Analyzing the Border Effect on China's Agricultural Trade

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Abstract

This paper uses the border effect estimate from a gravity model to assess the level of agricultural trade between China and its 36 trading partners for the 2001-2018. The border effect refers to the effect of restraining trade between countries due to borders or geographic boundaries. And the border effect can be influenced by policy factors including tariff and non-tariff barriers as well as non-policy factors including consumer preferences, information, culture, etc.

The main results are as below:

First, the border effect of agricultural trade between China and its trading partners has general dropping trends over time.

Second, the border effect on trading partners' agricultural exports to China is comparatively low in Brazil and the United States. Except for Brazil and the United States, most countries shows relatively high border effect when exporting agricultural products to China, especially in Singapore, Malaysia, Brunei Darussalam, Cambodia, Laos, South Korea and Japan.

Third, the border effect of China's agricultural exports is relatively large in Malaysia and India. But, there is nearly no border effect on China's agricultural exports to European Union, Switzerland, Costa Rica and Brunei Darussalam.

In general, the difference of the border effect means asymmetric bilateral trade barriers between China and its trading partners. It should be taken into consideration that countries with relatively large border effect take appropriate actions to reduce policy and non-policy trading barriers in order to expand trade. And it is expected that these analysis results can be used as basic information on agricultural trade policies and strategies in the future.

Keywords: Border Effect, Agricultural Trade, Trade Barriers, Gravity Model

JEL Classifications: F10, F13, F14

Introduction

The international trading environment has dramatically changed due to the creation of World Trade Organization (WTO) and the spread of Regional Trade Agreements (RTAs). The shallow integration is in progress, in which tariff and non-tariff barriers are reduced by signing Free Trade Agreements (FTAs), while the deep integration is also in progress in which countries establish closer political and cultural ties through custom unions, common markets and economic unions.

According to statistics of the WTO, as of October 2021, 350 RTAs were in force[1]. Following this trend, China has also signed 19 FTAs with 26 countries or regions, including ASEAN, Australia, New Zealand and South Korea. China has also completed domestic ratification procedures for the world's biggest free trade agreement, Regional Comprehensive Economic Partnership (RCEP).

However, relatively high trade barriers remain in sensitive sectors such as agricultural products. In agricultural sector, tariff barriers have been reduced considerably, but non-tariff barriers such as Technical Barriers to Trade measures (TPT measures) and Sanitary and Phytosanitary measures (SPS measures) become more sophisticated.

Thus, this paper uses the border effect estimate from a gravity model to assess the level of agricultural trade between China and its major trading partners.

The border effect refers to the effect of restraining trade between countries due to borders or geographic boundaries. And the border effect can be influenced by policy factors including tariff and non-tariff barriers as well as non-policy factors including consumer preferences, information, culture, etc.

In previous studies, McCallum(1995), Head an Mayer(2000), Okubo(2004), Olper an Raimondi(2008), Xu and Miao(2015) all analyzed the border effect in cross-border trade by using gravity models. McCallum(1995) found that inter-provincial trade in Canada is 22 times as large as Canada's international trade with the United States. Head and Mayer(2000) examined industry level border effects in the EU, and showed that it has a decreasing trend. Okuba(2004) analyzed the border effect in the Japanese market, showing that the border effect in Japan is much lower than in the United States and Canada, and has declined year by year between 1960 and 1990. Olper and Raimondi(2008) examined the bilateral border effect in food trade among Quad countries (Canada, USA, Japan and EU), and showed that the import border effect and export border effect are asymmetric. In addition, it was suggested that the border effect is affected by policy factors such as tariff and non-tariff barriers, as well as non-policy

1. http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx

factors such as consumer bias and the number of immigrants. Xu and Miao(2015) measured the bilateral border effects of manufacturing industry among ASEAN, and the result showed that the border effect in ASEAN which has established the FTA are not the lowest, the role which policy barriers play in border effect is more than the of non-policy barriers.

This paper differs from previous studies, in which we extend the research period and Chin's trading partners. Specifically, this paper will analyze the bilateral border effect in agricultural trade between China and its 36 trading partners including European Union for the 2001-2018.

The Model

This paper tries to estimate the border effect in agricultural trade between China and its major trading partners by using the Head and Mayer(2000)'s research method.

First, we set the CES(Constant Elasticity of Substitution) utility function as bellow equation(1). We assume that all varieties are differentiated from each other but products from the same country are weighted equally in the utility function. In the utility function, we denote a_{ij} as the preference of country i to country j. And c_{ijh} means that consumers in country i consume the h kinds of products from country i. n_j represents the type of products in country j, and σ means the elasticity of substitution.

$$U_i = (\sum_{j=1}^{N} \sum_{h=1}^{n_j} (a_{ij} c_{ijh})^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}} \qquad (1)$$

Denoting m_{ij} as the value of imports of country i from country $j(m_{ij} = c_{ij} p_{ij})$ and $m_i = \sum_k m_{ik}$ as expenditures on goods from all sources (including the home country), then the bilateral imports are as below equation (2).

$$m_{ij} = \frac{a_{ij}^{\sigma-1} n_j p_{ij}^{1-\sigma}}{\sum_k a_{ik}^{\sigma-1} n_k p_{ik}^{1-\sigma}} m_i \qquad (2)$$

According to Dixit-Stiglitz model of monopolistic competition, product diversity and production are proportional. And we denote gross output of country j as v_j , the production quantity as q, and the production price as p_j, it can be expressed to $v_j = n_j p_j q$. Then n_j can be converted as follows.

$$n_j = \frac{v_j}{p_j q} \qquad (3)$$

In addition, the import value p_{ij} that country i pays to country j can be expressed as a multiplicative function of the mill price (p_j), distance (d_{ij}) and policy factors (φ) including tariff barriers and non-tariff barriers. So the import value p_{ij} is as below. And defining B_{ij} as an indicator variable taking a value of one for $i \neq j$.

$$p_{ij} = p_j (1 + \varphi B_{ij}) d_{ij}^{\omega} \qquad (4)$$

Consumer preferences (a_{ij}) consist of a random component (e_{ij}) and non-policy factors (β) including preference for home-produced goods. We hypothesize that common language can mitigate this home bias. If the trading partners use common language, we take a value of one for the variable L_{ij}, and zero otherwise. Thus, when $L_{ij} = 1$, home bias falls from β to $\beta - \gamma$.

$$a_{ij} = \exp[e_{ij} - (\beta - \gamma L_{ij})B_{ij} \quad (5)$$

Next, substituting n_j of equation (3), p_{ij} of equation(4) and a_{ij} of equation (5) into equation (2), and taking logs leads to a formulation of the gravity equation.

$$lnm_{ij} = lnm_i + lnv_j - (\sigma - 1)\omega lnd_{ij} - \sigma lnp_j - I_i \quad (6)$$
$$-(\sigma - 1)[\beta - \gamma L_{ij} + \ln(1 + \varphi)]B_{ij} + (\sigma - 1)e_{ij}$$

Where I_i, the importer's "inclusive value", is defined as follows.

$$I_i = \ln(\textstyle\sum_k \exp[lnv_k - \sigma lnp_k + (\sigma - 1)(-\omega lnd_{ik} - [\beta - \gamma L_{ij} + \ln(1 + \varphi)]B_{ij} + e_{ik} \quad (7)$$

Since the Equation (6) is consist of variables to be estimated, it is difficult to analyze the effect of I_i. Therefore, I_i is removed from equation (6) by using Log Odds Ratio. We set $j = i$ to obtain an expression for lnm_{ii}. And subtracting lnm_{ii} from lnm_{ij} is as follows. Where $\epsilon_{ij} = (\sigma - 1)(e_{ij} - e_{ii})$ is error term

$$\ln\left(\frac{m_{ij}}{m_{ii}}\right) = \ln\left(\frac{v_j}{v_i}\right) - (\sigma - 1)\omega \ln\left(\frac{d_{ij}}{d_{ii}}\right) - \sigma \ln\left(\frac{p_j}{p_i}\right) \quad (8)$$
$$-(\sigma - 1)[\beta + \ln(1 + \varphi)] + (\sigma - 1)\gamma L_{ij} + \epsilon_{ij}$$

The constant $(\sigma - 1)[\beta + \ln(1 + \varphi)]$ in equation (8) captures bot the impact of policy factors(including tariff and non-tariff barriers) and non-policy factors(including home bias), which is regarded as the border effect.

When country i imports agricultural products from country j, the border effect coefficient can be expressed as $(a_{ij} - 1)[\beta_{ij} + \ln(1 + \varphi_{ij})]$. In order to avoid a perfectly linear relationship between explanatory variables, we include all dummy variables by country instead of constant term. Then the model for obtaining these least squares dummy variable(LSDV) regression model can be expressed as below.

$$\ln\left(\frac{m_{ij}}{m_{ii}}\right) = \ln\left(\frac{v_j}{v_i}\right) - (\sigma - 1)\omega \ln\left(\frac{d_{ij}}{d_{ii}}\right) - \sigma \ln\left(\frac{p_j}{p_i}\right) \quad (9)$$
$$-\sum_{i \neq j}(a_{ij} - 1)[\beta_{ij} + \ln(1 + \varphi_{ij})]D_{ij} + (\sigma - 1)\gamma L_{ij} + \epsilon_{ij}$$

And if the border effect is set as a variable that changes over time but does not change depending on countries, the estimation equation can be expressed as follows.

$$\ln\left(\frac{m_{ij}}{m_{ii}}\right) = \ln\left(\frac{v_j}{v_i}\right) - (\sigma - 1)\omega \ln\left(\frac{d_{ij}}{d_{ii}}\right) - \sigma \ln\left(\frac{p_j}{p_i}\right) \quad (10)$$

$$- \sum_{t=2001}^{2018} (a_t - 1)[\beta_t + \ln(1 + \varphi_t)]D_t + (\sigma - 1)\gamma L_{ij} + \epsilon_{ij}$$

Analysis Data

This paper utilizes the data of agricultural products corresponding to 01,02 (Agriculture, hunting, forestry), 03 (Fishing and aquaculture), 10,11,12 (Food products, beverages and tobacco) in ISIC Rev.4. The analysis period is from 2001 to 2018, and the analysis countries include Argentina, Australia, Brazil, Brunei Darussalam, Canada, Cambodia, Chile, China, Colombia, Costa Rica, Indonesia, India, Iceland, Israel, Japan, Kazakhstan, Laos, Morocco, Mexico, Myanmar, Malaysia, Norway, New Zealand, Peru, Philippines, Russia, Saudi Arabia, Singapore, South Africa, South Korea, Switzerland, Thailand, Tunisia, Turkey, the United States, Viet Nam and the European Union (EU)[2]. The total number of observations of the data used for estimation is 1,296 (China's 36 trading partners ×imports and exports (2) ×14 years).

The trade data and the gross domestic product(GDP) data come from OECD TIVA database. And we denote the amount of transactions between regions as the value of its gross domestic product minus the total exports. The distances between countries or regions[3] are extracted from the CEPII database, and the producer price index of agricultural products comes from the FAO database.

Results

National Border Effects in the Agricultural Trade

This paper analyzes the border effect of agricultural trade between China and its trading partners, and most of the estimates are statistically significant.

<Table 1> National Border Effects in the Agricultural Trade

Variables	$\ln(\frac{m_{ij}}{m_{ii}})$

[2] The EU consists a group of 28 countries including Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom.

[3] The distance between countries or regions was calculated by Mayer and Zignago(2005) in CEPII database. $d_{ij} = (\sum_{k\in i}(\frac{pop_k}{pop_i})\sum_{\ell\in j}(\frac{pop_\ell}{pop_j})d_{k\ell}^{\theta})^{\frac{1}{\theta}}$

$\ln(\frac{v_j}{v_i})$		0.339*** (0.0314)	
$\ln(\frac{d_{ij}}{d_{ii}})$		-1.906*** (0.0530)	
$\ln(\frac{P_j}{p_i})$		-0.0521 (0.0581)	
L_{ij}		7.977*** (0.462)	
Border Effect Coefficient (When Trading partners export to China)		Border Effect Coefficient (When China exports to Trading partners)	
Argentina→ China	-	China→ Argentina	-1.578*** (0.293)
Australia→ China	-1.068*** (0.148)	China → Australia	-1.881*** (0.202)
Brazil→ China	0.486*** (0.167)	China → Brazil	-2.102*** (0.220)
Brunei Darussalam → China	-8.867*** (0.303)	China → Brunei Darussalam	2.664*** (0.466)
Canada→ China	-1.355*** (0.153)	China → Canada	-1.848*** (0.197)
Cambodia→ China	-6.541*** (0.196)	China → Cambodia	-1.273*** (0.336)
Chile → China	-1.351*** (0.168)	China → Chile	-0.469 (0.310)
Colombia→ China	-5.630*** (0.165)	China → Colombia	-0.599** (0.300)
Costa Rica→ China	-4.399*** (0.178)	China → Costa Rica	3.255*** (0.425)
Indonesia→ China	-3.082*** (0.133)	China → Indonesia	-2.233*** (0.198)
India→ China	-4.189*** (0.129)	China → India	-5.080*** (0.166)
Iceland→ China	-4.613*** (0.190)	China → Iceland	0.375 (0.405)
Israel→ China	-5.455*** (0.163)	China → Israel	2.245*** (0.380)
Japan→ China	-6.180*** (0.122)	China → Japan	-1.416*** (0.161)
Kazakhstan → China	-5.723*** (0.167)	China → Kazakhstan	-3.630*** (0.241)
Laos→ China	-6.378*** (0.209)	China → Laos	-4.100*** (0.303)

Morocco→ China	-5.190*** (0.162)	China → Morocco	0.505 (0.310)
Mexico→ China	-4.178*** (0.157)	China → Mexico	-1.420*** (0.234)
Myanmar→ China	-4.901*** (0.157)	China → Myanmar	-3.988*** (0.256)
Malaysia → China	-10.69*** (0.496)	China → Malaysia	-9.529*** (0.314)
Norway→ China	-3.885*** (0.154)	China → Norway	-0.762*** (0.286)
New Zealand→ China	-1.143*** (0.159)	China → New Zealand	-0.353 (0.280)
Peru→ China	-1.654*** (0.170)	China → Peru	-1.469*** (0.310)
Philippines→ China	-5.732*** (0.139)	China → Philippines	-2.063*** (0.222)
Russian Federation → China	-2.843*** (0.136)	China → Russian Federation	-2.913*** (0.178)
Saudi Arabia→ China	-5.941*** (0.156)	China → Saudi Arabia	-1.708*** (0.251)
Singapore→ China	-12.44*** (0.559)	China → Singapore	-
South Africa→ China	-3.654*** (0.157)	China → South Africa	-1.008*** (0.272)
South Korea→ China	-6.763*** (0.139)	China → South Korea	-0.663*** (0.204)
Switzerland→ China	-4.264*** (0.157)	China → Switzerland	1.597*** (0.327)
Thailand→ China	-3.713*** (0.136)	China → Thailand	-0.348 (0.241)
Tunisia→ China	-7.146*** (0.176)	China → Tunisia	-0.808** (0.355)
Turkey→ China	-5.345*** (0.142)	China → Turkey	-2.445*** (0.238)
United States→ China	-0.326* (0.169)	China → United States	-2.013*** (0.153)
Viet Nam→ China	-4.229*** (0.142)	China → Viet Nam	-2.647*** (0.205)
European Union → China	-1.977*** (0.162)	China → European Union	1.686*** (0.230)
Observations		1,284	

R-squared	0.996

Note: 1) The value in () indicates the standard error. *, **, *** are statistically significant at 10%, 5% and 1% respectively.

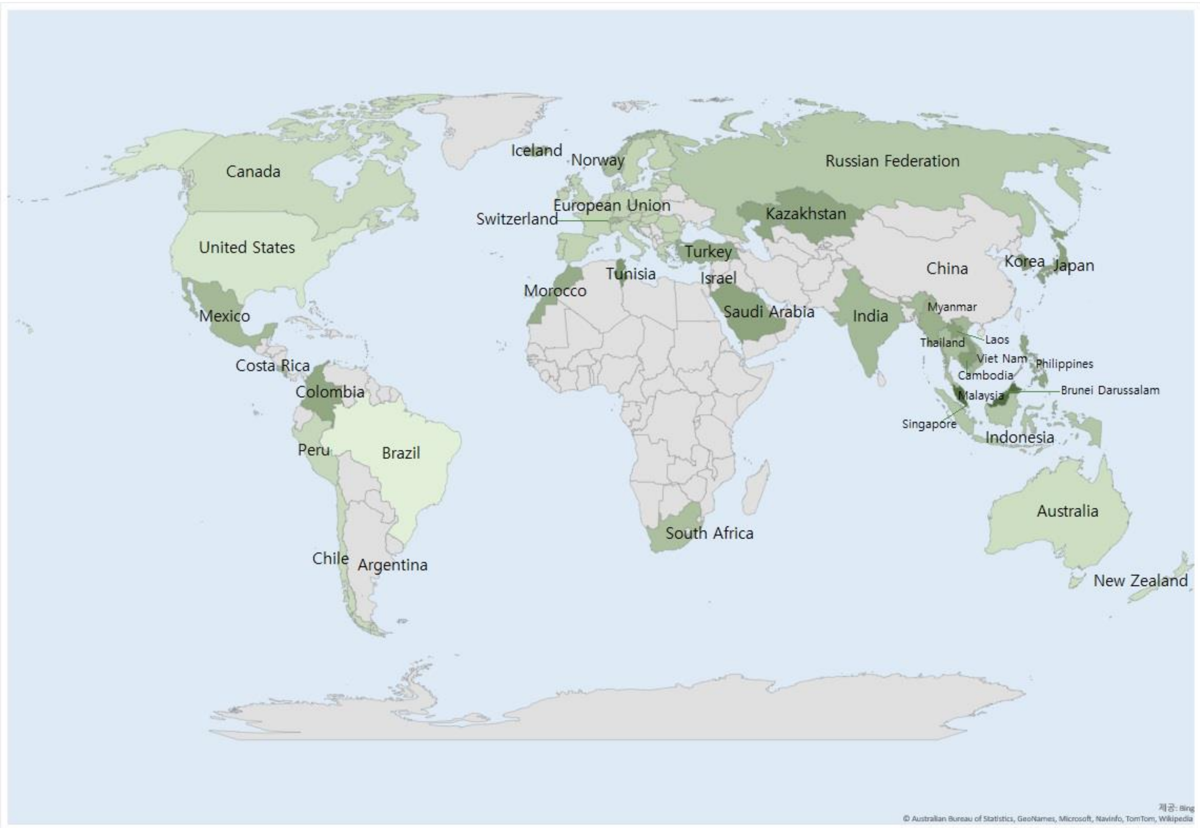
2) The part indicated by – in the table is not estimated because of multicollinearity.

The result shows that the GDP is positively correlated with export. And the distance is negatively related with export. The relative producer price index shows a negative (-) sign, indicating that the higher the producer price index of the exporting country, the more inhibition of exports. In addition, common language between trading partners is positively associated with trade.

And the border effect in this paper can be expressed as $\exp(-Border\ Effect\ Coefficient)$. For example, when South Korea exports to China, the border effect coefficient is -6.763, which means the border effect is $exp(6.673) = 865$. After controlling for market size and distance, China's agricultural interregional trade is 865 times larger than South Korea's agricultural exports to China during the analysis period because of policy and nonpolicy factors.

The smaller the estimation coefficient, the larger the border effect. The results of the border effect in the Table l are shown as below two figures.

Figure 1 The border effect on trading partners' agricultural exports to China

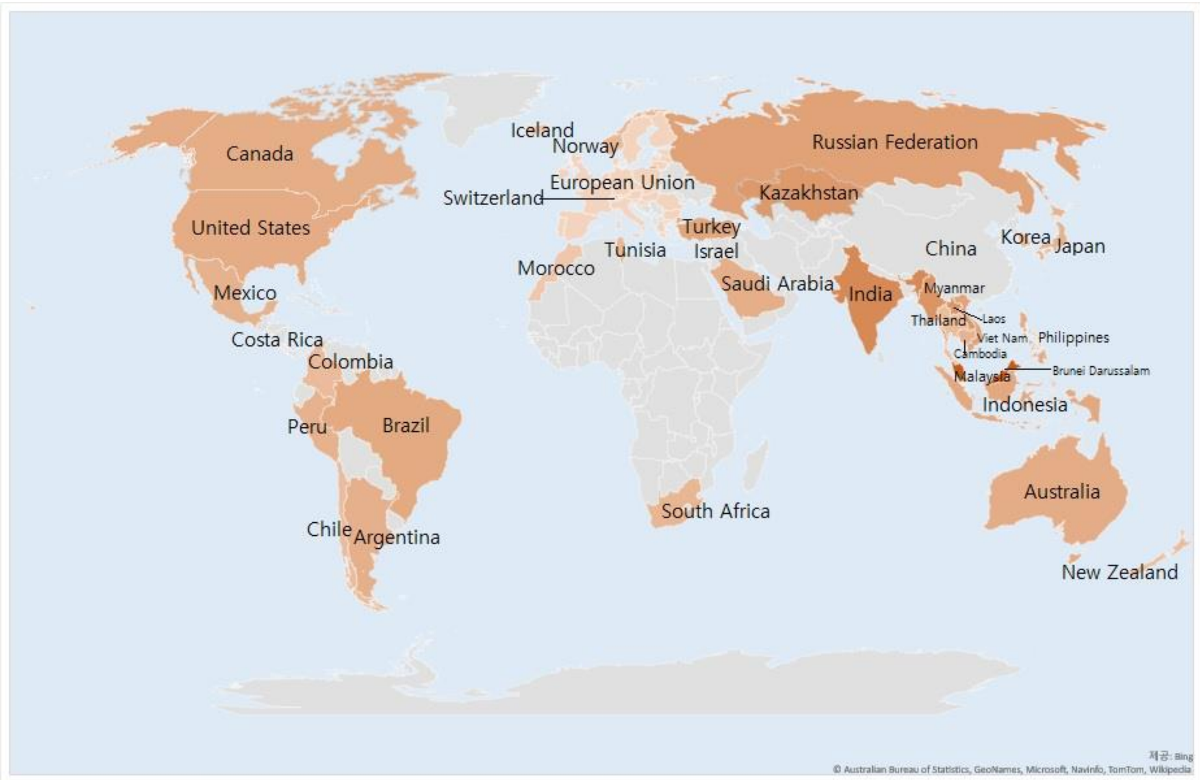


Note: Deeper color means the high border effect.

[Figure 1] shows the border effect on trading partners' agricultural exports to China. The border effect on trading partners' agricultural exports to China is comparatively low in Brazil and the United States. This is probably because Brazil and the United States are leading suppliers of China's main imported agricultural products such as soybean, corn, etc.

Except for Brazil and the United States, most countries shows relatively high border effect when exporting agricultural products to China, especially in Singapore, Malaysia, Brunei Darussalam, Cambodia, Laos, South Korea and Japan. With the signing of the Comprehensive Economic Partnership Agreement(RCEP) on November 15, 2020, the border effect for these countries is expected to be reduced in the future.

Figure 2 The border effect on China' agricultural exports to trading partners



Note: Deeper color means the high border effect.

[Figure 2] shows the border effect on China' agricultural exports to trading partners. The border effect of China's agricultural exports is relatively large in Malaysia and India, which appears to be the result of two counties' similarities in regional commonalities, agricultural-based societies, etc.

But, there is nearly no border effect on China's agricultural exports to European Union, Switzerland, Costa Rica and Brunei Darussalam. For European Union, which is main importer of Chinese agricultural products. And the border effect of China's agricultural exports is comparatively low in South Korea, that is probably because South Korea has high demand for imported Chinese seasoned vegetables such as cabbage, red pepper, garlic, which are geographically close and competitive in price.

Changes in the Border Effect, 2002-2018

Next, this paper analyzes changes in the border effect from 2002 to 2018, and most of the estimates are statistically significant. The border effect of agricultural trade between China and its trading partners has general dropping trends over time from 2002 to 2018 as below table.

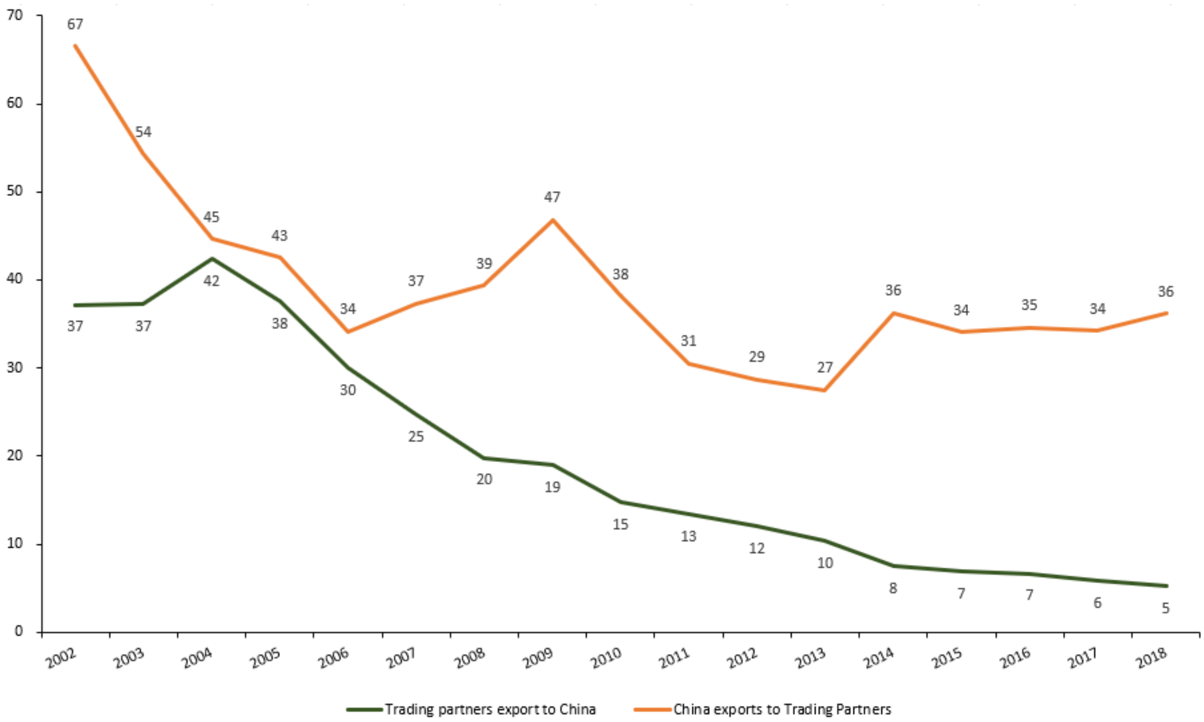
Table 2 Changes in the Border Effect, 2002-2018

Variables	$\ln(\frac{m_{ij}}{m_{ii}})$	$\ln(\frac{m_{ij}}{m_{ii}})$
	When Trading partners export to China	When China exports to Trading partners
$\ln(\frac{v_j}{v_i})$	1.224*** (0.0397)	0.193*** (0.0420)
$\ln(\frac{d_{ij}}{d_{ii}})$	-1.017*** (0.0851)	-0.788*** (0.0582)
$\ln(\frac{P_j}{p_i})$	-0.934*** (0.227)	-1.869*** (0.208)
L_{ij}	1.583*** (0.304)	2.891*** (0.282)
2002	-3.616*** (0.346)	-4.198*** (0.309)
2003	-3.619*** (0.346)	-3.994*** (0.311)
2004	-3.747*** (0.349)	-3.799*** (0.312)
2005	-3.626*** (0.349)	-3.750*** (0.312)
2006	-3.403*** (0.350)	-3.531*** (0.313)
2007	-3.210*** (0.347)	-3.620*** (0.310)
2008	-2.987*** (0.349)	-3.672*** (0.307)
2009	-2.941*** (0.349)	-3.846*** (0.307)
2010	-2.696*** (0.349)	-3.642*** (0.307)
2011	-2.593*** (0.353)	-3.418*** (0.310)
2012	-2.491*** (0.352)	-3.356*** (0.310)
2013	-2.340*** (0.354)	-3.313*** (0.310)
2014	-2.015*** (0.356)	-3.591*** (0.309)
2015	-1.935*** (0.358)	-3.529*** (0.310)
2016	-1.900*** (0.357)	-3.543*** (0.310)

2017	-1.758*** (0.358)	-3.533*** (0.310)
2018	-1.658*** (0.358)	-3.588*** (0.310)
Observations	639	645
R-squared	0.963	0.920

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Figure 3 Changes in the Border Effect, 2002-2018



The border effect on China's agricultural exports to trading partners is relatively high compared with the border effect on trading partners' agricultural exports to China. The border effect on trading partners' agricultural exports to China decreases from 37 to 5. Although the border effect on China's agricultural exports to trading partners repeats increase and decrease, which decreases from 67 to 36 as well.

Conclusion

This paper uses gravity model to assess the border effect between China and its trading partners and the main results are as below.

First, the border effect of agricultural trade between China and its trading partners has general dropping trends over time.

Second, the border effect on trading partners' agricultural exports to China is comparatively low in Brazil and the United States. Except for Brazil and the United States, most countries shows relatively high border effect when exporting agricultural products to China, especially in Singapore, Malaysia, Brunei Darussalam, Cambodia, Laos, South Korea and Japan.

Third, the border effect of China's agricultural exports is relatively large in Malaysia and India. But, there is nearly no border effect on China's agricultural exports to European Union, Switzerland, Costa Rica and Brunei Darussalam. And the border effect of China's agricultural exports is comparatively low in South Korea as well.

In general the difference of the border effect means asymmetric bilateral trade barriers between China and its trading partners. It should be taken into consideration that countries with relatively large border effect take appropriate actions to reduce policy and non-policy trading barriers in order to expand trade. It is expected that these analysis results can be used as basic information on agricultural trade policies and strategies in the future.

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