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The gravity model for rice exports: The cases of India and Thailand

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Abstract

This paper investigates the determinants of the rice exports of India and Thailand using the gravity model and tests the addition of new variables: the relative price of rice exports to the world price, dummy variables to explain the effects of eighteen regions, four income-level groups, and regional and country free trade agreements. Country-specific fixed effects Poisson Pseudo Maximum Likelihood and Poisson Maximum Likelihood methods were adopted to deal with endogeneity from omitted relevant explanatory variables. The results indicate that Thailand's rice exports are more sensitive to price than are those of India. Thailand's rice is a necessary good, while India's rice is a neutral good. Thailand's real GDP has a negative effect on its rice exports, but this is not so for India. Thailand's and India's population have a positive effect on their rice exports. India's partner's population has a negative effect, but this is not the case for Thailand. Countries in upper-middle income and high-income classes import India's rice more than those in low and lower-middle income classes. Thailand's rice exports to low, lower-middle, and upper-middle income classes are greater than to the high-income class. Not all free trade agreements benefit the rice exports of India and Thailand.

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1. Introduction

Thailand and India are competing to lead in international rice trade. Their market shares are not very far from each other, and the sum of their market shares is approximately 50%. The market share of rice export value in these two countries was 43% in 2007, and ten years later, the market share was 48.2% in 2016[1]. The gravity model has been extensively adopted to study the determinants of the levels of international trade, since Anderson (1979), Helpmen (1984), Bergstrand (1985) and Deardorff (1998) proved that the gravity model relates to economic theories. However, the gravity model still suffers from the omitted variable bias (Anderson and van Wincoop, 2003). They prove that the trade barrier and price should be added to the gravity model to avoid a bias in omitted variables. This leads to dummy variables for free trade areas (FTAs), and regional trade areas (RTAs) have been added to the gravity model. Much research has used a single dummy variable for any free trade area. Examples include Carrere (2006), Serrano and Pinilla (2012), Sheldon *et al.* (2013), Taguchi (2013), Dai *et al*. (2014), Kahouli and Maktouf (2014), Bergstrand *et al*. (2015) and Borchert and Yotov (2017). A dummy variable represented for a specific free (or regional) trade area is also used, such as the Greater Mekong Subregion (Poncet, 2006), the European Union (Sarker and Jayasinghe, 2007; Westerlund and Wilhelmsson, 2011; Persson and Wilhelmsson, 2016), and ASEAN-China (Sheng *et al*., 2014 and Yang and Martinez-Zarzoso, 2014). As far as we know, the study of the effect of disaggregated FTAs on international trade through the gravity model is still limited. For example, Siliverstovs and Schumacher (2009) used four dummy-variable FTAs to represent the European Union, European Free Trade Agreement, the Free Trade Agreement between the United States and Canada, and the Asia-Pacific Economic Co-operation. Taguchi (2013) used dummy variables for trade integration with Thailand, i.e. CLMV, advanced ASEAN, China, India, Japan, and the United States. Parra *et al*. (2016) used 10 dummy variables for 10 FTAs. There is evidence that the effect of the FTAs can be positive, negative or insignificant to trade flow. Castillo *et al*. (2016) added the export price of wine and several dummy variables of economic integration to the gravity model.

This paper studies the determinants of India's and Thailand's rice exports, where the empirical model is based on the gravity model. There are 13 FTAs signed and in effect between 2007 and 2016 for India and Thailand[2]. In order to avoid the omitted variables bias, as mentioned by Anderson and van Wincoop (2003), the disaggregated dummy variables of the 13 FTAs and the price of rice exports compared to the world price are added to the empirical gravity model. According to the United Nations and World Bank, countries are assigned to 18 areas[3] and four income-level groups[4], respectively; the culture of eating rice is different from area to area, and the behavior of eating rice may be affected by these variables. This study contributes by testing which countries classified by area and income-level groups import India's and Thailand's rice. From a policy making perspective, these would be beneficial to Indian and Thai rice exporters for planning their export strategies to the right targets.

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[1] https://oec.world/en/profile/hs92/rice?yearSelector1=tradeYear1

[2] The details are in the appendix A and B.

[3] They are (1) Eastern Africa, (2) Middle Africa, (3) Northern Africa, (4) Southern Africa, (5) Western Africa, (6) Eastern Asia, (7) South-Central Asia, (8) Southeastern Asia, (9) Western Asia, (10) Eastern Europe, (11) Northern Europe, (12) Southern Europe, (13) Western Europe, (14) the Caribbean, (15) Central America, (16) South America, (17) North America, and (18) Oceania. The lists of countries in each area are in appendix C.

[4] They are low, lower-middle, upper-middle, and high-income countries.

For the econometrics estimation method, we begin by focusing on two methods: Poisson Pseudo Maximum Likelihood (PPML) and Poisson Maximum Likelihood (Poisson ML). Santos Silva and Tenreyro (2006) found that OLS estimation of a log-linearized gravity model in the presence of heteroskedasticity gives inconsistent estimators, so they suggested the PPML method, which is robust to different patterns of heteroskedasticity. Westerlund and Wilhelmsson (2011) also showed that the performance of the log-linearized gravity model is likely to be so poor that it may not even be meaningful to estimate the results, while the Poisson ML estimator performs well with only a small bias and good accuracy in most cases. They proposed estimating the model directly using Poisson ML with bootstrap standard errors. Later, Fally (2015) proved that the fixed effects of PPML are consistent with the equilibrium constraints imposed by more structural approaches in Anderson and van Wincoop (2003). Baier and Bergstran (2004 and 2007) suggested that the gravity equation's error term might be correlated with the FTA if two countries have extensive unmeasurable domestic regulations, such as internal shipping regulations, that inhibit trade. We used the method of Wooldridge (2002) to test whether the FTAs are strictly exogenous independent variables. This study applies the econometric methods mentioned above to the empirical model. The results show that Thailand's rice exports are more sensitive to price than India's. Thailand's rice is a necessary good, while India's rice is neutral good. Thailand's real GDP harms its rice exports, but this is not so for India. Thailand's rice production depends on the quantity of labor while India's does not. The uniqueness of India's and Thailand's rice characteristics leads to their trade partners not diversifying their preference for other rice varieties or other foods. Countries in high-income economies import India's rice more than those in low, lower-middle, and upper-middle income classes. Thailand's rice exports to low, lower-middle, and upper-middle income classes are greater than the high-income class. Thailand's and India's FTA would have positive, negative, or no effects on their rice exports.

2. Empirical Model and Data

2.1 Empirical Model

The gravity model is used to study the determinants of India's and Thailand's rice exports. The dependent variable in the model is the export of rice. The common explanatory variables of the gravity model are the potential supply of exports, potential demand of imports, and trade barriers (Linnemann, 1996; Caporale *et al*. 2015). In this study, we use the real GDP and population of exporters and importers as proxies for the potential supply of exports and potential demand of imports, respectively (Martinez-Zarzoso *et al*., 2009; Westerlund and Wihelmsson, 2011; Sheldon *et al*., 2013; Kahouli and Maktouf, 2014; Yang and Martinez-Zarzoso, 2014; Persson and Wilhelmsson, 2016). The trade barriers are a negative function of trade costs and transportation costs (Caporale *et al*., 2015); hence, this study uses the distance between the capital cities of two countries and landlocked countries as proxies for trade barriers (Anderson and van Wincoop, 2003; Raballand, 2003; Santana-Gallego *et al*., 2016). The other independent variables are the relative export price of rice to the world price of rice, importer's area, importer's income-level groups, and FTAs between the exporter and importer.

The higher potential supply of exports implies more variety in export products (Caporale et al., 2015), hence the less productive resources for a specific product such as rice, *ceteris paribus*. That is, the effects of the real GDP of exporters (India and Thailand) are expected to be a negative relationship to their rice exports. The higher exporters' population implies more productive resources; this leads the exporters' population to have a positive relationship with

their rice exports. The higher potential demand for imports implies a larger market size for the importers; hence, the importers' real GDP and population are expected to have a positive relationship to rice exports from India and Thailand. More trade barriers imply more trade and transportation costs; hence, the relationship between distance and rice export is negative, and India's and Thailand's rice exports are less to landlocked countries. The empirical model can be expressed as

$$x_{ijt} = \alpha_0 y_{¿}^{\alpha_1} y_{jt}^{\alpha_2} dist_{ij}^{\alpha_3} pop_{¿}^{\alpha_4} pop_{jt}^{\alpha_5} \left(\frac{p_{ijt}}{p w_t}\right)^{\alpha_6} \left\{ \exp\left(\beta_1 locked_j + \sum_{k=1}^{17} \theta_k area_{kj} + \sum_{m=1}^{3} \gamma_m class_{mjt} + \sum_{q=1}^{13} \delta_q FTA_{ijt}^{q} \right) \right.$$

where x_{ijt} denotes the quantity of rice exports (thousands of metric tons) from exporter i (India or Thailand) to importer j in period t. y_{it} and y_{jt} are the real GDP (2010 billion USD) of country i and j, respectively, and pop_{it} and pop_{jt} are their populations (millions). $dist_{ij}$ is the distance from the capital city of exporter i to importer j (kilometers). p_{ijt} is the export price of rice (USD per kilogram) from exporter i to importer j, and pw_t is the export price of rice (USD per kilogram) from all exporters the world. $p_{ijt}/p w_t$ is the export price of rice from country i to j compared to the world price.

The dummy variables $locked_j$ take the value of 1 if importing country j is landlocked[5], and 0 otherwise; it is a time-invariant variable. Another time-invariant variable is $area_{¿}$, which is a dummy variable representing the area location k of the importing country j[6]. This variable is added because the rice exports from India or Thailand may differ from area to area; people in some areas normally prefer to consume rice and import more rice than people in countries which do not prefer to consume rice. This variable can provide information about areas that prefer Thai rice and Indian rice. We use the United Nations classification to classify all countries into 18 areas, so there must be 17 dummy variables with $area\_k_j$ (where $k = 1, \ldots, 17$)[7]; the reference area in this study is Oceania[8].

The dummy variable representing the income-class level of the importing countries j at time period t is $class\_m_{jt}$. This is a time-variant variable because the income-class can move up or down with the passage of time. We use the World Bank classification of income-countries to classify all countries into four income-classes: high income, upper-middle income, lower-middle income, and low-income. The dummy variables $class\_m_{jt}$ ($m = 1$, 2, and 3) are used to classify the four income class countries: high income (m =1), upper-middle income (m=2), lower-middle income (m = 3), and low-income. The low-income group is used as the base group, as it will be

[5] The information of landlocked countries is from UN-OHRLLS, Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, *"Landlocked Developing Countries: Things to Know, Things to Do*.

[6] See the details in Appendix C.

[7] They are Eastern Africa ($k = 1$), Middle Africa ($k = 2$), Northern Africa ($k = 3$), Southern Africa ($k = 4$), Western Africa ($k = 5$), Eastern Asia ($k = 6$), South-Central Asia ($k = 7$), Southeastern Asia ($k = 8$), Western Asia ($k = 9$), Eastern Europe ($k = 10$), Northern Europe ($k = 11$), Southern Europe ($k = 12$), Western Europe ($k = 13$), the Caribbean ($k = 14$), Central America ($k = 15$), South America ($k = 16$), North America ($k = 17$), and Oceania (base group). It takes the value of 1 if the importing country j is in region k and 0 otherwise.

[8] Oceania has the smallest population, 41 million people in 2018, i.e., 0.54% of the world population. (source: https://www.statista.com/statistics/262881/global-population-by-continent/). Other regions, such as the region with the median population, can be used as the reference region.

easier to understand the amount of rice exported from India and Thailand to the four income-classes by comparing them to the lowest income group. $class\_m_{ij}$ takes the value of 1 if an importing country j is in group m at period t, and 0 otherwise.

From 2007 until 2016, India had four regional FTAs and nine bilateral FTAs[9], while Thailand had six regional FTAs and seven bilateral FTAs[10] that were signed and in effect. This study will consider whether each of these FTAs affects rice exports from India and Thailand by using the dummy variables FTA_{ijt}^{q} (q = 1, 2, …, 13 for both India and Thailand), which is a time-invariant variable, after they were signed and in effect. It takes the value of 1 if the q^{th} FTA is signed and in effect between a rice exporter i (India or Thailand) and a rice importer j at period t[11], and 0 otherwise. η_{ijt} is a random error term.

To check the robustness of the model (1), we estimate the model by separating the independent variables of area location and income-class level of their partners which might have high multicollinearity into different models as shown below.

$$x_{ijt} = \alpha_0 y_{i}^{\alpha_1} y_{jt}^{\alpha_2} dist_{ij}^{\alpha_3} pop_{i}^{\alpha_4} pop_{jt}^{\alpha_5} \left(\frac{p_{i}}{p w_t}\right)^{\alpha_6} \left\{ \exp\left(\beta_1 locked_j + \sum_{k=1}^{17} \theta_k region_{kj} + \sum_{q=1}^{13} \delta_q FTA_{ijt}^{q} \right) \right\} \eta_{ijt} \quad (1a)$$

$$x_{ijt} = \alpha_0 y_{i}^{\alpha_1} y_{jt}^{\alpha_2} dist_{ij}^{\alpha_3} pop_{i}^{\alpha_4} pop_{jt}^{\alpha_5} \left(\frac{p_{i}}{p w_t}\right)^{\alpha_6} \left\{ \exp\left(\beta_1 locked_j + \sum_{m=1}^{3} \gamma_m class_{mjt} + \sum_{q=1}^{13} \delta_q FTA_{ijt}^{q} \right) \right\} \eta_{ijt} \quad (1b)$$

2.2 Data

The panel data set, namely for the partners of India's and Thailand's rice exports covering a 10-year period dating from 2007 to 2016 is used because Thailand's rice exports in the first five periods (2007 to 2011) were higher than those of India; while this situation switched in the last five periods (2012 to 2016), when Thailand's rice exports were less than those of India. The data in this period cover the interested characteristics of India and Thailand's rice exports.

The trade quantities and values of rice exports to Thailand's and India's partners are taken from the UN Comtrade Database and are based on the Harmonized System (HS) code 1006. The prices of Thailand's, India's, and the world's rice exports are calculated by their trade values divided by trade quantities. Real GDP and population are obtained from the World Development Indicators (WDI) of the World Bank. The data concerning the area location of a country and whether it is landlocked or not have been taken from the United Nations. The distances between the two countries were obtained from the webpage of *timeandtable*[12] and the data for Thailand's and India's FTAs are taken from the Asian Development Bank[13]. The data concerning the income class of a country is from World Bank.

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[9] See the details in Appendix A.

[10] See the details in Appendix B.

[11] If the date of being signed and in effect is in the third and fourth quarter, the dummy variable takes the value of 1 in the next year.

[12] https://www.timeanddate.com/worldclock/distanceresult.html?p1=28&p2=14

[13] https://aric.adb.org/database/fta

3. Descriptive Statistics of India's and Thailand's rice exports

The descriptive statistics of India's and Thailand's rice exports from 2007 to 2016 classified by area, income-class, and FTA are shown in Table 1. Table 1(a) shows that the most important rice export market in Africa for India's and Thailand's rice is Western Africa. The areas in Asia where India exported their rice was mostly Western Asia; and Thailand mostly exported its rice to Eastern and South-Eastern Asia. For Europe, Northern and Western Europe are the major rice markets for India, while Western Europe is the major rice market for Thailand. North America had a 1.5% – 3% share of India's exported rice and a 4.5% – 7% share of Thailand's rice. The Caribbean, Central America, South America, and Oceania were not major markets for India's and Thailand's rice. Table 1(b) shows that India's rice was exported the most to high-income countries; while Thailand's rice was exported less to high income countries, during the period of study. Table 1(c) indicates that India's and Thailand's rice were much more often exported to partners without FTA than to those with FTA.

4. Results

4.1. Thailand

PPML and Poisson ML Estimations

Table 2 shows the parameter estimates of model (1) using PPML and Poisson ML for the case of Thailand. The results show that the two methods yield similar estimators and standard errors. The Ramsey RESET test was performed on the empirical model by using the squares and cubed powers of fitted values with the method of PPML and Poisson ML. The results show that the coefficients on all powers of the fitted values were jointly insignificant. This indicates that the functional form of the empirical model (1) for Thailand is correct. The robustness checks by the estimation of the model (1a) and (1b) for the case of Thailand are shown in Table 2(a) and Table 2(b), respectively. The results show that the Ramsey RESET tests are insignificant in model (1a) but significant in model (1b), implying that the model (1b) would be an incorrect form. The estimation and significances of the parameters in both model (1) and (1a) are close to each other. The discussion of the results will draw on the empirical model (1).

According to Table 2, the explanatory variables in Thailand's real GDP and population (y_{it} and pop_{it}, respectively), Northern Africa, South Central Asia, Eastern Europe, Southern Europe, the Caribbean, AJCEP, ACFTA, JTEPA, and TCFTA are insignificant in both methods. That is, the ability to offer Thai products (measured by y_{it} and pop_{it}) has no effect on Thai rice exports. The results show that rice exports from Thailand depend on the destination area: ten areas import significantly more rice from Thailand than does Oceania, based on PPML and Poisson ML. Only one area, Southeastern Asia, imports significantly less Thai rice than Oceania. The average of Thai rice exports to Northern Africa, South Central Asia, Eastern Europe, Southern Europe and the Caribbean is not different from that of Oceania.

Table 1. Descriptive Statistics for the rice exports of India and Thailand (Thousands of Metric Tons) from 2007 to 2016 classified by (a) Area, (b) Income Class, and (c) FTA

(a) Area

	India's Destination	Statistics	Year									
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
AFROCA	Eastern Africa	Mean	25.46	10.57	2.38	1.81	14.28	30.78	38.82	35.84	38.52	45.87
		Std.	39.32	16.00	4.00	4.54	18.66	33.09	62.70	54.93	68.70	86.48
		Count	13	15	11	12	15	16	17	16	17	16
		Share of export	5.31%	4.49%	1.23%	0.87%	4.27%	4.66%	5.80%	5.14%	5.94%	7.41%
	Middle Africa	Mean	37.36	5.27	0.19	0.20	3.09	30.66	40.11	20.45	20.64	15.96
		Std.	59.46	8.82	0.27	0.10	3.69	64.68	94.56	34.51	39.01	29.14
		Count	4	3	3	4	6	8	9	8	9	8
		Share of export	2.40%	0.45%	0.03%	0.03%	0.37%	2.32%	3.17%	1.47%	1.69%	1.29%
	Northern Africa	Mean	21.70	0.99	0.38	0.93	10.00	53.99	15.02	20.27	25.27	39.00
		Std.	47.94	1.11	0.64	1.11	17.24	89.51	15.49	17.72	14.02	38.95
		Count	6	5	5	5	5	6	6	6	6	6
		Share of export	2.09%	0.14%	0.09%	0.19%	1.00%	3.04%	0.84%	1.08%	1.38%	2.36%
	Western Africa	Mean	117.63	12.32	3.11	0.26	58.17	259.07	231.26	170.61	179.00	168.18
		Std.	192.22	20.16	4.98	0.25	116.71	378.52	378.10	225.62	260.92	227.16
		Count	14	12	9	9	15	15	15	16	16	16
		Share of export	26.42%	4.19%	1.31%	0.09%	17.40%	36.77%	30.46%	24.46%	25.99%	27.16%
	Southern Africa	Mean	109.84	10.36	2.19	4.60	46.58	100.39	118.22	86.36	74.25	99.05
		Std.	189.89	17.88	3.64	7.88	92.02	196.89	230.12	165.56	142.30	162.73
		Count	3	3	3	3	4	4	4	4	4	3
		Share of export	5.29%	0.88%	0.31%	0.55%	3.72%	3.80%	4.15%	3.10%	2.69%	3.00%

	India's Destination	Statistics	Year									
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ASIA	Eastern Asia	Mean	0.29	2.48	0.09	0.12	0.27	2.80	6.44	1.74	1.14	1.33
		Std.	0.21	4.56	0.09	0.14	0.46	5.10	13.23	2.31	0.78	1.97
		Count	5	5	5	5	5	6	6	7	5	6
		Share of export	0.02%	0.35%	0.02%	0.02%	0.03%	0.16%	0.34%	0.11%	0.05%	0.08%
	South-Central Asia	Mean	226.08	161.73	53.84	44.50	74.26	101.85	210.93	249.43	164.97	99.99
		Std.	516.46	412.52	137.32	126.00	173.10	256.66	529.09	385.59	283.09	221.05
		Count	8	9	9	10	11	12	12	12	13	12
		Share of export	29.01%	41.22%	22.70%	17.85%	16.29%	11.57%	22.23%	26.82%	19.46%	12.11%
	South-Eastern Asia	Mean	6.46	6.42	3.23	2.86	10.31	60.66	36.77	38.41	28.68	21.09
		Std.	12.45	7.15	5.36	3.27	14.79	109.30	59.51	67.43	52.13	33.63
		Count	8	8	8	8	10	10	9	9	9	9
		Share of export	0.83%	1.46%	1.21%	0.92%	2.06%	5.74%	2.91%	3.10%	2.34%	1.92%
	Western Asia	Mean	93.86	95.08	101.37	113.26	143.38	159.19	159.58	182.60	214.92	214.95
		Std.	190.44	200.95	212.03	244.76	263.73	241.09	241.61	269.48	327.70	313.16
		Count	15	15	14	16	16	16	17	17	17	17
		Share of export	22.59%	40.39%	66.49%	72.69%	45.75%	24.10%	23.82%	27.81%	33.15%	36.89%

	India's Destination	Statistics	Year									
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EUROPE	Eastern Europe	Mean	5.20	0.81	0.32	0.14	1.28	9.96	6.02	14.46	11.56	13.59
		Std.	9.01	1.57	0.70	0.16	2.11	20.96	8.81	29.92	21.85	27.76
		Count	7	7	7	7	7	9	9	10	10	9
		Share of export	0.58%	0.16%	0.11%	0.04%	0.18%	0.85%	0.48%	1.30%	1.05%	1.23%
	Northern Europe	Mean	12.57	10.56	9.72	9.06	17.69	29.88	16.77	16.79	24.26	19.98
		Std.	30.93	25.09	22.77	20.35	47.45	79.93	49.49	49.02	67.29	53.07
		Count	8	7	6	6	8	8	10	10	9	9
		Share of export	1.61%	2.09%	2.73%	2.18%	2.82%	2.26%	1.47%	1.50%	1.98%	1.82%
	Southern Europe	Mean	4.68	2.42	0.83	1.31	4.60	13.23	9.68	6.74	6.23	5.79
		Std.	7.16	4.04	1.19	2.87	7.40	19.24	16.42	13.68	12.24	11.12
		Count	6	6	5	8	7	7	8	9	10	10
		Share of export	0.45%	0.41%	0.19%	0.42%	0.64%	0.88%	0.68%	0.54%	0.57%	0.58%
	Western Europe	Mean	13.09	8.09	2.69	5.56	15.32	33.94	32.62	23.69	27.07	29.75
		Std.	9.17	7.67	1.96	4.96	10.85	31.17	33.88	22.21	23.26	26.77
		Count	6	6	6	6	6	6	6	6	6	6
		Share of export	1.26%	1.37%	0.76%	1.34%	1.83%	1.93%	1.72%	1.27%	1.47%	1.80%

	India's Destination	Statistics	Year									
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
LATIN AMERICA AND THE CARIBBEAN	Caribbean	Mean	0.35	2.89	0.94	0.03	0.20	1.068	0.53	1.06	1.01	1.02
		Std.	0.42	5.96	1.29	0.05	0.27	2.626	0.50	1.34	1.69	1.43
		Count	4	5	2	3	7	6	6	4	8	5
		Share of export	0.02%	0.41%	0.09%	0.00%	0.03%	0.10%	0.03%	0.04%	0.07%	0.05%
	Central America	Mean	0.00	-	0.02	0.01	0.03	0.18	3.04	1.39	0.43	0.17
		Std.	0.00	-	0.02	-	0.02	0.21	-	1.93	0.59	0.21
		Count	2	0	2	1	4	5	1	2	3	2
		Share of export	0.0001%	0.0000%	0.0014%	0.0003%	0.0024%	0.0087%	0.0267%	0.0248%	0.0116%	0.0034%
	South America	Mean	0.06	0.03	0.01	0.03	0.03	0.24	0.79	1.31	1.12	0.10
		Std.	0.09	0.03	0.01	0.03	0.02	0.33	0.91	3.67	2.43	0.16
		Count	4	5	4	5	5	8	8	8	5	10
		Share of export	0.004%	0.004%	0.002%	0.007%	0.003%	0.018%	0.055%	0.094%	0.051%	0.010%

	India's Destination	Statistics	Year									
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NORTHERN AMERICA AND OCEANIA	Northern America	Mean	52.00	30.74	25.67	29.17	80.92	53.12	84.13	100.23	95.62	92.22
		Std.	47.92	15.78	18.95	14.42	79.09	63.92	73.13	102.69	78.47	78.30
		Count	2	2	2	2	2	3	2	2	2	2
		Share of export	1.67%	1.74%	2.41%	2.34%	3.23%	1.51%	1.48%	1.80%	1.74%	1.86%
	Oceania	Mean	6.92	2.94	2.32	3.74	6.52	5.12	7.75	9.89	10.19	8.41
		Std.	12.37	3.86	3.49	5.33	8.34	9.57	12.89	14.30	16.18	15.19
		Count	4	3	3	3	3	6	5	4	4	5
		Share of export	0.44%	0.25%	0.33%	0.45%	0.39%	0.29%	0.34%	0.35%	0.37%	0.42%

	Thailand's Destination		Year									
		Statistics	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
AFRICA	Eastern Africa	Mean	16.75	19.00	19.41	8.95	22.21	19.73	25.25	40.29	30.07	41.49
		Std.	41.89	47.07	49.20	25.85	55.41	60.65	71.39	107.10	89.97	101.77
		Count	11	13	12	13	10	11	9	12	12	11
		Share of export	2.02%	2.43%	2.72%	1.31%	2.08%	3.24%	3.45%	4.41%	3.70%	4.63%
	Middle Africa	Mean	55.19	61.05	60.90	78.46	72.03	83.35	121.42	135.32	122.87	137.73
		Std.	60.37	72.65	64.25	79.40	84.45	105.96	122.68	200.89	172.90	187.38
		Count	6	7	6	6	8	7	6	8	8	8
		Share of export	3.63%	4.21%	4.27%	5.29%	5.41%	8.71%	11.07%	9.89%	10.07%	11.18%
	Northern Africa	Mean	8.72	26.06	6.42	7.37	14.79	1.23	2.22	9.73	3.80	7.50
		Std.	14.05	40.57	10.93	12.62	19.35	1.31	2.55	19.06	4.68	13.89
		Count	6	6	6	6	6	5	6	6	6	6
		Share of export	0.57%	1.54%	0.45%	0.50%	0.83%	0.09%	0.20%	0.53%	0.23%	0.46%
	Western Africa	Mean	172.26	220.95	196.38	191.59	199.74	141.00	126.96	261.74	173.29	182.99
		Std.	253.13	292.70	301.10	354.67	384.39	300.22	235.57	402.38	257.73	372.76
		Count	15	15	16	16	16	16	15	16	16	16
		Share of export	28.30%	32.64%	36.70%	34.48%	29.99%	33.66%	28.95%	38.24%	28.40%	29.70%
	Southern Africa	Mean	124.33	141.25	191.63	146.01	147.02	92.06	105.25	178.94	142.49	287.31
		Std.	248.38	281.88	382.77	291.14	292.26	183.12	209.41	308.92	284.17	404.74
		Count	4	4	4	4	4	4	4	3	4	2
		Share of export	5.45%	5.56%	8.95%	6.57%	5.52%	5.49%	6.40%	4.90%	5.84%	5.83%

	Thailand's Destination		Year									
		Statistics	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ASIA	Eastern Asia	Mean	167.53	118.15	154.20	123.39	133.67	95.23	132.38	224.09	240.58	263.57
		Std.	169.14	125.67	158.21	137.14	137.81	92.30	142.06	280.38	370.70	400.09
		Count	7	7	6	7	7	6	6	6	6	6
		Share of export	12.84%	8.14%	10.81%	9.71%	8.78%	8.53%	12.07%	12.28%	14.78%	16.04%
	South-Central Asia	Mean	67.45	21.09	2.72	26.18	101.83	0.45	10.53	7.20	0.79	1.31
		Std.	198.82	56.32	7.98	51.65	233.35	0.83	27.05	17.50	1.43	2.71
		Count	9	9	10	8	10	10	7	7	7	7
		Share of export	6.65%	1.87%	0.32%	2.36%	9.56%	0.07%	1.12%	0.46%	0.06%	0.09%
	South-Eastern Asia	Mean	158.34	158.56	82.81	120.15	167.25	60.36	45.81	142.12	194.88	158.15
		Std.	191.62	225.67	88.52	167.51	281.38	105.80	55.41	171.83	264.32	170.05
		Count	10	10	10	10	10	10	10	10	10	10
		Share of export	17.34%	15.61%	9.67%	13.51%	15.70%	9.01%	6.96%	12.98%	19.96%	16.05%
	Western Asia	Mean	50.12	75.78	53.20	68.68	72.60	77.19	63.28	32.94	31.76	22.80
		Std.	83.19	131.21	83.48	125.04	155.68	190.67	168.58	40.86	52.36	23.74
		Count	16	17	17	17	16	16	17	16	17	16
		Share of export	8.78%	12.69%	10.56%	13.13%	10.90%	18.43%	16.35%	4.81%	5.53%	3.70%

	Thailand's Destination	Statistics	Year									
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
EUROPE	Eastern Europe	Mean	13.00	16.52	8.21	7.44	8.29	2.31	4.69	11.75	5.30	5.11
		Std.	31.97	41.39	19.59	15.73	13.88	3.46	9.28	25.70	10.72	9.71
		Count	9	10	10	9	8	8	8	7	9	10
		Share of export	1.28%	1.63%	0.96%	0.75%	0.62%	0.28%	0.57%	0.75%	0.49%	0.52%
	Northern Europe	Mean	8.84	10.47	9.73	9.50	9.96	5.08	6.65	7.71	9.02	7.96
		Std.	18.72	20.11	19.11	18.68	19.54	8.55	10.56	15.13	16.65	16.15
		Count	10	10	10	10	10	10	9	10	9	10
		Share of export	0.97%	1.03%	1.14%	1.07%	0.93%	0.76%	0.91%	0.70%	0.83%	0.81%
	Southern Europe	Mean	12.11	13.55	10.88	8.62	6.63	9.54	6.42	5.19	6.15	6.03
		Std.	16.29	18.18	16.29	13.22	11.34	14.20	10.09	9.63	11.57	11.84
		Count	7	8	8	8	9	6	7	11	9	10
		Share of export	0.93%	1.07%	1.02%	0.78%	0.56%	0.85%	0.68%	0.52%	0.57%	0.61%
	Western Europe	Mean	63.85	73.96	53.07	40.79	36.62	24.46	20.31	32.21	33.58	28.96
		Std.	53.76	61.59	46.90	32.98	36.59	22.03	20.05	25.76	27.06	28.78
		Count	6	6	6	6	7	6	7	6	6	7
		Share of export	4.20%	4.37%	3.72%	2.75%	2.41%	2.19%	2.16%	1.77%	2.06%	2.06%

	Thailand's Destination		Year									
		Statistics	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
LATIN AMERICA AND THE CARIBBEAN	Caribbean	Mean	0.20	1.04	0.23	1.03	1.55	0.19	0.24	0.19	0.24	0.24
		Std.	0.23	2.07	0.19	1.77	3.64	0.19	0.29	0.22	0.30	0.29
		Count	7	7	6	10	7	8	5	6	7	8
		Share of export	0.02%	0.07%	0.02%	0.12%	0.10%	0.02%	0.02%	0.01%	0.02%	0.02%
	Central America	Mean	0.04	0.10	0.08	0.07	0.08	0.04	0.47	21.44	8.08	1.24
		Std.	0.03	0.12	0.08	-	-	0.05	0.66	30.28	11.43	1.72
		Count	3	4	2	1	1	2	2	2	2	2
		Share of export	0.0013%	0.0038%	0.0018%	0.0008%	0.0008%	0.0010%	0.0143%	0.3915%	0.1656%	0.0252%
	South America	Mean	2.21	6.42	0.86	0.74	4.68	1.82	0.33	10.68	3.99	5.56
		Std.	5.05	15.30	2.07	0.88	11.69	4.05	0.33	21.06	7.15	11.86
		Count	8	8	8	6	7	6	7	8	6	7
		Share of export	0.193%	0.505%	0.080%	0.050%	0.308%	0.163%	0.036%	0.780%	0.245%	0.395%

	Thailand's Destination		Year									
		Statistics	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NORTHERN AMERICA AND OCEANIA	Northern America	Mean	155.01	154.53	176.30	159.38	160.15	146.02	155.42	188.07	259.45	189.21
		Std.	208.13	204.57	236.81	204.53	207.74	191.88	205.26	256.23	246.15	249.90
		Count	3	3	3	3	3	3	3	3	2	3
		Share of export	5.09%	4.57%	6.18%	5.38%	4.51%	6.54%	7.09%	5.15%	5.31%	5.76%
	Oceania	Mean	12.30	13.96	14.97	16.64	15.82	11.06	12.72	12.88	14.23	20.98
		Std.	23.30	30.53	34.47	33.97	30.23	21.27	22.64	24.35	25.56	37.16
		Count	13	15	14	12	12	12	10	12	12	10
		Share of export	1.75%	2.06%	2.45%	2.25%	1.78%	1.98%	1.93%	1.41%	1.75%	2.13%

(b) Income-Class

India's Destination	Statistics	Year									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
High	Mean	40.30	42.64	39.07	46.71	58.07	60.81	55.62	59.57	74.35	67.08
	Std.	120.65	133.28	134.73	161.49	173.80	154.68	152.51	167.97	210.76	188.39
	Count	41	37	38	40	42	46	51	52	46	47
	Share of export	26.51%	44.67%	69.57%	74.94%	48.63%	26.47%	24.91%	27.76%	31.03%	31.82%
Upper-Middle	Mean	16.76	2.67	21.60	16.62	27.86	52.27	85.74	63.11	55.03	54.61
	Std.	68.30	7.04	91.15	75.79	104.41	161.54	317.34	184.83	153.35	154.51
	Count	23	24	21	28	33	36	35	36	42	41
	Share of export	6.18%	1.82%	21.25%	18.66%	18.34%	17.81%	26.35%	20.36%	20.97%	22.60%
Lower-Middle	Mean	18.69	12.08	5.77	4.65	37.10	113.86	71.50	100.51	56.63	37.97
	Std.	34.72	19.02	12.66	11.83	88.29	267.24	159.29	209.51	121.14	72.30
	Count	24	26	25	28	30	36	31	34	36	35
	Share of export	7.19%	8.89%	6.76%	5.23%	22.19%	38.79%	19.47%	30.62%	18.50%	13.41%
Low	Mean	120.88	54.33	2.59	1.72	17.53	54.22	100.99	84.76	112.09	113.80
	Std.	290.34	232.42	5.57	5.84	31.48	101.98	251.26	161.22	217.94	198.27
	Count	31	29	20	17	31	33	33	28	29	28
	Share of export	60.12%	44.61%	2.42%	1.17%	10.83%	16.93%	29.27%	21.26%	29.49%	32.16%

Thailand's Destination	Statistics	Year									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
High	Mean	42.18	48.89	45.26	40.72	41.90	28.79	31.39	37.20	34.98	34.17
	Std.	78.28	81.33	86.28	76.24	77.81	60.91	68.26	81.79	76.83	81.36
	Count	51	53	53	53	53	55	53	58	51	56
	Share of export	23.56%	25.52%	28.02%	24.27%	20.84%	23.63%	25.29%	19.70%	18.27%	19.41%
Upper-Middle	Mean	36.43	48.55	36.12	34.50	50.56	50.46	58.19	71.37	69.41	64.96001
	Std.	115.04	133.24	136.79	107.01	123.09	152.43	150.21	170.90	193.25	202.9157
	Count	30	32	32	38	38	32	34	35	38	36
	Share of export	11.97%	15.30%	13.50%	14.74%	18.03%	24.10%	30.07%	22.81%	27.01%	23.73%
Lower-Middle	Mean	84.21	88.37	92.56	133.09	148.04	83.72	52.44	125.70	94.04	96.43
	Std.	164.91	194.47	202.02	266.97	320.10	216.54	85.71	260.73	197.34	167.72
	Count	32	41	39	34	34	34	31	34	38	34
	Share of export	29.51%	35.68%	42.16%	50.89%	47.24%	42.47%	24.71%	39.03%	36.60%	33.26%
Low	Mean	86.29	72.33	46.59	33.23	56.91	26.27	65.57	91.85	84.24	101.14
	Std.	179.07	158.69	117.58	91.92	144.75	76.01	206.84	245.56	188.08	299.94
	Count	37	33	30	27	26	25	20	22	21	23
	Share of export	34.96%	23.50%	16.32%	10.09%	13.89%	9.80%	19.93%	18.45%	18.12%	23.60%

(c) FTA

India's Destination	Statistics	Year									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
With FTA	Mean	230.25	140.11	6.19	3.28	15.95	43.68	48.35	96.92	71.51	30.49
	Std.	514.54	393.85	9.20	5.67	32.60	93.80	103.07	223.77	159.09	95.33
	Count	8	10	13	20	21	22	22	24	22	24
	Share of export	29.55%	39.67%	3.77%	2.63%	6.68%	9.09%	9.34%	20.84%	14.28%	7.39%
Without FTA	Mean	39.56	20.10	22.57	26.10	40.69	74.47	80.65	70.11	72.12	72.24
	Std.	109.75	80.70	97.93	114.58	127.19	191.88	237.63	171.13	182.77	170.88
	Count	111	106	91	93	115	129	128	126	131	127
	Share of export	70.45%	60.33%	96.23%	97.37%	93.32%	90.91%	90.66%	79.16%	85.72%	92.61%

Thailand's Destination	Statistics	Year									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
With FTA	Mean	166.54	158.60	115.81	131.17	166.33	68.71	73.08	165.53	205.37	180.17
	Sd	190.36	191.12	111.31	151.62	235.67	95.70	99.47	215.37	298.62	266.87
	Count	13	14	14	15	15	16	16	16	16	17
	Share of Export	23.71%	21.87%	18.94%	22.13%	23.41%	16.40%	17.77%	24.19%	33.65%	31.07%
Without FTA	Mean	50.85	54.72	49.58	50.54	60.00	43.10	44.34	62.42	49.08	51.47
	Sd	126.35	135.57	141.31	151.78	174.65	140.18	124.81	178.65	130.34	162.05
	Count	137	145	140	137	136	130	122	133	132	132
	Share of Export	76.29%	78.13%	81.06%	77.87%	76.59%	83.60%	82.23%	75.81%	66.35%	68.93%

Table 2. PPML and Poisson ML estimators of Model (1): Thailand

Variable	PPML	Poisson ML	Variable	PPML	Poisson ML
y_{it}	-0.007	-0.007	Central America	2.045	2.045
	(0.008)	(0.009)		(1.024)**	(1.361)
y_{jt}	0.0002	0.0002	South America	2.603	2.603
	(0.000)***	(0.000)**		(0.986)***	(1.072)**
$dist_i$	-0.366	-0.366	North America	4.208	4.208
	(0.081)***	(0.085)**		(0.715)***	(0.700)***
pop_{it}	0.262	0.262	Lower-middle income$_{it}$	0.766	0.766
	(0.302)	(0.355)		(0.182)***	(0.157)***
pop_{jt}	0.001	0.001	Upper-middle income$_{it}$	0.816	0.816
	(0.0006)*	(0.0007)		(0.236)***	(0.191)***
p¿/pw¿	-1.681	-1.681	High income$_{it}$	0.426	0.426
	(0.191)***	(0.144)***		(0.258)*	(0.239)*
$locked_j$	-3.138	-3.138	AFTA$_{it}$	3.298	3.298
	(0.261)***	(0.249)***		(0.422)***	(0.361)***
Eastern Africa	1.270	1.270	AANZFTA$_{it}$	1.257	1.257
	(0.362)***	(0.363)***		(0.559)**	(0.834)
Middle Africa	3.034	3.034	AIFTA$_{it}$	-1.088	-1.088
	(0.409)***	(0.389)***		(0.536)**	(0.775)
Northern Africa	0.168	0.168	AJCEP$_{it}$	-0.513	-0.513
	(0.402)	(0.438)		(0.353)	(0.374)
Southern Africa	3.865	3.865	ACFTA$_{it}$	0.675	0.675
	(0.454)***	(0.394)***		(0.775)	(0.896)
Western Africa	4.652	4.652	AKFTA$_{it}$	-1.519	-1.519
	(0.525)***	(0.532)***		(0.345)***	(0.420)***
Eastern Asia	1.407	1.407	JTEPA$_{it}$	-0.071	-0.071
	(0.456)***	(0.479)***		(0.469)	(0.514)
South-central Asia	-0.228	-0.228	LTPTA$_{it}$	1.404	1.404
	(0.685)	(0.593)		(0.505)***	(0.631)**
South-eastern Asia	-1.596	-1.596	PRCTFTA$_{it}$	-2.637	-2.637
	(0.513)***	(0.478)***		(1.147)**	(1.377)*
Western Asia	1.503	1.503	TAFTA$_{it}$	2.178	2.178
	(0.293)***	(0.321)***		(0.646)***	(0.974)**
Eastern Europe	0.023	0.023	TCFTA$_{it}$	0.538	0.538
	(0.353)	(0.297)		(0.455)	(0.590)
Northern Europe	0.924	0.924	ThaiNZCEP$_{it}$	1.233	1.233
	(0.375)**	(0.412)**		(0.685)*	(0.955)
Southern Europe	0.497	0.497	TPFTA$_{it}$	1.801	1.801
	(0.380)	(0.371)		(0.551)***	(0.644)***
Western Europe	2.569	2.569	Constant	-9.137	-9.137
	(0.384)***	(0.376)***		(17.646)	(20.927)
Caribbean	1.267	1.267			
	(0.908)	(0.887)	N (Observations)	1,438	1,438
			Log-Likelihood	–55,999.27	–55,999.27
			Ramsey RESET Test:		
			Chi-Square (2)	2.33	2.33
			(P-value)	(0.312)	(0.312)

Note: The numbers in parentheses are robust standard errors for PPML and are bootstrap standard errors for Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of PPML and Poisson ML.

Table 2 (a). PPML and Poisson ML estimators of Model (1a): Thailand

Variable	PPML	Poisson ML	Variable	PPML	Poisson ML
y_{it}	–0.009	–0.009	Central America	2.056	2.056
	(0.008)	(0.008)		(1.080)*	(1.427)
y_{jt}	0.0002	0.0002	South America	2.571	2.571
	(0.000)***	(0.000)***		(1.059)**	(1.229)**
$dist_i$	–0.355	–0.355	North America	3.803	3.803
	(0.088)***	(0.118)***		(0.721)***	(0.929)***
pop_{it}	0.377	0.377			
	(0.314)	(0.303)			
pop_{jt}	0.002	0.002			
	(0.000)***	(0.001)***			
p¿/ p w¿	–1.546	–1.546			
	(0.200)***	(0.220)***			
$locked_j$	–3.307	–3.307	$AFTA_{it}$	3.559	3.559
	(0.236)***	(0.264)***		(0.478)***	(0.584)***
Eastern Africa	1.044	1.044	$AANZFTA_{it}$	1.639	1.639
	(0.354)***	(0.433)**		(0.729)**	(1.045)
Middle Africa	3.077	3.077	$AIFTA_{it}$	–1.449	–1.449
	(0.443)***	(0.423)***		(0.667)**	(0.996)
Northern Africa	0.273	0.273	$AJCEP_{it}$	–0.471	–0.471
	(0.416)	(0.415)		(0.389)	(0.540)
Southern Africa	4.009	4.009	$ACFTA_{it}$	0.120	0.120
	(0.480)***	(0.444)***		(0.815)	(1.160)
Western Africa	4.323	4.323	$AKFTA_{it}$	–1.503	–1.503
	(0.588)***	(0.619)***		(0.347)***	(0.460)***
Eastern Asia	1.220	1.220	$JTEPA_{it}$	–0.101	–0.101
	(0.475)***	(0.733)*		(0.480)	(0.695)
South-central Asia	–0.545	–0.545	$LTPTA_{it}$	1.623	1.623
	(0.846)	(1.361)		(0.525)***	(0.668)**
South-eastern Asia	–1.411	–1.411	$PRCTFTA_{it}$	–2.670	–2.670
	(0.508)***	(0.714)**		(1.202)**	1.792
Western Asia	1.471	1.471	$TAFTA_{it}$	1.542	1.542
	(0.281)***	(0.356)***		(0.818)*	(1.012)
Eastern Europe	0.059	0.059	$TCFTA_{it}$	0.210	0.210
	(0.360)	(0.287)		(0.406)	(0.450)
Northern Europe	0.766	0.766	$ThaiNZCEP_{it}$	0.577	0.577
	(0.367)**	(0.363)**		(0.815)	(0.962)
Southern Europe	0.417	0.417	$TPFTA_{it}$	1.851	1.851
	(0.381)	(0.402)		(0.559)***	(0.600)***
Western Europe	2.294	2.294	Constant	–15.842	–15.842
	(0.361)***	(0.332)***		(18.264)	(17.732)
Caribbean	1.019	1.019			
	(0.970)	(1.097)	N (Observations)	1,438	1,438
			Log-Likelihood	-59,071.272	-59071.272
			Ramsey RESET Test:		
			Chi-Square (2)	1.22	1.22
			(P-value)	(0.542)	(0.542)

Note: The numbers in parentheses are robust standard errors for PPML and are bootstrap standard errors for Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of PPML and Poisson ML.

Table 2 (b). PPML and Poisson ML estimators of Model (1b): Thailand

Variable	PPML	Poisson ML	Variable	PPML	Poisson ML
y_{it}	–0.008	–0.008			
	(0.010)	(0.009)			
y_{jt}	0.0002	0.0002			
	(0.000)***	(0.000)***			
$dist_i$	0.008	0.008			
	(0.017)	(0.021)			
pop_{it}	0.409	0.409	Lower-middle income$_{it}$	0.344	0.344
	(0.369)	(0.327)		(0.204)*	(0.152)**
pop_{jt}	0.001	0.001	Upper-middle income$_{it}$	–0.296	–0.296
	(0.0005)*	(0.001)		(0.234)	(0.203)
p¿/ p w¿	–2.083	–2.083	High income$_{it}$	–0.293	–0.293
	(0.174)***	(0.208)***		(0.203)	(0.168)*
$locked_j$	–2.769	–2.769	AFTA$_{it}$	3.320	3.320
	(0.267)***	(0.252)***		(0.441)***	(0.587)***
			AANZFTA$_{it}$	1.374	1,374
				(0.664)**	(0.913)
			AIFTA$_{it}$	–1.174	–1.174
				(0.636)*	(0.918)
			AJCEP$_{it}$	–0.610	–0.610
				(0.403)	(0.624)
			ACFTA$_{it}$	–1.701	–1.701
				(0.559)***	(0.723)**
			AKFTA$_{it}$	–0.611	–0.611
				(0.247)**	(0.254)**
			JTEPA$_{it}$	0.536	0.536
				(0.415)	(0.688)
			LTPTA$_{it}$	1.172	1.172
				(0.516)**	(0.517)**
			PRCTFTA$_{it}$	1.326	1.326
				(0.869)	(0.853)
			TAFTA$_{it}$	0.473	0.473
				(0.673)	(0.931)
			TCFTA$_{it}$	–2.660	–2.660
				(0.208)***	(0.210)***
			ThaiNZCEP$_{it}$	–1.345	–1.345
				(0.631)**	(0.861)
			TPFTA$_{it}$	–1.729	–1.729
				(0.395)***	(0.453)***
			Constant	–18.527	–18.527
				(21.558)	(19.103)
			N (Observations)	1,438	1,438
			Log-Likelihood	-89,149.475	-89,149.475
			Ramsey RESET Test:		
			Chi-Square (2)	24.93	24.93
			(P-value)	(0.000)	(0.000)

Note: The numbers in parentheses are robust standard errors for PPML and are bootstrap standard errors for Poisson

ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of PPML and Poisson ML.

The signs for Thailand's partners' real GDP (y_{jt}), the distance ($dist_{ij}$), Thailand's relative export prices of rice ¿, and the population of Thailand's partners (pop_{jt}) are of expected signs. Landlocked countries (*locked*) import significantly less rice from Thailand than do coastal countries. The results show that Thai rice exports depend on the income level of the importing country. The high income, upper-middle income, and lower-middle income countries import more Thai rice than do low-income countries, where the group of upper-middle-income is highest in Thai rice imports after controlling for the effects of all other explanatory variables. Thailand currently has 13 FTAs with regions or countries, signed and in effect. Although the method of PPML and Poisson ML are robust to different patterns of heteroskedasticity, they cannot capture unobserved multilateral resistance in the gravity model (Fally, 2015). The estimate's coefficients are biased.

FE PPML and FE Poisson ML Estimations

Fally's (2015) suggested use of a fixed effects PPML is consistent with the equilibrium constraints imposed by more structural approaches in Anderson and van Wincoop (2003). When the method of country-pair fixed effects is adopted, time-invariant variables must be removed; hence, the distance (*dist*), landlocked countries (*locked*), and area dummy variables must be excluded in the country-pair fixed effect estimation, and Thailand's FTA signed and in effect after 2007 can be included in the country-pair fixed effect estimation[14].

Table 3 (Panel A) shows the parameter estimates of model (1) using the country-pair fixed effect versions of PPML (FE-PPML) and Poisson ML (FE-Poisson ML) for the case of Thailand. The Ramsey RESET test indicates that no misspecification occurs in the empirical model. The log-likelihoods increased by the methods of FE-PPML and FE Poisson ML compared to PPML and Poisson ML, respectively; this indicates that better fitting models are achieved. The coefficients of Thailand's real GDP (y_{it}), the real GDP (y_{jt}) of Thailand's partners, Thailand's population (pop_{it}), Thailand's relative export price of rice (p_{it}/pw_{it}), and the high-income dummy variable are significantly different from zero in both methods. The coefficients of $AIFTA_{it}$, $AJCEP_{it}$, and $TCFTA_{it}$ are significantly different from zero based on FE-PPML; while those of $TCFTA_{it}$ and $TPFTA_{it}$ are significantly different from zero based on FE-Poisson ML. The results show that the FE-PPML and FE-Poisson ML estimators are consistent: both methods find that Thailand's real GDP (y_{it}) and relative export price of rice (p_{it}/pw_{it}) have a negative effect on Thailand's rice exports. Moreover, Thailand's rice exports to the countries classified as high-income are lower than those to countries in the other income classifications. The results show that AIFTA and TCFTA, have positive effects on Thailand's rice exports, while that of AJCEP has negative effects, based on FE-PPML. TCFTA and TPFTA have positive and negative effects on Thailand's rice exports, respectively, based on FE-Poisson ML. When country-pair fixed

[14] They are AANZFTA (ASEAN-Australia and New Zealand Free Trade Agreement, signed and in effect on 2010-01-01); AIFTA (ASEAN-India Free Trade, signed and in effect on 2010-01-01); AJCEP (ASEAN-Japan Comprehensive Economic Partnership, signed and in effect on 2008-12-01); TCFTA (Thailand-Chile Free Trade Agreement, signed and in effect 2015-11-05); and TPFTA (Thailand-Peru Free Trade Agreement, signed and in effect 2011-12-31).

effects are adopted, the coefficient estimates of the population of Thailand's partners (pop_{jt}), dummy variable for high-income countries, AIFTA and TPFTA have opposite signs from those in Table 2, and those of AANZFTA and TCFTA turn to insignificant and significant, respectively.

Table 3. Country-pair Fixed effects of PPML and Poisson ML estimators: Thailand

Panel A			Panel B		
Variable	FE-PPML	FE-Poisson ML	Variable	FE-PPML	FE-Poisson ML
y_{it}	-0.011	-0.011	y_{it}	-0.0125	-0.0125
	(0.005)**	(0.006)*		(0.005)**	(0.005)*
y_{jt}	0.001	0.001	y_{jt}	0.0005	0.0005
	(0.0002)***	(0.0002)***		(0.0002)***	(0.0002)***
pop_{it}	0.504	0.504	pop_{it}	0.534	0.534
	(0.195)**	(0.205)**		(0.197)***	(0.214)**
pop_{jt}	-0.022	-0.022	pop_{jt}	-0.022	-0.022
	(0.014)	(0.016)		(0.013)*	(0.018)
p¿/ p w¿	-1.488	-1.488	p¿/ p w¿	-1.483	-1.484
	(0.209)***	(0.228)***		(0.206)***	(0.140)***
Lower-middle income$_{it}$	0.105	0.105	Lower-middle income$_{it}$	0.108	0.108
	(0.201)	(0.301)		(0.201)	(0.333)
Upper-middle income$_{it}$	-0.230	-0.230	Upper-middle income$_{it}$	-0.213	-0.213
	(0.322)	(0.365)		(0.323)	(0.461)
High income$_{it}$	-0.830	-0.830	High income$_{it}$	-0.819	-0.819
	(0.424)*	(0.482)*		(0.427)*	(0.537)
AANZFTA$_{it}$	-0.090	-0.090	AANZFTA$_{it}$	-0.059	-0.059
	(0.089)	(0.566)		(0.089)	(1.422)
AIFTA$_{it}$	0.437	0.437	AIFTA$_{it}$	0.490	0.490
	(0.251)*	(0.784)		(0.228)**	(1.457)
AJCEP$_{it}$	-0.523	-0.523	AJCEP$_{it}$	-0.234	-0.234
	(0.248)**	(0.355)		(0.225)	(0.394)
TCFTA$_{it}$	1.146	1.146	TCFTA$_{it}$	1.319	1.319
	(0.526)**	(0.192)***		(0.643)**	(0.233)***
TPFTA$_{it}$	-0.236	-0.237	TPFTA$_{it}$	-0.049	-0.049
	(0.496)	(0.108)**		(0.686)	(0.109)
			AANZFTA$_{it+1}$	-0.029	-0.029
				(0.083)	(0.624)
			AIFTA$_{it+1}$	-0.488	-0.488
				(0.311)	(0.763)
			AJCEP$_{it+1}$	0.082	0.082
				(0.258)	(0.224)
			TCFTA$_{it+1}$	0.938	0.938
				(0.642)	(0.230)***
			TPFTA$_{it+1}$	-0.277	-0.277
				(0.683)	(0.047)***
N (Observations)	1,438	1,427	N (Observations)	1,437	1,426
Log-Likelihood	–14,377.89	–13,938.61	Log-Likelihood	–14,220.01	–13,781.14
Ramsey RESET Test:					
Chi-Square (2)	2.86	1.31			
(P-value)	(0.239)	(0.520)			

Note: The numbers in parentheses are robust standard errors for FE-PPML and are bootstrap standard errors for FE-Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of FE-PPML and FE-Poisson ML.

Strict Exogeneity Test of FTAs

Baier and Bergstran (2004 and 2007) suggested that the gravity equation's error term might be correlated with the FTA if two countries have extensive unmeasurable domestic regulations, such as internal shipping regulations, that inhibit trade. Then the likelihood of the two countries' governments entering an FTA may be high if there is a large expected welfare gain. They adopted the method suggested by Wooldridge (2002) to test for the *strict exogeneity* of an FTA by adding a future level of FTA to the regression model. The insignificance of the coefficients in the future level of an FTA indicates that an FTA is exogenous to trade flows. This study follows them by adding a one-period lead on an FTA[15] to the country-pair fixed effects model; the results are in Table 3 (Panel B). The results demonstrate that AANZFTA, AIFTA, and AJCEP are strictly exogenous based on both FE-PPML and FE-Poisson ML, but TCFTA and TPFTA are not strictly exogenous based on FE-Poisson ML. It is possible that when TCFTA and TPFTA are a part of independent variables, these correlate to the random error term. To avoid this problem, the endogenous FTA variable TCFTA and TPFTA has been removed from the country-pair fixed effects estimation[16]. The results are reported in Table 4.

FE PPML and FE Poisson ML Estimations: After Removing the endogeneity of FTA

The results of the country-pair fixed effects estimation and the log-likelihoods without TCFTA and TPFTA (Table 4) do not change much from those with TCFTA and TPFTA (Table 3: Panel A). The Ramsey RESET test indicates that no misspecification occurs in the empirical model with the two estimation methods. Therefore, the results from the country-pair fixed effect of PPML and PML in Table 3 (Panel A) and Table 4 are robust and reliable. The results show that the estimated coefficient of Thailand's real GDP (y_{it}) is -0.011 and significant at the 0.05 level. This confirms that the greater the variety of export products in Thailand (which is measured by real GDP), the more competition for resources in rice production; hence, Thailand's rice exports are less. In other words, Thailand has the potential to produce both agricultural and industrial products, which do not require a high level of skills. Hence, when the variety of total outputs is higher, farmers can move into industrial sectors providing more earnings, and this leads to fewer rice exports. When we consider the coefficient of Thailand's population (pop_{it}), the results also indicate that a 1% increase in Thailand's population has a positive effect on its rice exports, by 0.504%, which implies that the quantity of rice produced depends on the amount of labor available. When we consider the potential demand of Thailand's partners for imports, the estimated coefficient of those partners' real GDP (y_{jt}) is 0.0005, which implies that Thailand's rice is a necessary good. The insignificance of the partners' population (pop_{jt}) implies that when their population is higher, their preference might not be diversified to the rice of other countries. The price elasticity of Thailand' rice exports is -1.488. Thus, a 1% increase in Thailand's rice exports decreases its rice exports by 1.488%, which indicates that the demand for

[15] They are $AANZFTA_{it+1}$, $AIFTA_{it+1}$, $AJCEP_{it+1}$, $TCFTA_{it+1}$ and $TPFTA_{it+1}$.

[16] When the dummy variable TCFTA and TPFTA have been removed, these variables will move into the random error term. Hence, there is no endogeneity problem of correlation between TCFTA and TPFTA and the random error term, which leads to consistent estimates.

its rice exports is elastic. This might be because Thailand's rice is substituted with rice from other countries; if the price of Thailand's rice is higher, most customers will purchase fragrant rice from other countries such as Vietnam or Cambodia. The results from the method of country-pair FE-PPML demonstrate that countries in the high-income groups consume less of Thailand's rice exports than do the other groups. This is because the high-income countries are mostly in Europe, in which rice in not a major food, and Arab countries, in which jasmine rice is not preferred. There is no effect of the ASEAN-Australia and New Zealand FTA (AANZFTA) on Thailand's rice export based on both econometric methods during the period of this study. A possible reason is that Australia and New Zealand are not countries that eat rice as a major food. Hence, Thailand's rice export did not receive benefits from the agreements. Based on the method of country-pair FE-PPML, the free trade agreement between ASEAN and India (AIFTA) shows evidence of benefits to Thailand's rice exports, while the free trade agreement between ASEAN and Japan (AJCEP) has a negative impact on Thailand's rice exports. This might be the reason why other ASEAN countries such as Vietnam and Cambodia also grow and export their jasmine rice, which may substitute for Thailand's rice; hence, Japan imports less of Thailand's rice[17].

4.2. India

PPML and Poisson ML Estimations

Tables 5, 5(a), and (5b) show that the two methods (PPML and Poisson ML) give similar estimators and very close standard errors for the model (1), (1a), and (1b) in the case of India, respectively. It found that the Ramsey RESET tests are significant in the model (1) and (1a) but insignificant in the model (1b), implying that the model (1b) be the correct form. The explanation, based on the method of PPML and Poisson ML, would draw on the estimation results of the model (1b). According to Table 5(b), the explanatory variables of India's real GDP and population (y_{it} and pop_{it}, respectively) have no effect on India's rice exports. The real GDP of India's partners has a positive effect on India's rice exports. India's rice exports are inelastic with respect to price. The landlocked countries (*locked*) import less rice from India than do coastal countries. Based on the income-class dummy variables, the results show that different income-class countries import different levels of Indian rice; high-income countries import the least. The coefficients of estimates for FTAs have a positive and negative effect on India's rice exports. To ensure reliable results, the method of country-pair fixed effect of PPML and Poisson ML will be adopted to the gravity model as in Thailand's case.

[17] The details of the AJCEP can be obtained from https://www.mofa.go.jp/policy/economy/fta/asean/annex1.html.

Table 4. Country-pair Fixed effects of PPML and Poisson ML estimators after removing endogenous FTA: Thailand

Variable	FE-PPML	FE-Poisson ML
y_{it}	-0.011	-0.011
	(0.005)**	(0.005)**
y_{jt}	0.0005	0.0005
	(0.0002)***	(0.0003)*
pop_{it}	0.504	0.504
	(0.195)*	(0.194)*
pop_{jt}	-0.022	-0.022
	(0.014)	(0.023)
p¿/ p w¿	-1.488	-1.488
	(0.209)***	(0.252)***
Lower-middle income$_{it}$	0.105	0.105
	(0.201)	(0.310)
Upper-middle income$_{it}$	-0.231	-0.231
	(0.322)	(0.429)
High income$_{it}$	-0.814	-0.814
	(0.422)*	(0.496)
AANZFTA$_{it}$	-0.089	-0.089
	(0.089)	(0.541)
AIFTA$_{it}$	0.437	0.437
	(0.252)*	(0.629)
AJCEP$_{it}$	-0.523	-0.523
	(0.248)**	(0.385)
N (Observations)	1,438	1,427
Log-Likelihood	–14,381.36	–13,942.08
Ramsey RESET Test:		
Chi-Square (2)	2.87	1.56
(P-value)	(0.238)	(0.459)

Note: The numbers in parentheses are robust standard errors for FE-PPML and are bootstrap standard errors for FE-Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of FE-PPML and FE-Poisson ML.

Table 5. PPML and Poisson ML estimators of Model (1): India

Variable	PPML	Poisson ML	Variable	PPML	Poisson ML
y_{it}	-0.001	-0.001	Central America	-2.076	-2.076
	(0.002)	(0.003)		(0.529)***	(0.591)***
y_{jt}	0.0005	0.0005	South America	-3.136	-3.136
	(0.0003)	(0.00027)*		(0.589)***	(0.585)***
$dist_i$	-0.217	-0.218	North America	-5.666	-5.666
	(0.102)**	(0.120)*		(3.884)	(3.446)
pop_{it}	0.016	0.016	Lower-middle income$_{it}$	-0.350	-0.350
	(0.018)	(0.021)		(0.291)	(0.326)
pop_{jt}	0.006	0.006	Upper-middle income$_{it}$	-0.218	-0.218
	(0.002)**	(0.003)**		(0.276)	(0.242)
p¿/pw¿	-0.769	-0.769	High income$_{it}$	0.698	0.698
	(0.190)***	(0.211)***		(0.333)**	(0.399)*
$locked_j$	-3.668	-3.668	AICECA$_{it}$	1.046	1.046
	(0.349)***	(0.345)***		(0.394)***	(0.341)***
Eastern Africa	0.460	0.460	APTA$_{it}$	2.753	2.753
	(0.707)	(0.791)		(0.507)***	(0.786)***
Middle Africa	0.615	0.615	IMPTA$_{it}$	-1.230	-1.230
	(0.522)	(0.526)		(0.646)*	(0.658)*
Northern Africa	0.221	0.221	SAFTA$_{it}$	-4.316	-4.316
	(0.643)	(0.645)		(0.391)***	(0.469)***
Southern Africa	2.524	2.524	IAFGPTA$_{it}$	-3.958	-3.958
	(0.476)***	(0.484)***		(0.572)***	(0.672)***
Western Africa	2.611	2.611	IBTNTA$_{it}$	3.018	3.018
	(0.455)***	(0.393)***		(0.542)***	(0.678)***
Eastern Asia	-15.844	-15.844	ICHLPTA$_{it}$	2.872	2.872
	(2.745)***	(3.187)***		(0.667)***	(0.767)***
South-central Asia	2.951	2.951	ISGPCECA$_{it}$	1.277	1.277
	(0.982)***	(1.068)***		(0441)***	(0.452)***
South-eastern Asia	-1.806	-1.806	ILKAFTA$_{it}$	-0.400	-0.400
	(0.834)**	(0.875)**		(0.748)	(1.070)
Western Asia	1.546	1.546	IKORCEPA$_{it}$	10.355	10.355
	(0.799)*	(0.923)**		(2.612)***	(3.003)***
Eastern Europe	-1.729	-1.729	INPLTT$_{it}$	6.257	6.257
	(0.685)**	(0.762)**		(0.528)***	(0.601)***
Northern Europe	-0.664	-0.664	JPNICCEPA$_{it}$	8.295	8.295
	(0.564)	(0.615)		(2.609)***	(3.248)*
Southern Europe	-1.885	-1.885	MYSICECE$_{it}$	0.788	0.788
	(0.535)***	(0.568)***		(0.440)*	(0.496)
Western Europe	-1.138	-1.138	Constant	-13.445	-13.445
	(0.756)	(0.798)		(18.736)	(21.527)
Caribbean	-1.053	-1.053			
	(0.499)**	(0.519)*	N (Observation)	1,303	1,303
			Log-Likelihood	–52,016.55	–52,016.55
			Ramsey RESET Test:		
			Chi-Square (2)	25.16	25.16
			(P-value)	(0.000)	(0.000)

Note: The numbers in parentheses are robust standard errors for PPML and are bootstrap standard errors for Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of PPML and Poisson ML.

Table 5 (a). PPML and Poisson ML estimators of model (1a): India

Variable	PPML	Poisson ML	Variable	PPML	Poisson ML
y_{it}	–0.001	–0.001	Central America	–1.613	–1.613
	(0.002)	(0.002)		(0.587)***	(0.741)**
y_{jt}	0.0007	0.0007	South America	–2.832	–2.832
	(0.0003)**	(0.0003)**		(0.631)***	(0.731)***
$dist_i$	–0.379	–0.379	North America	–7.078	–7.078
	(0.085)***	(0.090)***		(4.152)*	(4.269)*
pop_{it}	0.017	0.017			
	(0.018)	(0.017)			
pop_{jt}	0.002	0.002			
	(0.002)	(0.002)			
p¿/ p w¿	–0.664	–0.664			
	(0.185)***	(0.167)***			
$locked_j$	–3.877	–3.877	$AICECA_{it}$	1.155	1.155
	(0.342)***	(0.287)***		(0.409)***	(0.355)***
Eastern Africa	–0.476	–0.476	$APTA_{it}$	3.145	3.145
	(0.492)	(0.474)		(0.509)***	(0.626)***
Middle Africa	–0.022	–0.022	$IMPTA_{it}$	–1.007	–1.007
	(0.436)	(0.471)		(0.676)	(0.670)
Northern Africa	–0.878	–0.878	$SAFTA_{it}$	–4.327	–4.327
	(0.503)*	(0.482)*		(0.276)***	(0.371)***
Southern Africa	2.026	2.026	$IAFGPTA_{it}$	–3.803	–3.803
	(0.402)***	(0.400)***		(0.506)***	(0.833)***
Western Africa	2.226	2.226	$IBTNTA_{it}$	2.805	2.805
	(0.347)***	(0.367)***		(0.514)***	(0.488)***
Eastern Asia	–14.049	–14.049	$ICHLPTA_{it}$	4.026	4.026
	(2.548)***	(2.878)***		(0.617)***	(1.089)***
South-central Asia	1.437	1.437	$ISGPCECA_{it}$	1.716	1.716
	(0.716)**	(0.683)**		(0.438)***	(0.414)***
South-eastern Asia	–2.851	–2.851	$ILKAFTA_{it}$	–0.979	–0.979
	(0.669)***	(0.601)***		(0.727)	(0.823)
Western Asia	0.576	0.576	$IKORCEPA_{it}$	7.747	7.747
	(0.609)	(0.639)		(2.441)***	(2.707)***
Eastern Europe	–2.502	–2.502	$INPLTT_{it}$	6/427	6.427
	(0.560)***	(0.510)***		(0.481)***	(0.481)***
Northern Europe	–1.024	–1.024	$JPNICCEPA_{it}$	5.436	5.436
	(0.536)*	(0.584)*		(2.376)**	(2.664)**
Southern Europe	–2.302	–2.302	$MYSICECE_{it}$	0.333	0.333
	(0.502)***	(0.550)***		(0.427)	(0.394)
Western Europe	–1.668	–1.668	Constant	–12.517	–12.517
	(0.860)*	(0.835)**		(18.711)	(17.445)
Caribbean	–0.532	–0.532			
	(0.538)	(0.593)	N (Observations)	1,303	1,303
			Log-Likelihood	–54,103.32	–54,103.32
			Ramsey RESET Test:		
			Chi-Square (2)	9.29	9.29
			(P-value)	(0.01)	(0.01)

Note: The numbers in parentheses are robust standard errors for PPML and are bootstrap standard errors for Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of PPML and Poisson ML.

Table 5 (b). PPML and Poisson ML estimators of model (1b): India

Variable	PPML	Poisson ML	Variable	PPML	Poisson ML
y_{it}	–0.002	–0.002			
	(0.002)	(0.003)			
y_{jt}	0.0002	0.0002			
	(0.00003)***	(0.00005)***			
$dist_i$	–0.272	–0.272			
	(0.047)***	(0.048)***			
pop_{it}	0.022	0.022	Lower-middle income$_{it}$	–0.600	–0.600
	(0.021)	(0.023)		(0.268)**	(0.294)**
pop_{jt}	–0.002	–0.002	Upper-middle income$_{it}$	–0.768	–0.768
	(0.001)***	(0.002)		(0.227)***	(0.215)***
p¿/ p w¿	–0.597	–0.597	High income$_{it}$	–0.807	–0.807
	(0.204)***	(0.204)***		(0.258)***	(0.302)***
$locked_j$	–3.316	–3.316	AICECA$_{it}$	–1.408	–1.408
	(0.276)***	(0.243)***		(0.367)***	(0.374)***
			APTA$_{it}$	1.087	1.087
				(0.449)**	(2.557)
			IMPTA$_{it}$	–3.863	–3.863
				(0.533)***	(0.618)
			SAFTA$_{it}$	–0.862	–0.862
				(0.313)***	(0.522)*
			IAFGPTA$_{it}$	–3.495	–3.495
				(0.522)***	(0.633)***
			IBTNTA$_{it}$	0.146	0.146
				(0.473)	(0.706)
			ICHLPTA$_{it}$	–0.222	–0.222
				(0.663)	(0.739)
			ISGPCECA$_{it}$	0.887	0.887
				(0.418)**	(0.459)*
			ILKAFTA$_{it}$	–1.048	–1.048
				(0.731)	(3.127)
			IKORCEPA$_{it}$	–3.781	–3.781
				(0.662)***	(2.617)
			INPLTT$_{it}$	3.330	3.330
				(0.448)***	(0.604)***
			JPNICCEPA$_{it}$	–5.941	–5.941
				(0.305)***	(0.359)***
			MYSICECE$_{it}$	0.046	0.046
				(0.363)	(0.371)
			Constant	–17.778	–17.778
				(21.341)	(23.466)
			N (Observations)	1,303	1,303
			Log-Likelihood	-97,290.857	-97,290.857
			Ramsey RESET Test:		
			Chi-Square (2)	0.12	0.12
			(P-value)	(0.9415)	(0.9415)

Note: The numbers in parentheses are robust standard errors for PPML and are bootstrap standard errors for Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of PPML and Poisson ML.

FE PPML and FE Poisson ML Estimations:

Table 6 (Panel A) shows the consistent parameter estimates by the country-pair fixed effect of PPML (FE-PPML) and Poisson ML (FE-Poisson ML). When the method of country-pair fixed effects is adopted, the time-invariant variables must be removed; hence, the distance (*dist*), landlocked countries (*locked*), and area dummy variables must be excluded in the country-pair fixed effect estimation, and India's FTAs signed and in effect after 2007 have to be included in the country-pair fixed effect estimation[18].

According to Table 6 (Panel A), the log-likelihoods increased by the methods of country-pair FE-PPML and FE Poisson ML compared to PPML and Poisson ML, respectively; this indicates that better fitting models may be achieved. The Ramsey RESET test indicates that there is no misspecification problem when the method of country-pair FE-Poisson ML is adapted to the empirical model, but not for the country-pair FE-PPML; the discussion of results will draw on the country-pair FE-Poisson ML. The parameter estimates for India's real GDP (y_{it}) are still insignificant. The parameter estimate for the real GDP (y_{jt}) of India's partners is still positive, but it turns out to be insignificant. The parameter estimates for India's population (pop_{it}) are also positive and turn out to be significant, while that for the population (pop_{jt}) of India's partners is still insignificant. The effect of India's relative export price for rice (p_{it}/pw_{it}) is still negative and significant. For the effect of the income-level group, the low-, lower-middle, upper-middle, and high-income groups have no different effects on India's rice exports. The results show that IKORCEPA has a positive effect, but IMPTA and JPNICCEPA have negative effects on India's rice exports.

Strict Exogeneity Test for FTAs

Similar to the case of Thailand, we use the method suggested by Wooldridge (2002) to test for the *strict exogeneity* of FTAs. The endogeneity of the FTAs has been tested by adding a one period lead for the FTAs [19] to the country-pair fixed effect model; the results are in Table 6 (Panel B). The results based on the country-pair FE-PPML indicate that the five FTAs are not strictly exogenous. This implies that when the five FTAs are a part of independent variables, these correlate to the random error term[20]. Meanwhile the results based on the method of the country-pair FE-Poisson ML indicate that the four FTAs (AICECA, IKORCEPA, JPNICCEPA, and MYSICECE) are not strictly exogenous. Hence, the endogenous FTAs have been removed from the gravity model, after which the country-pair fixed effects are adopted again to obtain consistent estimators. With the method of country-pair FE-PPML, the five FTA have been removed, and with the method of country-pair FE-Poisson ML, the four FTAs have been removed. The log-likelihoods in Table 7 do not much change from those in Table 6: Panel A.

[18] They are AICECA (ASEAN-India Comprehensive Economic Cooperation Agreement, signed and in effect 2010-01-01); IMPTA (India-MERCOSUR Preferential Trade Agreement, signed and in effect 2009-06-01); IKORCEPA (India-Republic of Korea Comprehensive Economic Partnership Agreement, signed and in effect 2010-01-01); JPNICCEPA (Japan-India Comprehensive Economic Partnership Agreement, signed and in effect 2011-08-01); and MYSICECE (Malaysia-India Comprehensive Economic Cooperation Agreement, signed and in effect 2011-07-01).

[19] They are $AICECA_{it+1}$, $IMPTA_{it+1}$, $IKORCEPA_{it+1}$, $JPNCCEPA_{it+1}$, and $MYSICECE_{it+1}$.

[20] However, the Ramsey RESET test in Table 5 indicates misspecification occurs based on country-pair FE-PPML.

Table 6. Country-pair Fixed effects of PPML and Poisson ML estimators: India

Panel A			Panel B		
Variable	FE-PPML	FE-Poisson ML	Variable	FE-PPML	FE-Poisson ML
y_{it}	-0.002	-0.002	y_{it}	-0.002	-0.002
	(0.002)	(0.001)		(0.002)	(0.002)
y_{jt}	0.0004	0.0004	y_{jt}	0.0004	0.0004
	(0.0003)	(0.001)		(0.0002)	(0.0009)
pop_{it}	0.023	0.023	pop_{it}	0.022	0.022
	(0.013)*	(0.013)*		(0.014)*	(0.017)
pop_{jt}	-0.053	-0.053	pop_{jt}	-0.053	-0.053
	(0.024)**	(0.064)		(0.024)**	(0.061)
p¿/ p w¿	-0.417	-0.417	p¿/ p w¿	-0.413	-0.413
	(0.188)**	(0.159)***		(0.190)**	(0.251)
Lower-middle income$_{it}$	-0.251	-0.251	Lower-middle income$_{it}$	-0.250	-0.250
	(0.328)	(0.480)		(0.329)	(0.636)
Upper-middle income$_{it}$	1.271	1.271	Upper-middle income$_{it}$	1.272	1.272
	(0.437)***	(0.821)		(0.437)***	(0.787)
High income$_{it}$	1.650	1.650	High income$_{it}$	1.653	1.653
	(0.558)***	(1.150)		(0.558)***	(0.996)*
AICECA$_{it}$	1.226	1.226	AICECA$_{it}$	1.063	1.063
	(0.496)**	(1.435)		(0.464)**	(0.698)
IMPTA$_{it}$	-0.843	-0.843	IMPTA$_{it}$	-0.901	-0.901
	(0.841)	(0.511)*		(0.926)	(0.315)***
IKORCEPA$_{it}$	3.098	3.097	IKORCEPA$_{it}$	2.722	2.722
	(0.569)***	(0.298)***		(0.567)***	(0.380)***
JPNICCEPA$_{it}$	-1.397	-1.397	JPNICCEPA$_{it}$	-0.991	-0.991
	(0.643)**	(0.404)***		(0.579)*	(0.309)***
MYSICECE$_{it}$	0.595	0.595	MYSICECE$_{it}$	0.839	0.839
	(0.744)	(1.036)		(0.613)	(0.338)**
			AICECA$_{it+1}$	0.406	0.406
				(0.242)*	(0.219)*
			IMPTA$_{it+1}$	1.397	1.397
				(0.278)***	(1.004)
N (Observations)	1,303	1,292	IKORCEPA$_{it+1}$	1.021	1.021
Log-Likelihood	–20,524.68	–20,122.79		(0.536)*	(0.208)***
Ramsey RESET Test:			JPNICCEPA$_{it+1}$	-1.068	-1.068
Chi-Square (2)	17.40	0.01		(0.551)*	(0.115)***
(P-value)	(0.000)	(0.995)	MYSICECE$_{it+1}$	-0.713	-0.713
				(0.328)**	(0.256)***

Note: The numbers in parentheses are robust standard errors for FE-PPML and are bootstrap standard errors for FE-Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of FE-PPML and FE-Poisson ML.

FE PPML and FE Poisson ML Estimations: After Removing endogeneity of FTA

The results in Table 7 show that the country-pair FE-PPML and FE-Poisson ML give similar parameter estimates, while FE-PPML gives more significant parameters. Nevertheless, the Ramsey RESET test indicates that there is no misspecification problem when only the method FE-Poisson ML is adopted. The following discussion of results would draw on the country-pair FE-Poisson ML after removing endogenous FTAs. The results show that the potential supply of exports from India has no effect on India's rice exports. In other words, India's real GDP (y_{it}) and population (pop_{it}) have no effect on India's rice exports. The more variety there is in India's export products, the more competition there is for resources in rice production. However, *ceteris paribus*, farmers in India cannot move to other sectors providing more earnings. This might be because of the huge population and abundant labor that are available in India; hence, there is no effect on India's rice exports. The results show that the potential demand of India's partners for imports from India have no effects on India's rice exports. The real GDP (y_{jt}) of India's partners has no effect on India's rice exports—that is, India's rice is a neutral good. The insignificance of the population (pop_{jt}) of India's partners implies that when the population of the partners is higher, their preference might not be diversified to other countries' rice. The coefficient of India's export price is –0.424. The demand for India's rice exports is inelastic: with a 1% increase in the price of India's rice compared to the world price, India's rice exports will decrease by only 0.424%. These results imply that the characteristics of India's rice are unique and not easily substituted by rice from other countries. The high-income groups import more Indian rice than the low-, lower-middle, and upper-middle income groups. High-income countries such as the United States, France, and Italy are the lands of opportunity. Many Arab and Muslim people live there; hence, India's rice is exported the most to high-income countries. IMPTA (India-MERCOSUR Preferential Trade Agreement) has a negative effect on India's rice export. This is because basmati rice is not preferred by people in Argentina, Brazil, Paraguay, and Uruguay; moreover, there is no rice offered by MERCOSUR in the IMPTA agreement[21].

[21] https://wits.worldbank.org/GPTAD/PDF/annexes/india-mercosur_annexes.pdf (ANNEX I: MERCOSUR's offer list to India)

Table 7. Country-pair Fixed effects of PPML and Poisson ML estimators after removing endogenous FTA: India

Variable	FE-PPML	FE-Poisson ML
y_{it}	-0.002	-0.002
	(0.002)	(0.002)
y_{jt}	0.0004	0.0004
	(0.0003)	(0.001)
pop_{it}	0.023	0.023
	(0.013)*	(0.017)
pop_{jt}	-0.051	-0.051
	(0.023)**	(0.046)
p¿/ p w¿	-0.424	-0.424
	(0.189)**	(0.220)*
Lower-middle income$_{it}$	-0.269	-0.269
	(0.329)	(0.509)
Upper-middle income$_{it}$	1.236	1.236
	(0.434)***	(0.835)
High income$_{it}$	1.607	1.607
	(0.554)***	(0.974)*
IMPTA$_{it}$	-	–0.874
		(0.398)**
N (Observation)	1,303	1,292
Log-Likelihood	–20,669.84	–20,267.87
Ramsey RESET Test:		
Chi-Square (2)	24.05	0.05
(P-value)	(0.000)	(0.978)

Note: The numbers in parentheses are robust standard errors for FE-PPML and are bootstrap standard errors for FE-Poisson ML.

***, ** and * represent the 1%, 5% and 10% significance levels.

The squares and cubes powers of fitted values are used in the Ramsey RESET test with the methods of FE-PPML and FE-Poisson ML.

6. Conclusion

This study used the gravity model to find the determinants of the rice exports of India and Thailand. The Econometrics methods of PPML, Poisson ML, country-pair FE-PPML, and country-pair FE-Poisson ML, along with the endogeneity of the FTA test, have been adopted to the empirical model to ensure reliable results. It has been found that low-, lower-middle, and upper-middle-income countries do not differ in their imports of rice from Thailand, but they import more than do high-income countries. For India, the high-income countries are the largest importers. Hence, Thailand's rice exporters should look for an opportunity to introduce Thai jasmine rice into high-income countries, while India's rice exporters should expand their exports of rice to low-, lower-middle, and upper-middle-income countries.

India's real GDP has no significant effect on its rice exports, and that of Thailand has a negative effect. The size of the population of Thailand has a positive effect on its rice exports, which implies that Thailand's rice production depends on the quantity of labor, but this is not so in India. Therefore, the government of Thailand might consider training programs for rice farmers to enhance productivity. Other support from the government might include subsidies for capital goods such as tractors and fertilizers to enhance the labor productivity of farmers. The real GDP of India's trade partners has no effect on its rice exports, but it has a positive effect on Thailand's rice exports. This shows that India's rice is a neutral good, while Thailand's rice is a necessary good. This might be because India's rice was mostly exported to high-income countries, and rice is not a staple food in several countries of this class. Hence, India's partners might not import more rice when their real GDP increases. Meanwhile, Thailand's rice was mostly exported to low, lower-middle- and upper-income countries, where rice is a staple food. Therefore, Thailand's rice is a necessary good for its partners. The population of India's and Thailand's trade partners has no effect on rice exports. This is because of the uniqueness of India's and Thailand's rice quality and characteristics; trade partners would not diversify their preference to other breeds of rice.

The results also showed a price inelasticity in the demand for India's rice, while that for Thailand is elastic. This implies that India's rice characteristics are unique and less substituted by rice from other countries, while Thailand's rice is more substituted by, for example, Vietnam's or Cambodia's rice. Thailand's rice exporters might use a lower price strategy to enhance the quantity and revenue of their exports. Such a lower price strategy for India's rice exports might not be a good strategy: it would not increase the quantity by much, and so it would lower revenue from rice exports. The free trade agreement between ASEAN and Japan (AJCEP) has a negative impact on Thailand's rice exports. Thailand's government should differentiate its breed of jasmine rice from its competitors in ASEAN such as Vietnam and Cambodia. IMPTA (India-MERCOSUR Preferential Trade Agreement) has a negative effect on India's rice exports. India's government should introduce basmati rice to people in Argentina, Brazil, Paraguay, and Uruguay.

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Appendix A. India's FTAs with regions and countries

Agreements	Abbreviation	Signed and in effect	Member Countries
ASEAN-India Comprehensive Economic Cooperation Agreement	AICECA	2010-01-01	Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, and India
Asia-Pacific Trade Agreement	APTA	1976-06-17	People's Republic of China, Lao PDR, Bangladesh, Sri Lanka, Republic of Korea, Mongolia, and India
India-MERCOSUR Preferential Trade Agreement	IMPTA	2009-06-01	Argentina, Brazil, Paraguay, Uruguay, and India
South Asian Free Trade Area	SAFTA	2006-01-01	Bangladesh, Bhutan, Maldives, Nepal, Pakistan, Sri Lanka, and India
India-Afghanistan Preferential Trading Agreement	IAFGPTA	2003-05-13	India and Afghanistan
India-Bhutan Trade Agreement	IBTNTA	2006-07-29	India and Bhutan
India-Chile Preferential Trading Agreement	ICHLPTA	2007-09-11	India and Chile
India-Singapore Comprehensive Economic Cooperation Agreement	ISGPCECA	2005-08-01	India and Singapore
India-Sri Lanka Free Trade Agreement	ILKAFTA	2001-12-15	India and Sri Lanka
India-Republic of Korea Comprehensive Economic Partnership Agreement	IKORCEPA	2010-01-01	India and Republic of Korea
Indo-Nepal Treaty of Trade	INPLTT	2002-03-06	India and Nepal
Japan-India Comprehensive Economic Partnership Agreement	JPNICCEPA	2011-08-01	India and Japan
Malaysia-India Comprehensive Economic Cooperation Agreement	MYSICECE	2011-07-01	India and Malaysia

Appendix B. Thailand's FTAs with regions and countries

Agreements	Abbreviation	Signed and in effect	Member Countries
ASEAN Free Trade Area	AFTA	1993-01-01	Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines Singapore, Thailand, Vietnam
ASEAN-Australia and New Zealand Free Trade Agreement	AANZFTA	2010-01-01	Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, Australia, and New Zealand,
ASEAN-India Free Trade	AIFTA	2010-01-01	Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, and India
ASEAN-Japan Comprehensive Economic Partnership	AJCEP	2008-12-01	Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, and Japan
ASEAN-People's Republic of China Comprehensive Economic Cooperation Agreement	ACFTA	2005-07-01	Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, and People's Republic of China
ASEAN-Republic of Korea Comprehensive Economic Cooperation Agreement	AKFTA	2007-06-01	Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, and Republic of Korea
Japan-Thailand Economic Partnership Agreement	JTEPA	2007-11-01	Thailand and Japan
Laos-Thailand Preferential Trading Arrangement	LTPTA	1991-06-20	Thailand and Lao PDR
People's Republic of China-Thailand Free Trade Agreement	PRCTFTA	2003-10-01	Thailand and People's Republic of China
Thailand-Australia Free Trade Agreement	TAFTA	2005-01-01	Thailand and Australia
Thailand-Chile Free Trade Agreement	TCFTA	2015-11-05	Thailand and Chile
Thailand-New Zealand Closer Economic Partnership Agreement	ThaiNZCEP	2005-07-01	Thailand and New Zealand
Thailand-Peru Free Trade Agreement	TPFTA	2011-12-31	Thailand and Peru

Appendix C. Classification of the Major Areas and Regions[22]

Africa				
Eastern Africa	*Middle Africa*	*Northern Africa*	*Western Africa*	*Southern Africa*
Burundi	Angola	Algeria	Benin	Botswana
Comoros	Cameroon	Egypt	Burkina Faso	Lesotho
Djibouti	Central African Republic	Libyan Arab Jamahiriya	Cape Verde	Namibia
Eritrea	Chad	Morocco	Côte d'Ivoire	South Africa
Ethiopia	Congo	Sudan	Gambia	Swaziland
Kenya	Democratic Republic of the Congo	Tunisia	Ghana	
Madagascar	Equatorial Guinea	Western Sahara	Guinea	
Malawi	Gabon		Guinea-Bissau	
	Sao Tome and Principe		Liberia	
			Mali	
			Mauritania	
			Niger	
			Nigeria	
			St. Helena	
			Senegal	
			Sierra Leone	
			Togo	

Asia			
Eastern Asia	*South-central Asia*	*South-eastern Asia*	*Western Asia*
China	Afghanistan	Brunei	Armenia
China, Hong Kong SAR	Bangladesh	Cambodia	Azerbaijan
China, Macao SAR	Bhutan	East Timor	Bahrain
Democratic People's Republic of Korea	India	Indonesia	Cyprus
Japan	Iran	Lao People's Democratic Republic	Georgia
Mongolia	Kazakhstan	Malaysia	Israel
Republic of Korea	Kyrgyzstan	Myanmar	Jordan
	Maldives	Philippines	Kuwait
	Nepal	Singapore	Lebanon
	Pakistan	Lanka	Occupied Palestinian Territory
	Sri Lanka	Vietnam	Oman
	Tajikistan		Qatar
	Turkmenistan		Saudi Arabia
	Uzbekistan		Syrian Arab Republic
			Turkey
			United Arab Emirates
			Yemen

[22] Population Division, DESA, United Nations

Appendix C. Classification of the Major Areas and Regions (Continued)

Europe			
Eastern Europe	*Northern Europe*	*Southern Europe*	*Western Europe*
Belarus	Channel Islands	Albania	Austria
Bulgaria	Denmark	Andorra	Belgium
Czech Republic	Estonia	Bosnia and Herzegovina	France
Hungary	Faeroe Islands	Croatia	Germany
Poland	Finland	Gibraltar	Liechtenstein
Republic of Moldova	Iceland	Greece	Luxembourg
Romania	Ireland	Holy See	Monaco
Russian Federation	Isle of Man	Italy	Netherlands
Slovakia	Latvia	Malta	Switzerland
Ukraine	Lithuania	Portugal	
	Norway	San Marino	
	Sweden	Slovenia	
	United Kingdom of Great Britain and Northern Ireland	Spain	
		The former Yugoslav Republic of Macedonia	

Latin America and the Caribbean		
Caribbean	*Central America*	*South America*
Anguilla	Belize	Argentina
Antigua and Barbuda	Costa Rica	Bolivia
Aruba	El Salvador	Brazil
Bahamas	Guatemala	Chile
Barbados	Honduras	Colombia
British Virgin Islands	Mexico	Ecuador
Cayman Islands	Nicaragua	Falkland Islands (Malvinas)
Cuba	Panama	French Guiana
Dominica		Guyana
Dominican Republic		Paraguay
Grenada		Peru
Guadeloupe		Suriname
Haiti		Uruguay
Jamaica		Venezuela
Martinique		
Montserrat		
Netherlands Antilles		
Puerto Rico		
Saint Kitts and Nevis		
Saint Lucia		
Saint Vincent and the Grenadines		
Trinidad and Tobago		
Turks and Caicos Islands		
United States Virgin Islands		

Appendix C. Classification of the Major Areas and Regions (Continued)

North America	*Oceania*	
Bermuda	Australia	Northern Mariana Islands
Canada	New Zealand	Palau
Greenland	Fiji	American Samoa
St. Pierre and Miquelon	New Caledonia	Cook Islands
United States of America	Papua New Guinea	French Polynesia
	Solomon Islands	Niue
	Vanuatu	Pitcairn
	Guam	Samoa
	Kiribati	Tokelau
	Marshall Islands	Tonga
	Micronesia	Tuvalu
	Nauru	Wallis and Futuna Islands