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國際學碩士學位論文

**The Impact of Food Safety Regulation on Trade:
In the Case of Japan after 2011**
일본산 수입식품 안전성 규제에 따른 무역변화에
대한 연구

2015 年 2月

서울대학교 國際大學院

國際學科 國際通商專攻

韓 妊 希

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A thesis presented

by

Jung Hee Han

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of the requirements for the degree of Master
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韓 姪 希

韓 姪 希 의 碩士學位論文을 認准함

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委員長

文輝昌



副委員長

李永燮



委員

安德根



The Graduate School of International Studies
Seoul National University

THESIS ACCEPTANCE CERTIFICATE

The undersigned, appointed by

The Graduate School of International Studies
Seoul National University

Have examined a thesis entitled

**The Impact of Food Safety Regulation on Trade:
In the Case of Japan after 2011**

Presented by Jung Hee Han

Candidate for the degree of Master of International Studies that is worthy of
acceptance

Signature
Chairman



Moon, Hwyo-Chang

Signature
Vice Chairman



Rhee, Yeoungseop

Signature
Thesis Advisor



Ahn, Dukgeun

The Impact of Food Safety Regulation on Trade: In the Case of Japan after 2011

ABSTRACT

Japan relies heavily on import products including semiconductor, vehicles, computers, and most importantly the daily agricultural products. They also heavily rely on the export commodities for their economic growth and stability.

Among many traded commodities, Japan's food sectors consist of seafood, vegetable, and meat products. Of all the food products being exported, Japan is a leading exporter of seafood products, with the amount totaling up to about 40% of all food exports. However, since the Fukushima accident, the atmosphere in export has been changing.

The impact of Japan's earthquake and tsunami has left serious damage in many parts of Japan. It has made physical damage amounting up to \$195 billion to \$305 billion. 23,000 people went missing or were reported killed. The main side-effect led to Fukushima Dai-ichi nuclear power plant accident. KOTRA reported that the Japan production companies are facing 20 to 50% decrease in manufacturing products, depending on each commodities, due to the Japan's Dai-ichi nuclear plant incident. And there were more than 400,000 damaged buildings. It has been three years and eight months since the incident of the Japan's earthquake and Fukushima Dai-ichi nuclear power plants accident, however, the worrisome eyes towards the

food supplies being produced in Japan is growing bigger as the time pass. This is mainly because there are continuous reports stating that the leakage from nuclear power plant has not stopped and is still on going.

Japan has been showing trend of decrease in the trade volume of agricultural and seafood products since the 2011 Fukushima power plant accident. The Japanese government are aware of the possible danger in their food products. They have announced that fishery activities should not resume in the area of Fukushima prefecture. Naturally, many countries, including Canada, China, European Union, Korea, and United States has raised their surveillance levels on the imported food from Japan.

Japan has been requesting their trading partners to remove any discriminating policies and unreasonable increase in surveillance level of their food imports. It is true that in the previous studies it has been proven that the policies on food safety level of one country does impact the amount of trade volume of agricultural and seafood products. However, is the phenomenon of export volume decrease in Japan also due to the policy imposed on the Japanese food imports from neighboring countries? If it is, is it significant enough to blame the decrease in export volume on the regulations of the other countries?

The policies imposed on Japanese imported goods vary from one country to another, some having stricter restrictions as opposed to others not having any sort

of barriers. This study will find to see if the strictness of the policy imposed due to the Fukushima power plant accidents has significant impact on the change in export volume of Japanese agricultural and seafood commodities.

Key words: *Japan Fukushima Dai-ichi nuclear power plant, Japan FTA, agricultural sectors, seafood commodities, gravity model.*

Student ID: 2012-23835

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LIST OF ABBREVIATIONS

CBP	U.S. Customs and Border Protection
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
GMO	Genetically modified organism
KOTRA	Korea Trade-Investment Promotion Agency
TEPCO	Tokyo Electric Power Company
UNESCO	United Nations Educational, Scientific and Cultural Organization
WTO	World Trade Organization

I. Introduction

Japan relies heavily on import products including semiconductor, vehicles, computers, and most importantly the daily agricultural products. They also heavily rely on the export commodities for their economic growth and stability.

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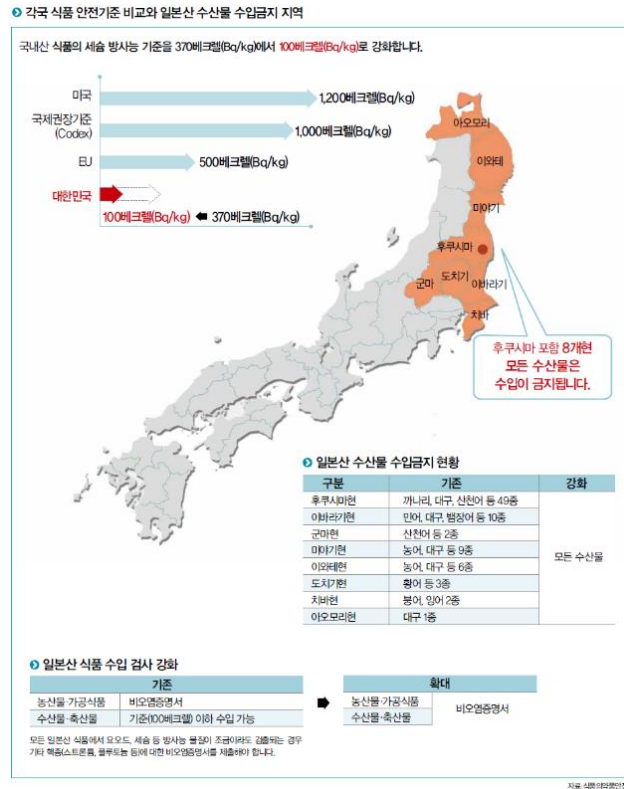
The policies imposed on Japanese imported goods vary from one country to another, some having stricter restrictions as opposed to others not having any sort of barriers. This study will find to see if the strictness of the policy imposed due to the Fukushima power plant accidents has significant impact on the change in export

volume of Japanese agricultural and seafood commodities.

1) Background in Japan's Dai-ichi nuclear plant incident

Though Fukushima Dai-ichi nuclear plant accident did have an impact on the exports of the edible products in Japan, it has only impacted close to Fukushima. Many countries, including Korea, United States and European Union, have banned the importation from the parts of the region close to the nuclear power plant, these regions ranging from four to twelve prefectures. In the case of Korea, with the growing concerns of the general public, they have banned the importation of fishery products from eight regions near Fukushima in the year 2013, as colored below in the figure 1.

Figure 1. Eight regions banned from imports in Korea



Source: Ministry of Food and Drug Safety

The impact of Japan’s earthquake and tsunami in March 11, 2011 has made physical damage amounting up to \$195 billion to \$305 billion. 23,000 people went missing or was reported dead. And there were more than 400,000 damaged buildings. It has been three years and eight months since the incident of the Japan’s earthquake and Fukushima Dai-ichi nuclear power plants accident, however, the worrisome eyes towards the food supplies being imported from Japan is growing bigger as the time

pass. This is mainly because there are continuous reports stating that the leakage from nuclear power plant has not stopped and is still on going. In February 2014, Tokyo Electric Power Company (TEPCO) reported that “one of the 1,000 makeshift tanks used to hold radioactive water at its Fukushima nuclear plant had leaked more than 100 tons of highly contaminated water over the previous day”¹. This shows that the nuclear waste is still flowing into the ocean threatening the food safety in Japan.

Japan’s food commodities consist of seafood, vegetable, meat products and Japan is a leading exporter of seafood products, with exports totaling up to about 40% of all food exports. However, since the Fukushima accident, the atmosphere in export has been changing. The Japanese government has announce that fishery activities should not resume in the area of Fukushima prefecture. Naturally, many countries, including EU and Korea has increased their surveillance on the imported food from Japan.

Japan is continuously providing documents regarding their radioactivity test-levels in the food. According to their tests, the food from the prefectures near Fukushima are at edible level under Codex regulations, however, many governments are generally unsatisfied and skeptical with the accuracy and the amount of information being provided by Japanese government.

¹ Morrow, Will. February 2014. *Japan: New radioactive water leak at Fukushima*. International Committee of the Fourth International.

2) Japan's Export Food Safety

The increase in Japanese food products' safety has caused some limitation in Japan's trade. Many countries have set the level of Becquerel limits restrictions at higher level for Japanese food products than Codex regulations on the Becquerel limits. Japan themselves have raised their restriction levels to 100Bq/kg on the food Japanese citizens may consume, which only increased the doubts of the trading partners of Japanese products.

In the case of Korea, among the imported food supplies from Japan in the year, there has been around 326,000 reports of "unsafe" food products. This number of unacceptable imported food supplies, accounts for 5.2% of the food supply imported from Japan. As shown in the table 1, Japan is fourth largest country to show unacceptable food product percentage, followed by that of China, U.S, and Vietnam.

Table 1. Unsafe Imported Food Supplies

(Units: %)

Country	Unacceptable Percentage
China	26.5
USA	14.0
Vietnam	10.3
Japan	5.2
Italy	2.9
Thailand	3.2
Germany	2.1
France	2.2
England	2.1
Philippines	2.3
Others	29.2

Source: Korea Customs Statistics Website

Japan was originally seventh country in the list of unacceptable food safety, around 2-3%) in 2011 and original sixth largest in 2012. The unsafe percentage of food has increased in 2013 compared to previous years.

3) Objective

As seen from the previous introduction, Japanese food market has been impacted by nuclear power plant accident. Following the accident, export of food in Japanese trade has decreased. The main objective of this study is to find out if the regulations implemented by other countries regarding radioactivity has impacted the export of Japanese food products. In the study, we will examine the regulations of Canada, China, EU, Korea and US. Through this study, we will find if indeed the Dai-ichi nuclear incident has impacted the trade volume and discuss how to overcome the current stagnation of Japanese food export industry.

II. Regulations

Following the accident, due to the fear of radiation, many countries temporarily blocked large amount of food being imported from Japan. However after the request to lift unjustified barriers by Japan at WTO meeting, the unreasonable barriers, such as blocking any food products without scientific proof from Japan, has been lifted by many countries. However, many different forms of regulations still stay put in countries such as Canada, China, European Union, Korea, and United States. In the following section, the study will review how the Japanese government controls their exports and also review the regulations between Japan and the listed countries.

1) Japan's governmental intervention

There are legal restraints issued by the Japanese government to assure the foreign government on Japanese food safety. After the 2011 Dai-ichi nuclear plant accident, Japan has been performing their own tests on the food from the region near the accident to show that their products are at edible level. After testing for radioactivity, Japan publicly reports the data and shows their continuous actions towards keeping their food at a safe level. They make sure that each region is being monitored at all times.

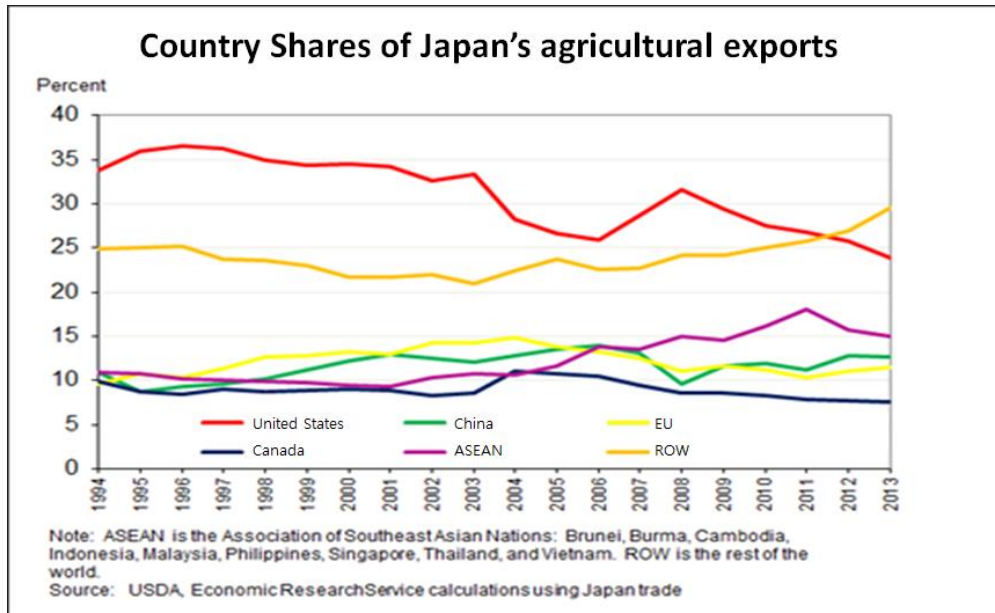
Japan also actively seeks to make sure that other countries are aware of their food safety. Matsumoto, the Minister of Foreign Affairs himself, continuously tries hard, at political level, to keep other countries informed of the Japanese food safety by producing explanation at different talking tables. Also, Japan officially requested, through WTO, that the other WTO member countries do not show any unreasonable discrimination against Japanese food products without any scientific evidence under SPS Agreement². At the WTO meeting, Japan has agreed to report the current nuclear plant situation and Japan's actions towards it extensively.

2) Regulations between Japan and other countries

The countries chosen to compare the changes in Japanese exports due to the strict policies regarding Japanese agricultural and seafood imports are as follows: Korea, China, United States, Canada and European Union. These countries were chosen because of their large shares in Japanese imports, as shown in the chart. Also, they individually implemented strict regulations regarding the import of Japanese food products after 2011.

² In Article 2.2 of SPS Agreement, it states: *Members shall ensure that any sanitary or phytosanitary measure is applied only to the extent necessary to protect human, animal or plant life or health, is based on scientific principles and is not maintained without sufficient scientific evidence, except as provided for in paragraph 7 of Article 5.*

Figure 2. Country Shares of Japan’s Agricultural Exports



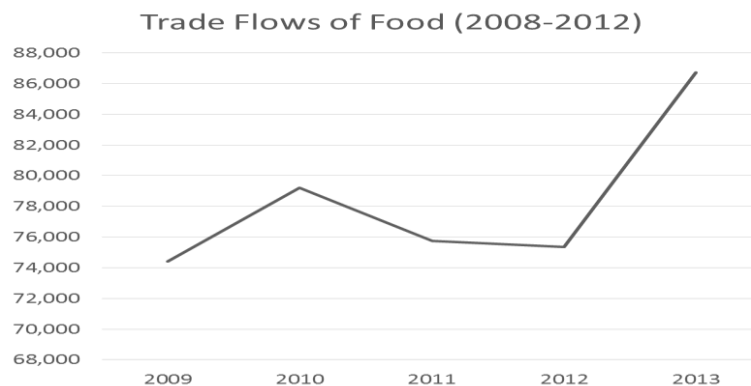
2.1 Canada and Japan

Canada also has its own regulations implemented after the 2011 Fukushima Dai-ichi Power Plant accident. In Canada, the CFIA (Canadian Food Inspection Agency) controls and monitors the quality of food products which are being imported from other countries. In the case of Japan, CFIA has raised the barrier on import controls for the food being imported from Japan. No food or animal feed products can be imported into Canada from the affected areas of Japan, unless proper documentation showing the acceptable test results with consumable levels of

radioactive substance in the food product is provided. Even with the acceptable documentations, CFIA has their own system in which they randomly test the samples of the food being imported at the coast of British Columbia to strengthen their securities.

Despite the Dai-ichi nuclear power plant accident and Canada's regulations on import, the food import of Canada from Japan has shown slight to no decrease in 2012 and significant increase in 2013.

Figure 6. Export Trade Volume of Canada (2008-2013)



Source: The World Bank

2.2 China and Japan

China is the third largest food importing country of Japan. Their large amount of import is only natural due to the size of China and the two countries' proximity. Right after the nuclear accident, the fear of radiation has led to panic in

Chinese people leading them to purchase large quantity of storable Japanese food products to shelve it in their homes.³

Following the Dai-ichi nuclear power plant accident, China had few limitations regarding imports from Japan. However, with the report published in late 2011 by the Japanese government stating Japan's decision to discharge water contaminated by radiation, amounting of 11.5 million liters, into the Pacific Ocean, China's officials have increased the limitation on imports from Japan. This led to China stopping importation of all food products from 12 prefectures near the Fukushima region. In the mid-2014, China lifted the blockage of food importation from two of the prefectures still leaving the restriction of importation of all food products from 10 prefectures.

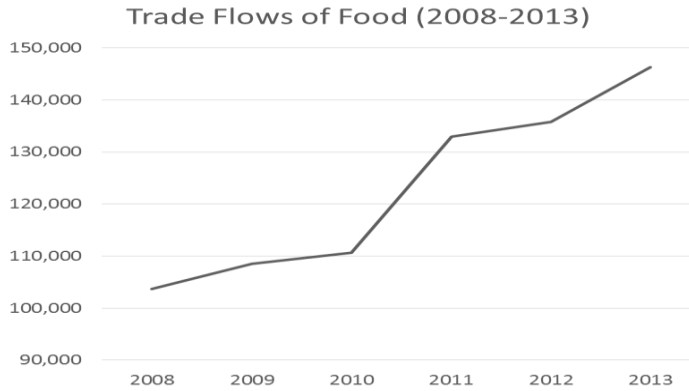
Hong Kong on the other hand has its own regulations, differing from that of China. Hong Kong has blocked food imports from five of the Japanese prefectures, which includes Fukushima, Ibaraki, Tochigi, Gunma and Chiba prefectures. However, with the proper documentation showing that the food has been certified as safe is exempted from the restriction and can be imported into Hong Kong.

However, despite the Dai-ichi nuclear power plant accident and the strict regulations imposed on importation of Japanese food products, the food import of

³ Brian Spegele, April 2011, *China Expands Import Ban*, The Wall Street Journal.

China from Japan has increased.

Figure 4. Export Trade Volume of China (2008-2013)



Source: The World Bank

2.3 European Union and Japan

European Union has carefully monitored the imported food products from 12 prefectures of Japan since the accident and the 12 prefectures include the four prefectures which were most seriously affected by the accident. Especially in the case of European Union, they have stricter monitoring system in which rather than relying on the documentations provided by Japan, the policy is to test all food products from the 12 prefecture of Japan before being exported to EU. And with the arrival in EU, the products are subjected to random testing. For the remaining 35 prefecture products, the food supplies are randomly tested at the arrival in EU to ensure the safety level of food products.

The following table 4 is a new regulation implemented starting in April 2014 and will remain in force until end of March 2015.

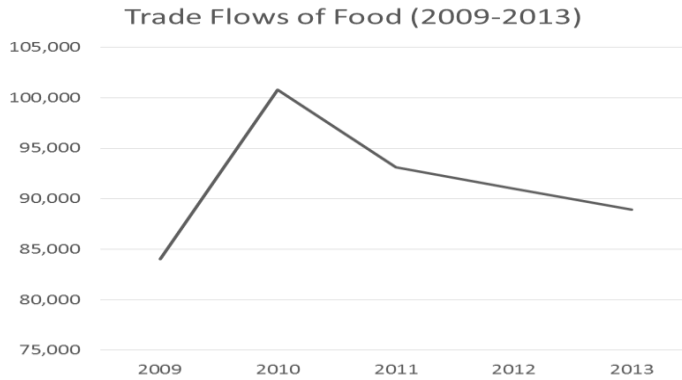
Table 4. Regulations implemented by EU starting April 2014

Prefecture	Product or compound product with >50% of ingredient of concern
Fukushima	All products
Akita, Yamagata, Nagano	Mushrooms, koshiabura, bamboo shoot, aralia sprout and bracken
Yamanashi, Shizuoka, Niigata, Aomori	Mushrooms & processed products
Gunma, Ibaraki, Tochigi, Miyagi, Saitama, Chiba, Iwate	Annex IV listed products

Source: Suffolk Coastal Port Health Authority

Since the Dai-ichi nuclear power plant accident and regulation implementation of the European Union, the food import of European Union from Japan has decreased.

Figure 7. Export Trade Volume of European Union (2008-2013)



Source: The World Bank

2.4 Korea and Japan

Korea is the nearest and therefore the country which is most highly affected by the incident. Among many countries Korea imports food supplies from, Japan is the third largest importing country, from which Korea imports 9.96% of its food⁴, followed by China and US. Japan being the third largest trading partner of Korea had a big impact on the Korean trading system as well. Due to its proximity and political friendship, Korea and Japan has continued the import and export from each other. Table 2 below shows, though not drastic, trend of decrease in export starting in

⁴ Ministry of Food and Drug Safety, *2014 Food & Drug Statistical Yearbook*, p54. The first three countries Korea imports the most from are China, US, and Japan. Korea imports 32.06% of the food supplies from China, 17.17% from US, and 9.96% from Japan.

March of 2011. Though this may be coincidental effect, the Table 3 which show yearly growth rate, shows that Korean import from Japan has been increasing until 2011 and showed continuous decrease starting from 2012.

Table 2. Monthly Import from Japan to Korea

(Units: USD1,000/%)

Month	2011(Jan-Dec)	
	Amount	Growth Rate
01	5,190,063	
02	10,420,109	14.4
03	16,711,264	12.4
04	22,538,380	10.1
05	28,098,570	10.9
06	34,237,983	10.7
07	40,105,707	9.5
08	46,166,929	9.7
09	51,744,583	9.0
10	57,086,801	7.9
11	62,446,518	7.0
12	68,320,170	6.3

Source: Korea Customs Statistics Website

Table 3. Yearly Import from Japan to Korea

(Units: USD1,000/%)

Year	Amount(Import)	Growth Rate
2014	40,333,901	-11.1
2013	60,029,355	-6.7
2012	64,363,080	-5.8
2011	68,320,170	6.3
2010	64,296,117	30.1
2009	49,427,515	-18.9
2008	60,956,391	8.4
2007	56,250,126	8.3

Source: Korea Customs Statistics Website

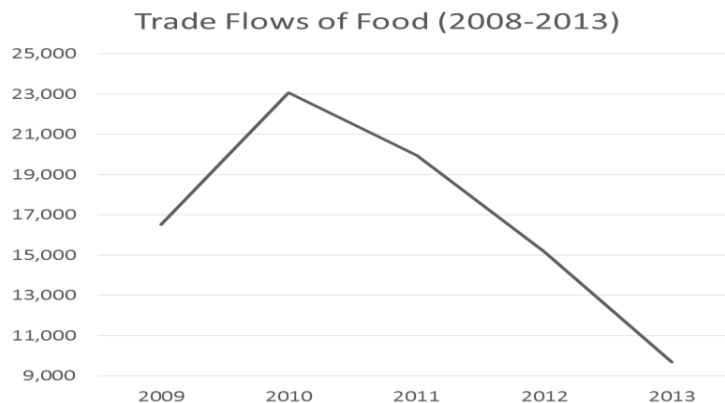
This trend was more significantly shown in the food import category. Korea is the fifth largest food supply importing country in the world. Among the food Korean's consume, more than 50% of the products are imported products, which are used at homes, restaurants, food producing factories, and so forth. Along with the increased food supply import, degree of food self-sufficiency has been decreasing on yearly bases from 57% in 2009 to 45.3% on 2012⁵, which puts Korea 26th on the

⁵ Statistics Korea Website

degree of food self-sufficiency among 30 OECD countries. This also suggest that on daily bases, each Korean rely on imported food supplies on more than two of the meals, out of three.⁶ In order to make up for the remaining 55% of the food supply that Korea cannot cultivate themselves, Korea has to turn to imported products. This, the amount being greater than that Korea can produce on its own, shows how heavily Korea relies on food supplies from foreign countries.

As discussed previously Korea relies heavily on imported food supplies. The chart shown below shows how much Korea has been importing from Japan. As it can be seen, between the years of 2010 and 2013, Korea has dramatically decreased the amount of importation of food supplies from japan.

Figure 3. Export Trade Volume of Korea (2008-2013)



Source: Korea Customs Statistics Website

⁶ In comparison, the food security level of few OECD countries are as follows: First-France(329%), Fourth-Germany(147.8%), 9th-USA(125%), 17th-Italy(77.6%)

This can be explained by the new implementation of regulations Korea imposed on Japanese agricultural and seafood products. Many Korean consumers showed concerns regarding the safety of the Japanese food products, even though Korean government reported that the food that is being imported are tested and at a consumable level. Korea, finding Japanese government's resources unreliable put restrictions on importation of Japanese seafood from 8 regions near Fukushima power plant. In Korea, the decrease of imports were most clearly seen in the fishery, vegetable, and meat markets.

2.5 United States of America and Japan

U.S. imports the most agricultural goods from Japan among any other countries. In the case of USA, the FDA, using various sources from different foreign government, closely monitors the information and data on the Japanese imported agricultural products. These programs includes:

- the Japanese government's food sample testing program
- the import sample testing programs of nations geographically close to Japan that import significant amounts of food from Japan
- Fukushima Dai-ichi incident related activities of international organizations

such as the International Atomic Energy Agency (IAEA)⁷

Along with the foreign government data, U.S. also monitors the imported Japanese food products by using their own testing results and continuous surveillance system. Through these efforts, it is ensured that any imported products which contains level of radiation higher than the FDA-regulated levels, and therefore is considered harmful, to be kept out of the U.S. food market.

U.S. not only has regulations regarding foods, but also on any other products entering their continents through air or boat. The U.S. Customs and Border Protection (CBP) monitors the situation in Japan continuously with caution. These measures includes:

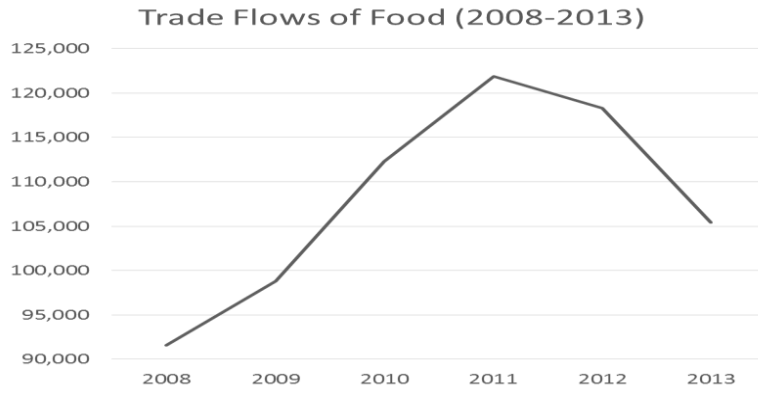
- CBP and the U.S. Food and Drug Administration carefully screen all food products for unsafe substances, including radiological material, at Ports of Entry.
- All inbound travelers, baggage, and cargo are screened for radiological materials.
- CBP employs radiation monitors at international mail facilities.⁸

Since the Dai-ichi nuclear power plant accident and after the new policy was implemented, the food import of United States from Japan has decreased.

⁷ U.S. Food and Drug Administration. *FDA Response to the Fukushima Dai-ichi Nuclear Plant Facility Incident.*

⁸ USA.gov, Japan 2011 Earthquake/Tsunami – U.S. Government Information.

Figure 5. Export Trade Volume of United States (2008-2013)



Source: The World Bank

III. Literature Review

There has been many studies performed regarding the food safety on imported goods as well as studies on the people's reaction towards the food products. There are two major ways in which the study was conducted.

1) Gravity Model

There are studies done by John S. Wilson and Tsunehiro Otsuki(2003), Laurian J. Unnevehr(2000), which involved calculating the impact of pesticides' regulation levels in each country and the volume change of the exporting country by using gravity model. In both studies, it shows that the international standards on food safety and individual countries' standards on food safety can have changes in the export volume. The stricter the standards on food safety of the importing country, it is less likely for the exporting country to be able to make trade with the importing country. In the study of J. S. Wilson(2003), it states, "we estimated that world exports would rise by \$38.8 billion if an international standard (Codex) were adopted, compared to the current divergent national standards in place."⁹ This alone shows how much impact the national standards impact the trade volume.

⁹ John S. Wilson. Tsunehiro Otsuki, 2003, *Food Safety and Trade: Winners and Losers in a Non-Harmonized World*, The World Bank, Journal of Economic Integration 266-287

In the Laurian J. Unnevehr(2000), she concludes by stating that “future growth in exports...will take place within a changing context for quality control in DCs.”¹⁰ This also shows that the quality control levels are strong decision making variable regarding the amount of export that is made between countries.

2) Customers’ Survey on Food Safety

The first studies reviewed are studies done by Choe Jeongsook(2004), Yu Young chul(2004), Oh Kyung Nam(2005) Min-Sun Chang(2009), Je Mo Koh(2011), In Sub Kim(2007), Hyun Jung Yu(2012). Their studies are based on survey of consumers seeing the behavior of consumer patterns towards the food that are either genetically modified organism (GMO) or contaminated with pesticides or radioactivity. In the study done by Choe, Jeongsook(2004), 57.8% of the people felt repelled by GMO products. In the study of Choe, Jeongsook. Kwon, Sung Ok. Park, Young Hee. Chun, Hye Kyung(2006), 53.4% of the customers were deeply concerned with food safety in the procedure of production and showed high attention to each products when purchasing them. In these studies, the researcher uses contingent valuation method in order to see the customers’ willingness to buy or their

¹⁰ Laurian J. Unnevehr, 2000, *Food safety issues and fresh food product exports from LDCs*, *Agricultural Economics* 23. 231-240

fear for the contaminated or unsafe food products.

Most of case studies regarding food safety are done from the developed countries to show the impact of food safety and imports from the least developed countries. However, recently there are many studies being done on Japanese food safety. Min Jung Jung(2013), Mu Ho Song(2012), Young Geun Kim(2013), Zhongyu He, Guofang Zhai, Takeshi Suzuki(2014), and Dick K. Nanto, William H. Cooper, J. Michael Donnelly, Renee Johnson(2011) which shows the consumer behavior changes made after the 2011 earthquake and the trade trend shift and how to manage the current trade risk Japan is facing as an exporting country or what danger other countries are facing as an importing country of Japanese food products.

IV. Analysis on the Impact of Regulations on Export of Agricultural and Seafood Supplies in Japan

Seeing from the previous studies, it shows that the impact of contaminated products and regulations lead the consumers to reject the consumption of those food products. This study will find to see if the regulations imposed on Japanese food products following the Dai-ichi nuclear power plant accident had similar effect on Japanese trade market.

This study will see the pattern changes in the Japanese food products since the earthquake and Daiichi nuclear accident in March of 2011. Throughout the study, there are extensive research regarding previous studies done on food safety and trade and analysis on statistical data provided by the government and other public agencies.

According to Japanese government reports, the Becquerel(Bq)¹¹ and cesium(Cs)¹² levels in their food products are consumable and exportable under Codex restriction level. Many countries still oblige by the Codex rules and continues import from Japan without restrictions. The following table 5 shows the implementation of restriction levels in each of those countries.

Table 5. Restriction Levels on Imported Food

¹¹ “Becquerel is the SI derived unit of radioactivity. One Bq is defined as the activity of a quantity of radioactive material in which one nucleus decays per second. The greater the amount the higher the radioactive.”

¹² “Cesium is an alkali metal and has physical and chemical properties similar to those of rubidium and potassium. Cesium is mined mostly from pollucite, while the radioisotopes, especially cesium -137, a fission product, are extracted from waste produced by nuclear reactors.”

(Units: Bq/kg)

Importing Country	Restriction
Global Standards (Codex)	1,000
US	1,200
EU	750
Japan	100
Korea	370
Canada	300
Germany	8

Source: FAO

In the study we will see if the countries that has implemented their own regulations have affected the mount of export trade flow in Japan. The main countries which have implemented their own restriction levels are Canada, China, European Union member countries, Korea, and United States. The following chart shows the implementation of restriction levels in each of those countries.

1) Gravity Model

In the research, this study will be using gravity model. According to previous studies, the restrictions posed on Japanese food products should be the significant

cause of the decrease in food products, if everything else holds steady. Using gravity model, this study will see if the restriction has indeed made the trade volume to decrease, posing a threat and challenge to the trade of food industry in Japan.

$$\text{Ln}V_{ij} = \beta_0 + \beta_1\text{LnGDPPC}_j + \beta_2\text{Ln}P_j - \beta_3\text{Ln}D_{ij} + \beta_4\text{Ln}D_{\text{Restriction Level}} + \beta_5\text{Ln}D_{\text{FTA}} + \epsilon_{ij}$$

2) Empirical Model and Data Collection

In the formula above, V , the outcome of the equation, represents the value of export from country i , Japan, to country j . This data was selected from the UN COMTRADE database. The GDPPC of country i and j are obtained from the World Bank, World Development Index, which represents the GDP per capita in the current US dollars. It has previously been studied that GDPPC presents more accurate representation since it is more likely that the country with higher GDP per capita has higher standards for importing any sorts of edible products. Naturally, we expect the export to increase with GDPPC.

The P_j represents the population of the importing country. Population is important since the greater the population, it is less likely for the country to have high self-sufficiency level, relying more on the importation of food products. D_{ij} is the distance between country i and country j . The greater the difference between the two country, it is less likely for the importing country to be importing from the other

country. This is especially significant with food products due to its perishable nature. Therefore, we expect the export volume to decrease with D_{ij} .

The restriction level of each country is not depended on the actual level it has set on the amount of increase, rather it is set to be a dummy variable where the most important difference is between rather the country has its own new policy or it does not have any restrictions. And the restrictions are divided into three different dummy variables. It is 0 for the countries that does not have any regulations, 1 for the countries with regulations which only allows imports of products that has proper documentations, and lastly 2 for the countries with regulations which blocks imports from prefectures near the Fukushima Dai-ichi nuclear power plant. It was set to use a dummy variable because the main focus of this study is to see the difference between the country which has imposed its own standards and those who does not rather than the absolute value of the restriction level itself. The Codex standards and individual countries' standards were found in FAO website. We expect that the trade volume will decrease with the countries with stricter regulations.

The last variable is the dummy variable for the countries that has made a Free Trade Agreement with Japan. This is also a valid variable because the country that has made an FTA with Japan, due to easier access and lower cost, will have greater amount of trade between the two countries. Therefore, the export will increase with the FTA.

Table 6. Summary of Hypothesized Gravity Model

Factors	Sign	Explanation
GDPPC (β_1)	+	Larger GDPPC indicates higher standards for imported goods
P _j (β_2)	+	Larger population indicated greater need for food sources, therefore increase in imports
D _{ij} (β_3)	-	Greater the distance, the less likely for the trade between the countries
D _{Restriction Level} (β_4)	-	Stricter the restriction policies, the less likely for the trade between the countries to take place
D _{FTA} (β_5)	+	With the FTA, it is easier for the trade to occur, leading in increase of trade volume

The countries chosen to see the impact of the newly implemented regulations on the trade volume of Japan are Korea, China, USA, Canada, and European Union countries. As shown in the chart below, the previously listed countries takes up significant shares in importing the goods of Japan. Also these countries are the countries who were one of the first to take action and implementing regulations on the importation of Japanese agricultural and seafood products.

3) Empirical Results

The test was ran separately for the year of 2012 and 2013 for the years the regulations on Japanese agriculture and seafood has been established for many countries.

Table 7. Regression Results for the year 2012 and 2013

Factors	2012	2013
LN_GDPPCj	1.282 (1.797**)	1.246 (1.568*)
LN_Population	0.782 (2.964***)	0.754 (2.923***)
LN_Distance	-1.8317 (-3.343***)	-1.698 (-3.22***)
Restriction Levels	-1.145 (-1.124)	-0.957 (-0.644)
FTA	0.959 (0.795)	1.334 (1.099)
Adjusted R-squared	0.807	0.815
Number of Observations	15	15

Note: t-values are in parenthesis. *** denotes significance at 1% level, ** denotes significance at 5% level, * denotes significance at 10% level

The r-squared showed high correlation between the expected and actual export amounts, having 0.807 correlation in the year 2012 and 0.815 correlation in 2013. This is close to 1, which is a perfect fit, therefore the gravity model equation sought from the data set can be considered reliable.

Figure 8. Residual Plot of year 2012

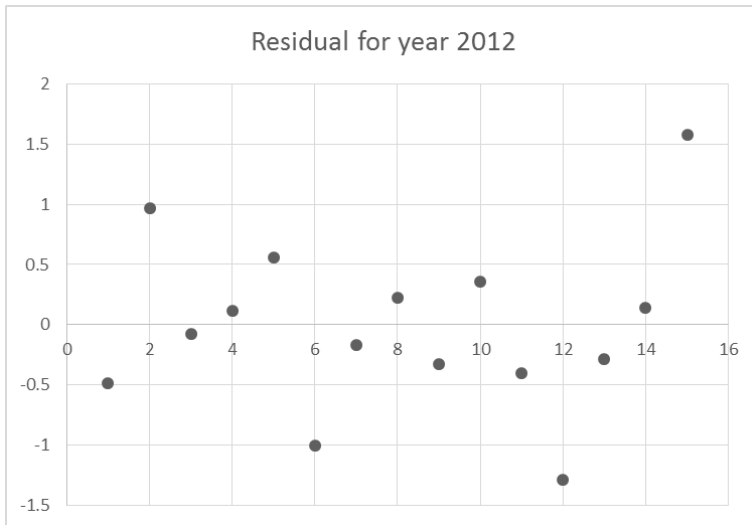
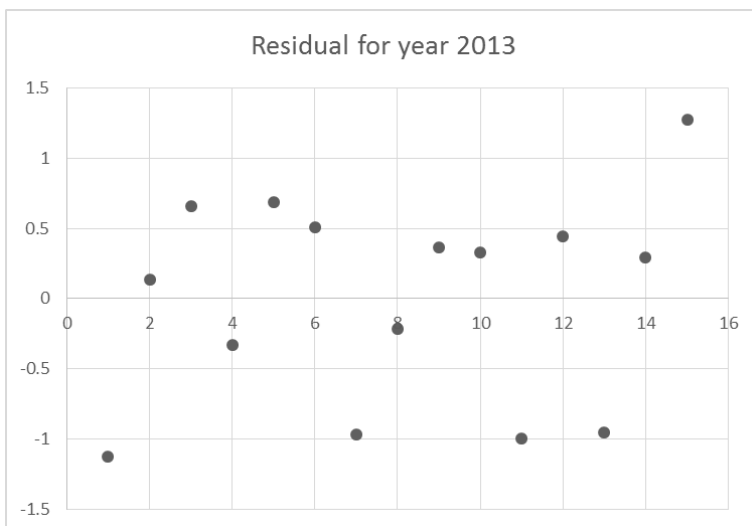


Figure 9. Residual Plot of 2013



The reliability of the two graphs can also be shown by two residual graph, Figure 8 and Figure 9. It is clear that the residual graph of both the year 2012 and 2013 does not show any patterns. The randomness of the residual graph indicates

that the difference value between the expected value and the observed value are unpredictable, therefore we can validate the model achieved from the data set.

As stated in the previous hypothesis, the export volume has increased 1.282% for every 1% of GDPPC change in 2012 and increased 1.246 for every 1% change of GDPPC in 2013. Population also contributed to increase in export volume of 0.782% for every 1% change in persons in 2012 and 0.754% per 1% change in population in 2013. As had been expected, the amount of export decreased 1.8317% and 1.698% for every 1% change in distance between the two countries in the year 2012 and 2013 respectively.

The correlation between the two dummy variables also came out as hypothesized. In the case of strictness of policy and export volume, for the countries with the stricter policy were more likely to decrease the amount of export. In the case of FTA, the countries holding FTA with Japan was more likely to contribute into increase in export volume.

However, as we can see from table 7, of the five factors which contributed to the gravity model equation, only the GDDPC, population, and distance shows significance at 1%, 5%, and 10% levels. Through this, we can see that the strictness of policy restriction levels and FTA is rejected indicating that there is no significant relationship between restriction levels and export volume changes. However, when studying the patterns of import volume changes (refer to figures 3~7), countries holding FTA with Japan seems to have less changes in volume and pattern of trade

with Japanese food products even after the 2011 Fukushima Dai-ichi nuclear power plant crisis.

V. Conclusion and Recommendations

The policies imposed on Japanese imported goods vary from one country to another, some having stricter restrictions as opposed to others not having any sort of barriers. As it has been shown through the gravity model, the regulations are not the trade barrier causing decrease in exports of agricultural and seafood products. In the case of FTA, the countries holding FTA with Japan was more likely to contribute into increase in export volume. Rather, it seems that the slow reaction and ambiguity regarding the Fukushima Dai-ichi nuclear power plant accident has turned individual consumers from Japanese food products, lowering the demand in food supply.

Japan can learn from Chernobyl accident, though the seriousness of the actual leakage in Chernobyl is much higher than that of Dai-ichi, by studying the actions taken by the Russian government. The Russian government paid high price in assuring the other countries that Russia is safe from Chernobyl disaster. They closed down the area completely from any civilians and sent millions of town people to other regions of the country. They also sent workforces and provided financial aid to prevent any further leakage from the power plant. Through the hard work and fast response of the government, most of the damages that were created in Chernobyl were sealed and buried. Though it would need to be reburied every 40 years, this secured the nuclear power plant from any further leakage of radioactivity waste. This action, if taken by Japan, gives the neighboring countries sense of security regarding

the agricultural and other food products being cultivated in Japan, possibly leading the trade partners to lift the regulations they are currently imposing on Japanese food commodities.

Japan has recently started to regain attention as a trading partner of food products. This is due to the UNESCO enlisted Washoku, enlisted December 2013, which is Japanese traditional cuisine for the New Year's celebrations. Through this opportunity, many foreigners became interested in the Japanese cuisine and the government is taking this opportunity as an advantage to globally expand and share Japanese cuisines. With proper advertisement and sponsor of the Japanese government, this regain of people's interest in Japanese cuisine can become a turning point for Japan's food market export, which has been showing decreasing trend since the Fukushima Daiichi nuclear plant accident.

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국문초록

일본의 식품 수출은 일본 전체 수출에서 매우 큰 비중을 두고 있다. 그러나 2011년 후쿠시마 원전 사고 이후 매해 그 비중이 줄고 있는 추세이다. 약 4년이 지난 지금도 일본 원전 오염수 유출 보도가 이어진다. 많은 국가들은 일본 후쿠시마 원전 사고 후 일본 농수산물의 안전성을 우려하여 수입금지 규제를 내렸다. 현 일본 정부는 식품, 동식물 위생검역(SPS)위원회를 통해 한국 외 다수의 나라들의 수입금지 규제를 관련하여 우려를 거듭 표명하고 있다.

본 논문은 현재 미국, 유럽 연합국, 중국, 캐나다와 한국 대 일본 농수산물 관련 규제를 각각 자세히 분석하였다. 또한 중력모델(gravity model)을 이용한 분석을 통하여 이러한 일본산 농수산물 안전성 규제가 일본 농수산물 수출에 위험을 초래하는지 살펴보았다.

키워드: 후쿠시마 원전, 일본 FTA, 농업 부문, 수산업 부문, 중력모델

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