Gravity Models of China's Bamboo and Rattan Products Exports: Applications to Trade Potential Analysis

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Abstract

Using export panel data for China and 24 bamboo and rattan trading partners from 2007 to 2017, this study simulates the export trade of Chinese bamboo and rattan products using a gravity model. Our results showed that economic size has a significant positive impact on the bilateral trade of bamboo and rattan products, while absolute distance between two major economic centers and population size have a significant negative impact. Furthermore, relevant Asia-Pacific Economic Cooperation (APEC) trade arrangements have an impact on bamboo and rattan product trade flows from China. Meanwhile, trade of bamboo and rattan between China and APEC countries such as South Korea, Canada, Russia, and Thailand shows much room for growth.

Bamboo and rattan are two of the most important nonwood renewable resources, offering a unique set of characteristics, high economic value, and a wide range of applications. According to the International Network for Bamboo and Rattan (INBAR), China has the greatest abundance of bamboo resources globally. With an estimated six million hectares of bamboo forests covering 40 genera and 500 species, as well as 300,000 ha of natural rattan resources consisting of four genera and 41 species, China is the largest producer and exporter of bamboo and rattan products.

In recent decades, China has focused more and more on the role of trade in the market for nonwood forest products, such as bamboo and rattan. This is because bamboo and rattan not only grow quickly and are renewable, but also have remarkable carbon sequestration ability and ecological function (Yannick et al. 2013), which help improve the surrounding ecosystem. More importantly, nonwood forest products, like bamboo and rattan, also play an increasingly important role in promoting energy savings and emissions reductions (Vogtländer et al. 2014). Therefore, these products enrich international trade and promote sustainable development.

Studies in China have analyzed the trade of individual bamboo and rattan products, such as bamboo and rattan furniture; the term of trade of Chinese bamboo and rattan products; and the import and export of Chinese bamboo and rattan products in a certain year (Wang 2003, 2008; Huang and Lu 2009; Zhang et al. 2009). However, existing studies mainly focus on the commodity structure and geographical direction of trade, and there are no empirical studies on the trade flow, trade influencing factors, and trade potential of bamboo and rattan products. Also, most of the studies have used qualitative analysis and index calculation as research methods.

The gravity model is the most popular analytical tool in the field of international trade. Previous studies have applied this model to aggregate trade flows (Rose 2000, Glick and Rose 2002, Berger and Nitsch 2008), agricultural commodities trade (Zahniser et al. 2002, Esmaeili and Pourebrahim 2011, Chung et al. 2013, Peterson et al. 2013, Atif et al. 2016), and the trade of wood forest products (Dai and Shen 2010; Buongiorno 2015, 2016; Larson et al. 2018).

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Buongiorno et al. (1980) applied the gravity model to forest product trade for the first time. Since then, more and more scholars have applied the gravity model to the trade of forest products, improving the technique and laying a foundation for further study of the trade of forest products (Zahniser et al. 2002; Akyuz et al. 2010; Dai and Shen 2010; Buongiorno 2015, 2016; Larson et al. 2018). In addition, the gravity model has also become a favored tool for assessing the effects associated with preferential trading arrangements (Frankel 1997, Soloaga and Winters 1999).

The overall goal of this study is to use a gravity model to empirically analyze influential factors in the trade of bamboo and rattan products from China and estimate their trade potential. We use the gravity model to first analyze the trade flows of bamboo and rattan products from China for the years 2007 to 2017. The coefficients thus obtained from the gravity model estimation are then used to predict the trade potential of bamboo and rattan products from China.

The rest of the article is organized as follows: the ''Materials and Methods'' section describes the methods and data used in the study. The ''Results'' section presents the current status of China's bamboo and rattan products exports, our econometric results for both the basic gravity model and the extended gravity model. It also presents our results of trade potential measurement. The final two sections are a discussion and a conclusion.

Materials and Methods

Model selection

The classical gravity model mainly includes three kinds of explanatory variables: the variables that measure the size of economic aggregate, the variables that measure geographical distance, and dummy variables that measure the volume of trade. The basic gravity model and the extended gravity model are used to simulate the panel data of the export volume of bamboo and rattan products of China and its main trading partners. The basic model is represented as follows:

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln \mathrm{GDP}_{it} + \beta_2 \mathrm{GDP}_{jt} + \beta_3 \ln \mathrm{Dist}_{ij} + \mu_{ij} \tag{1}$$

The explained variable X_{ijt} in the formula is the total export value of China (country i) to major trading partners of bamboo and rattan products (country j) in year t; GDP_{it} and GDP_{jt} are gross domestic products (GDP) of country i and GDP of country j in year t, respectively; Dist_{ij} is the absolute distance between countries i and j, using the absolute distance between the major economic centers of each country; and μ_{ij} is the random error term.

In order to further investigate the possible impact of other economic variables on bilateral trade in bamboo and rattan products, the model needs to be expanded appropriately. With reference to the studies of Sartori et al. (2017), Fracasso (2014), Dai and Shen (2010), etc., we put the population variable into the extended gravity model. For exporting countries, population usually has a negative impact on trade, since large countries generally have more diversified products to meet the needs of domestic diversification, while small countries tend to specialize in production and rely more on foreign trade. Therefore, the greater the population of the exporting country, the larger the local market and the relative reduction in foreign trade. The impact of importing countries' populations on trade, however, is less certain. On the one hand, the relatively large population size of the importing country may lead to the substitution of foreign production for domestic production, thereby reducing trade opportunities; on the other hand, the larger the population of the importing country, the greater the import capacity will become with the increase of income level, which is positively correlated with trade.

This article also considers the impact of common borders and preferential trade arrangements on the trade of bamboo and rattan products, as with most studies. First, when the two countries engaged in trade share a common border, the general cost of trade decreases, and the volume of trade tends to increase (Wall 2000, Benedictis and Vicarelli 2004, Sheng and Liao 2004, Millimet and Osang 2007, Dai and Shen 2010, Tian et al. 2018). Second, considering that the Asia-Pacific Economic Cooperation (APEC) is a consistent trading system across 21 countries on five continents, and that those countries that trade with China the most tend to be APEC members, this article uses ''whether or not the given country is an APEC member'' as a dummy variable for preferential trade policy. When the trade parties belong to the same economic organization, the scale of trade will increase due to the preferential trade policy (Lin and Wang 2004, Zhang and Tang 2006, Zhao and Lin 2008, Tian et al. 2018). The extended gravity model is as follows:

$$\begin{aligned}\ln X_{ijt} = {} & \beta_0 + \beta_1 \ln \mathrm{GDP}_{it} + \beta_2 \mathrm{GDP}_{jt} + \beta_3 \ln \mathrm{Dist}_{ij} \\ & + \beta_3 \ln \mathrm{POP}_{it} + \beta_4 \mathrm{POP}_{jt} + \beta_5 \mathrm{Border}_{ij} + \beta_6 \mathrm{APEC}_{ij} \\ & + \mu_{ij}\end{aligned} \tag{2}$$

where POP_{it} and POP_{jt} are the population of country i and country j in year t, respectively; Border_{ij} is a dummy variable, indicating whether or not the two countries border each other, where a value of 1 represents ''yes,'' while a value of 0 represents ''no''; and APEC_{ij} is a dummy variable that indicates whether both countries belong to APEC, with a value of 1 for yes and a value of 0 for no.

Methods

Estimation methods.—Traditionally, empirical gravity models have been estimated using linear estimators such as ordinary least squares (OLS). However, linear estimators can pose problems because of the multiplicative functional form of the theoretical gravity model (Silva and Tenreyro 2006). Larson et al. (2018) concluded that the Poisson pseudo maximum likelihood (PPML) estimator is best suited to applications of gravity models. Using PPML provides two distinct advantages over OLS and addresses both econometric concerns. First, heteroscedasticity will not result in biased estimates. Second, zero-trade observations can be included, since the PPML estimator remains consistent with or without the inclusion of zero-trade observations. Therefore, the discussion of results and analysis of trade potential in this article are based on PPML results. In addition, drawing on previous studies (White and Hewings 2010, Baltagi and Pirotte 2011, Jiang et al. 2017), we also use three methods of cross-section weights (CSW), period weights, and period seemingly unrelated to regression (Period SUR) for the gravity model to eliminate cross-sectional heteroscedasticity, time series heteroscedasticity, and time unit heteroscedasticity. The results of these three methods further prove the robustness of the PPML analysis results adopted in this article.

Trade potential measurement.—The measurement of trade potential is to simulate the actual export value (T) and theoretical export value (T') of China and sample countries by using the results of the regression equation. Liu and Jiang (2002) identify classification criteria for different types of trade potential. The type of trade with T/T' greater than 1.2 is called ''potential remodeling type,'' which indicates that the trade potential between trading partners is very limited, and only with the development of new positive factors will there be greater room for trade development. The type of trade with T/T' between 0.8 and 1.2 is called ''potential exploitation type,'' indicating that there is still a certain trade potential between trading partners, and new positive factors can be cultivated on the basis of continuing to play the role of the original positive factors. The trade type with T/T' less than 0.8 is called ''great potential type,'' indicating that the trade potential between trading partners is quite great, and the barriers to trade should be removed as much as possible in order to promote normal trade development.

Data source and sampling

In this article, we use the panel data for the exchange of major bamboo and rattan products between China and its major trading partners from 2007 to 2017 to conduct a simulation analysis using the gravity model. The dependent variable of the gravity model is the value for China of exporting major bamboo and rattan products to 24 countries or regions. Annual export data were obtained for the years 2007 to 2017 from the UN Comtrade Database (United Nations Commodity Trade Statistics Database 2019). Independent variables of the model include GDP, population, and forest area of each country. These data are from the World Bank Open Data (2019). The Center for Prospective Studies and International Information ([CEPII] 2019) database provides data on whether the two countries border each other and the absolute distance between them.

The reason that 2007 was chosen as the starting year for the analysis was that China had adjusted nearly one-third of the current customs tariff codes and also reclassified bamboo and rattan products starting in January 2007. For example, bamboo and rattan products are now listed separately from wood products. In addition to the existing 12 bamboo and rattan codes, 13 new six-digit codes are also included in this edition of the Customs Harmonized Commodity Description and Coding System (INBAR 2014), expanding the range of bamboo and rattan products. This article selected 16 main bamboo and rattan products, namely, all the products listed with the harmonized system (HS) codes shown in Table 1.

The specific trading partner countries or regions analyzed in this article include Hong Kong, the United States, the Netherlands, Japan, Germany, South Korea, Australia, France, Canada, the United Kingdom, Italy, Spain, Russia, Malaysia, Poland, Thailand, India, Belgium, Singapore, Mexico, Vietnam, Saudi Arabia, Brazil, and the United Arab Emirates, a total of 24 countries or regions.

The Chinese export volume of bamboo and rattan products to these countries or regions accounts for more than 85 percent of total Chinese export volume of bamboo and rattan products (see Fig. 1 for details). Also, these countries and regions are distributed across five continents. Thus, the research samples representatively reflect the overall bamboo and rattan product trade flow from China.

Table 1.—Harmonized system (HS) subheadings for bamboo and rattan commodities effective from January 1, 2007.[a]

HS codes	Description of the products
140110	Bamboos
140120	Rattans
200591	Bamboo shoots, prepared/preserved other than by vinegar/acetic acid, not frozen
440210	Including shell/nut charcoal, whether/not agglomerated
441210	Bamboo plywood, veneered panels, and similar laminated wood
440921	Bamboo including strips and friezes for parquet flooring, not assembled, continuously shaped, tongued, grooved, rebated, chamfered, V-jointed, beaded, molded, rounded/the like along any of its edges, ends/faces, whether/not planed/sanded/end-jointed
460121	Mats, matting, and screens of bamboo
460122	Mats, matting, and screens of rattan
460192	Plaits and similar products of bamboo, whether/not assembled into strips; bound together in parallel strands/woven, in sheet form, whether/not being finished articles
460193	Plaits and similar products of rattan, whether/not assembled into strips; bound together in parallel strands/woven, in sheet form, whether/not being finished articles
460211	Basketwork, wickerwork, and other articles, made directly to shape from bamboo
460212	Basketwork, wickerwork, and other articles, made directly to shape from rattan
470630	Pulps of fibers derived from recovered waste and scrap paper/paperboard of bamboo
482361	Trays, dishes, plates, cups, and the like, of paper/paperboard, of bamboo
940151	Seats of bamboo/rattan
940381	Furniture of bamboo/rattan

[a] Source: International Network for Bamboo and Rattan (INBAR), Beijing.

Additionally, these countries and regions are part of the top 40 major trading partners for China (according to China Statistical Yearbook 2018), which is conducive to further estimating the export potential of Chinese bamboo and rattan products.

Results

Current status of China's bamboo and rattan products exports

China is a major exporter of bamboo and rattan products. From 2015 to 2017, China was the world's largest exporter of raw bamboo, bamboo shoots, bamboo flooring, bamboo plywood, bamboo mat products, bamboo and rattan weaving, basketwork or wickerwork from bamboo and rattan, bamboo pulp, and paper or paperboard made of bamboo. The total exports of bamboo shoots (200,591), bamboo flooring (440,921), bamboo mat products (460,121), and bamboo weaving products (460,192) from China accounted for more than 85 percent of world exports of such products from 2015 to 2017 (Table 2).

From the perspective of export structure, bamboo and rattan products and bamboo shoots account for the vast majority of export shares. Among them, the average export values of products with export values of more than US$100 million from 2007 to 2017 are bamboo shoots (200,591; average US$226.45 million), bamboo flooring (440,921; average US$279.19 million), bamboo mat products (460,121; average US$136.91 million), basketwork or

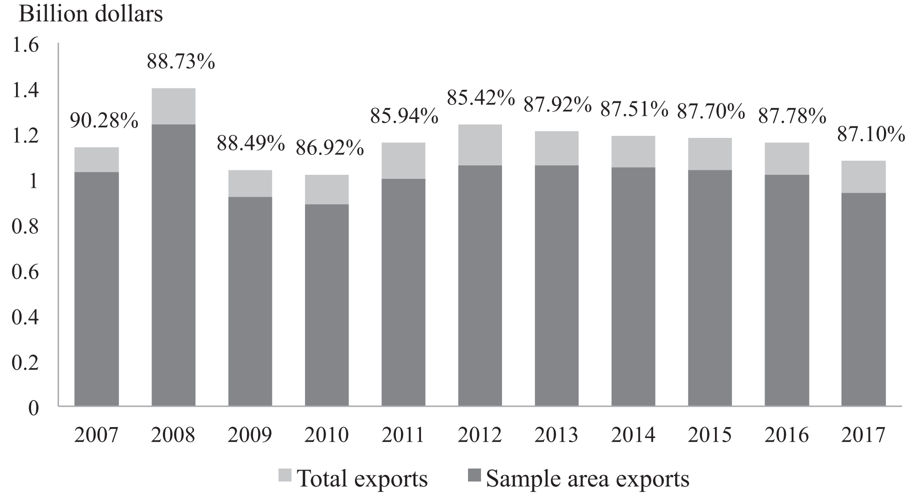

Figure 1.—Chinese exports of bamboo and rattan products to sample areas as a proportion of total exports from 2007 to 2017.

wickerwork made of bamboo (460,211; average US$172.47 million), and basketwork or wickerwork made of rattan (460,212; average US$104.13 million). However, rattan products, bamboo paper, and bamboo pulp have relatively low export values (as shown in Table 3).

Econometric results

This article uses panel data from 24 countries or regions, observed over 11 years, for analysis. The sample size is 264. The estimation results of the basic gravity model and the extended gravity model using the software Stata 15.0 are shown in Tables 4 and 5.

It can be seen from Tables 4 and 5 that the five estimation methods used in this article are basically consistent in terms of coefficient sign and significance. In terms of goodness of fit, the R^2 found using the PPML estimation method is larger than that found using OLS. Further comparing the basic gravity model with the extended gravity model, we find that the R^2 value (0.633) of the extended gravity model is significantly larger than the R^2 value (0.345) of the basic gravity model after the addition of other explanatory variables, which indicates that the relevant explanatory variables selected are reasonable. The model as a whole passes the test and has high explanatory power. The detailed analysis of the PPML results in Table 5 column 5 is as follows:

1. The GDP regression coefficient of importing countries is significantly positive, indicating that the trade volume of bamboo and rattan products between China and its major trading partners is positively correlated with the economic aggregate of the importing country. The regression coefficient is 0.057 (significant at the 1% level, row 3, column 5), indicating that economic scale is an important factor affecting bilateral trade volume, which is consistent with previous research results. The increase of economic strength in the importing country will lead to an increase of product trade volume.
2. The absolute distance regression coefficient of the two trading parties is significantly negative, indicating that distance still hinders trade. The regression coefficient of distance is –0.027 (significant at the 1% level, row 5, column 5), that is, every unit increase in the distance between the two countries will reduce the bilateral trade volume of bamboo and rattan products by 2.7 percent.
3. The population regression coefficient for the importing countries is significantly negative (significant at the 1% level, row 9, column 5), indicating that the greater the population of an importing country is, the less dependent on the international market the importing country will be, therefore leading to fewer exports.
4. The regression coefficient of the dummy variable APEC is significantly positive, with a value of 0.036, which shows that the trade volume of APEC members is 3.6 percent higher than that of non-APEC members.

Table 2.—China and world bamboo and rattan product exports from 2015 to 2017.

HS codes[a]	China (million US$)	World (million US$)	Proportion of China exports to world exports (%)
140110	217.54	301.05	72.26
140120	15.88	57.20	27.76
200591	866.11	961.90	90.04
440210	101.49	162.78	62.35
440921	730.19	779.81	93.64
441210	246.39	327.04	75.34
460121	224.78	254.45	88.34
460122	0.69	10.67	6.45
460192	142.52	156.19	91.25
460193	7.39	11.95	61.88
460211	459.21	700.27	65.58
460212	196.72	457.42	43.01
470630	7.86	13.21	59.50
482361	32.55	91.93	35.41
940151	23.56	191.32	12.31
940381	140.74	323.31	43.53

[a] HS = harmonized system.

Trade potential measurement results

The trade value of China and sample countries in 2017 was simulated according to the parameter estimation of the PPML method in Table 5, column 5, and then the actual

Table 3.—Export of bamboo and rattan products from China in the period 2007 to 2017 (million US$).

HS codes[a]	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
140110	33.41	33.14	28.54	34.11	40.24	48.23	52.31	60.15	72.82	69.87	74.85
140120	3.02	2.71	2.21	3.19	3.52	3.66	4.26	4.10	6.52	4.29	5.07
200591	161.55	163.46	157.51	191.06	222.00	240.93	245.68	242.70	278.07	303.40	284.63
440210	7.29	5.34	5.80	7.26	9.68	11.90	19.65	30.79	31.41	33.72	36.36
440921	270.67	329.34	224.35	221.58	252.76	332.82	313.37	296.96	262.14	255.35	212.70
441210	72.05	51.16	54.49	61.16	53.97	65.29	69.73	82.21	72.32	72.68	101.39
460121	194.91	329.50	210.47	120.62	128.82	105.93	97.85	93.11	77.40	74.08	73.31
460122	0.15	0.11	0.29	0.06	0.10	0.07	0.29	0.62	0.21	0.30	0.17
460192	13.78	42.14	47.07	56.51	55.90	65.03	66.17	63.22	58.96	40.12	43.44
460193	2.85	3.18	3.42	2.02	3.54	2.49	2.35	2.95	2.51	1.70	3.19
460211	189.52	222.71	142.53	146.01	200.62	204.09	177.87	154.63	150.82	141.65	166.73
460212	147.38	176.26	109.82	120.49	114.85	100.69	93.08	86.16	75.14	62.19	59.40
470630	0.00	0.04	0.20	1.96	1.22	1.46	2.02	2.39	3.19	2.70	1.97
482361	3.28	3.72	1.82	1.74	1.22	1.13	2.73	7.77	12.48	8.04	12.03
940151	17.65	13.79	19.56	16.09	18.92	14.96	9.94	9.23	10.62	12.94	—
940381	22.42	21.01	34.83	38.43	50.63	38.91	50.14	57.29	66.15	74.59	—

[a] HS = harmonized system.

export value T was compared with the theoretical value T' to analyze the trade potential of Chinese bamboo and rattan products. The calculation equation is

$$T' = e^{10.19+0.036\text{APEC}-0.014\text{Border}}\text{GDP}_i^{0.013}\text{GDP}_j^{0{,}057}\text{Dist}_{ij}^{-0.027} \times \text{POP}_i^{-0.622}\text{POP}_j^{-0.03} \quad (3)$$

According to the calculated results (as shown in Table 6 and Fig. 2), among the top 10 trading partners that China exports bamboo and rattan products to, the United States, Japan, Germany, the Netherlands, Malaysia, the United Kingdom, and Italy are all trading partners with the potential remodeling type. These results indicate that, according to the model analysis, the expansion potential of the trade of bamboo and rattan products between China and these trading partners has already been fully realized. In order to maintain sustained and stable growth in exports of bamboo and rattan products to these countries, it is necessary to further optimize the structure of Chinese bamboo and rattan product exports to these countries while maintaining the original positive factors. At the same time, the added value of products can be increased, or the dependence on exports from some countries can be appropriately reduced.

Among the other countries in the top 10, South Korea is the trading partner with the great potential type. According to the model analysis, China and South Korea have great potential to expand the trade scale of bamboo and rattan products. There is still much room for growth in the development of bamboo and rattan trade between these two countries. Australia and Singapore are in the middle and belong to the potential exploitation type. The bilateral trade potential between China and these two trading partners has not been fully realized, and there is still some room for expansion. Therefore, factors promoting the development of trade should be further explored.

Across the sample, countries with great trade potential with China include Thailand, Saudi Arabia, and the United Arab Emirates in Asia; Russia and Belgium in Europe; Brazil in South America; and Mexico and Canada in North America. The ratios of Russia, Canada, Thailand, Saudi Arabia, and Brazil are all less than 0.4, so these countries deserve our special attention. Countries with the potential exploitation type include Hong Kong, France, and India. Countries with the potential remodeling type include Vietnam, Spain, and Poland.

Discussion

Based on the gravity model, this study conducted an empirical analysis of the export panel data for China and 24 bamboo and rattan product trading partners from 2007 to 2017. The results show that distance is still a hindrance to trade. Increasing transportation costs and information exchange difficulties limit trade between countries, thus reducing trade volume. Previous studies have shown that the barrier coefficient of spatial distance is larger than the value

Table 4.—Regression analysis results of the basic gravity model.[a]

Variables	OLS (1)	CSW (2)	Period weights (3)	Period SUR (4)	PPML (5)
$\ln\text{GDP}_{it}$	−0.154 (0.142)	−0.134 (0.153)	−0.120 (0.092)	−0.112 (0.181)	−0.009 (0.009)
$\ln\text{GDP}_{jt}$	0.622*** (0.055)	0.629*** (0.052)	0.721*** (0.079)	0.514*** (0.051)	0.036*** (0.003)
$\ln\text{Dist}_{ij}$	−0.514*** (0.090)	−0.514*** (0.086)	−0.523*** (0.175)	−0.408*** (0.081)	−0.030*** (0.005)
Constant	8.640** (4.359)	7.869* (4.653)	5.097* (2.767)	9.494* (5.467)	2.336*** (0.300)
Observations	264	264	264	264	264
R^2	0.3378	—	—	—	0.345
Wald	—	147.20	99.53	101.27	—

[a] Standard errors in parentheses. *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$. OLS = ordinary least squares; CSW = cross-section weights; Period SUR = period seemingly unrelated to regression; PPML = Poisson pseudo maximum likelihood.

Table 5.—Regression analysis results of the extended gravity model.[a]

Variables	OLS (1)	CSW (2)	Period weights (3)	Period SUR (4)	PPML (5)
$\ln GDP_{it}$	0.210 (0.420)	0.178 (0.412)	0.207 (0.195)	0.178 (0.444)	0.013 (0.024)
$\ln GDP_{jt}$	0.964*** (0.058)	0.955*** (0.056)	0.886*** (0.084)	0.928*** (0.058)	0.057*** (0.004)
$\ln Dist_{ij}$	−0.480*** (0.079)	−0.474*** (0.076)	−0.392** (0.161)	−0.452*** (0.075)	−0.027*** (0.005)
$\ln POP_{it}$	−10.404 (10.489)	−9.128 (10.782)	−8.319* (4.773)	−9.075 (11.637)	−0.622 (0.643)
$\ln POP_{jt}$	−0.497*** (0.051)	−0.483*** (0.049)	−0.456*** (0.092)	−0.472*** (0.050)	−0.030*** (0.003)
$Border_{ij}$	−0.253* (0.148)	−0.261* (0.142)	−0.239 (0.292)	−0.276** (0.139)	−0.014 (0.009)
$APEC_{ij}$	0.613*** (0.095)	0.619*** (0.091)	0.617*** (0.194)	0.597*** (0.089)	0.036*** (0.005)
Constant	140.083 (136.116)	123.068 (140.469)	111.699* (62.683)	122.733 (151.636)	10.190 (8.378)
Observations	264	264	264	264	264
R^2	0.6271	—	—	—	0.633
Wald	—	461.99	202.36	415.18	—

[a] Standard errors in parentheses. *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$. OLS = ordinary least squares; CSW = cross-section weights; Period SUR = period seemingly unrelated to regression; PPML = Poisson pseudo maximum likelihood.

found in this study (Zhao and Lin 2008), which indicates that the negative influence of spatial distance is weakening. This may be due to the role of institutional arrangements. Regional economic integration factors such as APEC can offset the negative impact of spatial distance on trade to a certain extent.

Our research found that Chinese trade in bamboo and rattan products with APEC member countries is greater than with non-APEC member countries, which indicates that regional institutional arrangements play a significant role in promoting bilateral trade. These results also demonstrate the positive role played by APEC in guiding and coordinating the trade of bamboo and rattan products between China and many regions with different levels of economic development. After years of development, APEC has become an important link between countries on opposite sides of the Pacific Ocean and a major opportunity for cooperation among its members (Jung and Hyun-Hoon 2017).

Table 6.—Measurement of potential for trade of bamboo and rattan products between China and sample countries and regions in 2017.

Sample countries and regions	Actual trade volume T/ hundred million US$	Theoretical trade volume T'/ hundred million US$	T/T'
Hong Kong	0.24	0.28	0.85
United States	3.04	1.25	2.43
Netherlands	0.53	0.16	3.33
Japan	1.84	1.14	1.62
Germany	0.57	0.30	1.90
South Korea	0.33	0.83	0.40
Australia	0.35	0.36	0.97
France	0.19	0.23	0.82
Canada	0.12	0.34	0.36
United Kingdom	0.34	0.24	1.43
Italy	0.25	0.19	1.35
Spain	0.19	0.14	1.37
Russia	0.06	0.16	0.37
Malaysia	0.35	0.11	3.15
Poland	0.15	0.07	2.00
Thailand	0.02	0.12	0.17
India	0.06	0.06	1.01
Belgium	0.08	0.12	0.67
Singapore	0.25	0.27	0.93
Mexico	0.09	0.12	0.78
Vietnam	0.23	0.05	4.59
Saudi Arabia	0.04	0.10	0.38
Brazil	0.02	0.08	0.26
United Arab Emirates	0.05	0.12	0.42

Like most econometric projections, such forecasts must be viewed cautiously. They are subject to large potential error. Some errors are due to the gravity equations themselves. The derived elasticities are expected values over a very large number of trade flows and years of observation, but there were substantial variations for individual trade flows and years. Despite these limitations, which are shared, to a large extent, with other approaches, the gravity equation method has the advantage of simplicity and transparency compared with other models such as the global timber model, the global forest products model, as well as global computable general equilibrium models, due to the high data requirements of such models (Sohngen et al. 1999, Buongiorno et al. 2003, Suttles et al. 2014, Johnston 2016, Tian et al. 2016). All the data are readily available, and the results are easily reproduced. Applied to forecasting and policy analysis, the results represent another worthwhile source of information providing an alternative view of world trade in bamboo and rattan products that can be helpful for policymakers.

From a policy perspective, our results suggest that there is insufficient trade between China and other APEC countries. This is concerning because insufficient trade can impede international trade among APEC members over the long term. If the Chinese government wants to increase trade with other countries, particularly APEC countries, it will need to take more comprehensive measures to reduce trade barriers. This can be done by promoting electronic commerce through increased infrastructure. Recent research has found that cross-border e-commerce plays an important role in increasing international trade to and from China (Ma et al. 2019). It may be possible to improve e-commerce infrastructure to facilitate international trade. In designing effective programs, it will also be necessary to pay attention to the heterogeneity of trade areas. Our studies have shown that there is large potential for trade with Russia and South Korea, since they border China. Following this line of reasoning, it is important that e-commerce infrastructure is designed in northeast China in order to facilitate trade with potential trade partners.

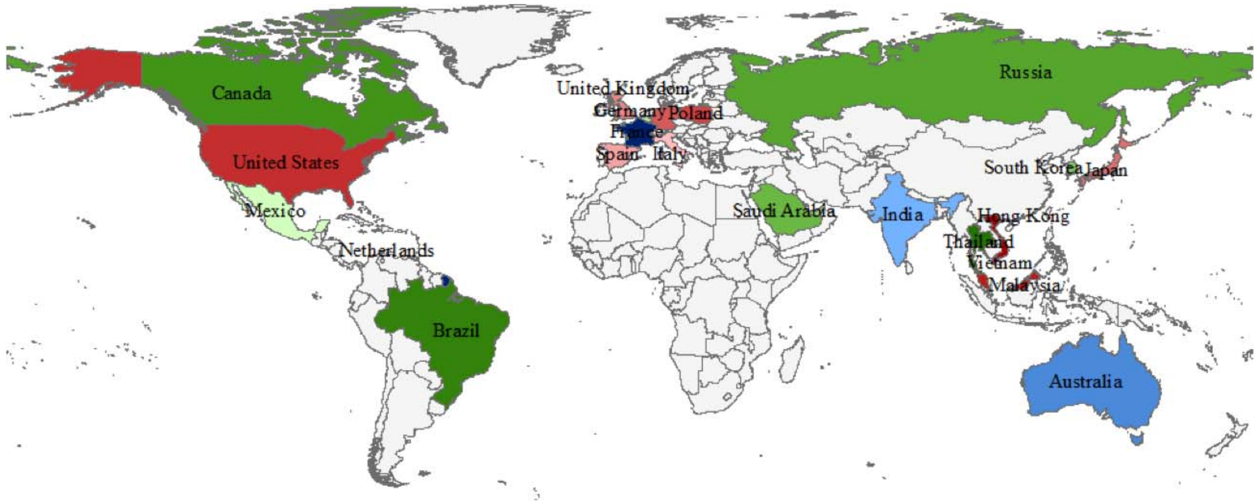

Figure 2.—Potential for trade of bamboo and rattan products between China and sample countries and regions in 2017. The countries marked red in the figure are potential remodeling type countries. The deeper the shade of red, the greater the saturation degree of trade in bamboo and rattan products. Countries marked green are great potential type countries. The darker the color, the greater the trade potential. The countries in blue are potential exploitation type countries. The darker the color, the bigger the potential exploitation space.

Conclusion

This study showed that the bilateral trade flows of bamboo and rattan products between China and its major trading partners are mainly influenced by factors such as economic size, population size, and the absolute distance between the two major economic centers. The trade potential measurement results showed that the United States, Japan, the Netherlands, and Germany are the largest importers of Chinese bamboo and rattan products. However, the potential for expansion of bamboo and rattan product trade between China and these trading partners has already been fully realized according to the model analysis. On the other hand, APEC countries such as South Korea, Canada, Russia, and Thailand showed much room for growth in the development of the bamboo and rattan trade between China and these countries. This will help policymakers to develop targeted programs for countries with insufficient trade relationships. In addition, our study confirms the importance of the use of PPML measures of gravity models for future research. Our study also confirms that an opinion question is sufficient to obtain an overall view of the bamboo and rattan product export determinants in China.

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