Determinants of China's Rice Export after WTO Accession: A Gravity Model Analysis

ABSTRACT

This paper applied the commodity-specific gravity approach to investigate the influenced factors to China's rice export to its major trading partners after World Trade Organization (WTO) accession over 2001- 2014 period. The gravity model was augmented with factors from both exporter's and importer's sides. The empirical results revealed that, excepting distance, the remained variables including Gross Domestic Product, population, income, exchange rate, production and price had statistical significance and correlated with the total export as hypothesized. Among these variables, price and production reported as the best predictors, explaining 81.30% and 80.54% variation in China's total export, respectively. Moreover, the determinants of China's rice export highly depended on the components of exporter side than that of importer sides. This study results provide the statistical and practical significance for trade policy formulation to promote China's rice exports in world markets.

Keywords: China rice exports, gravity model, factors, variables, WTO, determinants

1. INTRODUCTION

Rice is known as the most staple food in Asian countries where over 90 percent of the world's rice is produced and consumed in this region [1]. Asian countries like Thailand, India, Pakistan, Vietnam and China have been reported as the world's largest source of rice exports, utterly accounted for 69.3, 67.7 and 70.2% of the world share exports from 2011 to 2013, respectively. Among these countries, China is the largest rice producers in the world with production capacity of over 200 million tons per year since 2011, contributing more than one-third of world total rice production. In which, rice production of China is highly dependent on the production of more than 150 million smallholders who crop in most of China's provinces. Most of which are located in the Northeast region of China [2], only 1 or 2 percent comes from several state-run farms.

China has started to participate in the world's rice market in the early 1960s and was among the largest rice exporters worldwide. However, Chinese rice's export share tended to decline since 1980s; this mainly caused by the increase of domestic consumption resulted from the improving income and the changes of government tax policies in production [3]. Consequently, China's rice export position in the international market had shifted from the 1st or 2nd exporter in the 1960-70s down to the 6th place in the 2000s [4]. Recently, the value of China's rice export remained stable with light decreases, averagely constituted for 2.4, 2.8, 2.0, 1.8, 1.1 and 1.6 per cent of world rice export from 2008 to 2013, respectively.
These were actually not a large number but still revealed an irreplaceable role for China in the world rice trade. Moreover, the international rice export market was reported being well integrated, thin, volatile, segmented and highly distorted [5, 6]. Therefore, even a small change in production or consumption of any major rice producer can yield a significant

supply shock; the greater supply disturbance, the higher the odd of price fluctuation and market disruption [5]. As a large producer and consumer, China has its power to generate a tremendous impact on the global rice market. Specifically, China entrance into the world rice market significantly minimized the risk faced by major importers due to price appreciation caused by restrictive trade policies conducting by some big exporters [7]. To our knowledge, the empirical studies which investigated the causal factors to China's rice exports to its major importers still remains limited. Therefore, this research was conducted to provide better understandings on the status of China's rice export, which will have practical implication and statistical significance. ~~This was also the motivation of this study.~~

2. LITERATURE REVIEW

One of the landmark events that generated a massive impact on both China and the world trading system were China's accession of to the World Trade Organization (WTO) in 2001 [8]. Accordingly, this accession provided major implications and present both external competitions and internal shifts [9]. WTO accession has created preferential trading access for China: market access, accelerate economic reforms, attracting more foreign investment and fostering the rule of law [10]. Adversely, Chinese WTO commitments such as tariff cuts, eliminating export subsidies, further trade liberalisation and greater global competition had accelerated dramatic changes in domestic economy. In which, the agricultural and food sectors have faced the toughest challenge; for instance, China has agreed to limit domestic agricultural subsidies to 8.5% of production value and eliminated all agricultural export subsidies upon WTO entry [11]. Since rice is among major grains planted in China and China's role is considerably unrivalled in the world rice production, the impacts of WTO accession to rice production and trade activities are inevitable. The larger the country the more significant role the country could play in the world market, the more volatility it generated [12]. Before 2002, rice exporters in China were imposed by 13% value added tax, then refunded at 5% after export; the government, additionally, provided export subsidies differently in each region. Upon WTO accession, in order to follow the WTO rules, China committed to allow VAT exemption on rice exports from 2002, and by 2004 export subsidies under any programs was eliminated [4]. In term of literature in this section, several studies have been done to assess the impacts of WTO accession to China agricultural sectors [13-16]. To rice sector, there were some empirical works have been conducted but they were still limited in scope. Previously, Li [17] and Wu [18] reported that China's accession has certain influences to income, export value, price and domestic markets. Additionally, numerous studies to analyse China rice export performance in world markets have been conducted by many scholars [19-24].

Gravity model of international trade was originally developed from the conventional Newton's gravity law, considered as one of the practical econometric tools to scrutinize the trade flows between countries or regions. They have gained extensive application due to its consistence characteristic with empirical results [25]. Tinbergen [26], Pöyhönen [27] and Linnemann [28] were considered the pioneers in applying gravity model to international trade. Subsequently, numerous works has been done to estimate the export performance of given countries or regions [29-33]. Accordingly, the original gravity model in international trade stated that trade flows between two countries were measured by economic size and the distance between trading partners; the larger economic size, the larger trade volume; the larger distance between wo countries, the smaller bilateral trade attains [34]. The significant improvement of the gravity model is the additions of explanatory variables such as population, size, income and exchange rates. It has been popularly used by many different researchers [34-37] which can give a better demonstration on the aggregate factors affect to trade flows of exported product across countries (or regions).

Given the interest of this method, in a study of Zhu [38], a fundamental gravity model was employed to examine the significant determinants of China's rice export with the scope of total 26 importing markets in 2008. The results indicated that the Gross Domestic Product of exporter and importers both had a positive correlation with China's total rice export while distance was negatively correlated. Besides, on reviewing exchange rate and price export factors, Wu and Gu [39] concluded that the appreciation of Renminbi (RMB or CNY) exchange rate and the weakness of price competitiveness were the main causes constituted to the decrease of China's rice export volume over 1988-2003 period. Though some vital influenced factors to the rice export of China have taken into consideration and discussed in detail, such important determinants like population and income have not been mentioned in these researches. Therefore, it cannot fully describe the constituted factors to China's rice export in a broader sense so far. Thus, given a surge of interest in investigating China's rice export after WTO accession, this study would present a more comprehensive description on the influenced factors to China's rice export by adopting descriptive gravity model.

3. MATERIAL AND METHODS

3.1 Data selection

The secondary panel data of total 32 main and consistent importing partners of Chinese rice, namely Australia, Bangladesh, Bulgaria, Canada, Côte d'Ivoire, Ethiopia, Guinea, Hong Kong SAR (China), Indonesia, Japan, Kazakhstan, Korea Republic, Korea Democratic Republic, Kyrgyzstan, Lebanon, Liberia, Libya, Madagascar, Malaysia, Mongolia, Mozambique, Myanmar, Nigeria, Papua New Guinea, Philippines, Russia, Singapore, South Africa, Tanzania, Ukraine, United State of American and Vietnam, were used in this research based on the constitution of export share of these markets to China's rice export quantity over 2001-2014 period (Table 1). These countries averagely constituted over 92% of China's total rice export quantity during studied period (UN database) which can theoretically give a practical result. Since the WTO accession of China in 2001 have dramatically affected world rice trade in general and China rice trade in specific, the selection of the research point from 2001 can be more conducive to estimate the constitutive factors to China's rice export.

Table 1 Data of China and 32 importing countries were employed as sources (accessed at 2016)

Variables	Data sources
Export quantity (EX_{CNi})	United Nations COMTRADE Database
GDP (GDP_{ij} and GDP_{CNj})	Word Bank WDI
Population (POP_{ij} and POP_{CNj})	Word Bank WDI
Distance (DIS_{CNi})	Sea-distances.org
GNI per capita (INC_{ij} and INC_{CNj})	Word Bank WDI
Exchange rate (ER_{ij} and ER_{CNj})	International Monetary Fund International Financial Statistics Database
Production (PRO_{CNj})	Food and Agriculture Organization Of The United Nations Statistics Division
Import quantity (IM_{ij})	United Nations' COMTRADE Database
Average price (PRI_{CNj})	Author's calculation
$OPEN_{ij}$	Author's calculation

(Notes: due to some shortages of data from Myanmar and North Korea, GDP and GNI per capita of Myanmar and North Korea were obtained from UN data)

3.2 Data analysis

Based on the theory of gravity model, the determinants of trade flow between exporter and importers were described as followings in Table 2.

Table 2 The description of the trade gravity model variables

Variables	Meanings	Descriptions	Expected Signs*
EX_{CNij}	Export quantity/value from export country to recipient countries in year j	Dependent variable	--
GDP_{ij}	Gross domestic product of recipients countries in year j	Reflect import demand of recipient countries in year j	+
GDP_{CNj}	Gross domestic product of export country in year j	Reflect export supply of export country in year j	+
DIS_{ij}	Distance between export country and recipients countries	Represent the level of transportation costs, a hinder trade factor	-
INC_{ij}	GNI per capita of recipient countries in year j	Reflect the purchase power then affect the import potential	+/-
INC_{CNj}	GNI per capita of export country in year j	Reflect availability of goods for export	+/-
POP_{ij}	the population of recipient countries in year j	Reflect the domestic demand then affect to import power	+
POP_{CNj}	the population of export country in year j	Reflect the domestic demand then affect to export power	+
ER_{ij}	Exchange rate of recipient countries' currency/USD in year j	Reflect trade variation of recipient countries	+
ER_{CNj}	Exchange rate of export country' currency/USD in year j	Reflect trade variation of export country	+
PRO_{CNj}	Rice production of export country in year j	Reflect supply capacity of export country	+
PRI_{CNj}	Average export price of export country in year j	Determine the trade competitiveness in world markets	+/-
IM_{ij}	Import quantity/value of recipient countries from export country in year j	Reflect the import volume of recipient countries	+
$OPEN_{ij}$	Degree of import dependence of recipient countries	Reflect the level of openness of a country in international trade/ degree of trade relative to GDP	+
APEC	Dummy variable	When the two countries/regions belong to a free trade agreement, the corresponding trade volume will increase due to the preferential trade policy	+/-
WTO	Dummy variable	When the two countries/regions belong to a multilateral trade agreement, the corresponding trade volume will increase due to the preferential trade policy	+/-

*(+/-) indicate positive impact and negative impact, respectively.

According to the actual situation of this research, the following equation was augmented basing on the econometric model of Linnemann [28]. This equation was to describe in detail the internal and external influenced factors to China and its major rice importing partners. A total of thirteen explanatory variables and two dummy variables which related to China's rice export circumstances were investigated as follows:

$$Ln(EX_{CNj})=\beta_0+\beta_1 Ln(GDP_{ij})+\beta_2 Ln(GDP_{CNj})+\beta_3 Ln(POP_{ij})+\beta_4 Ln(POP_{CNj})+\beta_5 Ln(DIS_i)+\beta_6 Ln(INC_{ij})+\beta_7 Ln(INC_{CNj})+\beta_8 Ln(ER_{ij})+\beta_9 Ln(ER_{CNj})+\beta_{10} Ln(PRO_{CNj})+\beta_{11} Ln(PRI_{CNj})+\beta_{12} Ln(IM_{ij})+\beta_{13} Ln(OPEN_{ij})+\beta_{14} APEC+\beta_{15} WTO+e_{CNij} \quad (1)$$

Where:

EX_{CNj}: dependant variable represented by total export quantity of Chinese rice to 32 trading partners in year j (j=2001, 2002… 2014)

GDP_{ij}: GDP of country i in year j

GDP_{CNj}: GDP of China in year j

POP_{ij}: the population of country i in year j

POP_{CNj}: the population of China in year j

DIS_{CNi}: the ocean distance between Shanghai ports to the nearest port of imported countries, presented in nautical miles. Shanghai was used as port of departure due to the concentration of rice production and shipping volume scale. Since most of previous scholars were accustomed to use land distance from the capital of two trading partners as the main measure of distance, this research employed ocean distance as proxy variables. Vido and Prentice [40] pointed out that some sorts of bulk commodity with low value and quantities shipped such as rice or wheat then marine transport was a suitable transportation mode. So, ocean distance proxy would yield acceptable results for this research.

INC_{ij}: GNI per capita of country i in year j

INC_{CNj}: GNI per capita of China in year j

ER_{ij}: exchange rate of country i's currency/USD in year j

ER_{CNj}: the exchange rate of Renminbi/USD in year j

PRO_{CNj}: rice production of China in year j

PRI_{CNj}: the average price of China's export rice in year j

IM_{ij}: the total rice imports of investigated countries from China in year j

$OPEN_{ij}$: degree of dependence on import of imported country, calculated as (Exports+ Imports)/ GDP

APEC is a binary dummy variable, it was set to unity if country i is an APEC member, and zero otherwise

WTO is a binary dummy variable, it was set to unity if country i is WTO member, and zero otherwise

β_0 is a constant

e_{CNij} is standard random error

In sum, the research covered data of China and 32 rice importers over 2001-2014 period with one dependant variable and 15 explanatory variables (with 448 observations). All quantitative variables, except APEC and WTO variables were formulated with natural logarithm (Ln).

4. RESULTS AND DISCUSSION

In order to identify the determinants, two analyses were done: fixed effect (FE) and random effect (RE).

4.1 FE regression analysis

FE regression was firstly conducted; theoretically, it was assumed that FE model is merely applied to estimate the impact of the variables changing over time; then it does not give results for the fixed variables over time. In this case, distance and dummy variables were omitted and the FE regression results were shown in Table 3.

Table 3 Results for the fe regression for total rice exports of China

Variables	Coef.	Std. Err.	T	*P*>|t|	95% Conf.	Interval
C	-870.9399***	237.0138	-3.67	0.000	-1336.936	-404.944
GDP_{ij}	-0.3701**	0.1164	-3.19	**0.002**	-0.5995	-0.1419
GDP_{CNi}	3.8794***	0.3853	10.07	**0.000**	3.1219	4.6370
POP_{ij}	0.3376**	0.2408	1.40	0.162	-0.1359	0.8109
POP_{CNi}	43.9415***	11.0234	3.99	**0.000**	22.2684	65.6147
INC_{ij}	0.3973**	0.1179	3.37	**0.001**	0.1655	0.6291
INC_{CNj}	-5.1090***	0.5572	-9.17	**0.000**	-6.2046	-4.0135
ER_{ij}	-0.0272	0.0260	-1.05	0.295	-0.0781	0.0238
ER_{CNi}	-3.8429***	0.8718	-4.41	**0.000**	-5.5569	-2.1289
PRO_{CNj}	-4.8459***	1.3275	-3.65	**0.000**	-7.4559	-2.2359
PRI_{CNi}	-1.5354***	0.1081	-14.2	**0.000**	-1.7479	-1.3229
IMP_{ij}	-0.0307	0.0592	-0.52	0.605	-0.1471	0.0858
$OPEN_{ij}$	-0.0026	0.0146	-0.18	0.861	-0.0312	0.0261

R-squared: 0.9157
Prob>F=0.0000
Dependent variable: Ln(EX_{CNj})
Method: Panel Least Square Fixed Effect Regression
Total panel (strongly balanced) observations: 431
Coefficients with *, **, and *** are statistically significant at the 10, 5, and 1 per cent level, respectively

As shown in Table 3, there were eight of total twelve variables had statistical significance to dependent variable at 1 and 5 per cent significance level. Among these, five variables namely GDP_{ij}, INC_{CNj}, ER_{CNj}, PRO_{CNj}, and PRI_{CNj} were found to have negative impact on total export of Chinese rice during investigated period, with the coefficients of 0.37, 5.10, 3.84, 4.84 and 1.53, respectively. Obviously, INC_{CNj} had the largest impact; the larger China income, the lesser its total rice export to trading partners. Adversely, three values of GDP_{CNj}, POP_{CNj} and INC_{ij} confirmed the assumed positive effect to total export, showing high coefficient values of 3.87, 43.9 and 0.39, respectively. POP_{CNj} apparently had the largest impact; the larger China population, the greater China's rice export. In detail, 1 per cent increase in population will accelerate 43.9% of China's rice export to importers.

4.2 RE regression analysis

The empirical results obtained from RE regression were summarized in Table 4.

Table 4 Results for the re regression for total rice exports of China

Variables	Coef.	Std. Err.	z	*P*>|z|	95% Conf.	Interval
C	-885.8112***	231.0454	-3.83	0.000	-1338.652	-432.9707
GDP_{ij}	-0.1864**	0.0825	-2.26	**0.024**	-0.3480	-0.0247
GDP_{CNj}	3.7556***	0.3583	10.48	**0.000**	3.0533	4.4578
POP_{ij}	0.1834**	0.0812	2.26	**0.024**	0.0242	0.3425

POP_{CNi}	44.6707***	10.7420	4.16	**0.000**	23.6169	65.7244
DIS_j	0.0069	0.0124	0.56	0.578	-0.0174	0.0311
INC_{ij}	0.1843**	0.0822	2.24	**0.025**	0.0232	0.3454
INC_{CNi}	-5.0182***	0.5374	-9.34	**0.000**	-6.0714	-3.9650
ER_{ij}	0.0002	0.0035	0.05	0.964	-0.0067	0.0070
ER_{CNi}	-3.9448***	0.8405	-4.69	**0.000**	-5.5921	-2.2973
PRO_{CNi}	-4.7310***	1.2901	-3.67	**0.000**	-7.2595	-2.2026
PRI_{CNj}	-1.5356***	0.1050	-14.63	**0.000**	-1.7413	-1.3299
IMP_{ij}	-0.0320	0.0576	-0.55	0.579	-0.1448	0.0809
$OPEN_{ij}$	0.0008	0.0097	0.08	0.935	-0.0181	0.0197
APEC	0.0018	0.0289	0.06	0.950	-0.0544	0.0580
WTO	-0.0012	0.0252	-0.05	0.963	-0.0505	0.0481

R-square: 0.9148
Prob>F=0.0000
Dependent variable: Ln(EX_{CNj})
Method: Random-effects (within) regression LSDV model
Total panel observations: 431
Coefficients with *, **, and *** are statistically significant at the 10, 5, and 1 per cent level, respectively

It was shown that nine variables of GDP_{ij}, GDP_{CNj}, POP_{ij}, POP_{CNj}, INC_{ij}, INC_{CNj}, ER_{CNj}, PRO_{CNj} and PRI_{CNj} had statistical significance at the 1 and 5 per cent level. Among them, GDP_{ij}, INC_{CNj}, ER_{CNj}, PRO_{CNj} and PRI_{CNj} revealed the negative impact to total export; showing the values of 0.18, 5.01, 3.94 4.73 and 1.53, respectively. On the contrary, the positive coefficients of GDP_{CNj}, POP_{ij}, INC_{ij} and POP_{CNj}, correspondingly displayed the values of 3.75, 0.18, 0.18 and 44.6, implied that an increase in the level of these variables will increase the volume of China's rice export. Unambiguously, INC_{CNj} variable had the largest negative effect on dependent variable, a 1 per cent increase in income leads to 5.01 per cent depreciation on total export quantity; while POP_{CNj} variable was reported as the largest positive sign on dependent variable; the greater China population, the lesser total rice export. As estimated, a 1 per cent increase of China population leads to an appreciation of 44.6% in total export.

Summing-up two estimations, the outcome reported that China and importer's real GDP both had statistical significance at 1 and 5 per cent level, in which China GDP positively affected on total export as hypothesised while importer's GDP bear a negative sign on both methods. As estimated results, with 1 per cent increase in importers' GDP, the total rice export of China to these countries will decrease 0.37 (FE) and 0.18 per cent (RE) with the significant level of 5 per cent. This result was incompatible with the initial assumption, which suggested that importers' GDP positively affected on the same way with total imports, and being irrelevant with such a finding of Zhu [38] who has also studied about China's rice export performance in the year of 2008. Theoretically, GDP was considered as a mirror reflection to indicate the capacity of a country to pay for goods; so, GDP and import value of that country have relationship in the same way. However, this contradiction can be explained that the greater the importer's GDP, the higher efficiency of production the country obtained [36]. In this case, the importers may have sufficient capacity to meet domestic demand as well as produce goods as import substitution. As to China GDP, a 1 per cent increase in GDP will increase up to 3.87 and 3.75 per cent of total export as stated by FE and RE estimations, respectively. This finding confirmed previous reports on investigating the influences of exporter's GDP on trade flows [41-45] and positively correlated with theoretical expectation. These results implied that GDP rise would lead to increase of country's production capacity and generate more export opportunities.

Along with GDP, changes on population of exporter/importers also have an impact on their total export/import quantity; a positive effect of population from this estimation was relevant with initial expectations. When the population of importers increases, the import volume would concurrently intensify to meet domestic needs, by that means affecting the export turnover of exporters [36]. Based on the analysed results, 1 per cent increase of importer's population leads to 0.33 (FE) and 0.18 per cent (RE) increase of China total rice export. As of exporter side, it should be noted that China is the most populous country in the world, indicated that an increase of only 1 per cent in population would result in an enhancement in China's rice export quantity of 43.9 and 44.6% based on the obtained results from FE and RE estimation, respectively. Likewise, the growth of population will enhance the workforce, production capacity, and export supply to global markets. As expected, the population variables from both exporter/importer sides were highly significant and have positive impact on dependent variable.

Regarding income variables, the results revealed that importer's income had positive impact while China income negatively influenced to its total rice export. While reckon the fact that the importer's income increased, the purchase power of that country would marginally increase and consumers are becoming more aware of quality differences among varieties. Basically, rice consumption is driven by income growth, population, and other socio-demographic variables [12]. Asia and Africa are predominant importers of Chinese rice; thereby, rising incomes tend to augmenting rice demand from those countries where rice was considered as staple food. The results from this research revealed that a 1 per cent increase in importer's income, the total export of China would extend to 0.39 (FE) and 0.18 per cent (RE). Adversely, a negative sign of China income indicated that a diversion effect was taking place, each percentage of increasing in income resulted in depreciation of 5.10 and 5.01 per cent on total export yielded by FE and RE analysis, respectively. This result was inconsistent with economic theory which stated that a high-level income of the exporting country revealed a high level of production; thereby, increased the availability of goods for export.

Based on the hypotheses, the fluctuations of exchange rate greatly affected to the trade flows between countries. As we could see from the above results, China's exchange rate had significantly negative impact on total export of this country. This results were supported by the studies of Wu and Gu [39], Samad, Ashhari and Othman [46], Rahman [47] and Thursby and Thursby [48], who used the gravity model to investigate the impact of currency to the trade flows. That could be explained that China owns a strong currency where export price was listed in RMB, the exchange rate fluctuations directly influenced to export price, thereby affecting to total export value and quantity. Principally, an appreciation of a country's currency usually stimulates imports, but has a deteriorative impact on exports. In this case, the negative coefficients showed that each percentage appreciation of China's currency would result in decreasing 3.84 and 3.94 per cent of total export based on both estimation methods.

A negatively statistical significance (at 1 per cent level) of price effect was compatible with the assumption that the trade flows correlated with oscillation of export price; this was also accordant with the conclusions of previous studies [46, 49-51], which included price variable to explain trade flows among countries. Price component was one of the leading factors to determine the trade competitiveness in world markets. A considerably lower price from exporter side would increase trade with its trading partners [52]. Adversely, price increasing of exported goods will make the exporter less competitive in international markets. Viewed from the above results, a 1 per cent increase of China price leads to decreasing 1.53 per cent of China's total rice export can be explainable. This was relevant with the results of Wu and Gu [39] which also researched on the determinants of China's rice export during 1988-2003 period. In this respect, it was noteworthy that Chinese rice has a very strong

comparative advantage in export price comparing with such big rice exporters such as Thailand, Vietnam, Pakistan and India [38]. Additionally, China's rice export price was near to the world rice price, suggesting that it would not obtain much changes more than those in the world market [2]. In reality, China has the strategy of exporting fair-value rice while tend to import high quality rice. Asian and African countries are the main and consistent importing markets of Chinese rice. Therefore, an adequate supply and a reasonable price were critical for the food security of consumers in these regions.

Finally, the highly statistical significance of China's rice production variable has negatively impacted on dependant variable and decrease total export with the value of 4.8 and 4.7 per cent (with 1 per cent increase of production) on both FE and RE estimation, respectively. Production was defined as supply capacity that stimulated the export potential of an economy and generated access to world markets; countries with prosperity production were tended to export more [53]. A negative effect on production reported that an increase in production lowered exports. This was illogical and uncorrelated with predictors, and then it was not a major causal factor in affecting total export. The difference herein may be explained by the huge population of China. According to the predicted population increase by 2030, China needs to stock more rice, project to increase rice production about 20% in order to meet domestic needs if rice consumption per capita is to be remained at the current scale [54].

Regarding the results from two analysis, the value of determination R^2 was high (0.92 and 0.91) for FE and RE estimation, respectively, implied that the changes of China's rice export to 32 investigated importers belong to 92% (and 91%) of changes from independent variables included in the model.

4.3 The Hauman test

The Hausman test was applied to check the efficiency and accuracy between fixed and random effect. The results of Hauman test are shown in Table 5.

Table 5 Hausman test for FE and RE

Variables	Coefficients (b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	FE	RE	Difference	S.E.
GDP_{ij}	-0.3701	-0.1864	-0.1843	0.0821
GDP_{CNj}	3.8795	3.7556	0.1239	0.1417
POP_{ij}	0.3376	0.1834	0.1542	0.2267
POP_{CNi}	43.9415	44.6707	-0.7291	2.4750
INC_{ij}	0.3973	0.1843	0.2130	0.0845
INC_{CNj}	-5.1090	-5.0182	-0.0909	0.1474
ER_{ij}	-0.0272	0.0002	-0.0273	0.0257
ER_{CNj}	-3.8429	-3.9445	0.1019	0.2313
PRO_{CNi}	-4.8459	-4.7310	-0.1149	0.3131
PRI_{CNi}	-1.5353	-1.5356	0.0002	0.0259
IMP_{ij}	-0.0307	-0.0320	0.0013	0.0139
$OPEN_{ij}$	-0.0026	0.0008	-0.0034	0.0110

b = consistent under H_o and H_a; B = inconsistent under H_a, efficient under H_o
Test: H_o: difference in coefficients not systematic
$Chi^2(12) = 7.17$
$Prob>chi^2 = 0.8465$

In this case, with chi^2= 7.17 and Prob > 0.05, H_o hypothesis could not be rejected. Therefore, the RE estimation was considered to be more reliable. Thus, the RE model was assumed to be consistent and efficient.

4.4 Re-RE regression analysis

The model was then computed again with RE estimation after reducing some non-statistical significance variables. Among thirteen variables, only nine variables were correlated with China's rice export and were included in the final results. The re-RE regression test results were shown in Table 6.

Table 6 Results for the re-re regression for total rice exports of china (after ignored variables)

Variables	Coef.	Std. Err.	z	*P*>|z|	95% Conf.	Interval
C	-873.7560	204.4795	-4.27	0.000	-1274.5280	-472.9836
GDP_{ij}	-0.1757**	0.0761	-2.31	**0.021**	-0.3248	-0.0264
GDP_{CNj}	3.9087***	0.3328	11.75	**0.000**	3.2564	4.5608
POP_{ij}	0.1722**	0.0750	2.30	**0.022**	0.0254	0.3191
POP_{CNj}	43.3690***	9.9029	4.38	**0.000**	23.9598	62.7782
INC_{ij}	0.1732**	0.0752	2.30	**0.021**	0.0259	0.3205
INC_{CNi}	-5.1541***	0.4619	-11.16	**0.000**	-6.0595	-4.2487
ER_{CNj}	-3.5705***	0.7430	-4.81	**0.000**	-5.0267	-2.1144
PRO_{CNj}	-4.1778***	0.4200	-9.95	**0.000**	-5.001	-3.3545
PRI_{CNj}	-1.4912***	0.0931	-16.02	**0.000**	-1.6737	-1.3088

R^2: 0.9159
Prob > chi^2 = 0.0000
Dependent variable: EX_{CNj}
Method: Random-effects RLS regression
Total panel observations: 441
Coefficients with *, **, and *** are statistically significant at the 10, 5, and 1% level, respectively

As shown in Table 6, except for GDP_{CNj}, $POP_{ij,}$ POP_{CNj} and INC_{ij}, the remained variables tend to decrease over total export. It was incorporated with initial estimation in affecting trade. The findings also showed that exporter variables were much more influential in determining export volume than the variables from importer's side. ~~R^2 is the indication of the strength of the relationship between the dependent and the independent variables.~~ In this research, the R^2 value of 0.92 would imply that the variables used in this gravity equation revealed a high correlation. Therefore, they can explain quite fully the impact on exports of Chinese rice.

4.5 The consideration on the impact of each factor on China's total export

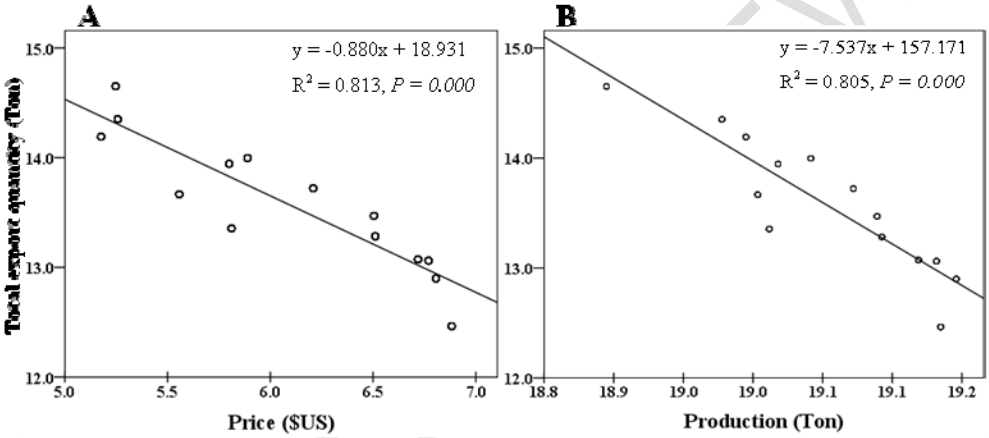
Nine factors which have statistical significance from final results were adopted to investigate which factors were the most influential elements on total exports; each factor was considered separately along with total export coefficient (Table 7). The findings showed that except population (Pop_{ij}) (*P*>0.05), all were significantly influenced to China's rice export (*P*<0.05) at different scale. Among these, the value of price and production (based on the value of R^2) were identified as the most causal factors, explaining 81.30% and 80.54% variation to China's total rice export, respectively (Figure 1).

Table 7 Determined coefficients to the impact of each factor to China's rice export

	Factor	R^2	*P*-value*
Statistical	GDP_{ij}	0.0199	0.00
	GDP_{CNi}	0.7286	0.00
	POP_{ij}	-0.0030	0.41
	POP_{CNi}	0.7262	0.00
	INC_{ij}	0.0238	0.00
	INC_{CNj}	0.7404	0.00
	ER_{CNi}	0.6790	0.00
	PRO_{CNi}	0.8054	0.00
	PRI_{CNj}	0.8130	0.00

significance at *P*<0.05

Figure 1



The best predictors, rice price (A) and rice production (B), explaining 81.30% and 80.54% variation in China's total export, respectively. The unstandardized coefficients (β) values in the equation (y = βx + b) indicated an inverse correlation between predictor with its dependent variable (China's rice export). Statistical significance were considered at *P*<0.05.

5. CONCLUSION

China WTO's accession has significantly influenced to the economic structure and international trade patterns of China. Since rice is one of the leading products of China exports; thereby, the empirical analysis will provide significant clues not only for China but also for all importing countries. In this study, the gravity model was firstly applied to identify the determinants of China rice exports after WTO accession with dependent variable of the total export quantity during the period from 2001 to 2014. Regression analysis was performed with FE and RE; then RE was qualified as the more reliable model through Hausman test results. The descriptive analysis indicated that total 32 investigated countries are consistent and predominant importers of China rice export which accounted for over 92% of the country's export over the selected period. The results also suggest that China rice exports flows was determined by the oscillation of GDP, population, income, exchange rate, price and production but negatively affected by distance, as standard results predicted.

One of the most important conclusions drawing from this empirical analysis is that rice trade from China to its trading partners is still under potential level. This study once again confirmed that the augmented gravity model is applicable to single commodity trade flows. ~~In the case of this research, the model provides statistical descriptions of rice flows and still retains the classical features of the conventional gravity models.~~

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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