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Trade Creation or Diversion?—Evidence from China's Forest Wood Product Trade

Lei Gao [1], Taowu Pei [2,*] and Yu Tian [3]

[1] School of Economics and Management, Yanshan University, Qinhuangdao 066004, China; gaolei@ysu.edu.cn or gkbmaster@yeah.net
[2] College of Economics and Management, China Agricultural University, Beijing 100083, China
[3] Institute of Ancient Books, Jilin University, Changchun 130012, China; yutian19@mails.jlu.edu.cn
* Correspondence: peitaowu@cau.edu.cn

Abstract: In recent years, trade protectionism and unilateralism have prevailed, and countries around the world have imposed restrictions on log exports. It has also become more difficult for China to import wood resources and export deep-processed wood forest products. Based on panel data from 2000 to 2019, this study uses social network analysis to measure the level of the Chinese wood forest product trade network, takes the Chinese free trade agreements (FTAs) as the natural experiment, and uses the multi-stage double-difference method to investigate the impact of the signed FTAs on China's wood forest product trade. The study finds that the trade network of Chinese wood forest products is becoming increasingly complex, and the central position of China and the Association of Southeast Asian Nations (ASEAN) in the network is increasing year by year. The signing of FTAs has had a significant positive impact on the trade of wood forest products in China and a significant trade creation effect. This finding remains true after conducting the placebo test and propensity score-matched regression control. At the same time, the import of wood forest products in China will have a significant trade transfer effect due to the signing of FTAs, and this will not affect exports. Although FTAs show significant trade creation and trade transfer effects in China's wood forest product trade, they also increase, to a certain extent, the mismatch of forest resources worldwide.

Keywords: forest products; wood products; wood market; FTA; trade

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1. Introduction

Since the initiation of China's reform and opening up, the nation's wood industry and the import–export trade of forest wood products have grown rapidly [1]. According to the Forest Products Yearbook (2019) published by the United Nations Food and Agriculture Organization (FAO), China's trade in forest wood products accounted for 11.06% of the global total. Notably, China's imports of timber, sawnwood, and wood pulp represent significant proportions at 44.18%, 25.55%, and 38.95%, respectively, compared with worldwide imports in these categories [2]. Furthermore, China dominates global plywood exports, with a share of 32.11%. However, this basic pattern of high dependence on international forest resources and product markets [3], and China's long-term export trade growth in the forest wood products industry with a high input, high output, and low-price competition, has resulted in Chinese forest wood products being stuck at the lower end of the global value chain, which makes them highly vulnerable to price fluctuations in international markets. Therefore, it is crucial for the development of China's forest wood product industry to resolve the risks posed in the international market.

International economic and trade patterns have changed rapidly in recent years. An atmosphere of trade protectionism and unilateralism has prevailed, and countries around the world have imposed restrictions on log exports, and challenges to China's wood resource imports and the export of deep-processed forest wood products have increased. Nevertheless, the deepening of globalization and the prevalence of offshore production have made global economic and trade relations stronger [4–6]. FTAs are an important measure for maintaining the stability of global economic and trade networks as the predominant carrier of trade relations. FTAs are an indispensable institutional guarantee for the development of regional value chains. A high-standard FTA that includes investment, intellectual property rights, competition policy, and other provisions can strengthen economic and trade links among members more effectively, promote the integration of production and supply chains, and reduce cost and uncertainty risks [7]. As of May 2022, the number of effective FTAs worldwide had reached 355, with each World Trade Organization member country signing at least one FTA [8,9]. Thus far, China has signed 22 FTAs involving 29 countries, including agreements with ASEAN, New Zealand, Australia, and other economies with rich forest resources and broad international markets. Although the trade creation effect of FTAs is conducive to the vigorous development of the forest wood product industry among FTA member countries, the trade diversion effect that FTAs can cause also increases the mismatch risk of forest resources worldwide and negatively affects the development of the forest wood product industry in countries that do not enter into FTAs [10–12]. Therefore, given the current circumstances of FTAs and China's forest wood product trade development, analyzing the trade effect of FTAs on China's forest wood products can help clarify the dynamic mechanisms of regional trade liberalization on the development of China's forest wood product trade to analyze potential future trends and the development trends of forest wood products worldwide, providing valuable insights for strategic government trade policy development.

We selected 40 countries that exhibited the highest value of forest wood product trade with China from 2000 to 2019 as research samples to explore the trade effect of FTAs. We argue that bilateral and multilateral economic cooperation leads to a mutually beneficial outcome, enhancing the welfare of all trading member countries. There are three major innovations in this paper: (a) Employing the social network analysis method, we meticulously examined the global trade patterns of forest wood products with a specific focus on China's evolution. (b) Unlike previous studies that have predominantly examined the trade effect of FTAs within the general equilibrium framework, we used a staggered difference-in-differences (DID) model to explore the trade creation and trade diversion effects of FTAs on China's forest wood product trade. (c) By conducting a heterogeneity analysis, our study further elucidates the trade diversion effects of FTAs on China's forest wood product trade and proposes valuable countermeasures for developing the global forest wood product industry.

The remainder of this paper is organized as follows. Section 2 includes a review of previous work conducted from relevant theoretical and empirical perspectives. Section 3 introduces the study subjects and data sources. Section 4 measures the trade network of Chinese forest wood products. Section 5 analyzes FTAs' influence on China's trade of forest wood products. Section 6 provides the discussion. Section 7 presents the conclusions and proposed policy implications.

2. Literature Review

2.1. Literature on Forest Wood Product Trade

The existing literature on the trade in forest wood products can be generally divided into two categories. The first category investigates the competitive and complementary studies of forest product trade in different countries. The second category includes studies examining the impact of policy shocks on the trade of forest wood products.

Su et al. [13] conducted research on the competitiveness and complementarity of the forest product trade in different countries. From the perspective of product complementarity analysis, Gorbachev argued that China and Russia have a complementary relationship regarding some forest wood products. Evgeniy [14] confirmed this, asserting that there is great potential for cooperation and trade between the two countries. Long et al. [15] found that the forest wood trade involves competition among all continents, but the intensity of this competition has decreased. Second, the core countries in the competitive network and the peripheral countries, China, Japan, and the United States, have had an important influence on the evolution of the core–peripheral structure of the forest product trade.

Buongiomo [16] conducted research on the impact of policy shocks on forest wood product trade. The author used least-squares and fixed-effect methods based on the 1998–2013 Euro union of 12 countries for sharing forest wood product trade data. The results showed that the establishment of the alliance had a positive or a neutral impact. Jiao et al. [17] used a statistical model based on trade theory to study the impact of the Lacey Act amendment on the import of plywood and hardwood. The results demonstrated that the import trade effect of the amendment was negative, resulting in a significant reduction in the quantity of imported plywood and hardwood and a significant increase in price. Using the Global Trade Analysis Project (GTAP) model, Stenberg and Siriwardana [18] simulated the reaction of Asia–Pacific Economic Cooperation members to the unilateral trade liberalization of forest products. The results showed that the unilateral trade liberalization of only forest products had a minimal impact; however, when more countries participated in trade liberalization, most of the countries and regions were able to obtain more welfare. To explore the impact of China's environmental regulations on forest product trade, Zhang et al. [19] constructed fixed-effect, random-effect, and regression models based on trade data from 2002 to 2015. The authors found that strict environmental regulations had positive and negative trade effects on the import and export of forest products, respectively. The proposed Global Forest Product Model that Prestemon [20] constructed revealed that the welfare of consumers and producers changed when the United States established import tariffs, but the findings did not pass data verification. Van et al. [21] developed the REPA-PFC Forest Trade Model to evaluate the liberalization of the Russian log export tax and the abolition of timber restrictions on Canadian exports to the United States, in addition to the changes in the production, consumption, demand, supply, price, and welfare of log and timber markets. Using the spatial partial equilibrium model, Chang and Gaston [22] found that, if Russia lowered export taxes, the impact would be greater on softwood products and trade. Zhang et al. [23] used the partial equilibrium model to analyze the welfare effect of China's tariffs on American hardwood products in the United States, demonstrating that the trade war would lead to the complete loss of welfare.

Some studies have investigated the influence of the exchange rate, trade facilitation, and other influencing factors on the forest wood product trade. Baek [24] examined the impact of currency exchange rate changes between the United States and Canada on forest trade between the two countries and determined that the former did not benefit from forest trade with the latter because of the depreciation of the dollar. Zhang et al. [25] explored the impact of trade facilitation improvement on changes in the export growth structure of China's forest products from the perspective of the ternary margin, arguing that improved trade facilitation also improved the quantity and price profit margins.

2.2. Literature on FTAs

Following trends in international trade liberalization, the development of FTAs between different countries and regions is rising. Historical and contemporary literature has examined FTAs' economic effects. Kemp [26] concluded that the signing of a bilateral or multilateral FTA would significantly increase member states' welfare and a customs union could improve all participants' economic efficiency. Using the general equilibrium model, DeRosa [27] and Lewis et al. [28] determined that the establishment of an ASEAN FTA would have a trade creation effect on relevant countries and improve member states' welfare. Suthiphand [29] predicted the possible trade creation and diversion effect of a China–ASEAN FTA and analyzed its impact on the production, GDP, welfare, and trade flow of various products. Hertel et al. [30] evaluated the potential impact of establishing FTAs in Japan and Singapore using the computable general equilibrium (CGE) model. John and Thomas [31] used the GTAP model to compare and estimate the welfare effects of three different forms of East Asian trade liberalization in China, Japan, and ASEAN.

Siriwardana [32] conducted a quantitative analysis of the GTAP model and found that the establishment of an FTA between China and Australia would benefit both countries and increase actual GDPs. Guilhot [33] and Lee and Don [34] explored the development of the East Asian Free Trade Area and analyzed the comprehensive impact of regional FTAs on relevant economies through a simulated gravity model and CGE, respectively. Jayasinghe and Sarker [35], Herath [36], and Mujahid and Kalkuhl [37] investigated the impact of the North American Free Trade Zone, the ASEAN Free Trade Zone, and the world's other major free trade zones, respectively, on agricultural trade. These studies determined that the establishment of free trade zones significantly promoted the development of agricultural trade between member states. Jin et al. [38] found a strong trade diversion effect between FTA members and other countries, with a significant negative impact on the economies of nonmember states. Okabe and Urata [39] examined the ASEAN Free Trade Area, finding that the area had a significant trade creation effect on agricultural trade, leading to the improvement in member states' welfare. In contrast, Pfaermayr [40] and Darma and Hastiadi [41] found that trade creation and diversion effects are simultaneously evident between multiple free trade zones.

Research on FTA trade effects for China has covered many considerations. Using a GTAP model simulation, Huang and Liu [42] found that the establishment of FTAs in East Asia would effectively improve regional social welfare and have a trade creation effect among regional members; however, all industries in China would be affected to varying degrees. Wang et al.'s [43] analysis demonstrated that the Australian dairy industry has strong international competitiveness, and establishing an FTA between China and Australia would advance the overall economic development of China; however, it would have a negative impact on the domestic dairy industry. Xi and Chen [44] found that the Closer Economic Partnership Arrangement (CEPA) had a certain trade creation effect on both mainland China and Hong Kong, but no trade diversion effect, which generally improved the welfare level of the two regions. Yuan and Tian [45] determined that the China–ASEAN Free Trade Area (CAFTA) had a significant influence on promoting bilateral agricultural trade and did not affect the domestic industry. Cao et al. [46] conducted a comprehensive and detailed analysis of the creation and diversion effects of trade under the CAFTA framework and estimated the trade effect of China's agricultural imports. Hu [47] compared the trade effect of the customs clearance timing of CAFTA agricultural product imports. Other authors have studied the trade effects of CEPA and CAFTA [48–50].

We have combed and summarized the above literature in Table 1. This will help us to see the connections between these studies in a simpler and clearer way.

Table 1. Literature list.

Main Research Field	Main Research Content	Author(s)
Forest Wood Product Trade	Research on the competitiveness and complementarity of forest product trade among different countries.	Su et al. [13]; Evgeniy [14]; Long et al. [15]
	Research on the impact of policy shocks on forest wood product trade.	Buongiomo [16]; Jiao et al. [17]; Stenberg and Siriwardana [18]; Zhang et al. [19]; Prestemon [20]; Van Kooten et al. [21]; Chang and Gaston [22]; Zhang et al. [23]
	Research on the impact of factors such as exchange rates and trade facilitation on forest product trade.	Baek [24]; Zhang et al. [25]
Free Trade Agreements (FTAs)	Research on the impact of FTAs on the economy.	Kemp [26]; Derosa [27]; Lewis et al. [28]; Suthiphand [29]; Hertel et al. [30]; John and Thomas [31]; Siriwardana [32]; Guilhot [33]; Lee and Don [34]; Jayasinghe and Sarker [35]; Herath [36]; Mujahid and Kalkuhl [37]; Jin et al. [38]; Okabe and Urata [39]; Pfaermayr [40]; Darma and Hastiadi [41]
	Research on China's FTAs.	Huang and Liu [42]; Wang et al. [43]; Xi and Chen [44]; Yuan and Tian [45]; Cao et al. [46]; Hu [47]; Li and Yu [48]; Zhang et al. [49]; Cheng and Feng [50]

3. Materials and Data Sources

3.1. Materials

We selected 40 countries that exhibited the highest value of forest wood product trade with China from 2000 to 2019 (Table 2). Taking 2019 as an example, there was a total of 215 countries (regions) engaged in the trade of forest wood products with China, amounting to a trade volume of USD 102.68 billion, of which the trade with these 40 countries accounted for 86.48%. In 2000 and 2010, the figures were 80.93% and 86.26%, respectively, indicating that the trade relationship between these countries and China was not only important, but also stable. Finally, we examined the geographic distribution of these countries and found that they were distributed on every continent except for Antarctica, covering a wide area. Therefore, we believe that these 40 countries are very representative and can largely reflect the pattern of China's forest wood product trade.

Table 2. Distribution of countries and continents.

Region	Country
Asia	Japan, Indonesia, South Korea, Thailand, Malaysia, Vietnam, Singapore, Saudi Arabia, United Arab Emirates, India, Philippines, Iran, Myanmar, Laos, Israel
Europe	Russia, United Kingdom, Germany, France, Sweden, Netherlands, Finland, Italy, Belgium, Spain, Turkey, Poland
North America	United States, Canada, Mexico
South America	Brazil, Chile, Uruguay
Africa	South Africa, Nigeria, Gabon
Oceania	Australia, New Zealand, Papua New Guinea, Solomon Islands

We reference Tian et al. [51] and use an HS classification system to define the range of forest wood products. The specific delineation for these products is presented in Table 3.

Table 3. Forest wood products and associated HS codes.

Type	HS Code
Timber	HS4403
Other rough wood	HS4401, HS4402, HS4404, HS4405
Sawnwood	HS4406, HS4407
Sheet	HS4408, HS4409
Wood-based panels	HS4410, HS4411, HS4412, HS4413
Wood ware	HS4414, HS4415, HS4416, HS4417, HS4418, HS4419, HS4420, HS4421
Pulp	HS4701, HS4702, HS4703, HS4704, HS4705, HS4706
Recovered paper and paperboard	HS4707
Paper and paperboard	HS48
Wooden furniture	HS940161, HS940169, HS940330, HS940340, HS940350, HS940360

3.2. Data Sources

The data of China's forest wood product trade are obtained from the UN Comtrade database [52]. FTA data are obtained from the China Free Trade Network (China FTA Network) [53]. GDP and population data are obtained from the World Bank database [54]. Distance, border, and language data are obtained from the CEPII database [55]. Finally, forest area data are obtained from the FAO database [56].

4. Trade Network Analysis

4.1. Measurement of the Chinese Forest Wood Product Trade Network

We used the point centrality index to comprehensively analyze the significance of different countries in the Chinese forest wood trade network. Point centrality is used to measure the trading ability of the subject in the network. If an entity is directly connected to many other entities, the measurement value will be higher, and we believe that the entity has a higher degree of centrality [52].

The formula for calculating the point degree centrality is as follows:

$$C_D(i) = \sum_{j=1}^{n} X_{ij}(i \neq j) \quad (1)$$

where $C_D(i)$ is the point center degree of country i, and X_{ij} is the export volume of forest products between country i and country j.

4.2. Analysis of China's Forest Wood Product Trade Network

Table 4 presents the results of the point centrality of various economies in the China forest wood product trade network in 2000, 2010, and 2019. The number of economies that signed FTAs with China increased annually. The China–ASEAN FTA had an important role in the development of China's forest product trade network.

Table 4. Results of point degree centrality measures.

Title 1	2000		2010		2019	
Noun	**Economies**	**Degree**	**Economies**	**Degree**	**Economies**	**Degree**
1	United States	5.168	Germany	9.605	United States	10.539
2	Canada	3.801	United States	8.516	China	10.285
3	Germany	2.158	China	6.427	Germany	8.712
4	Japan	1.511	Canada	4.435	ASEAN	5.334
5	France	1.448	France	4.229	France	4.451
6	ASEAN	1.434	ASEAN	3.917	Canada	4.376
7	United Kingdom	1.340	United Kingdom	3.232	Finland	3.876
8	Finland	1.138	Netherlands	2.921	Sweden	3.829
9	Italy	1.107	Italy	2.890	United Kingdom	3.599
10	Sweden	1.024	Japan	2.632	Netherlands	3.098
11	Belgium	0.952	Sweden	2.341	Italy	2.677
12	Netherlands	0.949	Belgium	2.169	Japan	2.659
13	China	0.821	Spain	2.158	Poland	2.071
14	Spain	0.723	Finland	1.879	Spain	2.071
15	Mexico	0.445	Poland	1.615	Brazil	1.931
16	Brazil	0.417	Russian	1.548	Russian	1.694
17	South Korea	0.412	Brazil	1.419	Mexico	1.370
18	Russian	0.379	South Korea	1.120	South Korea	1.280
19	Poland	0.326	Mexico	1.111	India	1.209
20	Australia	0.292	Australia	0.967	Turkey	1.044
21	Chile	0.215	India	0.879	Belgium	1.010
22	New Zealand	0.186	Turkey	0.755	Australia	0.999
23	Turkey	0.138	Chile	0.714	Chile	0.856
24	South Africa	0.117	New Zealand	0.598	United Arab Emirates	0.711
25	Saudi Arabia	0.114	Saudi Arabia	0.526	New Zealand	0.683
26	Israel	0.101	United Arab Emirates	0.482	Saudi Arabia	0.677
27	India	0.098	South Africa	0.354	South Africa	0.434
28	United Arab Emirates	0.078	Iran	0.312	Israel	0.336

Table 4. *Cont.*

Title 1	2000		2010		2019	
Noun	**Economies**	**Degree**	**Economies**	**Degree**	**Economies**	**Degree**
29	Uruguay	0.038	Israel	0.276	Iran	0.223
30	Iran	0.037	Nigeria	0.136	Nigeria	0.152
31	Gabon	0.034	Uruguay	0.046	Uruguay	0.068
32	Nigeria	0.022	Solomon Islands	0.021	Papua New Guinea	0.009
33	Papua New Guinea	0.008	Papua New Guinea	0.012	Gabon	0.007
34	Solomon Islands	0.000	Gabon	0.006	Solomon Islands	0.004

To illustrate the changes in China's forest wood product trade network more intuitively, we used forest product trade data to create a trade network map using Version 6.0 of NetDraw software (Figure 1). According to Figure 1, the complexity of China's wooden forest product trade network is increasing annually, and the changes in thick black lines in the figure indicate major changes in the relationship structure between the major trading countries, which leaned toward FTA signatories.

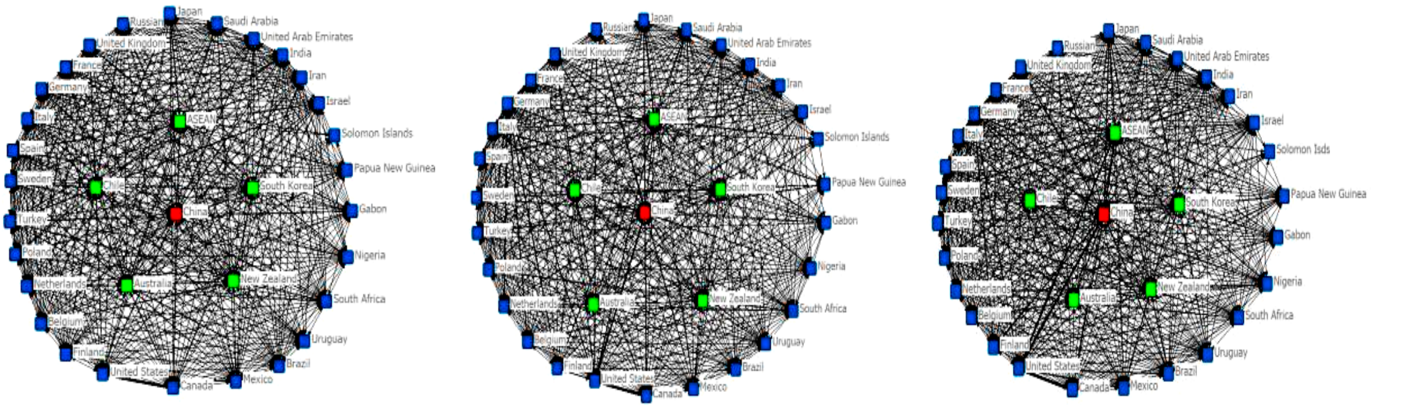

Figure 1. China's forest wood product trade network in 2000, 2010, and 2019. (Note: The red icon represents China. The green icon represents trading partners who have signed FTAs with China. The blue icon represents other trading partners).

Among the countries listed in Table 2, Chile entered into an FTA with China in 2005, followed by New Zealand in 2008, Singapore in 2009, ASEAN in 2010, and Australia and South Korea in 2015. Based on the stylized facts presented in Figure 1, it is evident that the signing of FTAs has significantly bolstered the trade relationship between China and its member countries concerning forest wood products. Consequently, we propose the following hypothesis:

Hypothesis 1. *FTA signings generate trade creation effects on China's forest wood product trade.*

5. Model Specification and Results

5.1. Model Specification

We used the trade gravity model introduced by Linnemann [57] with two-way fixed effects as the benchmark model this study. The specific model is formulated as follows:

$$\ln y_{ity} = \beta_0 + \beta_1 \ln gdp_{it} + \beta_2 \ln gdp_{jt} + \beta_3 \ln pop_{it} + \beta_4 \ln pop_{jt} + \beta_5 \ln dis_{ij} + \beta X_{ijt} + \sigma_{jt} + \gamma_t + \varepsilon_{ijt} \quad (2)$$

In Equation (2), y_{ijt} indicates the trade flow between countries i and j in year t, gdp_{it} is the GDP of country i in year t, gdp_{jt} is the GDP of country j in year t, pop_{it} is the total population of country i in year t, pop_{jt} is the total population of country j in year t, dis_{ij} is the geographical distance between the major cities in countries i and j, X_{ijt} is the group of control variables, β is the coefficient to be evaluated, σ_{jt} is the individual time-fixed effect, γ_t is time-fixed effect, and ε_{ijt} is the random error term. In this article, country *i* specifically refers to China.

To further examine the impact of FTAs on China's forest wood product trade, additional differential variables are incorporated into the benchmark model. Given the inconsistent FTA signing patterns between China and various countries, we employ a staggered DID model as our estimation approach. Moreover, considering the limited variability in GDP and population data, we incorporate them into the model in a multiplicative form for ease of parameter estimation. The specific model is formulated as follows:

$$\ln y_{ity} = \beta_0 + \alpha_1 treat_{ij} \times post_{ijt} + \beta_1 \ln gdp_{it} \times gdp_{jt} + \beta_s \ln pop_{it} \times pop_{jt} + \beta_3 \ln dis_{ij} + \beta X_{ijt} + \sigma_{jt} + \gamma_t + \varepsilon_{ijt} \quad (3)$$

where $treat_{ij}$ is a binary variable of the policy that divides the sample into treatment and control groups. When *treat* = 1, countries *i* and *j* have signed an FTA, forming the treatment group; otherwise, the countries are part of the control group. $post_{ijt}$ is also a binary variable indicating the FTA implementation time. If $post_{ijt} = 1$, it indicates that an FTA has been signed between countries *i* and *j* in year *t*; otherwise, no FTA has been signed. $treat_{ij} \times post_{ijt}$ is the differential variable of interest in this study, where the sample value for countries *i* and *j* signing an FTA in year *t* is assigned one, while others are assigned zero. The coefficient α_1 represents the difference estimator, which measures the trade creation effect of FTAs.

To further investigate the trade diversion effect resulting from FTA signing, we adopted Wang's [58] approach, creating a variable $untreat_{jt}$. Specifically, if China signed an FTA with a certain country, the variable $untreat_{jt}$ takes on a value of one for non-FTA member countries that are closest to this FTA member country; otherwise, it takes on a value of zero. (In the empirical analysis, we selected three continents that have signed FTAs with China, namely, Asia, Oceania, and South America, and specific countries from these continents that are relatively close to FTA member countries. Specifically, Japan and India were chosen from Asia, Papua New Guinea and Solomon Islands were chosen from Oceania, and Brazil and Uruguay were chosen from South America.) By estimating the coefficient α_1, we measured the trade diversion effects resulting from FTAs. The specific model is formulated as follows:

$$\ln y_{ity} = \beta_0 + \alpha_1 untreat_{ij} + \beta_1 \ln gdp_{it} \times gdp_{jt} + \beta_2 \ln pop_{it} \times pop_{jt} + \beta_3 \ln dis_{ij} + \beta X_{ijt} + \sigma_{jt} + \gamma_t + \varepsilon_{ijt} \quad (4)$$

5.2. Variables

5.2.1. Explanatory Variables

The variables in this study include the total trade value (ln*tradevalue*), export trade value (ln*ex_value*), and import trade value (ln*im_value*) between China and other countries.

5.2.2. Control Variables

In addition to the explanatory variables in the staggered DID model, which are based on the gravity model shown in Equation (4), some control variables are also included in the model. The first is forest resources (ln*forestarea*). The production and trade of wooden forest products rely on forest resources. Due to the relative scarcity of forest resources in China, according to the theory of factor endowment, countries with abundant forest resources are more likely to engage in forest wood product trade with China [59]. Based on the existing literature [60,61], it is crucial to consider adjacency (*border*) and common language (*language*) in the model. The assignment principle for these virtual variables is denoted as one for Yes and zero for No. First, when the jurisdictions of both sides are adjacent, general trade costs decrease, leading to increased trade volume. Second, it is crucial to consider the adjacency and common language within the model. Sharing a common language between the two sides can significantly reduce communication costs and enhance trade efficiency. We predicted that these two variables will have a positive impact on both import and export trades of Chinese forest wood products. Table 5 presents the descriptive statistics for the variables. Notably, out of the 800 samples, 14.7% are observations after signing an FTA with China.

Table 5. Descriptive statistics.

Variable	Unit	Obs	Mean	Std. Dev.	Min	Max
tradevalue	USD million	800	1353.557	2641.13	0.959	24,913.04
ex_value	USD million	800	679.993	1693.838	0.004	17,378.27
im_value	USD million	800	673.564	1197.02	0.001	8360.854
$treat \times post$	-	800	0.147	0.355	0	1
$gdp_i \times gdp_j$	USD billion	800	8,910,000	2.45×10^7	519.873	3.07×10^8
$pop_i \times pop_j$	million	800	121,000	260,000	521.043	1,910,000
dis	km	800	7753.246	4266.82	955.65	19,175.59
forestarea	1000 ha	800	69,408.2	158,000	15.75	815,000
border	-	800	0.125	0.331	0	1
language	-	800	0.050	0.218	0	1

We used short panel data in this study; thus, we referenced Harris and Tzavalis's [62] approach to test the panel unit root [63]. Table 6 presents the results of the HT test. After the first-order difference in all variables, there are five nonstationary variables, and ln*pop_xj* and ln*forestarea* are still nonstationary. After the second-order difference in all variables, all the data series are stationary.

Table 6. Unit root test.

Variables	Level Value			Second Difference Value		
	Rho	Z Value	*p* Value	Rho	Z Value	*p* Value
ln*tradevalue*	0.8481	−0.3854	0.3500	−0.4568	−50.3902	0.0000
ln*ex_value*	0.7830	−3.1697	0.0000	−0.5560	−54.2391	0.0000
ln*im_value*	0.6905	−7.1232	0.0000	−0.5583	−54.3271	0.0000
$treat \times post$	0.8749	0.7593	0.7762	−0.5012	−52.1117	0.0000
$\ln gdp_i \times gdp_j$	0.9290	3.0720	0.9989	−0.3186	−45.0290	0.0000
$\ln pop_i \times pop_j$	0.9497	3.9567	1.0000	0.4681	−14.5112	0.0000
ln*dis*	0.0000	−36.6477	0.0000	0.0000	−32.6693	0.0000
ln*forestarea*	0.9751	5.0420	1.0000	−0.0168	−33.3200	0.0000
border	0.0000	−36.6477	0.0000	0.0000	−32.6693	0.0000
language	0.0000	−36.6477	0.0000	0.0000	−32.6693	0.0000
ln*tradevalue*	0.8481	−0.3854	0.3500	−0.4568	−50.3902	0.0000
ln*ex_value*	0.7830	−3.1697	0.0000	−0.5560	−54.2391	0.0000
ln*im_value*	0.6905	−7.1232	0.0000	−0.5583	−54.3271	0.0000

We next conducted a cointegration test of all variables. Because many independent variables are included, we employed Kao's [64] approach to test cointegration. In Table 7, the three results of the cointegration test significantly reject the null hypothesis, indicating that there is a stable long-term equilibrium relationship between the independent and control variables and the dependent variable. This confirms that the original data can be used for regression, and the model setting is applicable.

Table 7. Cointegration test.

Explained Variable	Null Hypothesis	*t* Value	*p* Value
ln*tradevalue*		−3.5663	0.0001
ln*ex_value*	H_0: $\rho = 1$	−4.3865	0.0000
ln*im_value*		−5.1478	0.0000

5.3. Empirical Analysis

5.3.1. Parallel Trend Test

The parallel trend test is a prerequisite for conducting staggered DID estimation, ensuring that the change trends of the explanatory variables in both the treatment and control groups remain consistent prior to policy intervention. We employed Beck et al.'s [65] research findings to perform the parallel trend test. Due to the extensive time span covered by our data, to preserve all samples, we present the parallel trend chart only depicting the initial five and final four phases of policy intervention after the tail reduction (Figure 2). Figure 2 reveals that the regression coefficient of the signed FTAs between China and other countries for current and previous years is statistically insignificant, validating the parallel trend hypothesis.

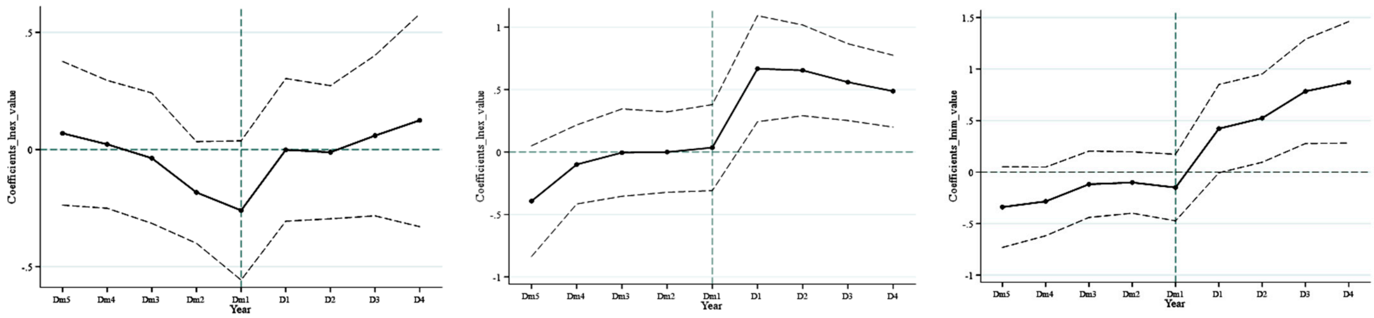

Figure 2. Parallel trend test.

5.3.2. Benchmark Regression

Table 8 summarizes the regression results. Columns (1)–(3) detail the estimates of the total trade, export, and import of Chinese forest wood products, respectively. According to the regression results, the overall model fit is good. In models (2) and (3), the treat × post variables pass the significance tests at 10% and 5% levels, indicating that FTA signings had a significant trade creation effect on the export and import of forest wood products in China.

Table 8. Impact of FTAs on the trade of forest wood products in China.

	(1) **lntradevalue**	(2) **lnex_value**	(3) **lnim_value**
treat × *post*	0.1181 (0.0916)	0.1382 * (0.0755)	0.2645 ** (0.1321)
ln$gdp_i \times gdp_j$	0.5933 *** (0.1236)	1.2925 *** (0.0981)	0.2000 (0.1962)
ln$pop_i \times pop_j$	1.0753 *** (0.2892)	0.8394 *** (0.2464)	1.7849 *** (0.5882)
ln*dis*	−61.3807 *** (11.7972)	−77.8179 *** (7.6546)	−124.1187 *** (17.2149)
ln*forestarea*	7.3557 *** (0.7109)	1.1059 ** (0.5560)	6.7307 *** (1.3691)
border	−85.9104 *** (27.8871)	−57.2601 ** (25.2399)	−141.9203 *** (44.8667)
language	57.7292 ** (26.7040)	6.0866 (19.2160)	319.4229 *** (38.1076)
constant	464.3657 *** (105.5007)	657.9441 *** (69.9491)	1012.2714 *** (156.0120)
country#c.year FE	yes	yes	yes
year FE	yes	yes	yes
observations	800	800	800
R-squared	0.9215	0.9737	0.9136

Note: standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The sign of the estimated coefficients for the other control variables is also largely as expected. In terms of economic scale, the coefficients ln$gdp_i \times gdp_j$ and ln$pop_i \times pop_j$ are significantly positive, indicating that a larger economic scale between trade partners entails the potential greater for trade. In terms of the geographical distance, the coefficient ln*dis* is significantly negative, indicating that a farther geographical distance raises transportation cost and lowers the likelihood of heightened trade between the two sides. The coefficient ln*forestarea* is significantly positive for import and export. Regarding proximity, the *border* coefficient is significantly negative, which is probably because the countries adjacent to China are neither a major exporter nor a major source of Chinese imports. Finally, the coefficient *language* is significantly positive, indicating that sharing a common language can increase trust and reduce the cost of trade information [66], which promotes bilateral trade.

5.3.3. Placebo Test

The staggered DID method requires confirmation that the policy shock is random. If the FTA signing is not random, the policy assessment may be biased; therefore, we next performed a placebo test on models (2) and (3) in Table 8. This study references Ferrara et al.'s [67] and Liu and Lu's [68] method to determine whether other unobserved factors drive the influence of FTAs on China's forest wood product trade. We applied randomization to the time points and China FTA member states, and performed 1000 Monte Carlo simulations. Figure 3 shows the estimated coefficient distribution of the resulting policy impact. The vertical dotted red line indicates the estimated coefficient of the real policy impact, confirming that the distribution of the kernel density estimates of the total trade, export, and import volume of the explanatory variables are all around zero. Therefore, the FTA signings meet the principle of random distribution, and other unobservable factors do not appear to drive the impact of FTAs on China's forest wood product trade.

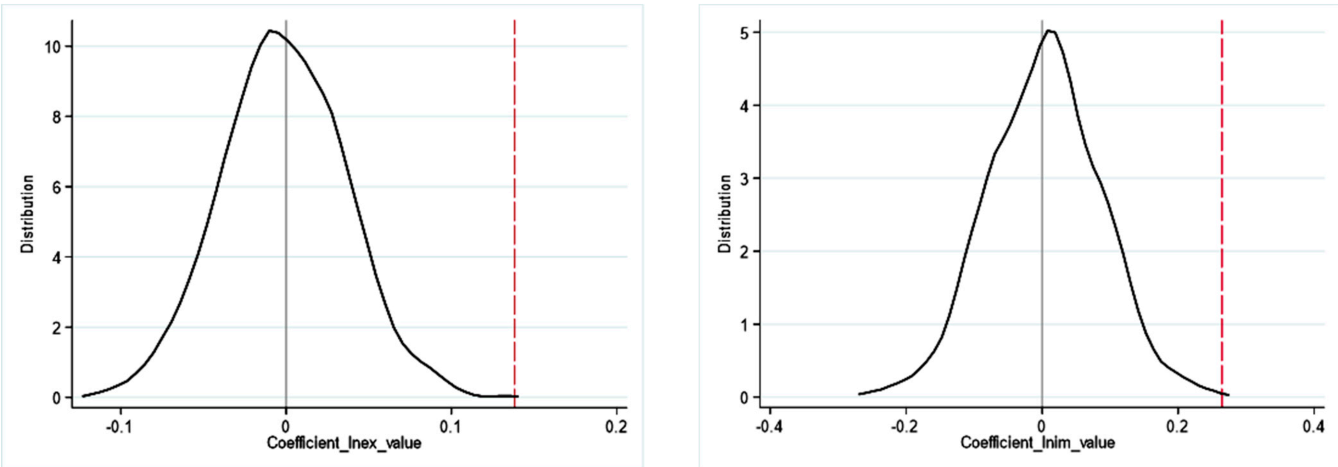

Figure 3. Placebo test.

5.3.4. Robustness Test

Propensity Score Matching Test

To avoid the endogeneity problems related to the nonrandom selection of the FTA itself, we referenced Yang and Yin [69], employing the propensity score matching (PSM)–DID method. The DID methodology has the demerit of selection bias in policy evaluation, and the conventional PSM might ignore individual heterogeneity, while the PSM-DID method uniquely offers the advantage of accounting for the heterogeneity intrinsic to different countries and overcomes the demerits of selection biases between treatment and control countries. This study provides a more compelling establishment of a causal relationship between FTAs and China's forest wood product trade via the PSM-DID method [70,71].

We calculated the corresponding propensity score of each sample by estimating the logit model, in which the explanatory variable is the total amount of forest wood product trade and the explanatory variables include all non-virtual variables in the main regression model. We then matched countries with similar tendency scores from the sample that had never signed an FTA with China as the control group to the signed sample treatment group in a 1:1 ratio. Table 8 reveals that the deviation between the signed and unsigned samples has significantly reduced, and the mean of other covariates (except lnforestarea) shows no significant difference at the 5% level, indicating that the matching effect is better. Based on the new sample, this study repeats the parallel trend test and examines the influence of FTAs on China's forest wood product trade, revealing that the main conclusions of this study still hold after using the PSM regression. Columns (1) and (2) in Table 9 present the specific regression results.

Table 9. Balance test.

Variable	Unmatched/Matched	Mean		%bias	*t* Value	*p* Value
		Treated	Control			
$\ln gdp_i \times gdp_j$	U	13.594	14.566	−44.8	−5.62	0.000
	M	13.594	13.945	−16.2	−1.46	0.144
$\ln pop_i \times pop_j$	U	10.58	10.67	−6.1	−0.75	0.454
	M	10.58	10.734	−10.5	−0.96	0.337
$\ln dis$	U	8.3583	8.9754	−100.3	−14.58	0.000
	M	8.3583	8.4409	−13.4	−1.24	0.215
$\ln forestarea$	U	9.3345	9.4604	−5.8	−0.75	0.451
	M	9.3345	9.7561	−19.5	−2.38	0.018

Replace Control Variables

Because the production and trade of forest wood products requires forest resources, according to factor endowment theory, the greater the difference in forest resources between the two sides, the higher the possibility of triggering trade in forest wood products [59]. Therefore, we replaced the forest area variable ($\ln forestarea_{ij}$) with the difference in timber yield ($round_{ij}$) as a proxy for determining the difference in forest resources between the two countries, where a higher $round_{ij}$ indicates the forest resources of trading partners compared to China. Our assumption was that more abundant forest resources raise the likelihood of forest wood product exports, and lower the likelihood of importing. The specific regression results are shown in columns (3) and (4) of Table 10, yielding the same results of the core explanatory variables as those in Table 8. Additionally, the results in column (3) demonstrate that the coefficient $round_{ij}$ is significantly positive at the 1% level, which is consistent with the previous analysis results, confirming that trading partners' richer forest resources generate stronger demand for forest wood products and raise China's forest wood product exports.

5.3.5. Trade Diversion Effect

We next applied the staggered DID model to investigate the trade diversion effects of FTA signings on China's forest wood product trade using Equation (3). Table 11 summarizes the estimated results, revealing that the export side produces a significant trade diversion effect. This means that, after signing FTAs, member countries have imported more forest wood products from China. The import side coefficient for *untreate* is insignificant, indicating no trade diversion effect.

Table 10. Robustness test.

	PSM + DID		Replace Control Variables	
	(1) lnex_value	(2) lnim_value	(3) lnex_value	(4) lnim_value
treat × *post*	0.1858 ** (0.0893)	0.4155 *** (0.1288)	0.1346 * (0.0765)	0.2284 * (0.1301)
$\ln gdp_i \times gdp_j$	1.2531 *** (0.1725)	−0.3658 (0.2844)	1.2648 *** (0.1011)	0.1155 (0.2115)
$\ln pop_i \times pop_j$	1.9324 ** (0.8422)	3.5928 *** (0.9021)	0.8431 *** (0.2438)	1.5541 ** (0.6484)
$round_{ij}$			3.7005 *** (1.3778)	1.5234 (2.1200)
controls	yes	yes	yes	yes
country#c.year FE	yes	yes	yes	yes
year FE	yes	yes	yes	yes
observations	354	354	800	800
R-squared	0.9744	0.9306	0.9736	0.9075

Note: standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11. Trade diversion effect of FTAs on China’s forest wood product trade.

	(1) lnex_value	(2) lnim_value
untreat	0.2823 ** (0.1114)	0.2920 (0.1803)
$\ln gdp_i \times gdp_j$	1.3120 *** (0.0920)	0.2689 (0.1800)
$\ln pop_i \times pop_j$	0.8118 *** (0.2403)	1.7057 *** (0.5871)
ln*dis*	−72.9743 *** (7.3628)	−114.6151 *** (15.2951)
ln*forestarea*	0.9554 * (0.5486)	6.5502 *** (1.3196)
border	−56.0717 ** (24.1130)	−138.2342 *** (45.6779)
language	−12.7048 (18.8209)	289.0118 *** (37.7176)
Constant	617.5851 *** (66.9599)	931.3635 *** (139.6368)
country#c.year FE	yes	yes
year FE	yes	yes
observations	800	800
R-squared	0.9740	0.9136

Note: standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6. Discussion

By applying quasi-natural experiments to FTA signings, this study used a staggered DID approach to investigate the influence of FTA signings on China’s forest wood product trade, measuring the effect from three levels of total trade, export, and import. The parallel trend test in Figure 2 indicates no substantial disparity in the change trend of the total trade value or export and import values of forest wood products between the treatment and control group prior to the policy implementation. However, following subsequent FTA signings, the regression coefficient of the difference variable between the export and import of forest wood products shows a significant upward trend, indicating that FTA-induced trade creation effects have certain long-term stability.

The findings presented in Table 8 demonstrate that the institutionalization of trade liberalization commitments led to the elimination of trade barriers among member states and effectively prevented the establishment of new barriers. This reduction in trade policy uncertainty had a significantly positive impact on China's trade in forest wood products. Moreover, compared to exports, FTAs exerted a stronger influence on China's import of forest wood products. And we also found that, for every 1% increase in GDP in China or its trading partner country, China's total trade in forest wood products increased by 0.59%, and the population size also had a significant promotional effect at both ends of the import and export of forest wood products. In addition, we found that, for China, because the trade of forest wood products is mainly processing trade, there is a large demand for the import of the upstream products of the industrial chain, such as timber and sawnwood. Therefore, China has more trade with countries rich in forest resources. On the other hand, countries rich in forest resources may have a stronger preference for forest wood products. There is also a greater demand for forest wood products with consumption stickiness, which further strengthens their trade in forest wood products with China. Through the placebo test and robustness test, we found that our research conclusion still holds.

Finally, we analyzed the trade diversion effect of FTAs. Notably, our results seem to differ from the findings of existing studies [40,41]. To analyze whether a trade diversion effect occurs after signing FTAs in China more accurately, we conducted subsample regression. Given that China has only entered into FTAs with countries in Asia, Oceania, and South America within the sample, we performed a heterogeneity analysis focusing on these three continents exclusively. The results demonstrate that the FTAs signed by China in Asia had a significant trade diversion effect at the import side, showing that, after signing the FTAs with ASEAN and South Korea, the amount of forest wood products imported by Asian countries that never signed FTAs decreased significantly. In other words, China is more inclined to import raw materials such as timber and sawnwood from FTA members in Asia. The results in Figure 4 also show that China's forest wood product exports to Brazil and Uruguay increased significantly after it signed an FTA with Chile.

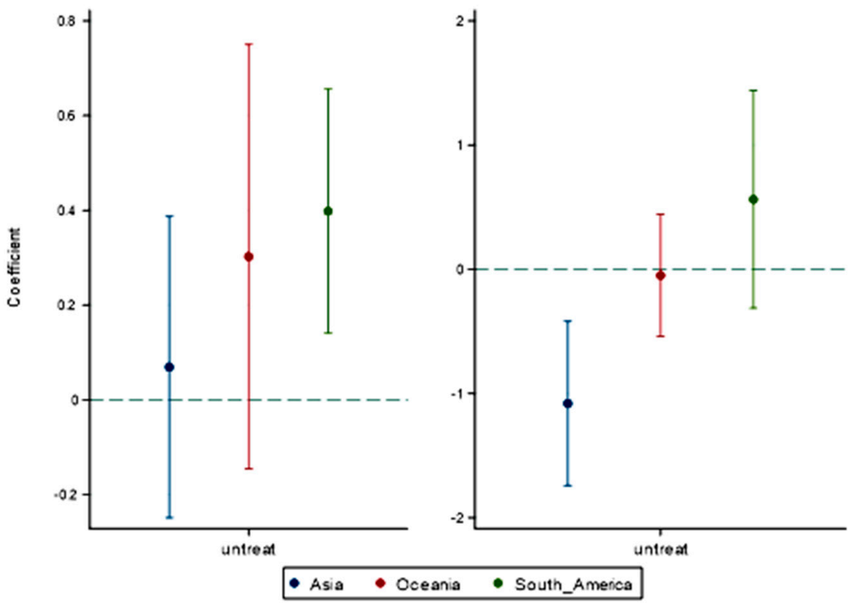

Figure 4. Analysis of trade diversion effects based on heterogeneity (export on the left; import on the right).

7. Conclusions and Implications

7.1. Conclusions

Employing a quasi-natural experiment based on FTA signings in China, we systematically examined the influence of these agreements on China's forest wood product trade. The findings demonstrate that FTAs have substantial trade creation effects that are characterized by enduring stability, and the import side has a greater trade creation effect than exports. Second, the benchmark regression and robustness test results demonstrate that economic scale and forest resource endowment are significant factors affecting the trade of forest wood products in China. Finally, we reveal significant trade diversion effects in terms of exports, while the effects on imports are only significant in Asia. This implies that the expansion of FTAs has exacerbated the mismatch of global forest resources to some extent, and fostering multilateral cooperation may help improve these circumstances.

7.2. Implications

Since China signed its first FTA with Chile in 2005, the scale of forest wood product trade between China and its trading partners has continuously expanded. The overall value of bilateral trade has steadily risen, accompanied by a diversification of the structure of product trade and significant the enhancement in economic and trade cooperation levels. Based on the findings presented in this study, valuable policy insights are evident regarding the stable and long-term development of forest wood product trade between China and FTA member states.

China should actively engage in FTA negotiations and enhance foreign collaboration in the forestry sector. The implementation of FTAs has effectively expanded China's trade volume in forest wood products, fostering trade diversion effects and augmenting the trade scale among all member states in the agreements. FTAs consequently contribute to strengthening bilateral economic and trade relations and promoting multilateral cooperation. Notably, China has signed on to the Regional Comprehensive Economic Partnership and submitted an application to join the Comprehensive and Progressive Agreement for Trans-Pacific Partnership, demonstrating its unwavering commitment to practicing multilateralism. In the future, as a beneficiary of free trade, China should steadfastly adhere to the strategic direction of free trade and actively engage in comprehensive free trade negotiations with stronger global influence. By fostering extensive multilateral economic and trade cooperation, eliminating barriers to commerce, and bolstering foreign collaboration in the forestry sector, China can effectively advance international prosperity and development within the forestry industry.

China should expand its scope of international cooperation based on the complementarity of factor endowments, which is particularly applicable to the forestry industry, for which the international division of labor relies heavily on forest resources. Given China's limited forest resources, it is crucial to collaborate with countries that have abundant forest resources as key partners for cooperation. Our empirical evidence demonstrates that forest resource endowment significantly influences China's wood and forest product trade; therefore, it is imperative to actively engage in partnerships with countries that are rich in forest resources, particularly those that align with China's factor endowment advantages. With the implementation of a robust international forest certification system, it is imperative to actively pursue unhindered trade channels with such countries in the domains of forest products, ecosystem services, and bioenergy products. China's forest certification production and marketing supervision chain standards should be harmonized with the specific requirements of these nations to establish a comprehensive international forestry trade system that encompasses all stages of the industrial chain, including production, processing, transportation, and the sales of forest products. This concerted effort serves to continuously broaden the scope of international cooperation while fostering sustainable long-term development within the global forest wood product trade sector.

China must reduce domestic circulation costs and expedite the cross-border flow of factors of production to enhance trade facilitation. The substantial trade creation effect resulting from FTAs demonstrates that reducing trade costs can effectively stimulate the growth of China's forest wood product trade. Previous studies have revealed that the institutional transaction costs associated with China's import and export activities, including customs clearance, inspection, and quarantine procedures; maritime operations; frontier inspections and supervision; document preparation for certification purposes; and direct and indirect cost and time expenses far exceed the import/export tariffs paid by enterprises and the costs incurred due to technical trade measures [68]. These excessive transaction costs can significantly impede enterprises' international competitiveness; therefore, it is imperative for China's forestry authorities to prioritize streamlining and harmonizing domestic procedures pertaining to plant quarantine and other aspects of forest product trade to advance international trade collaboration. Additionally, expediting the cross-border movement of resources and eliminating domestic barriers that hinder the implementation of FTAs are crucial steps for achieving the desired trade creation effect.

Still, many relevant questions remain beyond our current reach. For example, limited to the sample data, our focus was primarily on China's FTAs and the trade of forest wood products with its member countries, while neglecting other nations worldwide. Furthermore, our research takes a macroscopic perspective and lacks sufficient analysis on segmented products. In future studies, we will delve into the trade effect of specific FTA clauses at a product level to provide micro-evidence that better elucidates the changes in the global trade pattern of forest wood products.

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