1% increase in the logarithm of SPS/TBT (HS code 08), the logarithm of China's fruit exports to Japan, the United States and South Korea will decrease by 0.138%, which reflects the restriction of green trade barriers on export activities.

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The coefficients for the other variables align with expectations. The exchange rate is inversely proportional to the export value of fruits (-0.384), and the coefficient of GDP per capita abroad is directly proportional to the export value of fruits (0.68), and they are both significant at the 1% significance level. The transportation cost (disoil) is inversely proportional to the export value of fruits (-0.0651), which is significant at the level of 10%, and the reason for its low coefficient may be that for fruits, which are easily corroded, transportation speed may be more important than transportation costs in order to ensure freshness. Moreover, for fruit trade, fruit suppliers usually enter into long-term and effective agreements to lock in transportation prices, meaning short-term fluctuations in transport costs have minimal impact on the actual volume of Chinese fruit exports.

Additionally, to enhance the reliability of the data, this paper conducts a robustness test thattests the robustness of the results by lagging the core explanatory variable SPS by one period. As shown in Table 4, the SPS with a lag period still passed the robustness test, proving the accuracy of the regression data.

4. Discussion

Based on the results of the regression analysis, green trade barriers have a negative impact on China's fruit exports to Japan, the United States and South Korea. However, each country has a different legal and standard system, requiring tailored recommendations for each of the three countries.

4.1. Japan

Japan is deficient in fruit resources and relies heavily on fruit imports, making it theoretically a significant market for Chinese fruit. However, the reason why fruit trade between China and Japan has been hampered is that Japan has one of the strictest agricultural product control systems in the world, with an average inspection circumference of 21 days and about 200 new standards updated every year. Its core barrier, the "positive list system", has set a limit of more than 800 pesticide residues. Therefore, It can be asserted that the fruit trade between China and Japan has the following three characteristics:

Broad fruit trade prospects, Strict standard system, and Relatively stable China-Japan relationships.

Strengthen green control, solve the problem of pesticide residues from the source, accelerate the development of electronics, and promote the interconnection of fruit e-commerce platforms between China and Japan.

4.2. United States

For the United States, the competition between China and the United States has been fierce in recent years, especially after Trump took office, and the number of tariff and non-tariff policies issued are very frequent. For example, in 2023, the FDA will increase the sampling rate of Chinese fruits to 15%. (5% globally average) Therefore, the political factor in the United States will play a more dominant role in the fruit trade volume between China and the United States.

It is suggested that China expands diversified fruit sales platforms to reduce dependence on the U.S. fruit export market.

4.3. South Korea

South Korea represents a combination of political factors and technical constraints. The China-South Korea Free Trade Area (FTA) is China's largest trade zone to date, yet the political situation in South Korea is complex, with intense bipartisan struggles. This creates both risks and opportunities for the

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Chinese fruit market in South Korea. South Korea's core barrier is the "origin labeling system," which poses challenges for Chinese fruit exports.

Sign long-term strategic fruit contracts, such as those under the Regional Comprehensive Economic Partnership (RCEP), to help alleviate political instability and secure trade agreements.

Improve the transparency of the supply chain to meet South Korea's "origin labeling system" standards, ensuring better traceability and compliance with labeling requirements.

These country-specific recommendations aim to help Chinese fruit exporters navigate green trade barriers more effectively and optimize their strategies in response to the unique challenges posed by each market.

5. Conclusion

This paper expands the application of the gravitational model, excludes the GDP per capita, adds many new control variables, and innovatively uses the number of SPS/TBT (HS code 08) documents to express the degree of green trade barriers. The regression analysis of the impact of green trade barriers on China's fruit exports to Japan, the United States, and South Korea reveals statistically significant negative effects. Based on these findings, the paper offers targeted policy suggestions for the Chinese government, such as improving the transparency of the supply chain, strengthening green control measures, and enhancing product quality.

Despite these contributions, there are still several areas for improvement in this study. First, for the accuracy of the experimental results, this paper selects countries with large fruit exports and high green trade barriers, including Japan, the United States and South Korea, so the final data sample is only 60. However, due to the limited space of this article, it only summarizes the basic situation of the three countries and some suggestions. Future research could further explore policy recommendations in greater detail and consider a wider range of countries and variables to deepen the analysis.

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