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How Can Intra-Industry Trade of Forest Products be Promoted? An Empirical Analysis from China

Feng-ting Wang [1], Si-tong Liu [2], Bao-dong Cheng [2], Qin-er Jiang [3,4], Yuan Tian [5,*] and Li-chun Xiong [3,4,*]

1 National Agricultural and Rural Development Research Institute, China Agricultural University, Beijing 100083, China; wangft2016@cau.edu.cn
2 School of Economics and Management, Beijing Forestry University, Beijing 100083, China; liusitong455@gmail.com (S.-t.L.); baodongcheng@bjfu.edu.cn (B.-d.C.)
3 College of Economics and Management, Zhejiang A&F University, Hangzhou 311300, China; 20030158@zafu.edu.cn
4 Center for Farmer's Development Research, Zhejiang A&F University, Hangzhou 311300, China
5 Business College, Beijing Union University, Beijing 100025, China
* Correspondence: yuan.tian@buu.edu.cn (Y.T.); lichunxiong@zafu.edu.cn (L.-c.X.); Tel.: +86-134-8868-8541 (Y.T.)

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Abstract: Understanding the evolution of the intra-industry trade of forest products between China and its main partner countries is a prerequisite for improving the flow of trade. The intra-industry trade status and the main influencing factors of Chinese forest products trade were measured and identified via use of bilateral forest product trade data between China and its 24 partners from 2000 to 2014, and use of static, marginal, and structural intra-industry trade indices. The results show that, firstly, intra-industry trade of the major Chinese forest products is exhibiting a low-level growth trend and has considerable growth potential. The top five countries with relatively high intra-industry trade levels are Italy, Germany, the United States, Vietnam, and Japan, and the bottom five are New Zealand, Chile, Brazil, Russia, and Spain. Secondly, the intra-industry trade among China and 13 countries, represented by South Korea, is low quality and vertical-type trade; the intra-industry trade among China and seven countries, represented by Thailand, is high quality and a vertical type of trade. Finally, the empirical analysis shows that trade openness and geographical distance are the key factors of intra-industry trade of forest products. The per capita gross domestic product gap, urbanization, foreign direct investment, forest area, and import and export value of forest products also have certain impacts on intra-industry trade.

Keywords: forest products; intra-industry trade; geographical distance; trade openness

1. Introduction

With the continuous economic globalization, the foreign trade economy has become one of the most important issues for national development. In 2018, China's import and export of forest products exceeded USD $160 billion, ranking first in the world and making it a veritable big country in forest product trading [1,2]. In this context, relying on the increasing industrial technology used for forest products and the huge market demand, and as an important part of foreign trade of forest products, the level and scale of intra-industry trade of forest products have also expanded to varying degrees [3,4]. With the development of the national economy, residents' demand for forest products increases year by year [5,6]. While meeting the world's demand for forest products, China also imports a large number of forest products from partner countries, which promotes the market scale of the intra-industry trade of forest products [7]. Intra-industry trade has considerably improved the level of foreign trade, and the

horizontal intra-industry trade of forest products with developed countries has improved the overall quality of Chinese forest products, whereas the vertical intra-industry trade of forest products with developing countries has broadened the profit space. Therefore, continuously improving the level of intra-industry trade between China and its partner countries has become an important path to enhance the quality of foreign trade of forest products, to promote mutual benefit between China and its partners, and to provide targeted recommendations.

However, the intra-industry trade of forest products between China and its partner countries has encountered many bottlenecks. Since the late 2000s, as series of external factors such as prevailing trade protectionism and increasing transportation costs caused by the rise in international oil prices, have hindered the further development of the intra-industry trade of forest products [8]. In particular, since President Trump took office in 2016, trade protectionism has rapidly gained momentum, and its tariff barriers have affected the trade of forest products, seriously threatening the sustainable development of the intra-industry trade of forest products. The intra-industry trade of forest products provides an important index reference of the trade level of forest products. As the world's largest trading country of forest products, it is practically important for China to study the status quo of intra-industry trade and its influencing mechanisms.

Intra-industry trade, also known as horizontal trade or two-way trade, refers to a country's export and import of certain kinds of similar products [9]; and has become an important topic in academic research [10–12]. In terms of theoretical research, Linder first proposed the preference similarity theory, which suggested that similar demand preferences cause intra-industry trade [13]. Thereafter, some scholars found that specialized division of labor and two-way international trade exist within the industry, providing a new perspective for the study of intra-industry trade [14,15]. Intra-industry trade can be classified into horizontal and vertical types. Vertical intra-industry trade refers to the trade of products of the same type but of different quality, price, and input of technical factors [16]. Comparatively, horizontal intra-industry trade refers to the trade of products with a similar input of factors, similar quality, and similar price, but with different characteristics and attributes [17]. Further research showed that product differences and consumer preference differences are the main reasons for horizontal intra-industry trade [18]. Product preference, technology, and factor endowment convergence in various countries are also important foundations for intra–industry trade. Regarding vertical intra-industry trade, the country's comparative advantage in different products and the differences in product quality are the basis for vertical intra-industry trade [19]. The chamberlain model was first introduced to measure intra-industry trade. To better quantify the level of intra-industry trade, static intra-industry trade indices were proposed, the intra-industry trade index (IIT) has been widely used [20]. Thereafter, a dynamic index of intra-industry trade was constructed [21,22], improving the previous index, namely the marginal intra-industry trade index (MIIT). Based on the MIIT index, a specific measurement method of horizontal and vertical intra-industry trade was put forward [23], known as the intra-industry trade structure index (GHM).

In the research on the intra-industry trade of agricultural and forest products, studies have found that the agricultural trade between China and Brazil is mainly based on inter–industry trade, whereas trade with India, Russia, and South Africa is mainly based on intra-industry trade, which also shows that in the BRIC (Brazil, Russia, India and China) economic organization, the difference in market demand between countries and the difference in the economic development level lead to significant differences in the structure of bilateral agricultural products trade [24]. Some scholars have found that the characteristics of intra-industry trade of forest products and those of agricultural products in Sino–Russian countries are similar [25]. With regard to the factors influencing intra-industry trade, studies found that the main factors are: differences in market demand between countries [26,27], trade openness of partner countries [28,29], economic integration [23,30], and geographical distance [31,32]. Some scholars stated that per capita income differences [33], market scale [34,35], urbanization rate [17], resources endowment [18,36], trade quantity and structure [37,38], and foreign direct investment [39,40] also impact bilateral intra-industry trade. A study on the intra-industry trade of forest products

between China and Russia concluded that the trade volume of forest products between the two countries was large, but the level of intra-industry trade was low, which was related to the difference in market demand between the two countries. Specifically, China mainly imports raw material forest products from Russia, whereas Russia mainly imports final product forest products from China [26].

By reviewing the previous research, we found many reports about the intra-industry trade of forest products. However, some shortcomings still exist in the research that need to be addressed. Firstly, the authors only selected a single category of forest products or general categories of wood–based panels as research objects, which cannot represent the whole set of forest products of China. Secondly, in terms of trading partners, previous authors only chose one country or one region, without considering the global intra-industry trade distribution of China's forest products. As such, we tried to address these research gaps. The remaining structure of this paper is as follows: Section 2 outlines our materials and methods. By including 24 trading partner countries covering five continents, we selected a more representative sample. Section 3 provides the measurements of the static and dynamic intra-industry trade of forest products separately, and an analysis of the influencing factors with a rigorous empirical model, identifying the mechanism of intra-industry trade in the forestry industry. Section 4 outlines our conclusions and policy recommendations.

2. Materials and Methods

2.1. Data Collection

Data were selected for China's trade of forest products with major countries from 2000 to 2014, and bilateral trade of goods with the same three digits used in Standard International Trade Classification (SITC) commodity number was defined as intra-industry trade. In the selection of samples, we considered the following: (1) We selected forest products, plywood, particleboard, fiberboard, wood furniture, paper products, and other forest products as research objects according to the data availability. According to the China Forestry Development Report, wood forest products are mainly divided into eight categories: logs, sawn timber, wood–based panels, paper, wood products, furniture, wood chips, and others. Among them, the intra-industry trade of Chinese forest products is mainly concentrated in wood–based panels, wood furniture, and paper, and due to the differences in import and export markets, we subdivided the wood–based panels into plywood, particleboard, and fiberboard for statistical analysis. (2) Two aspects were involved in the selection of trading countries. The website of the Research Center for Economics and Trade in Forest Products of the State Forestry Administration [41] shows that the import and export trade market of forest products in China is highly concentrated. Although the trade market of forest products covers six continents, it is mainly concentrated in areas with rich forest resources and a large consumption of forest products. China and 24 representative countries of the world trading in these five types of forest products were selected based on the China Forestry Development Report (2000-2014) [42] and the United Nations (UN) Comtrade database [43], and considering the geographical location and national economic development level, 24 representative countries of the world plus China trading the above five types of forest products were selected. Note, the China Forestry Development Report also shows that from 2000 to 2014, the import and export trade volume of the five types of forest products between China and the 24 countries accounted for more than 75% of China's total import and export trade volume. The specific sample countries in Asia are: Thailand, Malaysia, Indonesia, South Korea, Japan, Vietnam, and the Philippines; the countries in Europe are: the U.K., Germany, Belgium, Italy, France, the Netherlands, Spain, Russia, Ukraine, Lithuania, and Belarus; the countries in North America are: Canada and the United States; the countries in Oceania are: Australia and New Zealand; and the countries in South America are: Chile and Brazil. Among them, the bilateral trade data of forest products between China and the 24 countries were taken from the UN Comtrade database. The degree of trade openness data was obtained from the International Monetary Fund (IMF) website, and the international oil price data was obtained from the World Energy Database, which mainly uses the price of light crude oil traded in

Texas, United States, excluding inflation. Shipping distance data of the two countries were obtained from the trade distance database. The per capita gross domestic product (GDP) difference and foreign direct investment (FDI) difference data were treated as absolute values and both obtained from the World Bank. The trade policy data were sourced from the China Free Trade Zone Service Network.

2.2. Measurement of the Intra-Industry Trade Index

Based on previous research, we used the IIT index, the MIIT index, and the GHM index to measure the status quo of intra-industry trade of forest products between China and its major trading partners. The formula of the static IIT index of forest products is as follows:

$$IIT_{ci} = 1 - \frac{|E_{ci} - I_{ci}|}{|E_{ci} + I_{ci}|} \quad (1)$$

where E_{ci} is the host country's export value of forest product i to country c, and I_{ci} is the host country's import value of forest product i from country c. The IIT_{ci} reflects the proportion of overlapping trade in intra-industry trade, and its value is generally between 0 and 1. The closer the IIT_{ci} value to 1, the higher the level of intra-industry trade. The IIT index of a country's forest products industry can be obtained by summing the IIT of the main products by weighting the intra-industry trade of the forest products; its equation is as follows:

$$IIT_{ci} = \frac{\sum_i (E_{\mathrm{ci}} + I_{ci} - |E_{\mathrm{ci}} - I_{ci}|)}{\sum_i (E_{\mathrm{ci}} + I_{ci})} \quad (2)$$

The static intra-industry trade index cannot be used to measure the dynamic trend in intra-industry trade. For this reason, the marginal intra-industry trade (MIIT) index is used for measurement, and its equation is as follows:

$$MIIT_{ci} = 1 - \frac{|\Delta E_{\mathrm{ci}} - \Delta I_{ci}|}{|\Delta E_{\mathrm{ci}}| + |\Delta I_{ci}|} \quad (3)$$

where ΔE_{ci} and ΔI_{ci} are the amount of change in the export and import of certain forest products of the host country during a certain period of time, respectively. The $MIIT_{ci}$ value also ranges between 0 and 1; the larger the $MIIT_{ci}$ value, the higher the share of intra-industry trade in marginal trade. To better understand the intra-industry trade structure of China's forest products, we referred to the classification method to construct the intra-industry trade structure index GHM. The specific calculation formula is as follows:

$$GHM_{ci} = \frac{UV_{E_{\mathrm{ci}}}}{UV_{I_{ci}}} \quad (4)$$

where $UV_{E_{\mathrm{ci}}}$ and $UV_{I_{ci}}$ represent the unit export value and import value of forest products i of country c, respectively. The type of intra-industry trade structure is determined by the GHM index, as shown in Table 1 [44].

Table 1. The intra-industry trade structure (GHM) index corresponds to the type of intra-industry trade.

Range	Type
GHM < 0.8 or GHM > 1.25	Vertical type
0.8 < GHM < 1.25	Horizontal type
GHM < 0.8	Low–quality vertical type
GHM > 1.25	High–quality vertical type

2.3. Modeling the Factors Influencing the Intra-industry Trade of Forest Products

The static and marginal intra-industry trade levels (IIT and MIIT) of the five major categories of forest products were used as the dependent variables. The specific independent variables were selected based on (1) the degree of trade openness and (2) geographical distance. The traditional

gravity model takes the shipping distance of two countries as the index, but this method has some shortcomings. Firstly, the traditional distance does not change with time, so the distance cost cannot be truly reflected. Secondly, when the invariant distance is used for fixed–effect regression, the distance is treated as an individual fixed effect, and thus is not recognized, which affects the accuracy of the regression result. Therefore, we referred to the practices in the existing research and multiplied the shipping distance between the two countries by the international oil price of the year as the distance cost [45]. The next selection criterion was (3) the per capita GDP difference, which indicates the similarity degree of demand, and the Linder demand similarity theory holds that the closer the per capita GDP of two countries, the larger the overlap of the mutual demand, and the higher the probability of intra-industry trade. (4) The population size of the trading partner country was the next factor. Relevant research in the field of agriculture found that in bilateral trade, the larger the population of trading partners, the greater the potential demand for agricultural products, and the higher the share of intra-industry trade in agricultural products. (5) The difference in the urbanization rate was considered because with the continuous development of urbanization, the urban population increases, the demand for wood products by residents continues to grow, and the demand for forest products gradually diversifies. This may be beneficial to the development of intra-industry trade in the forest products industry. (6) The foreign direct investment difference was considered as the type and purpose of FDI directly affect the development direction of intra-industry trade. Foreign investment of the market hinders the development of intra-industry trade, and the pursuit of efficient foreign investment promotes the intra-industry trade. We also considered (7) the trade policy, which was measured by the dummy variable of the bilateral signing of a free trade agreement, and (8) forest area. Forest area represents the forest resource endowment of trading partner countries. The larger the forest area, the richer the resources for producing wood products, and the more likely a country is to have a large–scale intra-industry trade of forest products with China. We also considered (9) the difference in the import value of forest products takes the absolute value. The greater the import value of forest products, and the higher the possibility of intra-industry trade in bilateral markets, which will promote the intra-industry trade. The final consideration was (10) the difference in the export value of forest products. The greater the export value of forest products, the higher the possibility of intra-industry trade of a bilateral type, which promotes intra-industry trade. Based on the above definition of dependent variables and independent variables, the improved trade gravity model was set as follows:

$$\begin{array}{c} T_{ijt} = \beta_0 + \beta_1 open_{it} + \beta_2 dis_{it} + \beta_3 dpgdp_{it} + \beta_4 peo_{it} + \beta_5 city_{it} + \beta_6 dfdi_{it} \\ +\beta_7 fta_{it} + \beta_8 farea_{it} + \beta_9 fimport_{it} + \beta_{10} f\exp ort_{it} + \mu_i + \varepsilon_{ijt} \end{array} \quad (5)$$

where T_{ijt} represents the IIT, $MIIT$, and GHM values of forest product i between China and country c in the t period of time, and the specific independent variable statistics and description are shown in Table 2; $\beta_1 - \beta_{10}$ are the parameters to be estimated, and μ_i is the unobserved effect, and ε_{ijt} is the disturbance term.

To increase the robustness of the model, the logarithm of the dependent variable and some of the independent variables were selected, the variance of the variable was compressed, and the heteroscedasticity problem was eliminated to some extent [46], forming a new semi-logarithmic model as follows:

$$\begin{array}{c} \ln(T_{ijt}) = \beta_0 + \beta_1 \ln(open_{it}) + \beta_2 \ln(dis_{it}) + \beta_3 \ln(dpgdp_{it}) + \beta_4 \ln(peo_{it}) + \beta_5 \ln(city_{it}) + \beta_6 \ln(dfdi_{it}) \\ +\beta_7 \ln(fta_{it}) + \beta_8 \ln(farea_{it}) + \beta_9 \ln(fimport_{it}) + \beta_{10} f\ln(\exp ort_{it}) + \mu_i + \varepsilon_{ijt} \end{array} \quad (6)$$

Table 2. Variable statistics and expected impact direction.

Table	Variable	Definition	Unit	Mean	SD
Dependent variable	IIT	Static intra-industry trade index	–	0.289	0.299
	MIIT	Marginal intra-industry trade	–	0.712	0.299
	GHM	Intra-industry trade structure index	–	1.439	1.758
Key independent variables	open	Trade openness	%	78.133	44.992
	dis	Geographic distance	USD	474,510.200	339,092.200
Control variables	dpgdp	Per capita GDP difference	USD	21,096.450	16,030.850
	peo	People size of trading partner	Person	83,669.800	75,567.610
	city	Urbanization rate	%	29.457	13.616
	dfdi	Foreign direct investment difference	Millions USD	137,729.300	101,233.400
	fta	Sign a free trade agreement	Yes = 1, No = 0	0.075	0.263
	farea	Forest area	Square kilometers	112,407.800	206,353.500
	fimport	Forest product import	USD	17,100,000.000	11,300,000.000
	fimport	Forest product export	USD	5,629,788.000	5,049,360.000

3. Results

3.1. Intra-industry Trade Index Status of Forest Products

Table 3 shows the annual intra-industry trade index of the annual average forest products in China and 24 major forest product trading countries from 2000 to 2014, including the IIT, MIIT, and GHM indices. The IIT index measurement value shows that the overall intra-industry trade level of China and the 24 forest product trading partners is not high, and the maximum annual average IIT was 0.49, indicating that China's foreign forest products industry trade was at a medium-to-low level, so its growth potential is considerable. Among the 24 trading partner countries, the top five countries with a relatively high level of intra-industry trade were Italy, Germany, the United States, Vietnam, and Japan, with IIT index values of 0.49, 0.37, 0.36, 0.34, and 0.33, respectively. Comparatively, the five countries with the lowest level of intra-industry trade were New Zealand, Chile, Brazil, Russia, and Spain, with IIT index values of 0.18, 0.19, 0.21, 0.22, and 0.23, respectively. The MIIT index value shows that there are many countries whose MIIT values were close to one, which indicates that their share of intra-industry trade was relatively large in the annual increase in marginal forest products trade between China and major forest product trading countries. Among the marginal growth of bilateral forest products in China, the top five countries with a large intra-industry trade share were Italy, France, the United States, Germany, and Vietnam. These countries also had a relatively high static intra-industry trade index value, which indicates that the overall level of intra-industry trade of forest products between China and the above countries was relatively high. The GHM index shows that among the 24 sample countries, 83% of the countries' trade with Chinese forest products was vertical intra-industry trade, while the countries of Japan, Britain, Germany, and the United States were horizontal intra-industry trade. The vertical intra-industry trade demonstrates the differences in the quality and price of the intra-industry trade of forest products between the mentioned countries above and China. China's horizontal intra-industry trade was mainly characterized by the similarity of the above four countries and China in the forestry industry economy and technology level. The main reason for the intra-industry trade of forest products lies in the economies of scale and consumer preference. Among the vertical intra-industry trading countries, the intra-industry trade between

China and 13 countries (GHM < 0.8) represented by South Korea is categorized as low-quality vertical intra-industry trade, and intra-industry trade between China and 7 countries (GHM > 1.25) classified by Thailand is high-quality vertical intra-industry trade. Although the number of high-quality vertical intra-industry trade countries among the main trading partners of China's forest products was less than that of low-quality vertical intra-industry trade countries, the total trade of high-quality vertical intra-industry trade of forest products still accounted for the main share.

Table 3. Annual average intra-industry trade index of forest products between China and the 24 countries from 2000 to 2014.

Country	IIT	MIIT	GHM	Country	IIT	MIIT	GHM
Thailand	0.31	0.71	2.19	Netherlands	0.24	0.73	1.22
Malaysia	0.29	0.71	1.89	Spain	0.23	0.75	1.26
Indonesia	0.29	0.71	2.05	Russia	0.22	0.78	2.93
Korea	0.27	0.73	0.61	Ukraine	0.28	0.72	2.06
Japan	0.33	0.67	1.11	Lithuania	0.31	0.65	0.96
Vietnam	0.34	0.79	2.22	Belarus	0.30	0.70	0.58
Philippines	0.26	0.77	0.66	Canada	0.26	0.70	1.45
United Kingdom	0.31	0.67	1.07	United States	0.36	0.81	1.28
Germany	0.37	0.80	1.19	Australia	0.26	0.77	0.93
Belgium	0.30	0.70	1.26	New Zealand	0.18	0.78	1.84
Italy	0.49	0.96	1.53	Chile	0.19	0.69	0.53
France	0.24	0.84	1.50	Brazil	0.21	0.70	1.32

3.2. Factors Influencing Intra-Industry Trade of Forest Products

The intra-industry trade index of China's forest products was measured first, after which the impact mechanism of intra-industry trade of major forest products was rigorously empirically tested. To this end, we built a quantitative regression model.

The multicollinearity test is presented prior to providing the model regression results, and it was tested by the correlation coefficient matrix and the variance inflation factor (VIF) as the Table 4 shows. The correlation coefficient of independent variables is small, and the maximum value of the VIF is less than 10, and the minimum value is greater than 0. Therefore, there is no serious multicollinearity problem in the model.

Table 4. Multicollinearity test results.

Variable	open	Dis	Dpgdp	Peo	City	Dfdi	Fta	Farea	Fimport	Fexport
open	1.00									
dis	−0.13	1.00								
dpgdp	−0.18	0.36	1.00							
peo	−0.65	−0.10	−0.27	1.00						
city	−0.13	0.13	0.51	−0.37	1.00					
dfdi	0.08	0.27	−0.04	0.04	−0.24	1.00				
fta	0.23	0.09	−0.06	−0.13	−0.21	0.25	1.00			
farea	−0.58	0.19	−0.20	0.54	−0.07	0.07	−0.03	1.00		
fimport	0.17	0.35	−0.17	−0.06	−0.25	0.59	0.29	0.12	1.00	
fexport	0.03	0.34	0.15	0.10	−0.06	0.34	0.21	0.11	0.33	1.00
VIF	3.66	1.69	2.22	3.69	1.99	1.67	1.22	2.12	1.99	1.47
1/VIF	0.27	0.59	0.45	0.27	0.50	0.60	0.82	0.47	0.50	0.68

Different from the 24 full samples in the calculation of the average intra-industry trade index of forest products, in the empirical analysis of the intra-industry trade impact mechanism of the five

major forest products, the sample countries corresponding to each type of forest products are the best partner countries in the 24 full samples. We used these countries due to the non-availability of partial independent variable data and the small intra-industry trade of some forest products between China and a few countries. In the regression model for plywood, Lithuania, Belarus, and Chile were excluded and 21 countries remained; in the regression model for particleboard, Russia, Ukraine, Lithuania, Belarus, Chile, and Brazil were excluded; in the regression model for fiberboard, Vietnam, the Philippines, Russia, Ukraine, Lithuania, and Belarus were excluded; in the regression model of wood furniture, Ukraine, Belarus, and Chile were excluded; and all 24 countries were included in the model of paper products.

Table 5 provides the regression results of static intra-industry trade. The table shows that the degree of trade openness had a certain impact on the static intra-industry trade of major forest products, but the influence directions were different. The degree of trade openness had a positive impact on plywood, wood furniture, and paper products, indicating that the above forest products were strongly competitive in a trade market with a high degree of openness. The import and export trades of these three types of forest products were relatively large and the proportion of intra-industry trade was also high; the looser the bilateral trade environment, the better the level of intra-industry trade of the mentioned forest products above. However, the degree of trade openness had a relatively negative impact on the intra-industry trade of particleboard and fiberboard. The reason for this may be that China's imports of particleboard and fiberboard were relatively higher than its exports, and the international competitiveness of these products was relatively inadequate. Therefore, a looser bilateral trade environment adversely affects the domestic exports, which will have a negative impact on intra-industry trade. Geographical distance had a positive impact on the intra-industry trade of plywood, particleboard, and fiberboard, indicating that trade with a market that had a higher distance cost meant that the wood-based panels were more likely to be promoted. Wood-based panels are the most demanded forest product in the global market. Bilateral partner countries choose to trade wood-based panels in a market with a higher cost, which indicates the high trust in the quality of products, and thus improves the intra-industry trade of bilateral wood-based panels. The geographical distance had a significant negative impact on the intra-industry trade of the paper products, showing that the paper products market was mostly dominated by countries located around China, and the intra-industry trade was lower in areas with a higher distance cost.

In terms of control variables, the per capita GDP difference had a strong negative impact on the intra-industry trade of particleboard and a significantly positive impact on the intra-industry trade of wood furniture, which is consistent with the actual situation. Specifically, the difference in per capita GDP between some developing or underdeveloped countries and China was large, so the intra-industry trade of wood-based panels or chipboard was extremely small. Whereas the difference in GDP between China and developed countries was also large, the intra-industry trade of wood furniture was large. For example, Europe and the United States import Chinese wood furniture all year round, and China imports similar products of a different quality and price from European and American countries simultaneously, which is closely related to the product demand and national economic development level. The population size of the trading partner countries had a significantly positive impact on the intra-industry trade of plywood and a significantly negative impact on fiberboard and paper products. The main reason for this is that plywood trade is the main trade between China and large-population countries, whereas the intra-industry trade of fiberboard and paper products is relatively small. The difference in the urbanization rate had a significantly negative impact on the intra-industry trade of fiberboard, wood furniture, and paper products, which is in line with expectations. The bigger the difference in the urbanization rate, the bigger the gap in the urbanization development between the two sides. The demand for woody forest products increases with increasing urbanization. Therefore, the difference in the demand for bilateral forest products also increases, and an inverse relationship is formed. The difference in FDI had a significantly positive impact on the intra-industry trade of plywood, indicating that FDI plays a certain role in promoting the production

of plywood, and investment in the plywood industry is efficiency-seeking. Whether or not a free trade agreement is signed had a strong positive impact on the intra-industry trade of the particleboard industry. The forest area had a strong negative impact on the intra-industry trade of fiberboard, and the main reason for this is that China's small amounts of fiberboard export is not able to form a higher level of intra-industry trade with other countries. However, it had a significantly positive impact on the intra-industry trade of paper products, indicating that the intra-industry trade of the paper product industry depended on the abundance of forest resources. The difference in the bilateral export value of forest products has a significant negative impact on the plywood industry's intra-industry trade. Due to the large amount of plywood export in China, the larger the difference in the export value of China's plywood, the larger the demand difference for bilateral products and the more unfavorable the improvement in its intra-industry trade. The difference in the import value of bilateral forest products had no significant impact on the intra-industry trade of major forest products.

Table 5. Static intra-industry trade index (IIT) regression results.

Variable		Plywood	Particleboard	Fiberboard	Wood Furniture	Paper Products
ln(open)		0.775 *	−2.196 **	−4.482 **	0.733 *	0.911 *
		(1.76)	(−2.09)	(−2.48)	(1.83)	(1.87)
ln(dis)		0.334 *	1.324 ***	2.058 ***	−0.113	−0.630 ***
		(1.65)	(2.98)	(2.98)	(−0.58)	(−2.87)
ln(dpgdp)		−0.0247	−0.495 **	−0.610	0.361 ***	0.0330
		(−0.23)	(−2.02)	(−1.25)	(3.39)	(0.32)
ln(peo)		0.663 **	0.982	−15.59 **	0.512	−10.78 ***
		(2.47)	(0.21)	(−2.21)	(1.27)	(−6.45)
ln(city)		0.0610	−0.349	−1.247 **	−0.325 **	−0.463 **
		(0.35)	(−1.11)	(−2.04)	(−1.99)	(−2.49)
ln(dfdi)		0.221 **	−0.0609	−0.0517	−0.107	0.0546
		(2.41)	(−0.54)	(−0.31)	(−1.60)	(0.78)
ln(fta)		0.0703	1.125 **	0.711	0.169	0.415
		(0.21)	(2.49)	(1.04)	(0.69)	(1.63)
ln(farea)		0.136	−5.188	−18.11 **	−0.138	6.997 ***
		(1.14)	(−1.15)	(−2.26)	(−0.57)	(2.80)
ln(fimport)		−0.128	0.0242	−0.361	0.0124	−0.0579
		(−0.96)	(0.14)	(−1.41)	(0.13)	(−0.56)
ln(fexport)		−0.244 ***	−0.156	0.326	−0.0486	0.0468
		(−2.80)	(−1.20)	(1.72)	(−0.77)	(0.73)
_cons		−14.32 ***	37.99	347.3 ***	−9.644 **	49.37*
		(−2.91)	(0.64)	(3.11)	(−2.12)	(1.65)
Hausman test	Chi2(10)	15.91	18.56	24.05	18.37	60.95
	p	0.1023	0.0462	0.0075	0.0590	0.0000
HT test	ρ	0.1238	0.1117	0.2856	0.2071	0.1156
	Z	−7.5038	−7.1411	−4.3635	−6.0672	−8.1731
	p	0.0000	0.0000	0.0000	0.0000	0.0000
N		315	270	270	315	360

Notes: The values in parentheses are the t-statistic. *, **, and*** represent significance levels of 10%, 5%, and 1%, respectively.

Table 6 shows the estimation results of the factors affecting the marginal intra-industry trade index of forest products between China and its major trading partners. The marginal intra-industry trade index reflects the proportion of intra-industry trade in marginal trade, which directly reflects the dynamic changes in intra-industry trade. Table 6 shows that trade openness had a strong influence on the marginal intra-industry trade of plywood, particleboard, and fiberboard, in which it had a strong negative influence on plywood. However, trade openness had a strong positive impact on the marginal intra-industry trade of particleboard and fiberboard, which indicates that the loose

environment of trading partners improves the small amount of particleboard and fiberboard products, and forms a balance between imports and exports, thus promoting improvement in the marginal intra-industry trade.

Geographic distance had a strong negative effect on the marginal intra-industry trade of plywood, showing that if the distance cost of bilateral trading increases, the proportion of intra-industry trade declines. The possible reason for this is that plywood is one of the largest export shares of forest products in China. With the increase in distance cost, its export volume also exhibits a trend of gradual growth, which leads to the scale effect of the export, resulting in a decline in the import proportion, thus reducing the share of intra-industry trade. Geographic distance had a positive influence on wood furniture and paper products. The possible reason for this is that although the export volume of wood furniture and paper products is large, the domestic demand for wood furniture and paper products is also large. Therefore, to reduce the purchase cost for the countries with a high distance cost, it is better to import wood furniture or paper products with horizontal or vertical differences from partners, which has a positive influence on the marginal intra-industry trade.

Table 6. Marginal intra-industry trade index (MIIT) regression results.

Variable		Plywood	Particleboard	Fiberboard	Wood Furniture	Paper Products
ln(open)		−0.524 **	0.542 ***	1.423 **	0.0181	0.190
		(−2.06)	(3.14)	(2.26)	(0.12)	(0.89)
ln(dis)		−0.301 **	−0.0553	−0.169	0.142 *	0.440 ***
		(−2.56)	(−0.67)	(−0.70)	(1.76)	(4.56)
ln(dpgdp)		−0.0408	0.0323	0.579 ***	−0.0724	−0.0929 **
		(−0.65)	(0.54)	(3.42)	(−1.64)	(−2.07)
ln(peo)		−0.233	0.0484	−0.315	0.0258	0.490
		(−1.60)	(0.52)	(−0.13)	(0.23)	(0.67)
ln(city)		−0.0384	−0.0356	0.307	0.129 *	0.0956
		(−0.35)	(−0.50)	(1.44)	(1.93)	(1.17)
ln(dfdi)		−0.129 **	−0.0404	−0.0158	0.0191	−0.00883
		(−2.02)	(−1.27)	(−0.27)	(0.65)	(−0.29)
ln(fta)		0.225	−0.328	−0.247	0.0854	0.0659
		(0.95)	(−1.31)	(−1.04)	(0.80)	(0.59)
ln(farea)		−0.0921	0.138 ***	7.783 ***	0.0175	−1.885 *
		(−1.52)	(3.60)	(2.79)	(0.26)	(−1.72)
ln(fimport)		0.171 *	−0.0901 *	0.0136	−0.00527	0.123 ***
		(1.88)	(−1.80)	(0.15)	(−0.12)	(2.73)
ln(fexport)		0.109 *	−0.0689 *	0.0452	−0.0128	−0.0656 **
		(1.82)	(−1.74)	(0.69)	(−0.46)	(−2.34)
_cons		6.120 **	−1.181	−84.90 **	−2.318	5.947
		(2.05)	(−0.58)	(−2.18)	(−1.51)	(0.45)
Hausman test	Chi2 (10)	15.60	6.28	20.51	11.05	26.21
	p	0.1117	0.7908	0.0248	0.3537	0.0035
HT test	ρ	0.2371	0.0046	0.2420	0.2845	0.1037
	Z	−5.5500	−8.8511	−5.0595	−4.7323	−8.3932
	p	0.0000	0.0000	0.0000	0.0000	0.0000
N		315	270	270	315	360

Notes: The values in parentheses are the t–statistic. ***, **, and * indicate significance levels of 10%, 5%, and 1%, respectively.

In terms of control variables, the bilateral GDP per capita gap had a significant positive impact on the intra-industry trade of fiberboard, but a significant negative impact on paper products, indicating that countries with a large difference in per capita GDP from China had a large increase in the intra-industry trade of fiberboard, as well as a small increase in the intra-industry trade of paper products. The difference in the bilateral urbanization rate had a positive influence on the marginal

intra-industry trade of wood furniture, whereas the difference in bilateral FDI had a strong negative effect on the marginal intra-industry trade of plywood. Forest area had a significant positive effect on the marginal intra-industry trade of particleboard and fiberboard, but a negative impact on the marginal intra-industry trade of paper products. The value difference of the bilateral import of forest products had a positive effect on the marginal intra-industry trade of plywood and paper products, but a negative effect on the marginal intra-industry trade of particleboard. The value difference of the bilateral export of forest products had a positive effect on the marginal intra-industry trade of plywood, and a negative effect on the marginal intra-industry trade of particleboard and paper products. The other variables had no significant impact on the marginal intra-industry trade of forest products.

Finally, because the panel data mentioned above are short panel data, a unit root test was needed to verify the stability of the sequence of variables in the sample. Therefore, we adopted the HT test method, which is suitable for short panel data (Tables 5 and 6). From the Tables 5 and 6, we can see that the statistics (p, z) are significant, which strongly rejects the null hypothesis of the unit root. Therefore, the panel data are relatively stable.

3.3. Model Robustness Test and Endogeneity Test

To test the robustness of the regression results, according to the product attributes of the above five types of forest products, plywood, particleboard, and fiberboard are classified as intermediate products, wood furniture and paper products are classified as final products, the corresponding IIT and MIIT values are respectively taken as the average value of intermediate products and final products, the independent variables remain unchanged, and the empirical analysis was conducted again (Table 7). We found that the regression results after classification subtly changed in the saliency of some variables, but most of the factors of the intermediate and final products were consistent with the significance of the corresponding variables in Tables 5 and 6, especially the influence direction. The economic interpretation of the influencing factors is consistent with that in the unclassified regression results, so the empirical estimation results in this paper are robust.

Table 7. Model robustness test results.

Variable	Intermediate Product		Final Product	
	IIT	MIIT	IIT	MIIT
ln(open)	−0.0620	0.158	0.0459	−0.00787
	(−0.28)	(1.50)	(0.15)	(−0.13)
ln(dis)	0.300 ***	−0.110 ***	−0.492 ***	0.189 ***
	(3.76)	(−2.69)	(−3.57)	(5.96)
ln(dpgdp)	−0.0105	0.0147	0.0916	−0.0670 ***
	(−0.12)	(0.38)	(1.29)	(−3.85)
ln(peo)	0.280 ***	−0.0137	−5.973 ***	0.0103
	(2.79)	(−0.27)	(−5.49)	(0.20)
ln(city)	0.0608	0.0230	−0.235 **	0.0299
	(0.63)	(0.51)	(−2.01)	(1.13)
ln(dfdi)	0.0506	−0.0243	0.00558	0.00571
	(1.08)	(−1.30)	(0.13)	(0.51)
ln(fta)	0.172	−0.138 *	0.0883	0.0417
	(0.81)	(−1.66)	(0.54)	(1.02)
ln(farea)	−0.0495	0.0192	5.835 ***	0.00115
	(−1.14)	(0.85)	(3.77)	(0.04)
ln(fimport)	0.0945	0.0205	−0.0899	0.0402 **
	(1.50)	(0.77)	(−1.44)	(2.42)
ln(fexport)	−0.0829	0.0266	0.000701	−0.0222 **
	(−1.46)	(1.20)	(0.02)	(−2.10)
_cons	−8.429 ***	−0.393	12.35	−2.682 ***
	(−3.32)	(−0.33)	(0.65)	(−4.13)

Table 7. *Cont.*

Variable		Intermediate Product		Final Product	
		IIT	MIIT	IIT	MIIT
Hausman test	Chi2 (10)	26.29	27.44	51.59	15.54
	p	0.0034	0.0022	0.0000	0.1137
HT test	ρ	0.3765	0.1117	0.4372	0.3558
	Z	−2.7457	−7.1411	−2.0981	−3.5020
	p	0.0030	0.0000	0.0179	0.0002
N		240	240	315	315

Notes: The values in parentheses are the t-statistic. ***, **, and * indicate that the estimated results are significant at the level of 1%, 5%, and 10%, respectively.

Given the possible endogeneity problems with regression results, we tested the problems from three aspects: missing variables, measurement errors, and reverse causality [47], and the results are shown in Table 8. Firstly, in the choice of variables, we fully considered the influencing factors at the macro-trade level and the forestry industry level, and empirically analyzed both static and dynamic intra-industry trades. The regression results are more robust, so the possibility of missing important independent variables is less likely. Secondly, the empirical analysis data were derived from the authoritative data at the macro level, and definition and error processing of the independent variables were performed, so the possibility of measurement error is also small. Finally, as the import and export values of forest products in bilateral trading countries may affect the intra-industry trade and the intra-industry trade may also adversely affect the value of import and export forest products, we used the Davidson-MacKinnon test to identify the endogenous issue of the two independent variables of bilateral forest products. The results show that there is no obvious reverse causal relationship between the two variables and intra-industry trade. Therefore, there is no serious endogenous problem in the model.

Table 8. Endogenous test results.

Index	Variable	Plywood	Particleboard	Fiberboard	Wood Furniture	Paper Products
IIT	Fimport	0.635	0.214	0.340	0.668	0.960
	Fexport	0.963	0.825	0.282	0.175	0.967
MIIT	Fimport	0.532	0.139	0.174	0.978	0.069
	Fexport	0.361	0.534	0.211	0.644	0.900

4. Discussion

The improvement of intra-industry trade of forest products between countries can find a breakthrough from the factor of trade openness. Trade openness has a positive impact on marginal intra-industry trade of particleboard and fiberboard, while it has a negative impact on that of plywood. The reason for this may be that China's plywood export volume was relatively high, with a small import volume. Therefore, the looser the trade environment of trading partners, the easier it is for plywood to enter the market, resulting in a larger surplus trade, which is not conducive to the improvement in the level of marginal intra-industry trade.

The limitation of this paper is mainly reflected in the timeliness of the data, and it is worth noting that this does not affect the reliability of the research content. Specifically, due to the availability of data, the most recent year of the data in this article is 2014, which may not reflect the situation in China and its partners in the most recent period. However, it should be noted that this does not affect the reliability of the results revealed in this article, namely the evolution law of intra-industry trade of forest product and its influencing factors. The reasons are as follows: firstly, the object of this study is reliable, for the sample selection of forest products and trading countries are representative; secondly,

the data acquisition is accurate on account of the most authoritative data sources; lastly, based on representative samples and reliable data, this paper not only makes statistical descriptive analysis, but also explores the factors influencing intra-industry trade of forest products by quantitative research methods. In the future, with further disclosure of data, more recent data will be added to further track the development of trade between China and its important partners in the domestic industry.

The future research object of intra-industry trade of forest products will focus on a wider range of groups, while vertical specialization of intermediate products of forest products and the impact of intra-industry trade of forest products on national economy will be the future research directions in terms of research contents. This paper focuses on China and its major countries, and with the trade in forest products in developed and developing countries, the relationship and changes in the trade of forest products in developing and developed countries are more worthy of attention, and their impact on global intra-industry trade is greater. In addition, with the rapid growth of China's trade volume of intermediate forest products, the dynamic evolution of the competitiveness of intermediate forest products in national trade and international trade is still unclear, which needs further study. Besides, research on the effect of intra-industry trade of forest products on national economy starts from the relationship between intra-industry trade and labor market. Specifically, in recent years, the supply-demand relationship in the labor market of national forest products trade has been in an unstable state. However, there is still a lack of strong theoretical and empirical support for the mechanism of the impact of changes in the labor market relationship on Intra-industry trade, and further research is needed.

5. Conclusions

We measured the main forest products' intra-industry trade level with the IIT (GL), MIIT, and GHM index, and analyzed the status quo and factors influencing intra-industry trade of five major forest products between China and its major trading partners from 2000 to 2014. The conclusions are as follows: first, the static and marginal intra-industry trade of the main forest products in China was increasing, but the overall level was not high, so there is still considerable room for growth. The top five countries with a relatively high level of intra-industry trade were Italy, Germany, the United States, Vietnam, and Japan, while the bottom five were New Zealand, Chile, Brazil, Russia, and Spain. Second, the intra-industry trade between China and 13 other countries, represented by South Korea, was low–quality vertical intra-industry trade, and intra-industry trade with seven countries, represented by Thailand, was high–quality vertical intra-industry trade. The share in high–quality vertical intra-industry trade was greater than the low–quality type, indicating that the current intra-industry trade in China's forest products is mainly driven by the volume of high–quality vertical intra-industry trade. Thirdly, trade openness and geographical distance had an important influence on the static and marginal intra-industry trade level of the main forest products, but there were differences in the influence direction for different types of forest products. The main reason for this is the difference in the import and export scale of different types of forest products and bilateral products. The per capita GDP difference, urbanization rate, difference in foreign direct investment, forest area, import, and export, value difference of forest product had a certain influence on the intra-industry trade of forest products.

Based on the above conclusions, we think that, to further improve the level of intra-industry trade of forest products, the following measures should be actively taken under the momentum of the increasing scale of intra-industry trade of forest products in China. Firstly, the quality of exported forest products and the technical content of products should be improved. Taking wood furniture as an example, developing furniture products with Chinese characteristics, increasing the popularity of local brands, and supporting forest product trading enterprises with advantages in international competition will help enhance their advantages in scale economies under imperfect competition and promote the development of forest products trade to high–quality vertical intra-industry trade. In addition, it is necessary to actively adjust the industry structure of wood processing; strengthen

the input of innovation; enrich the types, functions, and added values of forest products on the basis of meeting the international standards of product quality; and gradually narrow the industrial gap with developed countries to improve the intra-industry trade share of forest products with developed countries. Besides, the forest products trade market should be rationally selected under the market conditions, and the forest products trade cooperation should be conducted in a market with a high degree of complementation, high openness, and a relatively low cost. In addition, the intra-industry trade advantage in some developing countries should be maintained and the market demand for forest products in developing countries should be met with high quality and inexpensive forest products. Last, but not least, it is necessary to strengthen the construction of free trade zones with developed countries, improve the level of trade openness, and create a loose and favorable international environment for China's intra-industry trade of forest products while reducing the cost of tariffs.

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