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The Impacts of Food Safety Standards on China Export of Vegetables and Fruits

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Abstract**—**Participation in global trade means that China's vegetables and fruits industry faces international food safety standards and increased scrutiny worldwide. The objectives of this paper were to investigate how existing food safety standards and regulations in the importing countries impact the export of vegetables and fruits from China. This paper discussed the current and historical situations of China's vegetables and fruits export from 1996 to 2010, analyzed the Maximum Residual Limit (MRL) standards of pesticides imposed by importing countries, quantitatively estimated the impacts of food safety standards on China's vegetables and fruits export based on a gravity model. The results showed that although transportation distance between trade partners and tariff rates on vegetables and fruits were still the importantly resistant factors for China export, vegetables and fruits export was sensitive to the number of regulated pesticides, the strictness, and the level of food safety standards imposed by importing countries, which showed a significant trade flow effect, stricter food safety standards, increased number of regulated pesticides significantly inhibit China export of vegetables and fruits. Moreover, China's food safety standards also showed a significantly effect on vegetables and fruits export, which inhibited export to some extent.

Keywords**—**Food safety standards, MRL, Vegetables, Fruits, Export.

I. Introduction

WITH the increasing consumer incomes, dietary demands, and the accession to the World Trade Association (WTO), Chinese farmers and exporters have anticipated an obvious, positive impact on production and export of vegetables and fruits. Participation in global trade means that China's vegetables and fruits industry faces international standards and increased scrutiny worldwide, and the revealed comparative advantage of vegetables and fruits are often significantly affected by international regulations. The rapid expansion of domestic and export markets of vegetables and fruits, however, coupled with the poorly regulated food safety controls in China have led to a situation that vegetables and fruits growth rely heavily on agricultural chemicals and pesticides to control pests and diseases problems to increase yields. As a result, the overuse of agricultural chemicals and pesticides increases risks for farmers and consumers' health, and environmental pollution.

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The Agreement on the application of Sanitary and Phytosanitary (SPS) Measure and Technical Barriers to Trade (TBT) of the World Trade Organization (WTO) took effect in 1995. They allow WTO member countries to apply SPS and TBT measures to protect domestic human health, animal and plant health, and the environment. However, Increasingly stringent food safety and agricultural health standards issued in developed countries pose major challenges for high-value food products entering into international markets, especially from most developing countries [1], [2]. Food safety standards, particularly Sanitary and Phytosanitary (SPS) measures, are becoming major barriers to agricultural trade. Between 1996 and 2009, the global average tariff rates (simple average rates) on agricultural products declined from 14.6% to 10.8%, whereas the number of total SPS notifications across the world on agricultural products increased considerably, from 136 in 1996 to 564 in 2009. The increasing number of SPS notifications indicates that food safety standards have become stricter in many importing countries [3].

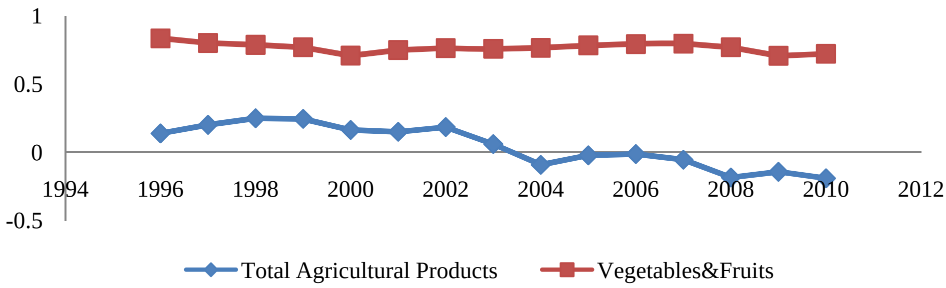
From the perspective of exporters, these sanitary and phytosanitary requirements may affect the costs of international trade [4]. The additional cost of complying with the stringent standards abroad is rising, for instance, China agricultural products that are exported to Japan are confront with very stringent inspection, the cost of procedures at custom inspection is about 150~170 thousand Japanese Yen, and it takes about 4 days. The time for inspection procedures is extended to 10~20 days if the agricultural products were inspected. In addition, the cost for agricultural products storage and inspection increase exponentially with the time extension, and on the other hand time-consuming procedures make the quality of vegetables and fruits fall substantially, which directly lead to competitiveness decrease in the destination markets. Moreover, the Korea inspection procedures for some China's agricultural products are more than 100 items. In 2009, 954 batches of plant and plant-source products export from China to U.S., Japan, Korea and E.U. were blocked, accounting for 52.2 percent of total blocked batches, especially blocked vegetable and cereal products account for more than 20 percent of all plant and plant-source products (Ministry of Commerce of the P.R.C, 2010). In this context, the compliance cost could significantly decrease export volumes and drop small exporting firms out of the foreign markets. This was the trade-cost effect, or the supply-inhibiting effect of technical measures, which corresponded to the conventional "standards as barriers" argument in the international development literature on market access [5].

Therefore, the objectives of this study were to investigate how existing food safety standards and regulations in the importing countries affect the export of vegetables and fruits from China. Specifically, this study would address two questions: 1) how and to what extent the food safety standards affect China export of vegetables and fruits, including the establishment of food safety standards, the level, number, and strictness of regulated pesticides? 2) what kind of trade flow effect for vegetables and fruits can be attributed to the implementation of China's food safety policies?

This paper was organized as follow: Section II presented the current and historical situations of China export of vegetables and fruits from 1996 to 2010. Section III discussed and compared the MRL standards imposed by importing countries, China and Codex. Section IV developed an econometric model based on gravity equation to estimate the impacts of food safety standards on China export of vegetables and fruits. Section V analyzed the regression results by different agricultural products group, simulated the impacts of China's food safety standards on China export. The calculation was conducted three times based on the impacts of the number, level, and strictness of MRL standards, respectively. Finally, this study was concluded and discussed the further perspectives of China export of vegetables and fruits.

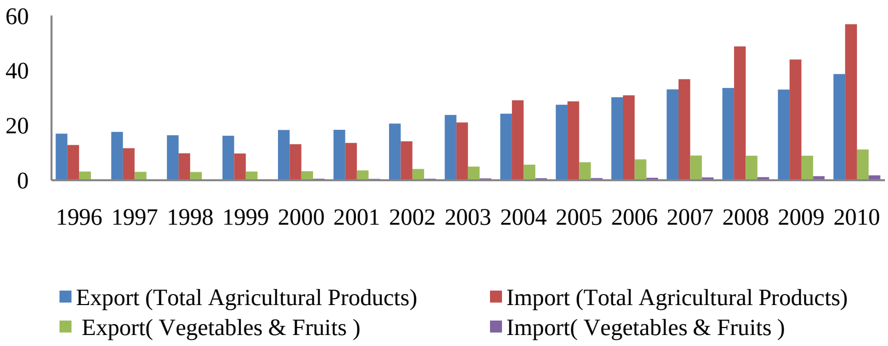
II. The Production and Export of Vegetables and Fruits in China

China's vegetables and fruits industry is a very important agricultural sector domestically and is playing an increasingly important role in the world vegetables and fruits export market [6]. Since 1990s, China has substantially improved its position in the global market for fruits and vegetables, has already becoming one of the main producers of vegetables and fruits in the world, accounting for 52 percent of world vegetables production and 21 percent of world fruits production in 2011 (FAO, 2013). Also, China has become a major exporter of vegetables and fruits in recent decades and has accounted for a steadily increasing share of total agricultural products export. Although China's revealed comparative advantage by the net export ratio (NER) for total agriculture products substantially declined gradually from 1996 to 2010, especially from 2004, China have become a net agricultural importer, the net export ratio for vegetables & fruits was keeping positive and stable (Fig. 1). Fig. 2 showed the export and import values of total agricultural products and vegetable & fruit products from 1996 to 2010. Since 1996, China export of vegetable & fruit products rose continuously, the export value was 3.5 times of that in 1996, or an annual growth rate of 9.8 percent, nearly 11.3 billion US$ in 2010. During the same period, the import value was 6.4 times of that in 1996, or an annual growth rate of 14.7 percent, more than 1.8 billion US$ in 2010. The growth rates of export and import values for vegetable & fruit products have exceeded the growth rates for total agricultural products (6.3 and 12.9 percent, respectively), with the vegetables & fruits export share of total agricultural products export increasing from 18.7 percent in 1996 to 29.0 percent in 2010, and import share increasing from 2.2 percent to 3.3 percent in the same period. The net trade position for vegetable & fruits products has also come close to 3.3 times during this period, reaching 9.4 billion US$ in 2010 (Table I).



Source: China Agriculture Yearbook, author's calculation

Fig. 1 The Net Export Ratio (NER) by Agricultural Products Group



Source: China Agriculture Yearbook, author's calculation

Fig. 2 China Export and Import Values by Agricultural Products Group in 1000$

TABLE I
THE STATISTICAL DATA OF EXPORT AND IMPORT BY AGRICULTURAL PRODUCTS GROUP IN CHINA

Year	Agricultural Products		Vegetables & Fruits			
	Increase of Export (%)	Increase of Import (%)	Increase of Export (%)	Increase of Import (%)	Share of Export (%)	Share of Import (%)
1996	———	———	———	———	18.67	2.22
1997	3.55	-9.02	-3.62	18.21	17.37	2.88
1998	-6.67	-15.69	-1.45	6.12	18.35	3.62
1999	-1.19	-0.29	4.32	14.31	19.37	4.15
2000	13.04	33.99	5.38	38.37	18.06	4.29
2001	0.30	3.11	9.29	-8.30	19.67	3.81
2002	12.30	4.66	14.58	7.12	20.07	3.90
2003	15.07	48.18	19.71	22.67	20.88	3.23
2004	2.09	38.51	14.68	10.78	23.46	2.58
2005	13.45	-1.37	15.19	5.25	23.82	2.76
2006	9.84	7.79	16.84	11.40	25.33	2.85
2007	9.52	19.02	17.13	15.13	27.10	2.76
2008	1.52	32.33	-0.55	14.00	26.54	2.38
2009	-1.67	-9.78	0.23	32.03	27.06	3.48
2010	17.04	29.11	25.55	18.19	29.02	3.18
Average	6.30	12.90	9.80	14.66	22.58	3.28

Source: China Agricultural Yearbook, author's calculation.

In 2010, China export volumes of vegetables were close to 8500 thousand tonnes, export value was about $7.8 billion, increasing 45.2 percent by the previous year. China export volumes of fruits were more than 5000 thousand tonnes, and export value was $3.4 billion, increasing 14.6 percent by the previous year. The export markets of China vegetables mainly focused on Japan, the Association of Southeast Asian Nations (ASEAN), E.U., the U.S. and Russian. The share of vegetables export value in Asian areas accounted for more than 60 percent. Japan, Korea and Indonesia had the largest market shares for edible vegetables. China main export destinations of fruits were U.S., Vietnam, Russian, Indonesia and Japan, export value had come close to $2 billion in 2010, accounting for 50 percent of total fruits export value.

III. LITERATURE REVIEW AND DESCRIPTION OF RESEARCH SCOPE

Despite growing concerns about the impacts of food safety standards on agricultural products export from developing countries, researches on quantitatively estimate the impacts of food safety standards on vegetables and fruits export have received little attention. Recent studies used the gravity model to estimate the effect of food safety standards on international trade [7], [8]. Wilson examined regulatory data from 11 OECD importing countries and trade data from 19 exporting countries, the results showed that a 10 percent increase in regulatory stringency (Chlorpyrifos) leaded to a decrease in banana import by 14.8 percent [9]. Sun estimated the impacts of Japan's food safety standards on China's agricultural products export. The establishment and application of vegetable pollution-free standards in China did not promote the export to Japan as expectation, because there was a big gap between

Japan's and China's standards [10]. Chen tested the effect of the residue standards of pesticides on China export of vegetables (Chlorpyrifos MRL) and aquatic products (Oxytetracycline MRL). Their findings showed that food safety standards imposed by importing countries had a negative and statistically significant effect on China export of agricultural products [11]. Wei analyzed the maximum residual limit of pesticides and the coverage of tea safety standards concerning regulatory pesticides in major importing countries, and estimated the impacts of MRL standards of pesticides (Endosulfan, Fenvalerate and Flucythrinate) imposed by importing countries on China's tea export. The results showed that China's tea export had been significantly restricted when importing countries increase coverage of tea safety standards concerning regulatory pesticides [3]. Bao analyzed the effect of food safety standards on China's grain export, which indicated that food safety standards imposed by importing countries had the negative effect on China's grain export, and this conclusion did not vary with the income level of importing countries. Another interesting finding showed that China's food safety standards had a negative effect on China's grain export [12].

Various measures imposed by importing countries were recorded at each HS-6 product level (Xiong, 2011). The commodities included in this study were potatoes (070190, 071010), tomatoes (070200), onions (070310, 071220), garlics (070320), carrots (070610), spinaches (070970, 071030), apples (080810, 081330), oranges (080510), pears (080820), grapes (080610, 080620) and peaches (080930). The importing countries in this study focused on Japan (JPN), Korea (KOR), Malaysia (MYS), Indonesia (IDN), Thailand (THA), Philippines (PHL), Vietnam (VNM), the United States of American (USA), Canada (CAN), E.U., Russian (RUS), Australia (AUS), New Zealand (NZL), Singapore (SPG), Mongolia (MNG) and Hong Kong ,China (HKG), which were the main destinations for China export of vegetables and fruits. The E.U. countries in this study included Netherland (NLD), Italy (ITA), Germany (DEU), France (FRA) and United Kingdom (GBR).

The important indexes for food safety standards often used in empirical studies include the MRL standards and coverage of regulated pesticides. The more pesticides that were regulated, the smaller values of MRL standards, the more stringent the standards were. For the selected exporting vegetables and fruits, the U.S. established the maximum pesticide regulations (1206 regulated pesticides); E.U., Japan, and Korea also issued about 1000 regulated pesticides for the selected vegetables and fruits, respectively, far more than the number of regulated pesticides issued by Codex and China (516 and 140). Except for Mongolia, Indonesia was the only importing country that issued less number of regulated pesticides for the selected vegetables and fruits than that of China. Furthermore, the numbers of regulated pesticides for tomatoes, potatoes were far more than the other selected vegetables. Apples and grapes had more regulated pesticides than the other selected fruits (Table II).

TABLE II
THE STATISTICAL DATA OF REGULATED PESTICIDES

	Number of Regulated Pesticides																
	Pot	Tom	Oni	Gar	Car	Spi	App	Ora	Per	Peh	Gra	Total	MAX	MIN	AVE	STD	MID
USA	129	131	90	92	79	82	130	103	121	118	131	1206	6000	0.01	7.91	173.06	0.4
E.U.	113	114	79	79	67	70	112	85	105	100	115	1039	100	0.01	1.76	7.96	0.1
AUS	63	74	35	33	33	30	81	61	73	82	74	639	50	0.01	2.42	5.19	0.5
CAN	67	74	45	22	28	35	80	43	66	62	68	590	100	0.01	2.86	6.91	0.7
HKG	59	67	31	13	27	17	68	55	61	54	64	516	75	0.01	2.62	6.03	0.5
IDN	23	0	11	2	7	0	12	28	13	15	20	131	50	0.01	3.35	6.47	1
JPN	109	112	74	64	63	60	110	88	105	97	111	993	150	0.01	3.10	9.79	0.5
KOR	105	107	75	74	64	65	106	82	101	96	112	987	50	0.01	1.77	4.75	0.5
MYS	61	73	33	13	27	18	69	61	62	54	64	535	75	0.01	2.59	5.95	0.5
NZL	43	72	35	17	21	23	76	55	74	63	72	551	75	0.01	3.78	8.48	1
PHL	59	67	31	13	27	17	68	55	61	54	64	516	75	0.01	2.62	6.03	0.5
RUS	41	39	19	5	11	2	41	9	22	14	43	246	100	0.003	0.96	6.60	0.13
THA	56	68	32	14	27	17	67	55	60	54	67	517	75	0.01	2.59	5.95	0.5
VNM	64	72	33	15	27	17	72	55	67	59	66	547	75	0.01	2.53	5.94	0.5
SGP	33	71	36	20	28	21	75	57	68	60	68	537	75	0.01	3.06	6.22	1
MNG	0	0	0	0	0	0	0	0	0	0	0	0	---	---	---	---	---
COD	59	67	31	13	27	17	68	55	61	54	64	516	75	0.01	2.62	6.03	0.50
CHN	12	12	4	7	5	8	32	24	21	6	9	140	15	0.02	1.88	2.49	1.00

Note: Pot, Tom, Oni, Gar, Car, Spi, App, Ora, Per, Peh, Gra denoted Potatoes, Tomatoes, Onions, Garlics, Carrots, Spinaches, Apples, Oranges, Pears, Peaches and Grapes.

IV. Econometric Model and Data Collection

Gravity equation model were widely used to estimate bilateral trade flows and their determinants such as the attributes of trading countries (e.g., GDP, population, and remoteness) and various trade cost terms (e.g., tariffs, distance, contiguity, colonial ties, and preferential trade agreement), including certain technical measures imposed by the importing countries [1]. The gravity equation originally developed by Tinbergen in 1962, predicts bilateral trade flows based on the economic sizes (often using GDP measurements) and distance between two countries. That is to say larger and closer countries trade more with one another than smaller and more distance countries [13], [14].

In this study, gravity equation was defined in several aspects to realize our objectives. First, we aimed to estimate the impacts of food safety standards on China export of vegetables and fruits, the commodity denoted as k (vegetables and fruits). Second, the exporting country was China. Thus, a trade flow observation in our dataset was China shipping a particular vegetable or fruit commodity k to importing country j, in year t. Finally, we used the MRL standards and some dummy variables of food safety standards in gravity equation to estimate the impacts of food safety standards on export.

The model equation in this study was defined as follow:

$$\begin{aligned} \mathrm{Ln}(V_{jtk}+1) &= \alpha_0 + \alpha_1 \ln(OP_{tk}) \\ &+ \alpha_2 \ln(GDP_{jt}) + \alpha_3 \ln(Dist_j) + \alpha_4 \ln(Tar_{jtk} \\ &+ 1) + \alpha_5 \ln(MRL_{jk}) + \alpha_6 DChina_{jk} + \alpha_7 DYear_t + \varepsilon_{ijt} \end{aligned}$$

Where, V_{jtk} was the export value of commodity k from China to importing country j at year t. $GDP_{jt}$was the gross domestic product of importing country j at year t, this factor captured the purchasing power and the market size of the importing country j, that is the demand-side effect of the commodity. Export value was measured in thousands of US dollars and GDP was measured in billions of US dollars, both were expressed at 2005 constant US$ prices. OP_{tk} was the production capacity of China's commodity k in year t calculated as output of vegetable or fruit, this factor could reveal the supply-side effect of the commodity k, and was recorded in tonnes. The variables of GDP_{jt} and OP_{tk} were lagged by one year to avoid potential endogeneity. $Dist_j$ was the transportation distance between the capital cities of China and trade partner j, Tar_{jtk} was ad valorem tariff rates imposed by importing country j on commodity k in year t. MRL_{jk} was the Maximum Residual Limit standards of pesticides on commodity k imposed by importing country j, $DChina_{jk}$ was a dummy variable equal to one if China's food safety standards on commodity k were stricter than importing country j. Dummy variable $DYear_t$ was introduced into the gravity model to avoid inconsistent problems and measured the export situations in different years.

We constructed a comprehensive dataset on international trade regulations pertaining to the export of vegetables and fruits from China. Because there were zero trade flows and zero tariff rates existing in the trade, we added one to all original export values and tariff rates, so the logarithmic function could be well defined. The export data were from the United Nations Commodity Trade Statistics Database (COMTRADE) and China Agriculture Yearbook, GDP data were from Economic Research Service International Macroeconomic Data Set, United States Department of Agriculture. Vegetables and fruits outputs data were from the Food and Agriculture Organization (FAO) statistical database. The bilateral distance between the capital cities of China and trade partner was from the Institute for Research on the International Economy (CEPII). Tariff rates data were from the Trade Analysis Information System (TRAINS) of the United Nations Conference on Trade and Development (UNCTAD). The MRL standards of regulated pesticides were mainly from the international MRL database of the Food and Drug Administration of the Department of Agriculture of the United States. The MRL standards data of 18 frequently-used pesticides were selected in this study. Some countries didn't establish specific MRL standards for the selected vegetables and fruits. In that case quite a few samples would be dropped out in the calculation, which could lead to biased estimates. No specific MRL standards meant the standards were very relax, therefore we solved this problem by assigning MRL value by 150 ppm to that no specific MRL values in the calculation.

V. Results and Discussion

We estimated the impacts of food safety standards on China's vegetables and fruits export by three aspects. Firstly, we introduced the number of regulated pesticides, denoted as $MRLNO_{jk}$, which included all regulated pesticide for every selected vegetable or fruit, to conduct regression analysis by non fixed effect estimation. The collinearity problems happened in the fixed effect estimations. Secondly, we used the MRL level of 18 selected pesticides, denoted as MRL_{jk}, and dummy variable $DChina_{jk}$ for the comparison standards strictness between China and importing countries, to conduct regression analysis by commodity fixed effect estimation and commodity & year fixed effect estimation. Finally, we used two dummy variables $DStandard_{jk}$ and $DChina_{jk}$ to conduct regression analysis by the two fixed effect estimation. $DStandard_{jk}$ equaled to one if importing country j had MRL standards on commodity k.

A. Regression Results by Vegetables & Fruits Group

Table III showed the econometric results of China export of vegetable & fruit products in 1996-2010. The gravity equation applied to China's vegetables & fruits export performed quite well. The elasticity of production capacity of exporting country as measured by output was consistently positive and relatively elastic for all estimations, which indicated that rising outputs of vegetables & fruits in China would significantly enforce the supply capacity and promote export. The elasticity of market size of the importing country as measured by importing country GDP was significant but inelastic for all estimations. Although higher purchasing power in importing countries would increase the demand for vegetables and fruits, the other exporting countries were also shipped vegetables and fruits into importing countries. Transportation distance and tariff rates showed significantly negative impacts on China's vegetables & fruits export. The sign of coefficients of distance and tariff variables were consistent in the non fixed effect and fixed effect estimation, which showed farther distance or (and) higher importing tariff rates would decrease export from China.

The coefficients of the variables measuring food safety standards had sign as expectation. The coefficient of dummy variable $\mathrm{DStandard}_{jk}$ was negative and significant, which showed food safety standards had a significantly negative effect on vegetables and fruits export. Using column 8 in Table III, the results showed that vegetables & fruits export would decrease by 1.15 times (exp (0.139)) if importing countries had food safety standards, compared to the importing countries that did not have food safety standards. The coefficient of MRL level was positive and inelastic. The coefficient of dummy variable DChina_{jk} was positive and significant, which showed vegetables & fruits export would increase to the importing countries that had less strict food safety standards than China, compared to that had stricter food safety standards than China. The results were robust to different specification of alternatively estimations. Using the result from column 5 in Table III, the export would increase by 1.19 times (exp (0.176) if the vegetables & fruits were export to the importing countries that food safety standards were relax than China. The number of regulated pesticides had a statistically significant and negative effect on vegetables & fruits export. The number of regulated pesticides imposed by importing countries increased one percent would result in an approximate eight-fold decrease (exp (2.047)) in China's vegetables and fruits export.

B. Regression Results by Disaggregating Vegetables Group and Fruits Group

The impacts of food safety standards on vegetables group and fruits group were estimated, respectively. We disaggregated the MRL standards variables and dummy variables for vegetable products and fruit products, respectively. The results were presented in Table IV and Table V. The vegetables export would decrease six-fold (exp (1.848)) if the number of regulated pesticides for vegetables increased one percent, and fruits export would decrease thirteen-fold (exp (2.595)) if the number of regulated pesticides for fruits increased one percent, respectively. Fruits export was sensitive to the number of regulated pesticides than vegetables export. The MRL level had a significant effect on China's vegetables export. The result in column 5 Table IV suggested that vegetables export would increase by 0.05 percent (exp (0.049)-1) if MRL level increased one percent. MRL level appeared to have no significant effect on China's fruits export. As the above results, the coefficient of dummy variable $\mathrm{DStandard}_{jk}$ gave a significantly negative effect both for vegetables and fruits, especially for the vegetables, MRL standards had resulted in a 1.50 times decrease (exp (0.410) in vegetables export to the importing countries that had food safety standards, compared to export to the importing countries that did not have standards. For fruits, MRL standards could lead to a 1.15 times decrease (exp (0.137)). The significant level of the coefficient of dummy variable DChina_{jk} decreased. This could be explained by that the number of samples decreased, which influenced the accuracy of the results to some extent. The impact of DChina_{jk} on vegetables was significant at 10 percent level (column 8, Table IV), the vegetables export would increase by 1.27 times (exp (0.238)) to the importing countries that had less strict standards than China. Although the impact of DChina_{jk} on fruits was not significant, fruits export to the importing countries that had less strict standards would increase by 1.06 times on simple average, compared to the fruits export that faced stricter MRL standards than China.

C. Regression Results by Introducing China's MRL Standards into the Econometric Model

To recognize what extend the China's food safety standards affect vegetables and fruits export, we supposed China implemented the same MRL standards to export commodities as import commodities. We introduced variables of $\mathrm{ChinaMRL}_{k}$ and $\mathrm{ChinaMRLNO}_{k}$, and dummy variable $\mathrm{DStanChina}_{jk}$ to estimate the impacts of China's food safety standards on vegetables and fruits export. Table VI showed the regression results. The coefficients of all variables in Table VI showed consistent sign and significant as Table III. From the aspect of China's food safety standards, the $\mathrm{ChinaMRLNO}_{k}$ coefficient was negative and statistically significant, which showed that the vegetables & fruits export would decrease by 0.89 percent (exp (0.635)-1) if the number of regulated pesticides imposed by China increased one percent. Although China's MRL level did not had resulted in a significant trade flow effect for vegetables & fruits, the export would decrease by 0.02 percent (exp (0.018)-1) if China's MRL standards level decreased one percent. In addition, the export would decrease by 1.09 times (exp (0.089)) compared to the situation that China did not implement MRL standards. In general, China's food safety standards for vegetables & fruits inhibited the export to some extent. This result was consistent with Bao's research on food safety standards restricted China's grain export [12].

TABLE III
REGRESSION RESULTS OF CHINA EXPORT BY VEGETABLES & FRUITS GROUP IN 1996-2010

Variable		Variable	Commodity FE	Commodity &Year FE	Variable	Commodity FE	Commodity &Year FE
C	20.578***	C	-8.066***	26.073***	C	-8.011***	26.131***
	0.580		2.317	0.284		2.316	0.283
OUTPUT	1.097***	OUTPUT	2.200***	---	OUTPUT	2.199***	---
	0.028		0.138	---		0.138	---
GDP	0.139***	GDP	0.133***	0.110***	GDP	0.143***	0.122***
	0.020		0.014	0.014		0.014	0.014
DIST	-2.295***	DIST	-2.052***	-1.873***	DIST	-2.056***	-1.878***
	0.042		0.037	0.036		0.037	0.036
TARIFF	-0.582***	TARIFF	-0.736***	-0.697***	TARIFF	-0.734***	-0.694***
	0.020		0.017	0.017		0.017	0.017
MRLNO	-2.047***	MRL	0.004	0.005	DSTAN	-0.123***	-0.139***
	0.038		0.006	0.006		0.047	0.047
DCHINA	---	DCHINA	0.164*	0.176**	DCHINA	0.132	0.143*
	---		0.089	0.088		0.089	0.088
R-squared	0.450	R-squared	0.381	0.409	R-squared	0.380746	0.408769
Obs.	53085	Obs.	56467	54883	Obs.	56482	54898

Note: *, **, *** indicated statistically significant at 10%, 5% and 1%, respectively. Standard error was under the coefficient of variable. The variable of MRLNO denoted the number of regulated pesticides for vegetables & fruits, which was estimated in non fixed effect model. The dummy variable of DCHINA was dropped out from the non fixed effect estimation because the scope of regulated pesticide was different from that of MRLNO. In the commodity & year FE method, the time dummies were not introduced into the gravity model because there was no historical information on MRL standards. The samples contained 20 countries, 15 years and 11 vegetable and fruit products.

TABLE IV
REGRESSION RESULTS OF CHINA EXPORT BY VEGETABLES GROUP IN 1996-2010

Variable		Variable	Commodity FE	Commodity &Year FE	Variable	Commodity FE	Commodity &Year FE
C	54.353***	C	14.700***	31.037***	C	14.960***	31.392***
	0.857		3.448	0.368		3.448	0.366
OUTPUT	-0.821***	OUTPUT	1.161***	---	OUTPUT	1.161***	---
	0.046		0.201	---		0.201	---
GDP	0.799***	GDP	0.682***	0.664***	GDP	0.687***	0.672***
	0.027		0.018	0.019		0.019	0.019
DIST	-3.024***	DIST	-3.051***	-2.801***	DIST	-3.061***	-2.817***
	0.053		0.047	0.047		0.047	0.047
TARIFF	-0.459***	TARIFF	-0.782***	-0.699***	TARIFF	-0.784***	-0.701***
	0.024		0.021	0.022		0.021	0.022
MRLNO	-1.848***	MRL	0.037***	0.049***	DSTAN	-0.295***	-0.410***
	0.052		0.008	0.008		0.061	0.063
DCHINA	---	DCHINA	0.173	0.231	DCHINA	0.178	0.238*
	---		0.145	0.145		0.145	0.145
R-squared	0.231	R-squared	0.394	0.405	R-squared	0.394	0.405
Obs.	28584	Obs.	30710	29126	Obs.	30710	29126

Note: *, **, *** indicated statistically significant at 10%, 5% and 1%, respectively. Standard error was under the coefficient of variable. The variable of MRLNO denoted the number of regulated pesticides for vegetables, which was estimated in non fixed effect model. The dummy variable of DCHINA was dropped out from the non fixed effect estimation because the scope of regulated pesticide was different from that of MRLNO. In the commodity & year FE method, the time dummies were not introduced into the gravity model because there was no historical information on MRL standards. The samples contained 20 countries, 15 years and 6 vegetable products.

TABLE V
REGRESSION RESULTS OF CHINA EXPORT BY FRUITS GROUP IN 1996-2010

Variable		Variable	Commodity FE	Commodity &Year FE	Variable	Commodity FE	Commodity &Year FE
C	-24.952***	C	-29.432***	20.319***	C	-29.338***	20.341***
	0.836		3.150	0.429		3.147	0.427
OUTPUT	3.977***	OUTPUT	3.137***	---	OUTPUT	3.133***	---
	0.042		0.192	---		0.192	---
GDP	-0.679***	GDP	-0.501***	-0.504***	GDP	-0.489***	-0.491***
	0.026		0.021	0.020		0.021	0.020
DIST	-1.522***	DIST	-0.850***	-0.824***	DIST	-0.851***	-0.8251***
	0.057		0.056	0.020		0.056	0.054
TARIFF	-0.782***	TARIFF	-0.706***	-0.683***	TARIFF	-0.703***	-0.681***
	0.028		0.028	0.027		0.028	0.027
MRLNO	-2.595***	MRL	0.002	0.002	DSTAN	-0.137**	-0.137**
	0.067		0.010	0.010		0.071	0.069
DCHINA	---	DCHINA	0.083	0.078	DCHINA	0.038	0.032
	---		0.113	0.109		0.113	0.109
R-squared	0.406	R-squared	0.414	0.450	R-squared	0.414	0.449
Obs.	24501	Obs.	25757	25757	Obs.	25772	25772

Note: *, **, *** indicated statistically significant at 10%, 5% and 1%, respectively. Standard error was under the coefficient of variable. The variable of MRLNO denoted the number of regulated pesticides for fruits, which was estimated in non fixed effect model. The dummy variable of DCHINA was dropped out from the non fixed effect estimation because the scope of regulated pesticide was different from that of MRLNO. In the commodity & year FE method, the time dummies were not introduced into the gravity model because there was no historical information on MRL standards. The samples contained 20 countries, 15 years and 5 fruit products.

TABLE VI
REGRESSION RESULTS OF CHINA EXPORT BY VEGETABLES & FRUITS GROUP WITH CHINA'S MRL STANDARDS IN 1996-2010

Variable		Variable	Commodity FE	Commodity &Year FE	Variable	Commodity FE	Commodity &Year FE
C	20.466***	C	-8.140***	25.992***	C	-8.016***	26.123***
	0.578		2.318	0.289		2.316	0.283
OUTPUT	1.177***	OUTPUT	2.200***	---	OUTPUT	2.199***	---
	0.028		0.138	---		0.138	---
GDP	0.078***	GDP	0.133***	0.110***	GDP	0.143***	0.121***
	0.020		0.014	0.014		0.014	0.014
DIST	-2.328***	DIST	-2.051***	-1.871***	DIST	-2.055***	-1.876***
	0.042		0.037	0.036		0.037	0.036
TARIFF	-0.628***	TARIFF	-0.736***	-0.697***	TARIFF	-0.734***	-0.694***
	0.020		0.017	0.017		0.017	0.017
MRLNO	-1.779***	MRL	0.001	0.003	DSTAN	-0.112**	-0.126***
	0.040		0.007	0.007		0.049	0.049
CMRLNO	-0.635***	CMRL	0.016	0.018	DSTANC	-0.078	-0.089
	0.034		0.012	0.012		0.080	0.080
DCHINA	---	DCHINA	0.260**	0.280***	DCHINA	0.202*	0.221**
	---		0.113	0.112		0.114	0.113
R-squared	0.197	R-squared	0.381	0.409	R-squared	0.381	0.409
Obs.	53085	Obs.	56467	54883	Obs.	56482	54898

Note: CMRLNO and CMRL denoted the number and MRL level of regulated pesticides for vegetables & fruits implemented by China, and DSTANC was a dummy variable of China's MRL standards. *, **, *** indicated statistically significant at 10%, 5% and 1%, respectively. Standard error was under the coefficient of variable. The variables of MRLNO and CMRLNO were estimated in non fixed effect model because of the collinearity in the fixed effect model. The dummy variable of DCHINA was dropped out from the non fixed effect estimation because the scope of regulated pesticide was different from that of MRLNO and CMRLNO. In the commodity & year FE method, the time dummies were not introduced into the gravity model because there was no historical information on MRL standards. The samples contained 20 countries, 15 years and 11 vegetable and fruit products.

VI. Conclusions

The growth in China export of vegetables and fruits has been impressive over the last two decades. However, agricultural products trade is thought to be one of the main pathways for pest and disease transmission. Thus, the importing countries, especially developed countries issued some kinds of food safety standards to control the risks of pests and diseases spread when commodities enter into the domestic markets of importing counties.

How and to what extend do food safety standards affecting China's vegetables and fruits trade flow? What kinds of SPS measures do importing countries enforce? Surprisingly, there was very little empirical evidence that had attempted to answer these questions. One reason for this was the lack of data pertains to the implementation and application of food safety standards and SPS notifications in international trade. The objectives of this paper were tried to answer these questions. To achieve this objectives, we analyzed and discussed the background of China's vegetables and fruits production and export, estimated the impacts of exporting country's product capacity, importing countries' GDP, trade distance, tariff rates, and MRL standards on 11 vegetable and fruit products export from China in 1996-2010. A detained dataset was constructed for empirical work that match MRL standards application of vegetables and fruits with China export trade flows.

The initial results showed that although transportation distance between trade partners and tariff rates on vegetables and fruits were still the importantly resistant factors for export trade, China export of vegetables and fruits was sensitive to the food safety standards abroad and domestically. Although high income countries were more prone to regulate stricter standards, most countries regulated stricter standards than international standards implemented by Codex. Food safety standards level and strictness, especially the number of regulated pesticides imposed by importing countries can significantly affect China's vegetables and fruits export. On the other hand, China's food safety standards also had a significant effect on China export of vegetables and fruits. Moreover, China's MRL standards might inhibit the export to some extent. This could be explained by that China just regulated 140 pesticides MRL standards for selected vegetable and fruit products now, and only a few standards were stricter than some importing countries. The intend of farmers for export and production of vegetables and fruits might be inhibited if China apply same food safety standards to export products as import products, and finally lead to export decrease.

While this work is still ongoing, the priorities for China export trade might pay more attention to the mutual cooperation and recognition of inspecting procedures. Although it is different to unify the food safety standards in the world, mutual cooperation between trade partners could reduce the risk that export commodities will be rejected by importing countries, and thus reduce transactions costs in international trade. Secondly, although China has already established food safety standards, the number, level, and strictness were not well defined, it still have a large difference in line with international and most importing countries' standards. China should establish systematic food safety standards and inspecting procedures as soon as possible to avoid the abuse of inspecting procedures in China. Thirdly, China should absorb foreign techniques and investments to promote bilateral cooperation, develop high quality agricultural products, e.g. organic agricultural products, to improve food safety and consumer satisfaction, and thus enhance the competitiveness of China's agricultural products in the international market.

References

[1] Xiong, B., Beghin, J. (2011). Disentangling the Demand-Enhancing Effect and Trade-Cost Effect of Technical Measures in Agricultural Trade among OECD Countries. Working Paper No. 11019. Department of Economics, IOWA STATE UNIVERSITY.

[2] Disdier, A., L. Fontagné, M. Mimouni (2008). "The Impact of Regulations on Agricultural Trade: Evidence from the SPS and TBT Agreements." American Journal of Agricultural Economics 90(2): 336-350.

[3] Wei, G., Huang, J., Yang, J. (2012). The impacts of food safety standards on China's tea exports. China Economic Review, 23,253-264.

[4] Calvin, L., B. Krissoff, and W. E. Foster (2008). "Measuring the Costs and Trade Effects of Phytosanitary Protocols: A U.S.–Japanese Apple Example." Review of Agricultural Economics 30 (1): 120-135.

[5] Otsuki,T., Wilson,J., Sewadeh, M. (2001). What price precaution? European harmonization of aflatoxin regulations and African groundnut exports. European Review of Agricultural Economics, 28, 263–284.

[6] Huang, S., Gale, F. (2006). China's rising fruit and vegetable exports challenge U.S. industries. Electronic outlook report from the economic research service FTS-320-01, ERS, USDA.

[7] Otsuki, T., J. Wilson, M. Sewadeh (2001). "Saving Two in a Billion: Quantifying the Trade Effect of European Food Safety Standards on African Exports." Food Policy 26(5): 495-514.

[8] Wilson, J S., Otsuki, T. (2004). To spray or not to spray: Pesticides, banana exports and food safety. Food Policy, 29, 131- 145.

[9] Wilson, J S., Otsuki,Y., Majumdsar,B.(2003). Balancing food safety and risk: Do drug residue limits affect international trade? Journal of International Trade and Development, 12(4), 377- 402.

[10] Sun, D., Zhou, J., Yang, X. (2005). Study on the effect of Japan's technical barriers on China's agricultural exports. Journal of Agricultural Technical Economics, 5, 6–12.

[11] Chen, C., Yang, J., Findlay, C. (2008). Measuring the effect of food safety standards on China's agricultural exports. Review of World Economics, 144, 83–106.

[12] Bao, X. (2011). Do food safety standards promote or restrict China's grain exports? Journal of Finance and Economics. 37, 60-70.

[13] Anderson, J., E. van Wincoop (2003). "Gravity with Gravitas: A Solution to the Border Puzzle." The American Economic Review 93(1): 170-192.

[14] Bergstrand, J. 1985. "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence." The Review of Economics and Statistics 67(3): 474-481.