China's Agricultural Exports and their Effects on other Exporters

Huong Nguyen
Deakin University,
Melbourne, Australia
huonghalan@gmail.com

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Huong Nguyen[1]

Abstract

This paper critically investigates the effects of China's agricultural exports on its competitors in third markets in a global context for the 1993-2012 period. We estimate a gravity equation using 6-digit HS classification data of China and 25 major exporters to the top 50 markets. Using instruments for China's bilateral exports we find that China's agricultural exports have both complementary and displacement effects on certain exporter groups in third markets. US, Asian and OECD exports are generally promoted by China's export expansion on both margins while Latin American and African exports are displaced by China's agricultural products. There is strong evidence of displacement effects in African market on the intensive margin and in Latin American market on the extensive margin. Most exporters are positively influenced in Asian and OECD markets. In addition, China's key agricultural products in animals and meat; and fruit and vegetables have strong competition power to most China's rivals on both margins. Although complementary effects are generally found in grains and other products on both margins, China displaces these products from all of its competitors in Latin American markets on the extensive margin. In brief, although heterogeneous effects of China's agricultural exports in third markets and sectors are found but complementary effects of China's products are more significant and stronger.

Keywords*: China, agricultural exports, gravity model, effects, intensive and extensive margin*

[1] Department of Economics, Deakin Business School, Deakin University, Geelong Victoria Australia. Email: huong.nguyen@deakin.edu.au.

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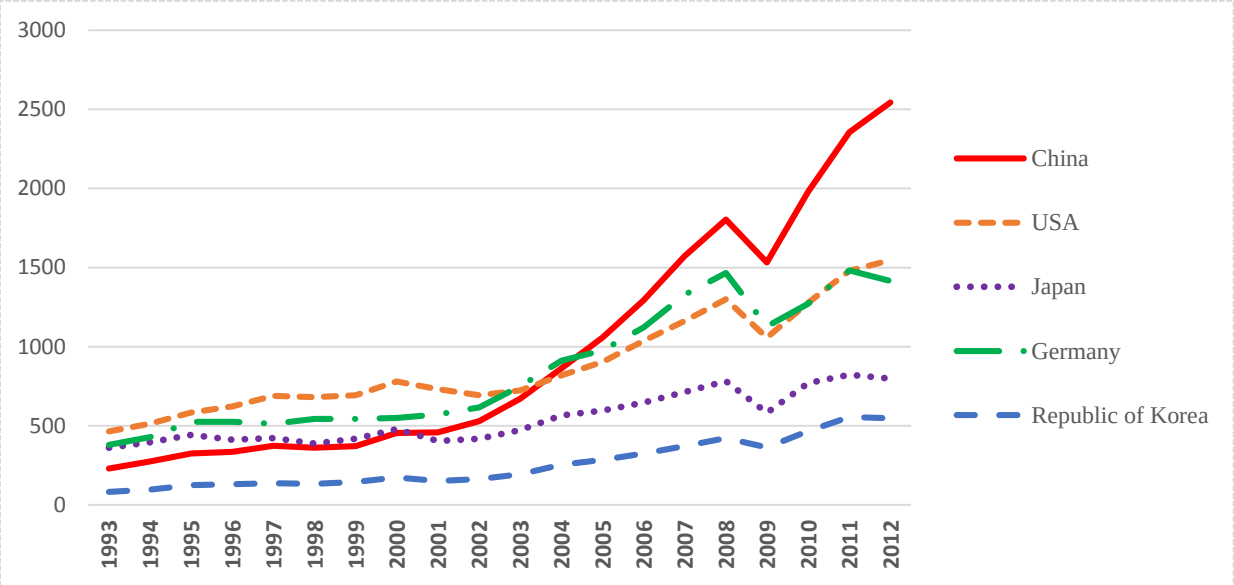
1. Introduction

Since 2005 China has emerged as the world leader in exports and its average export growth rate has surpassed other leading exporters[2]. Although being affected by global financial crisis (GFC) in 2007 like other countries, China's exports could recover quickly and grow at a greater rate.

Figure 1: Total Exports of Top Five Exporters - In billions of USD



Source: UN COMTRADE database and author's calculation

Notes: China includes PRC, Hong Kong and Macau.

Chinese export market share increased dramatically from a mere 1 per cent in the early 1980s to over 10 per cent in 2009, when China overtook Germany to become the first world manufacturing exporter (Giovannettia et al, 2013). According to UN Comtrade statistics, average market share of China's exports in 2011-2013 accounted for about 14 per cent. China's fast export growth is likely to have effects on the export performance of other countries.

The emergence of China's economy and exports has raised some questions concerning the effects of China's exports on both intensive and extensive margins of trade[3]. In the last few years, there have been a number of studies on the impact of China's export growth on other countries that

[2] See Figure 1 and Appendix A.

[3] Existing literature notably Andersson (2007) Paul Krugman (1980) Chaney (2008) Helpman, Melitz and Rubinstein (2008), Flam and Nordstrom (2011) extensively discuss the effects of trade barriers and the determinants of intensive and extensive margin of trade.

compete with China in third markets notably Lall and Albaladejo (2004); Shafaeddin (2004); Jenkins and Edwards (2006); Blazquez-Lidoy et al. (2006); Ianchovichina and Martin (2006); Jenkins (2008a); Eichengreen et al. (2007); Greenway et al. (2008); Giovannettia and Sanfilippob (2009); and Giovannettia et al. (2013); Lovely and Pham (2015) and Pham et al. (2016). These studies except the last four studies are rather aggregative studies. Most of them investigated the impact of China's exports on certain regions or more specific analyses mainly concentrating on China's neighbors in Asia and less focusing on Latin America and Africa. They used a number of different methodologies including an extension of constant market share analysis, export similarity indices, econometric estimation of elasticities of substitution and gravity model of trade. It is found that China's exports have had a mixed impact on the developing countries and China competes mainly with Asian countries, transition economies of Eastern Europe and a few Latin American and African countries. Different studies also found that competition from China is not a major threat to African exports.

Regarding agricultural exports, China is the world's largest agricultural economy and one of world producers of agricultural products. It is considered a major global exporter of horticultural products. China's agricultural exports which are concentrated in labour-intensive products have been increasing dramatically, particularly since its 2001 accession to the World Trade Organization (USITC, 2011). According to UN Comtrade data, China was still the second leading global agricultural exporting country behind the United States and before Brazil and Canada in 2012. There is also a stream of empirical studies on China's agricultural exports and their effects on its competitors, notably Wang (1997), Holst and Weiss (2004), Chuan (2006), López Córdova et al (2005), Freund and Ozden (2006) and Jenkins et al (2008).

Given China's potential economic power with remarkable growth rates and export market expansion, this research aims to empirically examine the effects of China's exports on the exports of other countries on the intensive and extensive margin[4]. This paper explores the impact of Chinese agricultural exports on the exports of its competitors by using product-level data. It critically examines the impact of China's agricultural exports on the trade values of its 25 main competitors to 50 most important importing destinations. Applying a gravity model it will provide

[4] The intensive/ extensive margin of trade discusses the extent to which exports of one country affect the values/ the probability of exports by other countries to the same destination or market.

new insights into the effects, if any, that China may have on the intensive and extensive margin of trade of its competitors for the last 20 years.

The impact of China's exports in agriculture is chosen due to the following reasons. First, this export component has played important roles in international trade. According to UN Comtrade data, it reached 1480 billion USD which accounts for more than 8% of the total world export in 2013[5]. While agricultural trade has exhibited some decline in world merchandise exports it remains a source of income for the millions of people who are directly or indirectly involved in it. For many countries agricultural trade still constitutes a major source of foreign exchange for import financing and development while for many others agricultural trade helped them to alleviate their concern of food insecurity. Agricultural trade remains an important for researchers and policy makers because the ongoing movement towards greater liberalization in agricultural trade within the WTO also shifted the focus of this organization's multilateral negotiations onto the reduction of protection in agricultural trade. In addition, these products are labor intensive and have a critical role in economic development of many developing countries with relative abundance of labour (Truett and Truett, 2010). These products are also key exports for low to middle income countries. Another reason is that with an increasing trend of China's agricultural imports, the effects of China's agricultural exports can be questioned. Finally, China's export structure changed and there is evidence of reallocation of traditional Chinese exports (Naughton, 2007 and Giovannettia et al., 2013). Thus the impact of traditional Chinese exports is likely to be different from the previous findings and evaluating the effects of China's exports is still an interesting topic.

This paper may have potential contributions in the following aspects. Firstly, it provides a comprehensive and elaborate analysis of the impact of China's agricultural exports on its rival exporters. Specifically, the sample of data used in this study spans a longer (20 years) and more recent (1993-2012) period than previous studies. For instance, the existing studies applying the gravity model to investigate the effects of China's exports mainly discuss about the period before 2005 and use trade data for a period of less than 15 years (Geda and Meskel, 2008; Giovannettia and Sanfilippob, 2009; Eichengreen, et al., 2007; Greenaway, et al., 2008; Athukorala, 2009; and Giovannettia et al., 2013). It is, hence, unlikely to find out best policy implications for current time with numerous rapid changes in the economic situations over the last 10 years. In addition, this

[5] See Appendix B

research uses disaggregated data at 6-digit level. It is important to note that existing studies have used mainly aggregate data not product-level data. Using product-level data can help to better identify and explain clearly displacement and complimentary effects of China's agricultural exports. The reason is that the more aggregate level of data is used the more different the same product classifications exported by countries are likely to be. Even at disaggregate level of data studies such as Schott (2004) documented differences of products in terms of characteristics and quality. Secondly, there are not many sectoral studies which have focused on the impact of China's exports on its competitors in agricultural sector. Thirdly, in addition to intensive margin, another important component of the research also focuses on study of the China's impact on the extensive margin. Note that studies on the China's impact on the extensive margin of its competitors remain scant due to the use of disaggregate data and heavy workload required to construct the data. The paper also includes the importance of China's agricultural imports in the analysis of the impact of China's agricultural exports and this variable has not been popularly used in the existing literatures. Finally, recent major developments such as China's accession to the WTO, and ongoing WTO negotiations of the Doha Round with focus on liberalizing agricultural trade have made the topic on China's impact for the recent years more relevant. The findings of the research can certainly help policy makers of related countries in the formation of their trade policies in order to promote domestic growth and optimize their integration to the world economy. In brief, the finding from this comprehensive and rigorous research can contribute to better awareness and understanding of the implications the rapid growth of China's exports in agriculture may have for both advanced and developing economies in the coming years.

In general, the results of our study show that China's agricultural exports have both complementary and displacement effects on the exports of its competitors in third markets on intensive and extensive margin. First, our findings reveals that there is strong evidence of China's displacement effects on its competitors across regions notably Latin American and African exporters; and in different markets especially African markets on the intensive margin and Latin American markets on the extensive margin. Second, complementary effects can be mainly found in Asian and OECD markets on both margin. In addition, China's agricultural exports increase US exports in most markets on both margins. Finally, we found that China has significant competition effects in animals and meat; and fruit and vegetable sector but complimentary effects in grains and other products.

This paper empirically examines the extent to which China affects the export values of its competitors in agricultural sector to most important importing destinations. It will start with an elaborate review of the related existing theoretical and empirical literature on the determinants of the intensive and extensive margin of trade. Then it describes the data and points out the model. Next sections analyzes the results and findings. After that the paper provides a description of robustness checks.

2. Empirical literature on the impact of China's agricultural exports

Using different methods, existing literature on the displacement effects of China's agricultural exports has generated mixed results. Previous studies find both displacement and complimentary effects of China's agricultural exports.

The results from an early study by Wang (1997) showed that China's WTO entry would have impact on world labour-intensive export and primary agricultural import market. Using econometric and trade flow analysis, Holst and Weiss (2004) documented that ASEAN were experiencing serious competition with China in third markets especially in Japan and the US. In addition, they used extensive trade flow analysis and found that in the long run globalisation can accommodate export growth by all the economies of East Asia if an optimal regional division of labour is promoted. López Córdova et al (2005) examined how sensitive Latin American exports were to Chinese competition in the U.S. market by using elasticity of substitution and reported that the elasticity for agriculture is 3 and lower than other products (7 for mining). Lall and Weiss (2005) found China's potential competition effects on Argentina's exports in vegetables and fruit, meat and cereals as well. Using different indices (Relative Comparative Advantage Index, Complementarities Index and Similitude Index), Chuan (2006) also found an evidence of competitiveness effects between China and ASEAN countries which were dominating. Another study undertaken by Freund and Ozden (2006) reveals that China's exports in cereals and cereal preparations adversely affected the exports of Latin American countries. In addition, results from a study conducted by Jenkins et al (2008) also showed that Brazil's world market loss to China was about 44 per cent of fruit preserved and fruit preparation export and 5 per cent of meat and fish exacts during 1990-2004 period.

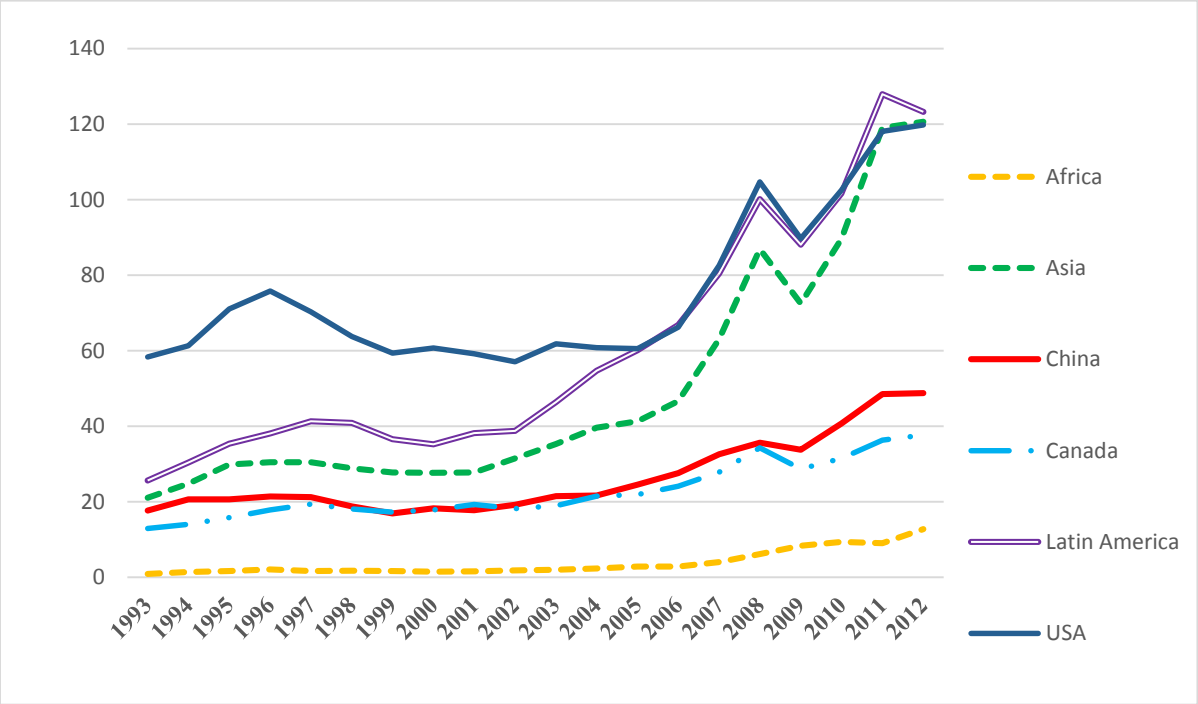
In brief, there are a series of empirical literature on Chinese manufacturing exports but only few literatures which profoundly study the impact of China's agricultural exports, particularly for the

current period. The effects of Chinese agricultural products seems to be negative in major exported agricultural products.

3. China's agricultural exports

China is one of world producers of agricultural products notably fruits, vegetables, rice, and pork. It produces over half of the world's pork; one-third of the world's horticultural products, rice, and nearly one-fifth of the world's wheat, corn, and poultry. China is considered a major global exporter of horticultural products especially vegetables, garlic, mandarin oranges, apples and apple juice (USITC, 2011).

Figure 2: Agricultural Exports by China and Its Competitors - In 2005 billions of USD



Source: UN COMTRADE database and author's calculation

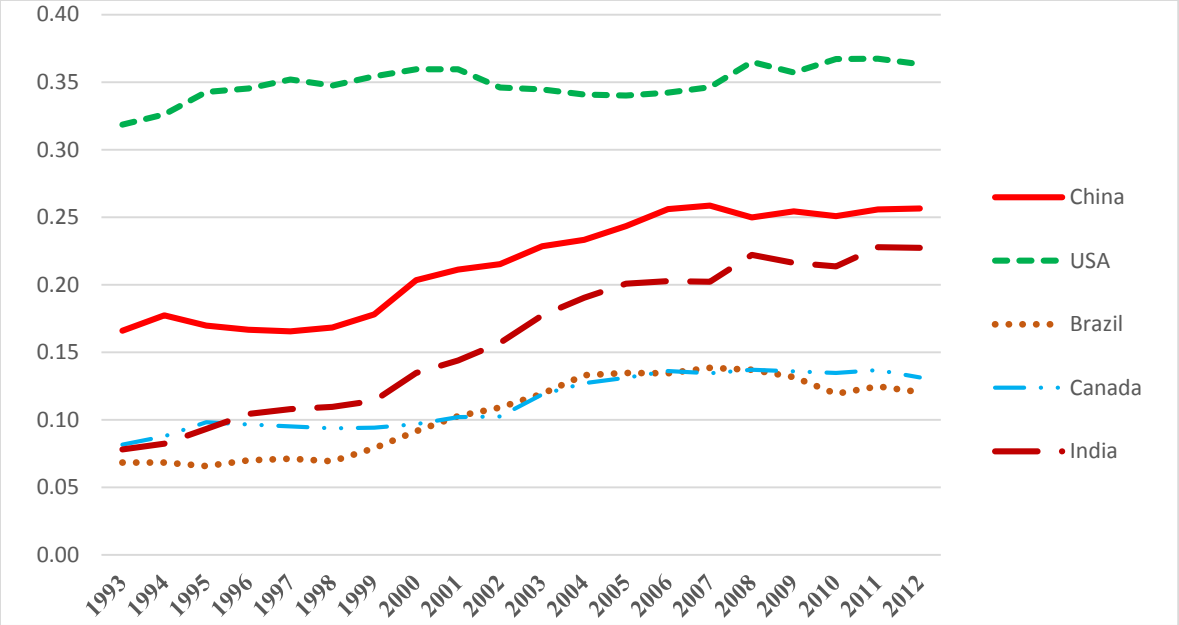
Notes: 1. China includes PRC, Hong Kong and Macau.
2. Exporters in each groups are also described in Appendix C.

Figure 2 illustrates that China's agricultural export growth rate has been higher after WTO accession. Although the growth rate seemed to be smaller than other regions such as Asia and Latin America, China was still the second leading global agricultural exporting country behind the United States and before Brazil and Canada in 2012. Besides world leading agricultural exporters

namely United States, Brazil and Canada and EU28, China also faces competition from developing countries all over the world[6].

The extensive margin of trade discusses the extent to which exports of one country affect the probability of exports by other countries to the same destination or market. An increase in nonzero trade flows implies higher probability of exports of that country to a destination. The share of nonzero flows of one country is calculated as the ratio of the total number of nonzero export flows a country has to the total of possible nonzero flows of exports in all products to all markets/countries. In our sample of agricultural exports, the possible nonzero flows include 683 HS 6-digit products to 50 destinations/ countries. It means 34150 possible nonzero flows[7].

Figure 3: Nonzero flows of agricultural exports of top five exporters



Source: UN COMTRADE database and author's calculation.

Note: See Appendix G for further information.

Figure 3 presents the shares of nonzero flows of agricultural exports of top five exporting countries. China has high ratio of nonzero flows and ranks second among top five exporters. In general, it has upward trend on extensive trade margin which implies a gradual growth rate in the number of products-destinations for which it has positive agricultural exports. China's positive exports

[6] See Appendix C for the list of major exporters in agricultural products.
[7] 34150 nonzeroflows equals 683 products multiplied by 50 destinations.

accounts for 0.26 of possible nonzero export flows in 2012. China's ratio is only lower than that of USA but higher than India and much higher than Brazil and Canada. The good performance of China's agricultural exports can raise the question on China's effects on its competitors on the extensive margin of trade.

4. Econometric models and data

4.1. The models

3.4.1.1. The model to analyze China's effects on the intensive margin

The paper applies the gravity model first introduced by Tinbergen (1962), one of most successful empirical models in both trade and factor movements. This model explains that bilateral trade is proportional to the product of an index of their economic size. The factor of proportionality is determined by trade resistance which includes geographic distance, dummies for common borders and Commonwealth and Benelux memberships. This model was developed by Linnemann (1966), Aitken (1973), Anderson (1979), Krugman (1979), Bergstrand (1985), McCallum (1995), Frankel and Romer (1999), Eaton and Kortum (2002), Anderson and van Wincoop (2003), Cheng and Wall (2005) to Baier and Berganstrand (2009a) and others.

Notably, Anderson and van Wincoop (2003) worked out a gravity model which explains that the bilateral trade between two countries depends on the two countries' characteristics (GDPs), characteristics of the pair (bilateral distance) and the resistance between each country to the rest of the world which is called multilateral resistance. The multilateral resistance, a nonlinear function of GDPs and bilateral trade cost from each country to the rest of the world has correlation with independent variables in the gravity model. The omission of multilateral resistance in estimating gravity model, thus, is likely to result in biased gravity estimates.

The gravity model has been found to successfully explain the volume of trade as revealed by the studies which are reviewed in the previous parts. Using gravity model has significant advantages in analyzing the impact of China's export. First, the model allows for a sectoral analysis of disaggregation of trade data for 6 digits which can produce more credible results for better policy implications. Second, the model can include of numerous explanatory variables even technological change and capital accumulation (Amann, et al, 2009).

The econometric model used in this paper is the modified gravity equation using panel data:

$$Log(X_{ijt}) = \alpha + \alpha_p + \alpha_i + \alpha_y + \beta_1 Log(X_{cnjt}) + \beta_2 Log(X_{icnt}) + \beta_3 Log(GDP_{it} * GDP_{jt}) + \beta_4 Log(GDPC_{it} * GDPC_{jt}) + \beta_5 Log(Distance_{ij}) + \beta_6 dummies_{ij} + \varepsilon_{ijt} \quad \textbf{(1)}$$

where X, *i, j, p, y* and *cn* denote export value, exporter, importer, product, year and China respectively. GDPs are used as proxies for the economic sizes and GDPC indicates GDP per capita. Dummies are a vector including regional trade agreement and standard bilateral dummies variables (common border, common language, common former colonial relationship, common language and common currency) and β_6 is corresponding vector of coefficients. X_{cnjt}, the explanatory variable of interest, is the export value of a product by China to importer j in year t. α_p and α_y are included to control for the time-invariant product-specific factor and time factor[8]. Exporter fixed effects (α_i) is used to control for multilateral resistances[9].

We also include exports of agricultural products to China from exporter *i* X_{icnt} in the model as China is one of top importers of agricultural products. The exports of these products to China has been increasing and accounted for more than 13 per cent of total exports of 25 major exporters to 50 major destinations[10]. Therefore, export to China, a measure of the multilateral resistance of the exporter with respect to China (a major market) needs to be controlled for in the second stage of the IV regression.

It is assumed that importer *j* has a fixed budget to buy domestic and foreign goods. If China's and its competitors' products are substitutes (complements) then we expect to observe a negative (positive) effect of China's exports to importer *j* on the exports of exporter *i* to *j*[11]

To analyze the impact of China's exports on different exporter groups, variables X_{cnjt}_AF, X_{cnjt}_AS, X_{cnjt}_LA, and X_{cnjt}_OECD are added. These variables are the products of China's exports and dummies of the exporter regions: Africa (AF), Asia (AS), Latin America (LA), or OECD[12].

The endogeneity is likely to present because Chinese exports to an importer j (i.e. $Log(X_{cnjt})$) is likely correlated with unobservable component of the error term ε_{ijt}. Specifically, an improvement

[8] Giovannettia and Sanfilippob (2009) also include time factor in their study using a gravity model.
[9] See Appendix E for further information.
[10] See Appendix C and D and F for further information.
[11] See Pham et al. (2016); and Lovely and Pham (2015)
[12] See Appendix C for further information

in consumer sentiment worldwide will result in a positive correlation between Chinese agricultural exports and the agricultural exports of its competitors and consequently in an upward bias of the OLS gravity coefficient estimates vis-à-vis the IV gravity coefficient estimates. Similarly a world-wide negative shock from the supply side will reduce both the exports of China and the exports of other exporters to the same importing markets. In this case, we also have positive correlation between Chinese agricultural exports and the agricultural exports of its competitors. As a result, there will be an upward bias of the OLS gravity estimate vis-à-vis the IV gravity estimates of $Log(X_{cnjt})$.

This paper, thus, plans to address the problem of endogeneity of the variable of Chinese exports in agricultural products by using geographical bilateral distances between China and importing markets as an instrument. This instrument has been used separately or jointly in studies such as Eichengreen et al. (2007), Greenaway et al. (2008), Athukorala (2009), Giovannetti et al. (2013) and Pham et al. (2016). Note that since bilateral distance between China and importing markets used as one of the instruments which varies so we cannot include the importer fixed effects in regression (1). We use an instrument variable estimator based on both two stage least square (2SLS) and generalized method of moments (GMM) estimators.

The analysis on the intensive margin is carried out first for total sample, then by group of exporters, group of importers/ market[13] and sector[14] Using the formula introduced by Fringer and Kreinin (1979), used by Schott (2008) and Pham et al. (2015), export similarity indices (ESI) for T&A sectors are also computed to provide an insight into the effects of China's exports[15]. We also undertake a series of sensitivity check of which those using different subsamples are typical.

3.4.1.2. The model to analyze China's effects on the extensive margin

To investigate the impact of China's T&A exports on the extensive margin, the following probit regressions are used:

$$\rho_{ijt} = Pr\left(T_{ijpt} = 1 \middle| Observed\ variables\right)$$
$$= \emptyset\{\ \alpha + \alpha_p + \alpha_i + \alpha_y + \beta_1 Log(X_{cnjt}) + \beta_2 Log(X_{icnt}) + \beta_3 Log(GDP_{it} * GDP_{jt}) +$$
$$\beta_4 Log(GDPC_{it} * GDPC_{jt}) + \beta_5 Log(Distance_{ij}) + \beta_6 dummies_{ij} + \varepsilon_{ijt} \qquad \textbf{(2)}$$

[13]See Appendix C and D.
[14]See Appendix G
[15] See Appendix H for the computation of similarity indices.

where ρ_{ijt} is the probability that exporter *i* exports to importer *j* in year *t*. T_{ijpt} is the indicator variable equal to 1 when country *i* exports in product *p* to country *j* in year *t* and 0 otherwise. The sample used in our probit regression only includes zero export flows which could have occurred but could not[16]. We include only zero export flows for products that an exporter could export to at least one destination but not all in year *t*. To address the endogeneity problem of $Log(X_{cnjt})$ we estimate the above probit regression using bilateral distance between China and the importer *j* as an instrument.

Using a full sample our analysis is first carried out to find out China's effects on all exporters. We examines the China's effects (i) on all agricultural exporters , (ii) on groups of exporters, (iii) on groups of importers (or in different markets) and (iv) in different sectors of agriculture. We also undertake a series of sensitivity checks by using different subsamples.

4.2. Data

The paper uses trade data of 6-digit HS classifications from the UN Comtrade database[17]. It uses available data from 1993 to 2012.

We use export values of China including Hong Kong and Macau and 25 major agricultural exporters, China's competitors, to 50 major importing countries, 50 largest GDP countries[18]. Note that the selection of these major agricultural exporters and major importing countries is adopted because trade in agricultural products among them account for the majority of world agricultural trade. Data on GDP and GDP per capita[19] are available from the World Development Indicator database. We collect data on standard gravity variables from CEPII's gravity dataset and data on common currency and free trade agreement from De Sousa's database. Table 1 summarizes the descriptive statistics of main variables.

5. Preliminary Findings and Analysis of the Results

5.1. The effects of China's agricultural exports on the intensive margin

Table 2 shows the regression results of ordinary least squares (OLS) and instrumental variables (IV) regressions which include two-stage least squares (2SLS) and Generalized Method of

16 See Baldwin and Harrigan (2011) for further information
17 The list of detailed products will be provided upon request. Trade values are in USD measured at 2005 price.
18 See Appendix C and D.
19 GDP and GDP per capita are at 2005 price.

Moments (GMM). These regressions use a full sample of 1993-2012 data of exports at the product-level and apply the gravity equations (1). The OLS results and IV results are generally consistent with those of gravity model and statistically significant. GDPs of both countries (GDP_{it} and GDP_{jt}) have positive relationship with bilateral trade while bilateral distance ($distance_{ij}$) has negative relationship. Bilateral trade is promoted by common border, language, former colony, currency and trade agreement. China's agricultural imports also have positive relationship with the bilateral trade. The impact of China's exports (X_{cnjt}) is early similar in these regressions but the positive effects of China's exports are little weaker in IV regressions. 1 per cent increase in Chinese exports will lead to more than 0.1 per cent rise in the exports of other competing countries. The overall effect of China's agricultural is statistically significant at 1 per cent. In addition, the first-stage F-statistic value (637.36) verifies that the instrument is relevant. The Anderson likelihood ratio statistics and Cragg-Donald statistics both reject the null hypothesis that the equation is underidentified.

Regarding exporter groups, Table 3 illustrates IV regression results by exporter groups or the effects of China's agricultural exports (X_{cnjt}) on the exports of its competitors from different regions: Asia (AS), Latin America (LA), Africa (AF), OECD and the United States of America (USA). Note that there may be some concern that the analysis of the effect of China's exports on different groups of China's competitors may be biased by the way the groups are selected. It is our view that this is unlikely to be a problem for our sample. First, as already mentioned above we select top 25 major agricultural exporters no matter which country may be part of our sample and our subsamples. Second, we define the groups of exporters purely based on geographic reason. The idea is that the effect of China on the exports of its competitors may be specific to each region. For example, in terms of technology and relative factor endowment China is likely to be similar to its competitors in Asia, Latin America than competitors of OECD group. It is also possible that China's trade policy has been designed with regional focus and implemented in order to compete with advanced exporters of OECD in the third markets rather than with developing or emerging exporters of Asia and Latin America. Note that it is for the very same reasons mentioned that studies such as Eichengreen et al. (2007) and Greenaway et al. (2008) also looked into the effect of China on the exports of different groups of exporters. Since those region-specific factors mentioned above influence the sign of $Log(X_{cnjt})$ in opposite directions, the net effect of China on the exports of different groups of exporters is purely an empirical issue. We prefer USA in one

group as it is the largest agricultural exporter and has large volume of agricultural trade with China (Zheng and Qi, 2007)

Table 3 illustrates China's different effects on exporter groups in different markets. Column 1 shows that in overall China had positive effects on the exports of its competitors except Latin American groups when using IVs and data for all markets. USA benefited most from China's exports and US agricultural exports increased by 0.35 per cent in line with 1 per cent increase in China's exports. It can be explained by strong trade complementarity of US and China in major agricultural products studied by Zheng and Qi (2007) and Shuai and Wang (2011). They explain the difference in China's and US agricultural products are caused by comparative advantages and resource endowment of each country. In general, the exports of China's competitors are mainly displaced in Africa and promoted in other markets namely Asia, Latin America and OECD. From Column 2 of Table 3, there is evidence of displacement effects of China's exports in African markets with a decline of agricultural exports from Latin America, OECD and USA by 0.23, 0.05 and 0.006 per cent respectively when responding to 1 per cent rise in China's exports. Latin American exporters were most seriously affected by China's agricultural products in all markets except its home market, Latin America. Only African products exported to Latin American markets and Latin American products to OECD markets were negatively affected by China's exports. All the agricultural products of other exporters are promoted by China's exports in these two markets. Interestingly, greatest complementary effects were found in Asian markets, about 0.25-0.5 per cent increase in exports of Asia, OECD and US when China exports rise by 1 per cent. In brief, all exporters except Asian countries were negatively affected by China's exports to a certain extent. However, China's complementary effects which are more statistically significant outweigh its displacement effects.

Agricultural products cover a large number of products so China's exports may have different influences on different sectors of agriculture. Table 4 illustrates these effects in four broad sector: animals and meat; fruit and vegetables; grains and other products[20]. Displacement effects were mainly found in two major agricultural sectors namely animals and meat; and fruit and vegetables. China's exports in animals and meat reduced about 0.2 per cent of exports from Latin America and Africa; and more than 0.01 per cent of those from OECD. These results confirms the argument

[20] See Appendix G for the classification.

on China's competition in these sectors from Lall and Weiss (2005) and Jenkins et al (2008). Complementary effects were found in China's grains to all exporters; and also in other products to all exporter except the case of Latin American producers. In addition, USA enjoys greatest China's complementary effects in all sectors. If China increases its exports in agricultural products by 1 per cent, US agricultural exports will rise by around 0.3 per cent.

The effects of China's agricultural exports can be also explained by using similarity index[21]. A greater value of the index implies more overlapping in export patterns of China and its competitors and greater competitive effect of China's exports may appear[22]. Following Pham et al. (2016), the similarity indices of exporter groups are calculated as the mean of the similarity indices of groups.

Table 5-7 illustrate similarity indices for China's agricultural exports at 6 digit level. In general similarity index can explain China's replacement effects to a limited extent. Only in the case of African markets, the exporters groups whose products are more similar to China's products face more competition from China. In terms of sector, displacement effects also found in animals and meat; and fruit and vegetables to OECD exporters whose products are much more similar to China's. In other markets and sectors, USA and OECD's exports have highest similarity indices with China's but they gain from China's exports. This can be explained by the difference in product quality of the goods from these countries in comparison with China's product quality. So the results from Table 5-7 partially support the previous findings about China's effects. It implies that some exporters may produce the same category as China but their products are different in quality and not close substitutes. This point needs further study on detailed structure and quality of exports of China and its exporters.

5.2. The effects of China's agricultural exports on the extensive margin

We use probit regressions (2) to investigate the effects of China's agricultural exports on the extensive margin, the likelihood of exports by other countries to the same destination. Using a full sample our analysis is first carried out to find out China's effects on all exporters. We examines the China's effects (i) on all agricultural exporters , (ii) on groups of exporters, (iii) on groups of importers (or in different markets) and (iv) in different sectors of agriculture.

[21] See Appendix H. Schott (2008), Edwards and Lawrence (2010) and Pham et al. (2016) use similarity indices in their studies.
[22] An assumption of identical quality in their exports is needed.

Table 9 which presents the results of the standard and 2SLS IV probit regressions illustrate the regression results on the intensive margin. From both standard probit regression and 2SLS IV probit regressions we found that China's exports in agricultural products have a positive effect in terms of coefficient and marginal effect (0.057and 0.139) on the export probability of its competitors at the significance level of 1 per cent.

Table 10 illustrates China's effects on (i) all markets (Column 1-2); (ii) specific markets (Column 3-10); (iii) all exporters (first two lines); and (iv) particular exporter groups from Asia, Latin America, Africa and OECD (next 10 lines). In general, all groups of exporters were positively affected by the competition from China on the extensive margin but the effects vary in different market. In contrast to China's effects on the intensive margin, all exporters groups are negatively affected in Latin American markets on the extensive margin. The likelihood of exports to Latin America is most adversely influenced by China's exports in term of both coefficients (-0.52) and marginal effects (-0.17). We found China's displacement effects in this market on the significance level of 1 per cent. There was also evidence of China's negative effects in African markets at a weaker extent, coefficients (-0.054) and marginal effects (-.019) as only displacement effects were found to Asian and Latin American exporters. In addition, complementary effects are found to all groups in OECD markets and most groups (excluding African exporters) in Asian markets on the extensive margin. These markets commonly include medium and high income consumers who may prefer strict requirements on compliance with sanitary measures which is likely a large challenge to China (Dong and Jensen, 2007). Like the effects on the intensive margin, US exporters also gained most from China's exports in these markets.

The China's effects in different sectors of agriculture are shown in Table 11. We found consistent positive impact for all exporters, among exporter groups and in different markets. The findings on the extensive margin are also consistent with those on the intensive margin with greatest complementary effects in grain and other products (0.20 and 0.15 coefficients); and most gain for US exporters (around 0.3 coefficient). However, when analyzing in more detail by including particular destinations, we found hetergoreneity of effects in four markets from Table 12. First, we found strongest evidence of displacement of China's exports in fruit and vegetables in all markets and to most of exporter groups especially Latin American and African markets and to Asian exporters. All fruit and vegetables exporters were seriously affected at the coefficient of more than 1 and marginal effect of more than 0.3. This result confirms China's effects found by Holst and

Weiss (2004). There is also evidence that China was a great competitor to most exporters of animals and meat in African and Latin American markets. Unlike fruit and vegetables, Asian animals and meat exporters gained from China's exports in all four markets (Africa, Asia, Latin America and OECD). Exporters of grains and other products mainly faced competition with China in Latin American market which was already mentioned by Freund and Ozden (2006) and Lall and Weiss (2005). African group was also exposed to China's threat in Asian market while Asian exporters were negatively affected by China's grain exporters in Asian and OECD markets. African markets were good destinations for grain and other product exports to avoid the threat from China. In addition, they were positively affected by China's exports from the coefficient of 0.4 to 0.9 in these markets. There was strong evidence of complementary effects in OECD markets (especially in animals and meat; grains and other products) and Asian markets (in animals and meat; and other products).

In brief, although we found positive effects of China's exports when using data for all exporters in all markets or all exporters in different sectors, China's competition affected more exporting countries, more sectors and in more markets on the extensive margin.

5.3. Robustness check

For the intensive margin, we have undertaken a series of sensitivity check by using different subsamples namely before and after China's WTO accession samples; sample excluding Global Financial Crisis (GFC), before and after GFC samples. All the results for the subsamples are included in Table 8. The coefficients of China's effects are approximately similar and have the same expected signs which indicate overall complementary effects. However, the effect is weaker before Global Financial Crisis (GFC) and China's WTO accession. We also check the sensitivity by using only inland China's exports. The findings are similar to those of the case of China including Hong Kong and Macau.

We also used subsamples for GFC and WTO to test China's influence on the extensive margin of trade and found similar results regarding both values and signs to the full sample. Like the results on the intensive margin, the effects of China's agricultural exports are stronger after the GFC and WTO accession.

6. Conclusion

The findings of this paper have some points in line with but some different from previous studies. We found a mixture of China's effects on the exports of its rivals to the same destination on both margins. On the whole, China's complementary effects on the intensive and extensive margin of its competitors in agricultural products seems to be greater but the displacements effects to different exporter groups were found in certain markets and sectors. US. Asia and OECD exporters are remarkable winners from China's export expansion on both margins while Latin American and African exporters are main losers. The strongest evidence of displacement effects are found in African market on the intensive margin and in Latin American market on the extensive margin. In terms of agricultural sector, all rival exporters are displaced by China's exports in fruit and vegetables on both margins. There is also evidence of competition from China in animals and meat, especially in African and Latin American markets to all exporters except Asian exporters. China's complementary effects are found in grains and other products on both intensive and extensive trade margins. In brief, when analyzing in detail, we found a heterogeneity of China's effects in agricultural exports.

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Table 1
China's Agricultural Exports - Summary of Statistics of Main Variables

Variable	Mean	S. Deviation	Min	Max
$Log(X_{ijt})$	12.12087	2.601227	6.907755	22.2009
$Log(X_{cnjt})$	12.27548	2.554948	6.907755	20.82982
$Log(X_{icnt})$	12.31307	2.597718	6.907755	23.27439
$Log(GDP_{it}*GDP_{jt})$	54.95475	1.879913	48.24308	59.80793
$Log(GDPC_{it}*GDPC_{jt})$	19.4915	1.693945	11.76239	22.2307
$Log(distance_{ij})$	8.481644	1.025328	5.080959	9.880193
$Log(distance_{cnj})$	8.716984	.6291013	7.06319	9.857974

Table 2
The Effects of China's Agricultural Exports - Intensive Margin

	OLS	2SLS IV	GMM
	(1)	(2)	(3)
$Log(X_{cnjt})$	0.126	0.121	0.121
	(29.99)***	(2.34)**	(23.02)***
$Log(X_{icnt})$	0.437	0.437	0.437
	(92.91)***	(75.04)***	(367.24)***
$Log(GDP_{it}*GDP_{jt})$	0.417	0.420	0.420
	(18.86)***	(13.20)***	(126.07)***
$Log(GDPC_{it}*GDPC_{jt})$	0.110	0.110	0.110
	(5.74)***	(5.67)***	(43.63)***
$Log(distance_{ij})$	-0.725	-0.724	-0.724
	(18.37)***	(18.21)***	(159.94)***
$Border_{ij}$	0.815	0.816	0.816
	(6.37)***	(6.36)***	(70.84)***
$Language_{ij}$	0.320	0.320	0.320
	(3.94)***	(3.95)***	(37.64)***
$Colony_{ij}$	0.111	0.110	0.110
	(1.01)	(1.00)	(10.41)***
$Currency_{ij}$	0.372	0.372	0.372
	(4.43)***	(4.41)***	(34.71)***
RTA_{ij}	0.214	0.213	0.213
	(3.49)***	(3.45)***	(24.46)***
First stage F-stat.		637.36	
Anderson canon. corr. likelihood ratio stat [p]		27567.59 [0.0000]	
Cragg-Donald N*minEval stat [p]		28131.70 [0.0000]	
R^2	0.39	0.39	0.39
Observations	682,764	682,764	682,764

*Notes: (1) The regressions use clustering of exporter pairs. (2) Results for the year, exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 10 per cent, ** 5 per cent and *** 1 per cent. (5) T-statistics based on the robust standard errors in parentheses.*

Table 3
The Effects of China's Agricultural Exports on Exporter Groups - Intensive Margin
By Market

	All markets	Africa	Asia	Latin America	OECD
	(1)	(2)	(3)	(4)	(5)
$Log(X_{cnjt})$_All	0.121	-0.084	0.254	0.044	0.106
	(2.34)**	((0.12)	(2.21)**	(0.28)	(1.43)
$Log(X_{cnjt})$_AS	0.043	0.148	0.243	0.164	0.020
	(0.57)	(0.21)	(1.87)*	(0.97)	(0.23)
$Log(X_{cnjt})$_LA	-0.022	-0.225	-0.073	0.025	-0.044
	(0.35)	(0.32)	(0.55)	(0.17)	(0.52)
$Log(X_{cnjt})$_AF	0.043	0.416	0.096	-0.176	0.033
	(0.49)	(0.57)	(0.45)	(0.87)	(0.33)
$Log(X_{cnjt})$_OECD	0.094	-0.053	0.275	0.006	0.057
	(2.09)*	(0.07)	(2.13)**	(0.04)	(0.94)
$Log(X_{cnjt})$_USA	0.351	-0.006	0.502	0.267	0.439
	(4.40)**	(0.01)	(3.50)***	(1.45)	(3.97)**
Observations	682,764	22,937	136,668	35,199	487,960

*Notes: (1) The IV regressions use clustering of exporter pairs. (2) Results for the year, exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 10 per cent, ** 5 per cent and *** 1 per cent. (5) T-statistics based on the robust standard errors in parentheses.*

Table 4
The Effects of China's Agricultural Exports on Exporter Groups - Intensive Margin
By Sector

	Animals and Meat	Fruit and Vegetables	Grains	Others
	(1)	(2)	(3)	(4)
$Log(X_{cnjt})$_All	*0.066*	*-0.003*	*0.202*	*0.154*
	(0.97)	*(0.04)*	*(4.42)***	*(2.93)***
$Log(X_{cnjt})$_AS	0.193	-0.060	0.062	0.019
	(1.84)	(0.69)	(0.69)	(0.27)
$Log(X_{cnjt})$_LA	-0.175	0.092	0.061	-0.024
	(1.49)	(0.93)	(0.57)	(0.35)
$Log(X_{cnjt})$_AF	-0.190	-0.106	0.188	0.091
	(0.83)	(0.89)	(1.65)	(0.95)
$Log(X_{cnjt})$_OECD	-0.013	-0.093	0.213	0.165
	(0.21)	(1.34)	(4.42)**	(3.36)***
$Log(X_{cnjt})$_USA	0.336	0.259	0.368	0.339
	(4.32)***	(2.53)**	(3.92)**	(3.75)***
Observations	65174	162,125	68,409	387,056

*Notes: (1) The IV regressions use clustering of exporter pairs. (2) Results for the year, exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 10 per cent, ** 5 per cent and *** 1 per cent. (5) T-statistics based on the robust standard errors in parentheses.*

Table 5
Similarity Index of China's and its Competitor Groups in Agricultural Exports

	1993-1997	1998-2002	2003-2007	2008-2012
Asia	0.201	0.215	0.241	0.223
Latin America	0.118	0.133	0.136	0.142
Africa	0.026	0.025	0.046	0.062
OECD	0.243	0.234	0.264	0.289
USA	0.389	0.389	0.376	0.377

Table 6
Similarity Index of China's and its Competitor Groups in Agricultural Exports by Market

	African Market				*Asian Market*			
	1993-1997	1998-2002	2003-2007	2008-2012	1993-1997	1998-2002	2003-2007	2008-2012
Asia	0.081	0.120	0.111	0.149	0.253	0.256	0.214	0.203
Latin America	0.094	0.156	0.104	0.138	0.203	0.146	0.116	0.105
Africa		0.033	0.049	0.021	0.023	0.042	0.035	0.049
OECD	0.116	0.140	0.182	0.206	0.181	0.168	0.209	0.224
USA	0.249	0.251	0.264	0.358	0.395	0.355	0.291	0.319
	Latin American Market				*OECD Market*			
Asia	0.130	0.140	0.111	0.102	0.181	0.194	0.229	0.215
Latin America	0.122	0.168	0.190	0.205	0.107	0.114	0.121	0.117
Africa	0.082	0.055	0.031	0.023	0.027	0.021	0.044	0.062
OECD	0.222	0.284	0.217	0.228	0.230	0.226	0.252	0.277
USA	0.306	0.403	0.337	0.262	0.358	0.341	0.340	0.347

Table 7
Similarity Index of China's and its Competitor Groups in Agricultural Exports by Sector

	Animals and Meat				*Fruit and Vegetables*			
	1993-1997	1998-2002	2003-2007	2008-2012	1993-1997	1998-2002	2003-2007	2008-2012
Asia	0.189	0.233	0.340	0.323	0.181	0.178	0.190	0.213
Latin America	0.167	0.174	0.157	0.188	0.040	0.075	0.141	0.128
Africa	0.005	0.003	0.033	0.084	0.028	0.019	0.039	0.043
OECD	0.291	0.319	0.331	0.329	0.271	0.278	0.280	0.298
USA	0.298	0.342	0.289	0.252	0.296	0.319	0.313	0.368
	Grains				*Other Products*			
Asia	0.242	0.274	0.274	0.312	0.225	0.266	0.265	0.242
Latin America	0.288	0.186	0.202	0.190	0.112	0.150	0.178	0.180
Africa		0.164	0.090	0.155	0.062	0.052	0.087	0.095
OECD	0.254	0.208	0.334	0.419	0.268	0.296	0.346	0.347
USA	0.517	0.650	0.582	0.455	0.475	0.468	0.513	0.472

Table 8
The Effects of China's Agricultural Exports - Intensive Margin
Subsamples and Robustness Checks

	Global Financial Crisis(GFC)			WTO	
	Excluding GFC (2007-2008)	*Before GFC 1993-2006*	*After GFC 2009-2012*	*Before WTO 1993-2001*	*After WTO 2002-2012*
	(1)	(2)	(3)	(4)	(5)
$Log(X_{cnjt})$	0.121	0.116	0.128	0.113	0.120
	(2.33)**	(2.16)**	(2.44)**	(1.85)**	(2.45)**
$Log(X_{icnt})$	0.437	0.430	0.454	0.429	0.444
	(74.66)***	(66.34)***	(75.61)***	(58.05)***	(77.30)***
$Log(GDP_{it}*GDP_{jt})$	0.419	0.420	0.435	0.414	0.429
	(13.20)***	(13.69)***	(11.34)***	(12.84)***	(12.97)***
$Log(GDPC_{it}*GDPC_{jt})$	0.108	0.097	0.149	0.095	0.120
	(5.54)***	(4.67)***	(7.69)***	(4.00)***	(6.36)***
$Log(distance_{ij})$	-0.727	-0.720	-0.745	-0.743	-0.726
	(18.15)***	(16.08)***	(18.52)** *	(13.04)***	(18.66)***
$Border_{ij}$	0.805	0.779	0.867	0.752	0.850
	(6.35)***	(6.30)***	(6.36)***	(5.99)***	(6.41)***
$Language_{ij}$	0.328	0.348	0.287	0.377	0.295
	(4.01)***	(4.07)***	(3.58)***	(3.99)***	(3.77)***
$Colony_{ij}$	0.098	0.066	0.158	0.020	0.143
	(0.89)	(0.59)	(1.44)	(0.17)	(1.31)
$Currency_{ij}$	0.374	0.340	0.377	0.281	0.368
	(4.48)***	(4.29)***	(3.88)***	(3.46)***	(3.99)***
RTA_{ij}	0.202	0.182	0.252	0.108	0.245
	(3.23)***	(2.17)**	(4.31)***	(0.90)	(4.19)***
R^2	0.39	0.38	0.39	0.38	0.39
First Stage F-statistic	610.78	482.56	880.78	345.74	828.54
Observations	592533	398,141	194,392	212,025	470,739

*Notes: (1) The IV regressions use clustering of exporter pairs. (2) Results for the exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 5 per cent and ** 1 per cent. (5) T-statistics based on the robust standard errors in parentheses.*

Table 9
The Effects of China's Agricultural Exports – Extensive Margin

	Standard Probit	IV Probit Coefficient	IV Probit Marginal Effect
	(1)	(2)	(3)
$Log(X_{cnjt})$	0.057	0.139	0.055
	(31.49)***	(4.90)***	(4.92)***
$Log(X_{icnt})$	0.148	0.151	0.059
	(72.78)***	(74.38)***	(72.36)***
$Log(GDP_{it}*GDP_{jt})$	0.251	0.208	0.082
	(19.26)***	(10.41)***	(10.34)***
$Log(distance_{ij})$	-0.482	-0.475	-0.187
	(16.46)***	(15.65)***	(15.71)***
$Border_{ij}$	0.320	0.306	0.116
	(2.88)***	(2.74)***	(2.88)***
$Language_{ij}$	0.368	0.364	0.138
	(5.12)***	(5.13)***	(5.41)***
$Colony_{ij}$	0.236	0.237	0.091
	(3.16)***	(3.16)***	(3.26)***
$Currency_{ij}$	0.381	0.407	0.152
	(6.72)***	(7.12)***	(7.64)***
RTA_{ij}	0.281	0.287	0.111
	(6.16)***	(6.25)***	(6.41)***
First stage F-stat.		331.68	331.68
Observations	1,436,838	1,436,838	1,436,838

*Notes: (1) The regressions use clustering of exporter pairs. (2) Results for the year, exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 10 per cent, ** 5 per cent and *** 1 per cent. (5) Z-statistics based on the robust standard errors.*

Table 10

The Effects of China's Agricultural Exports on Exporter Groups - Extensive Margin
By third markets

	All Markets		Africa		Asia		Latin America		OECD	
	Coef.	Marg. Effect	Coef.	Marg. Effect	Coef.	Marg. Effect	Coef.	Marg. Effect	Coef.	Marg. Effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$Log(X_{oij})$_All	0.139	0.055	-0.054	-0.019	0.308	0.122	-0.517	-0.170	0.081	0.030
	(4.90)**	(4.92)**	(0.09)	(0.09)	(3.27)***	(3.27)***	(5.96)***	(5.88)***	(1.90)**	(1.91)
$Log(X_{oij})$_AS	0.129	0.051	-0.046	-0.017	0.235	0.093	-0.490	-0.161	0.061	0.022
	(3.29)***	(3.29)***	(0.07)	(0.07)	(2.18)**	(2.18)**	(4.72)***	(4.63)***	(1.23)	(1.23)
$Log(X_{oij})$_LA	0.109	0.043	-0.034	-0.012	0.188	0.075	-0.447	-0.147	0.098	0.036
	(2.81)***	(2.82)***	(0.05)	(0.05)	(2.15)**	(2.15)**	(4.41)***	(4.37)***	(1.92)*	(1.92)*
$Log(X_{oij})$_AF	0.123	0.049	0.128	0.046	-0.213	-0.084	-0.495	-0.163	0.099	0.037
	(2.19)**	(2.19)**	(0.20)	(0.20)	(1.07)	(1.07)	(4.56)***	(4.51)***	(1.44)	(1.45)
$Log(X_{oij})$_OECD	0.123	0.048	0.066	0.024	0.358	0.142	-0.548	-0.180	0.039	0.015
	(4.36)***	(4.37)***	(0.10)	(0.10)	(3.62)***	(3.62)***	(6.65)***	(6.54)***	(0.95)	(0.95)
$Log(X_{oij})$_USA	0.284	0.112	0.401	0.146	0.464	0.184	-0.408	-0.134	0.378	0.139
	(5.14)***	(5.15)***	(0.63)	(0.63)	(3.91)***	(3.92)***	(3.69)***	(3.68)***	(6.43)***	(6.46)***
Observations	1,436,838	1,436,838	69,862	69,862	329,211	329,211	119,470	119,470	918,292	918,292

*Notes: (1) The IV regressions use clustering of exporter pairs. (2) Results for the year, exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 10 per cent, ** 5 per cent and *** 1 per cent. (5) Z-statistics based on the robust standard errors.*

Table 11
The Effects of China's Agricultural Exports on Exporter Groups – Extensive Margin
By sector

	Animals and Meat		Fruit and Vegetables		Grains		Other Products	
	Coef.	Marg. Effect	Coef.	Marg. Effect	Coef.	Marg. Effect	Coef.	Marg. Effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log(X_{cnjt})_All	*0.114*	*0.045*	*0.104*	*0.042*	*0.119*	*0.046*	0.164	*0.063*
	*(3.65)****	*(3.64)****	*(2.54)***	*(2.54)***	*(4.88)****	*(4.90)****	(6.03)***	*(6.06)****
Log(X_{cnjt})_AS	0.176	0.070	0.099	0.039	0.058	0.022	0.138	0.053
	(4.03)***	(4.03)***	(1.93)*	(1.93)*	(1.51)	(1.51)	(3.72)***	(3.73)***
Log(X_{cnjt})_LA	0.124	0.049	0.149	0.059	0.045	0.017	0.102	0.039
	(2.40)**	(2.40)**	(2.73)***	(2.73)***	(0.73)	(0.73)	(2.80)***	(2.80)***
Log(X_{cnjt})_AF	0.082	0.033	0.096	0.038	0.066	0.025	0.152	0.058
	(1.24)	(1.24)	(1.12)	(1.12)	(1.05)	(1.05)	(2.76)***	(2.77)***
Log(X_{cnjt})_OECD	0.074	0.029	0.080*	0.032*	0.128	0.049	0.160	0.062
	(2.11)**	(2.11)**	(1.95)	(1.95)	(4.92)***	(4.93)***	(6.02)***	(6.04)***
Log(X_{cnjt})_USA	0.251	0.100	0.231	0.092	0.252	0.097	0.303	0.116
	(5.37)***	(5.37)***	(3.22)***	(3.22)***	(4.07)***	(4.07)***	(5.13)***	(5.14)***
Observations	151,509	151,509	387,750	387,750	135,778	135,778	761,801	761,801

*Notes: (1) The IV regressions use clustering of exporter pairs. (2) Results for the year, exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 10 per cent, ** 5 per cent and *** 1 per cent. (5) Z-statistics based on the robust standard errors.*

Table 12
The Effects of China's Agricultural Exports on Exporter Groups – Extensive Margin
By sector and market

	Animals and Meat							
	Africa		Asia		LA		OECD	
	Coef.	M.Effect	Coef.	M.Effect	Coef.	M.Effect	Coef.	M.Effect
Log(X_{cnjt})_All	*-0.006*	*-0.002*	*0.368*	*0.135*	*-0.124*	*-0.033*	*0.081*	*0.032*
	(0.04)	*(0.04)*	*(2.79)***	*(2.80)***	*(1.97)***	*(1.98)***	*(1.97)***	*(1.98)***
Log(X_{cnjt})_AS	0.035	0.011	0.447	0.163	0.093	0.024	0.114	0.045
	(0.21)	(0.21)	(3.24)***	(3.26)***	(1.21)	(1.22)	(2.03)**	(2.03)**
Log(X_{cnjt})_LA	0.135	0.043	0.081	0.030	-0.240	-0.063	0.116	0.046
	(0.79)	(0.79)	(0.45)	(0.45)	(3.02)***	(3.02)***	(1.65)*	(1.65) *
Log(X_{cnjt})_AF	-0.623	-0.200	0.150	0.055	-0.862	-0.225	0.035	0.014
	(0.85)	(0.85)	(0.59)	(0.59)	(3.44)***	(3.41)***	(0.43)	(0.43)
Log(X_{cnjt})_OECD	-0.102	-0.033	0.419	0.153	-0.179	-0.047	0.034	0.013
	(0.67)	(0.67)	(3.07)***	(3.08)***	(3.00)***	(3.00)***	(0.74)	(0.75)
Log(X_{cnjt})_USA	-0.133	-0.043	0.375	0.137	0.028	0.007	0.304	0.119
	(0.66)	(0.66)	(1.96)*	(1.96) *	(0.33)	(0.33)	(5.01)***	(5.01)***
	Fruit and Vegetables							
Log(X_{cnjt})_All	*-3.075*	*-0.928*	*0.014*	*0.005*	*-1.313*	*-0.333*	*0.023*	*0.009*
	(1.63)	*(1.60)*	*(0.08)*	*(0.08)*	*(5.35)***	*(5.36)***	*(0.40)*	*(0.40)*
Log(X_{cnjt})_AS	-2.785	-0.838	-0.038	-0.014	-1.377	-0.351	-0.004	-0.002
	(1.49)	(1.48)	(0.22)	(0.22)	(5.35)***	(5.32)***	(0.07)	(0.07)
Log(X_{cnjt})_LA	-2.424	-0.730	-0.063	-0.024	-1.130	-0.288	0.072	0.028
	(1.29)	(1.28)	(0.39)	(0.39)	(4.49)***	(4.52)***	(1.04)	(1.04)
Log(X_{cnjt})_AF	-1.838	-0.553	-0.486	-0.184	-1.298	-0.330	0.035	0.014
	(0.95)	(0.95)	(1.66)*	(1.66)*	(4.62)***	(4.63)***	(0.34)	(0.34)
Log(X_{cnjt})_OECD	-2.475	-0.745	0.086	0.032	-1.339	-0.341	-0.021	-0.008
	(1.31)	(1.30)	(0.50)	0.50)	(5.61)***	(5.65)***	(0.39)	(0.39)
Log(X_{cnjt})_USA	-2.261	-0.681	0.049	0.019	-1.294	-0.330	0.297	0.115
	(1.18)	(1.18)	(0.28)	(0.28)	(5.02)***	(5.07)***	(3.39)***	(3.40)***
	Grains							
Log(X_{cnjt})_All	*0.474*	*0.183*	*0.074*	*0.029*	*-0.666*	*-0.206*	*0.083*	*0.030*
	*(1.99)***	*(1.99)***	*(0.97)*	*(0.97)*	*(3.77)***	*(3.75)***	*(2.16)***	*(2.17)***
Log(X_{cnjt})_AS	0.448	0.173	-0.046	-0.018	-0.712	-0.221	-0.003	-0.001
	(1.79) *	(1.79)*	(0.41)	(0.41)	(3.84)***	(3.81)***	(0.06)	(0.06)
Log(X_{cnjt})_LA	0.838	0.324	-0.157	-0.062	-0.436	-0.135	0.156	0.056
	(2.50)**	(2.49)**	(0.91)	(0.91)	(2.19)**	(2.18)**	(2.14)**	(2.15)**
Log(X_{cnjt})_AF	0.739	0.286	-0.456	-0.180	-0.787	-0.244	0.044	0.016
	(2.14)**	(2.14)**	(1.51)	(1.51)	(1.67)*	(1.67)*	(0.60)	(0.60)
Log(X_{cnjt})_OECD	0.459	0.178	0.136	0.054	-0.685	-0.213	0.063	0.023
	(1.86) *	(1.86)*	(1.56)	(1.56)	(3.73)***	(3.73)***	(1.56)	(1.56)
Log(X_{cnjt})_USA	0.364	0.141	0.221	0.087	-0.687	-0.213	0.393	0.141
	(1.12)	(1.12)	(1.74)*	(1.74)*	(3.39)***	(3.38)***	(6.95)***	(6.85)***
	Other Products							
Log(X_{cnjt})_All	*0.486*	*0.184*	*0.450*	*0.180*	*-0.543*	*-0.196*	*0.110*	*0.038*
	(1.06)	*(1.07)*	*(5.33)***	*(5.33)***	*(6.40)***	*(6.33)***	*(2.59)***	*(2.61)***
Log(X_{cnjt})_AS	0.458	0.173	0.348	0.139	-0.506	-0.183	0.087	0.031
	(1.02)	(1.02)	(3.53)***	(3.53)***	(4.95)***	(4.89)**	(1.80)*	(1.81) *
Log(X_{cnjt})_LA	0.469	0.178	0.369	0.147	-0.527	-0.190	0.107	0.037
	(1.07)	(1.08)	(4.32)***	(4.32)***	(5.52)***	(5.48)**	(2.24)**	(2.25)**
Log(X_{cnjt})_AF	0.491	0.186	-0.072	-0.029	-0.505	-0.183	0.149	0.052
	(1.03)	(1.03)	(0.44)	(0.44)	(4.75)** *	(4.71)**	(2.25)**	(2.26)**
Log(X_{cnjt})_OECD	0.551	0.208	0.484	0.193	-0.568	-0.205	0.073*	0.026 *
	(1.20)	(1.21)	(5.51)***	(5.51)***	(7.01)***	(6.91)**	(1.79)	(1.80)
Log(X_{cnjt})_USA	0.945	0.357	0.735	0.293	-0.422	-0.153	0.394	0.138
	(1.99)**	(2.01)**	(6.71)***	(6.71)***	(4.13)***	(4.12)**	(6.00)***	(6.04)***

*Notes: (1) The IV regressions use clustering of exporter pairs. (2) Results for the year, exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 10 per cent, ** 5 per cent and *** 1 per cent. (5) Z-statistics based on the robust standard errors*

Table 13
The Effects of China's Agricultural Exports - Extensive Margin
Subsamples

	Global Financial Crisis(GFC) Subsample						WTO Subsample			
	Excluding GFC (2007-2008)		*Before GFC 1993-2006*		*After GFC 2009-2012*		*Before WTO 1993-2001*		*After WTO 2002-2012*	
	Coef.	Marg. Effect	Coef.	Marg. Effect	Coef.	Marg. Effect	Coef.	Marg. Effect	Coef.	Marg. Effect
$Log(X_{ijt})$	0.132	0.052	0.123	0.048	0.163	0.064	0.073	0.029	0.163	0.064
	(4.67)***	(4.69)***	(4.17)***	(4.19)***	(5.61)***	(5.63)***	(2.13)**	(2.14)**	(6.04)***	(6.05)***
$Log(X_{imt})$	0.151	0.060	0.157	0.062	0.146	0.057	0.169	0.066	0.148	0.058
	(73.98)***	(71.89)***	(68.76)***	(67.12)***	(70.96)***	(68.55)***	(64.67)***	(62.95)***	(72.44)***	(70.60)***
$Log(GDP_i*GDP_j)$	0.207	0.082	0.210	0.083	0.213	0.084	0.220	0.086	0.206	0.081
	(10.42)***	(10.34)***	(10.66)***	(10.58)***	(9.15)***	(9.10)***	(10.51)***	(10.40)***	(10.05)***	(10.01)***
$Log(distance_{ij})$	-0.474	-0.186	-0.481	-0.190	-0.462	-0.181	-0.511	-0.200	-0.469	-0.185
	(15.55)***	(15.61)***	(14.10)***	(14.16)***	(15.62)***	(15.64)***	(11.13)***	(11.21)***	(15.97)***	(16.00)***
$Border_{ij}$	0.302	0.115	0.299	0.114	0.339	0.128	0.279	0.106	0.336	0.128
	(2.73)***	(2.87)***	(2.66)***	(2.79)***	(2.85)***	(3.03)***	(2.64)***	(2.76)***	(2.80)***	(2.97)***
$Language_{ij}$	0.363	0.138	0.366	0.139	0.359	0.136	0.392	0.147	0.353	0.135
	(5.00)***	(5.28)***	(4.74)***	(4.99)***	(5.62)***	(5.92)***	(4.43)***	(4.72)***	(5.46)***	(5.73)***
$Colony_{ij}$	0.235	0.090	0.232	0.089	0.240	0.092	0.206	0.079	0.248	0.096
	(3.11)***	(3.21)***	(2.92)***	(3.00)***	(3.21)***	(3.32)***	(2.27)**	(2.33)**	(3.43)***	(3.54)***
$Currency_{ij}$	0.408	0.152	0.325	0.123	0.548	0.199	0.327	0.122	0.429	0.161
	(7.25)***	*(7.79)***	(5.58)***	(5.86)***	(8.52)***	(9.58)***	(4.17)***	(4.42)***	(7.18)***	(7.72)***
RTA_{ij}	0.280	0.108	0.260	0.101	0.322	0.124	0.171	0.066	0.315	0.122
	(6.24)***	(6.40)***	(4.46)***	(4.56)***	(6.73)***	(6.91)***	(1.84)	(1.87)	(6.58)***	(6.76)***
First stage F-stat.	311.39	311.39	216.14	216.14	176.57	176.57	168.59	168.59	377.79	377.79
Observations	1,240,132	1,240,132	921,203	921,203	418,385	418,385	415,272	415,272	1,021,566	1,021,566

*Notes: (1) The regressions use clustering of exporter pairs. (2) Results for the year, exporter dummies and product dummies are not reported. (3) All columns include a constant (not shown). (4) Statistical significance is denoted as * 10 per cent, ** 5 per cent and *** 1 per cent. (5) Z-statistics based on the robust standard errors.*

Appendix A: *Export Growth Rates of Top Five Exporters*

Period	China	USA	Japan	Germany	Republic of Korea
1994	17.2	7.8	7.4	10.0	14.3
1995	16.3	11.6	9.7	20.3	27.7
1996	0.9	4.9	-8.9	-1.8	2.1
1997	9.9	8.7	0.8	-3.8	3.0
1998	-4.3	-2.2	-8.8	5.1	-4.0
1999	1.5	0.4	6.1	-1.7	7.5
2000	19.1	9.8	11.9	-1.1	16.6
2001	-0.9	-8.1	-17.5	1.8	-14.5
2002	13.4	-6.9	1.6	6.0	6.1
2003	23.8	2.4	10.9	19.1	17.3
2004	24.6	9.5	16.2	18.0	26.8
2005	18.8	6.8	1.6	3.5	8.0
2006	18.3	11.8	5.7	11.5	11.3
2007	18.6	8.7	7.5	15.7	11.2
2008	12.2	9.6	7.0	8.1	11.3
2009	-15.5	-18.9	-26.0	-23.6	-14.2
2010	27.4	18.9	30.5	10.7	26.1
2011	16.1	13.2	4.6	14.1	16.6
2012	4.9	1.7	-5.8	-6.8	-4.2
Average	***11.7***	***4.7***	***2.9***	***5.5***	***8.9***

Source: UN COMTRADE database and author's calculation
Notes: China includes PRC, Hong Kong and Macao.

Appendix B: *World Agricultural Exports - Shares of World Exports*

Year	World Exports	World Agricultural Exports	
		Billion USD	Per cent
2010	14891.0	1070.0	7.2
2011	17689.4	1300.0	7.3
2012	17382.1	1310.0	7.5
2013	17939.3	1480.0	8.3

Source: UN COMTRADE database and author's calculation

Appendix C: *Major Exporters of Agricultural Products (by group)*

Asia (AS): India, Indonesia, Malaysia, Vietnam and Thailand; *Latin America (LA)*: Argentina, Brazil and Mexico; *Africa (AF)*: Egypt, Morocco and Nigeria; *OECD (OECD)*: Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, New Zealand, Russian Federation, Spain, , United Kingdom; *United States of America (US)*

Appendix D: *Major Importers of Agricultural Products (by group/market)*

Africa (4 countries): Algeria, Egypt, Nigeria and South Africa; *Asia (11 countries)*: India, Indonesia, Iran, Iraq, Malaysia, Pakistan, Philippines, Qatar, Saudi Arabia, Thailand and United Arab Emirates; *Latin America (7 countries)*: Argentina, Brazil, Chile, Columbia, Mexico, Peru and Venezuela; *OECD (22 countries)*: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Kazakhstan, Netherlands, Norway, Poland, Portugal, Republic of Korea, Russian Federation, Singapore, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States of America

Appendix E: *Main Variables of the Gravity Model*

Export: export value of exporter i to importer j in log form.

GDP: the product of GDP of exporter i and GDP of importer j in log form.

GDPC: the product of GDP per capita of exporter i and GDP per capita of importer j in log form.

Distance: the distance in km between exporter's i and importer's j capitals in log form.

Border: a binary variable that equals one if importer i and exporter j have common physical boundary and zero otherwise.

Language: a binary variable that equals one if importer i and exporter j have a common language and zero otherwise.

Colony: a binary variable that equals one if importing country i formerly colonized exporting country j or vice versa and zero otherwise.

Currency: a binary variable that equals one if importing country i and exporting country j use the same currency and zero otherwise.

RTA: a binary variable that equals one if exporting country j and importing country i belong to a common regional trade agreement, and zero otherwise.

Appendix F: *Share of Agricultural Exports to China from 25 Major Exporters*

Year	Export to China (in 2005 bn USD)	Total Exports to World (in 2005 bn USD)	Share of Exports to China (%)
1993	6.9	211.0	3.27
1994	11.6	281.0	4.13
1995	16.6	317.0	5.24
1996	15.4	332.0	4.64
1997	14.6	321.0	4.55
1998	12.2	303.0	4.03
1999	10.2	328.0	3.11
2000	12.6	312.0	4.04
2001	13.1	315.0	4.16
2002	13.4	330.0	4.06
2003	19.8	373.0	5.31
2004	23.6	406.0	5.81
2005	23.4	417.0	5.61
2006	26.9	445.0	6.04
2007	35.2	522.0	6.74
2008	46.3	617.0	7.50
2009	47.1	531.0	8.87
2010	61.9	576.0	10.75
2011	79.2	691.0	11.46
2012	88.2	667.0	13.22

Source: UN COMTRADE database and author's calculation

Appendix G: *Agricultural products by sector (2-digit HS classification)*

01 live animals	17 sugars & sugar confectionery
02 meat & edible meat offal	18 cocoa & cocoa preparations
04 dairy, eggs, honey, & ed. products	19 preps. of cereals, flour, starch or milk
05 products of animal origin	20 preps of vegs, fruits, nuts, etc.
06 live trees & other plants	21 misc. edible preparations
07 edible vegetables	22 beverages, spirits & vinegar
08 ed. fruits & nuts, peel of citrus/melons	23 residues from food industries, animal feed
09 coffee, tea, mate & spices	24 tobacco & manuf. tobacco substitutes
10 cereals	35 albuminoidal sub, starches, glues, enzymes
11 milling industry products	41 raw hides & skins & leather
12 oil seeds/misc. grains/med. plants/straw	50 silk, inc. yarns & woven fabrics thereof
13 lac, gums, resins, etc.	51 wool & fine or coarse animal hair, inc. yarns & woven fabrics thereof
14 vegetable plaiting materials	52 cotton, inc. yarns & woven fabrics thereof
15 animal or vegetable fats, oils & waxes	53 veg. textile fibers nesoi, yarns & woven etc.
16 ed. prep. of meat, fish, crustaceans, etc	

Appendix H: *Similarity Index*

According to Fringer and Kreinin (1979), export similarity index (ESI) is computed as follows:

$$ESI_{i,China} = \sum_{p \in s} Min(S_{i,p}, S_{China,p})$$

Where *i* and *p* denotes country *i* and product *p*. $S_{i,p}$ and $S_{China,p}$ denotes the shares of country *i*'s exports and China's exports in the world exports of product *p*.

A greater value of the index implies more overlapping in export patterns of China and its competitors and with the assumption of identical quality in their exports, greater competitive effect of China's exports may appear.