Radiological Protection
NEA/CRPPH/R(2015)1
September 2015
www.oecd-nea.org

An Evidence-based Approach to Post-accident Food Safety Policy and Insights for Protection Optimisation

OECD
BETTER POLICIES FOR BETTER LIVES

NEA
NUCLEAR ENERGY AGENCY

Radiological Protection

An Evidence-based Approach to Post-accident Food Safety: Policy and Insights for Protection Optimisation

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Foreword

In early 2012, following closely on the heels of the 2011 Fukushima Daiichi nuclear accident, the Committee on Radiation Protection and Public Health (CRPPH) of the OECD Nuclear Energy Agency (NEA) began exploring many important questions related to radiological criteria for commodities and food in post-nuclear accident circumstances. Realising that the subject area had been little as yet examined, the CRPPH tasked the Expert Group on the Radiological Protection Aspects of the Fukushima accident (EGRPF) to examine the issue, and at the second annual meeting of the EGRPF in June 2012 the participating members established a sub-group on Trade in Commodities and Food. The sub-group's initial purpose was to develop a framework paper which could subsequently be passed to the International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization (FAO) as input to their development of new safety standards on trade in post-accident contaminated food. By the end of 2013, the EGRPF sub-group had developed preliminary recommendations for the development of trade criteria for food, consumer products and commodities following a nuclear or radiological emergency. In quick succession, at the end of 2014, the NEA Secretariat, working in co-ordination, subsequently published its Framework for the Post-accident Management of Contaminated Food to further clarify the reasoning behind these recommendations with the input of international trade and food safety experts. As the work related to the framework unfolded, additional interest emerged within the NEA Secretariat to more systematically enumerate and quantifiably analyse the costs and benefits of strategies used to protect individuals from radiation exposure. Over the course of several months at the end of 2014, with the input and close collaboration of the OECD Trade and Agriculture Directorate (TAD), the NEA Secretariat developed and carried out the following evidence-based study of international trade and food safety, which it hopes will serve as a solid basis for a mutual exchange and identification of least-cost solutions for future accidents.

Table of Contents

List of tables and figures

Tables

Figures

List of abbreviations and acronyms

CAA	Japanese Consumer Affairs Association
COMTRADE	United Nations Commodity Trade Statistics Database
CRPPH	Committee for Radiation Protection and Public Health
CRS	Congressional Research Service (United States)
EGRPF	Expert Group on the Radiological Protection Aspects of the Fukushima Accident
FAO	Food and Agriculture Organization (United Nations)
GDP	Gross domestic product
HR	Harmonized codes
HS	The Harmonized Commodity Description and Coding System
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
MEXT	Japanese Ministry of Education, Culture, Sports, Science and Technology
MHLW	Japanese Ministry of Health, Labour and Welfare
MRL	Maximum residue level
NAFTA	North American Free Trade Agreement
NISA	Nuclear and Industrial Safety Agency of Japan
NTMs	Non-tariff measures
OECD	Organisation for Economic Co-operation and Development
NEA	Nuclear Energy Agency
QALYs	Quality adjusted life years
SPS Agreement	Agreement on the application of sanitary and phytosanitary measures
TBT	Technical barriers to trade
UNCTAD	United Nations Conference on Trade and Development
USDA	United States Department of Agriculture
WTO	World Trade Organisation

Public and policy overview

The NEA suggested in its *Framework for the Post-accident Management of Contaminated Food* that the framework for managing food from affected areas should be built around protecting those most at risk, i.e. those people living in contaminated areas. In particular, the same radiological criteria to allow the consumption of food in affected areas should be used for the marketing of food from affected areas to the rest of the accident-site country and for export of all foods from the accident country. It was also noted that radiological criteria should evolve as the circumstances on the ground concerning food production and monitoring from affected areas also evolve.

This report gives the results of a study to explore the effect that such a framework has on trade volumes of food from an accident country. Specifically, this work looked at the effects governmental approaches to monitoring food and to fixing domestic and export acceptability criteria had on the volume of exports. While no definitive conclusions can be made, this report demonstrates first that following the 2011 Fukushima accident, the volume of certain food products imported by other countries from Japan appear to have dropped, and the goods that were most evidently affected were those goods that are typically associated with Japan and which are traded in the greatest volume. Clear and well-publicised governmental management of food exports, through extensive monitoring and evolving radiological criteria were expected to have contributed to trade volumes rebounding after significant reductions immediately following the accident. However results were very mixed. The volumes of Japanese goods imported by other countries do not appear to have been restored as a direct result of the Japanese government's monitoring or evolving radiological criteria.

Further data and study are needed to explore how food risks are communicated to consumers in international markets following nuclear or radiological emergencies, and to explore how Japanese governmental policies affected domestic consumption patterns.

Executive summary

To date, the international economic effects associated with post-accident radiological protection strategies and regulation for the management of contaminated foods have not been extensively studied, but there is a clear need to provide such information to decision makers. The food security policy priorities that emerged following the Fukushima Daiichi nuclear accident of 2011, which included the adoption of domestic regulatory criteria for radioactivity in food products and the Sanitary and Phytosanitary (SPS) trade related measures at borders around the world, worked together to remove food judged to be unacceptably contaminated from markets and, to some degree, to communicate the overall risk to consumers. Food security policies seek to achieve fundamental social objectives by eliminating or drastically diminishing health risks to consumers, while addressing what is known in economics as "market imperfections." In the aftermath of the Fukushima accident, and as it relates more broadly to radiological protection strategies, the most pertinent of these market imperfections was asymmetric information in traded goods, wherein the attributes of certain food products and the related health risks were generally *uncertain* to consumers.

By quantifying the economic effects of the two policy priorities used to secure the safety of food following the accident in Japan, this report seeks to broadly outline some of the significant aspects of cost-benefit analyses used as input to the optimisation of policies. By identifying the options that contribute to maximising net benefits, this report hopes to contribute to the optimisation of future radiological protection strategies in post-accident situations. Identifying optimal radiological protection strategies, in terms of food safety policy, involves isolating, as best possible, the economic and trade effects of governmental food-safety policies by both exporting and importing countries.

To meet these ends, this report examines the volume in monthly Japanese exports between the years 2004-2014 for agriculture and fisheries goods to determine any changes across the year of the accident and beyond. This report does not investigate domestic demand or domestic consumer confidence in Japan, but future studies may need to do so. The initial hypothesis was that the asymmetry in food risk information and understanding would generally affect all Japanese food exports in a negative way and that the change in radiological criteria levels would send forceful messages to consumers and restore any lost export volumes. In the end, the SPS trade measures could not be examined directly.

The results collectively reveal less overwhelmingly demonstrative changes across time, in some ways undercutting this hypothesis. No definitive conclusions are made in this report, but the analysis of monthly export volumes, however, when narrowed across individual commodities, suggests the importance of the concepts of "export volume" and "market association" when examining the potential consequences of a nuclear or radiological accident.

As expected, the Japanese exports in several specific commodities, for example arrowroot to Singapore and Chinese Taipei and pacific salmon to China, dropped off precipitously in 2011 to never recover, most likely as a result of the earthquake and nuclear accident of TEPCO's Fukushima Daiichi nuclear power plant (NPP). In several instances export volumes showed similar drops but then new life following the Japanese government's decision to revise its

radiological criteria for traded foods, as was true for apple exports to Hong Kong and scallops exports to Singapore. All the while, in other cases, no structural change in exports was detected or a structural change in the export pattern was identified at points in time other than those predicted.

Export volumes were expected to drop following the Great East Japan Earthquake and Fukushima nuclear accident but to show signs of recovery after the change in radiological criteria levels. The hypothesis seemed to fit best with the export destination pair countries that historically imported very large volumes of that good from Japan. In the case of Japanese apple exports for example, countries like Indonesia, Russia, and Singapore witnessed no significant trend changes in its imports, but the historic volume of Japanese apples imported by these countries pales in comparison to the levels historically witnessed for other regional partners like China, Hong Kong, Chinese Taipei, and Thailand, who did show structural breaks in the volumes they imported. Most interestingly, those export destination countries whose import patterns seem most aligned with the expected trend are all regional partners and the trend is strongest for those goods that are very traditionally associated as being a sort of Japanese “specialty”. While no overwhelmingly determinative lines can be drawn, it is indeed curious to note. Consumers that paid the most attention to radiological food safety after the accident, after the Japanese consumers themselves, were likely consumers in neighbouring countries and the products that would be of most concern to them were likely products that were well-known to be Japanese.

As it relates to the effect that the change in radiological limits played in communicating risk to consumers, very little evidence was found. It is logical that an *information effect* provided by radiological criteria limits, which would attach “credence values” to food products, is likely more muted for those commodities that are overwhelmingly seen as originating from an accident country. Much more analysis is needed, and it is also probable that consumers are not being passed any clear risk information since radiological criteria are not listed explicitly on exported goods.

Section I: Introduction

The Great East Japan Earthquake that struck the northeast pacific coastal region of Japan in March 2011 was one of the largest natural disasters in recent memory. The aftermath of the earthquake for Japan and the greater world economy was greatly magnified due to the nuclear accident at the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant. In the months that followed, food safety quickly became a matter of concern for the domestic population while questions pertaining to radioactive substances in food for human consumption circled among national administrations and international organisations worldwide. To secure the safety of food, the regulatory criteria for radioactivity and, more broadly, the related policies determining the supply of safe agriculture and fishery products sold domestically and as exported food became intertwined priorities.

In regard to the first of these priorities, at the domestic level, in response to the nuclear accident, the Japanese Ministry of Health, Labour and Welfare (MHLW) rapidly set provisional regulatory criteria for radioactivity in food products under the Food Sanitation Act. These values, which were guided by international food standards set by the Codex Alimentarius Commission, an arm of the Food and Agriculture Organisation of the United Nations (FAO), and the views of the International Commission on Radiological Protection (ICRP),[1] were used to ensure that no food products, or a substantial volume of food products, circulated in domestic or international markets that could expose consumers to a radiation dose that would exceed 1 mSv per year. After a year of more detailed assessments, and further consultations of the MHLW with the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Consumer Affairs Association (CAA), these provisional regulatory criteria were revised, lowered, and re-entered officially into force on April 1, 2012 (Table 1). The Japanese food safety measures were enhanced and, by consequence, constituted measures stricter than those suggested by the international community.

Table 1: Japanese radiological criteria

Provisional radiological criteria for radioactive caesium (March 17, 2011)

Category	Regulation Value (Bq/kg)
Drinking Water	200
Milk, dairy products	
Vegetables	500
Grains	
Meat, eggs, fist, etc.	

Values entered into force (April 1, 2012)

Category	Regulation Value (Bq/kg)
Drinking Water	10
Milk	50
General Foods	100
Infant Food	50

1. Consumer Affairs Agency, Government of Japan (2013), "Food and Radiation Q & A", 2 September 2013, Web: 30 January 2015. www.caa.go.jp/jisin/pdf/130902_food_qa_en.pdf, p. 15.

With regard to the second of these food security priorities, at the international level a host of countries, both near and far to Japan, diligently erected a number of heightened food inspection trade related procedures and food safety documentation requirements at their borders, also called non-tariff measures (NTMs). The majority of these measures conformed to the legal framework outlined by the Agreement on the Application of Sanitary and Phytosanitary Measures at the World Trade Organisation (WTO) (see Annex C). The Agreement on the Application of Sanitary and Phytosanitary Measures (henceforth referred to as "the SPS Agreement"), which explicitly references the Codex Alimentarius Commission ("Codex") for standards related to food safety,[2] permits any domestic decree, regulation, requirement, or procedure implemented by policy makers in order to protect human or animal life or health from risks posed by additives, contaminants, toxins, or disease-carrying organisms in food that may enter a country from beyond its borders. In the short history since the founding of the WTO, fundamental disagreements have emerged over these measures and their related economic costs, reflecting differences in attitudes and broader domestic political pressures.

The various governments involved introduced these intertwined policies – in a largely unco-ordinated way – in order to achieve fundamental social objectives related to the protection of human, animal and plant health and even to a large extent the environment within their domestic borders. On one level, from a health science perspective, these policy measures are used to drastically diminish the possibility for any significant "internal exposure", or "exposure through the intake into the body of air, water, food, etc. that contain radioactive materials."[3] The challenges to reducing this possibility are considerable given the dynamics of international trade and of the domestic distribution processes of food. Preliminary estimates made days after the accident by the Nuclear and Industrial Safety Agency of Japan (NISA) indicated that "160 PBq of ^{131}I, 18 PBq of ^{134}Cs and 15 PBq of ^{137}Cs were spewed into the atmosphere between 11 and 16 March 2011."[4] A nuclear accident has the potential to affect those living in the territories where an accident occurs, the unaffected territories in the accident country(ies), and those living in other countries importing food or water from the affected country(ies). The OECD Nuclear Energy Agency (NEA), in its *Framework for the Post-accident Management of Contaminated Food* proposes that national regulatory criteria for radioactive material be formulated to protect the most exposed group in any future emergency exposure situation. The logic being that it would be socially and operationally difficult to use different criteria for those living in the unaffected territories in an accident country(ies) and those living in other countries importing food or water from the affected country(ies). Using a single set of radiological criteria, based on protection of those most exposed, would assure that those outside of the affected territory would receive a much less significant dose rate exposure as a result.

More generally, on another level, security regulations and policy measures in the food and agriculture sectors, as has been addressed by the OECD before, seek to achieve social objectives by addressing what is known in economics as "market imperfections". Market imperfections, without corrective government action, are forces in unregulated markets that can result in "undesired" or "inefficient outcomes."[5] In the aftermath of the Fukushima Daiichi nuclear

2. Büthe, Tim (2008), "The Globalization of Health and Safety Standards: Delegation of Regulatory Authority in the SPS Agreement of the 1994, Agreement Establishing the World Trade Organisation", Law and Contemporary Problems 71.1, the Law and Politics of International Delegation: 219-55, Print, p. 225.

3. Consumer Affairs Agency, Government of Japan (2013), "Food and Radiation Q & A." 2 September 2013, Web: 30 January 2015, www.caa.go.jp/jisin/pdf/130902_food_qa_en.pdf, p. 11.

4. Hamada, N., H. Ogino, and Y. Fujimichi (2012), "Safety Regulations of Food and Water Implemented in the First Year following the Fukushima Nuclear Accident", *Journal of Radiation Research* 53.5: 641-71, Web: p. 641.

5. van Tongeren, F., J. Beghin and S. Marette (2009), "A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade", *OECD Food, Agriculture and Fisheries Working Papers*, No. 21, Paris, p. 3.

accident, and as it relates more broadly to radiological protection strategies, the most pertinent of these market imperfections is asymmetric information in internationally traded goods. By definition, asymmetric information is a dynamic by which a "consumer derives a benefit from consuming [a] good but also bears a cost or benefit not exactly known to him via a health impact."[6] In the months following the accident, the Japanese government and international organisations such as the International Atomic Energy Agency (IAEA) and the NEA, came to realise that a large asymmetry existed between not only the information that consumers had concerning the food that they consume but also their knowledge of the risk involved.

For individuals, "ingestion of radioactively contaminated food and water is the most significant route of radionuclide intake, leading to internal radiation exposure."[7] The threat to human health is sometimes significant. At the same time, after the Fukushima accident, consumers faced the task of filtering out the explosion of misinformation and rumour in broadcast and social media related to radiological risk. Pacific Bluefin tuna caught off the shores of California, for example, while revealing detectable traces of radioactive material from the Fukushima nuclear disaster, posed no significant health threat to consumers in the United States, particularly when compared to the levels of mercury evaluated in the same aquatic species.[8] Yet, consumers still raised risk questions. The policy priorities outlined previously, in addition to their function to reduce the possibilities for internal exposure, are often intended to bridge and reduce this asymmetry in consumer understanding.

The dynamics of asymmetric information can become costly in the instance of a food safety issue because such market imperfections can result in raised production costs for individual producers, tarnished reputations for brands or countries, or closed off international markets for exporting countries.[9] The consequences of the information contributing to consumer perceptions can affect firms, entire industries or individual commodity groups, or the volume of exports of an entire country. At any moment in time, when a consumer makes a food purchase "[s]ome attributes, either experience or credence attributes, are unknown or uncertain to the consumer [...] and may decrease (as in the case of unhealthy ingredients) or increase (as in the case of nutritional benefits) the value of the good."[10] This represents the backbone of an "inefficient outcome" in the presence of asymmetric information in an unregulated market and it can clearly influence consumer behaviour. The attributes of a certain food product are generally *unknown* to the consumer before any relevant food safety incident has been identified, while the attributes are generally *uncertain* to the consumer after any food safety incident has been identified. Regardless of whether the attributes of certain food products are unclear or not before the safety threat has been established, there are often consequences in reputation once the threat has been found.

To understand more fully the differences between what is *unknown* and *uncertain*, consider first the reputational impact of contaminated imports on trade flows in the case of US imported

6. Ibid. p. 3.

7. Hamada, N., H. Ogino, and Y. Fujimichi (2012), "Safety Regulations of Food and Water Implemented in the First Year following the Fukushima Nuclear Accident", *Journal of Radiation Research* 53.5: 641-71, Web: p. 642.

8. Madigan, D. J., Z. Baumann, and N. S. Fisher (2012), "Pacific Bluefin Tuna Transport Fukushima-derived Radionuclides from Japan to California", *Proceedings of the National Academy of Sciences*, 109.24: 9483-486.

9. Buzby, Jean (2003), "International Trade and Food Safety: Economic Theory and Case Studies" *Agricultural Economic report No. AER-828*, United States Department of Agriculture, Economic Research Division, Washington DC, p.1.

10. van Tongeren, F., J. Beghin and S. Marette (2009), "A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade", OECD *Food, Agriculture and Fisheries Working Papers*, No. 21, Paris, p. 8.

Guatemalan raspberries associated with Cyclospora, an infection transmitted by faeces-contaminated fresh produce and water. An outbreak of Cyclospora in the US in 1996 was initially, and falsely, attributed to California strawberries. The implication alone shattered the reputation of California strawberries, according to the California Strawberry Commission, costing growers in the central coast of California USD 16 million in lost revenue.[11] The attributes of the food causing this particular outbreak were *unknown* in the sense that consumers, and later regulators, were initially unaware of the risk and later could not identify the source. The outbreak of Cyclospora was later attributed to Guatemalan raspberries, and over the course of several outbreaks that followed, "the Guatemalan raspberry industry shrank from eighty five producers to three."[12]

The source of the contaminated raspberries was, in fact, one producer, but the broad effect of the outbreak devastated Guatemala's exports. Other similar examples include a case of US imports of Mexican strawberries associated with Hepatitis A (of which it is still uncertain whether contamination occurred in Mexico or after passage into the United States), and US imports of cantaloupe from Mexico laced with Salmonella. What is most important to note is that the contamination in these cases occurred at the grower or shipper level and the individual countries involved, as a whole, faced a costly reputational backlash.[13] Undoubtedly, as the NEA *Framework for the Post-accident Management of Contaminated Food* makes clear, a large foodborne illness or food safety incident linked to traded goods of a specific commodity emerging from an *identified* country could result in a precipitous decline in the global demand for that commodity itself over concerns for safety. Likewise, even if a large foodborne illness or food safety incident becomes linked to one specific region or, further, to a few select farms or producers within a country, demand for one singular country's entire exports can suffer.

Parallels between these food safety incidents of the last decade and the radiologically contaminated food situation following the 2011 Fukushima accident can be drawn, but several crucial distinctions deserve a closer look. Most importantly, the attributes of the food products emerging from Japan were not similarly *unknown* to the consumer, as is more generally the case, because the severity of the nuclear accident was not lost on international headlines. The Japanese government and the international community mobilised without delay, and any above normal detection of radioactivity in food would likely have been linked immediately to Japan as the source. As an example, in 2011 the French government had "to dispose of a shipment of green tea from the Shizuoka Prefecture after detecting radioactive caesium above the European Union limit at Charles de Gaulle airport."[14] By contrast, the attributes of food products from Japan could more accurately be characterised as *uncertain* to consumers, both in Japan and abroad, given the complexities of emergency and existing exposure situations. Upon closer examination it becomes evident why.

Foods in various categories were indeed contaminated in 2011 above the Japanese provisional radiological criteria in various areas, as was detected and addressed by the Japanese government. Seventeen prefectures were assigned for radiation monitoring surveys in the months immediately following. The initial priority target food categories were leafy vegetables and milk, but aquatic products and other major food items consumed by the Japanese citizens (including rice, tea, milk, potatoes, vegetables, fruit mushrooms pork, poultry, beef and edible algae) were rapidly given priority as well. By the end of March 2012, nearly one year later, the

11. Buzby, Jean (2003), "International Trade and Food Safety: Economic Theory and Case Studies" *Agricultural Economic Report No. (AER-828)*, United States Department of Agriculture, Economic Research Division, Washington DC, p. 80.

12. Ibid. p. 6.

13. Ibid. p. 76.

14. Kyodo, "French Find Cesium in Shizuoka Tea" *Japan Times RSS*, 18 June 2011, Web: 2 February 2015, www.japantimes.co.jp/news/2011/06/19/national/french-find-cesium-in-shizuoka-tea/.

MHLW had reported monitoring data of 137 337 food samples and 83 074 tap water samples of which 1 519 food samples (11%) and 68 tap water samples (0.08%) exceeded provisional radiological criteria.[15] The data revealed that the percentage of foods above the radiological criteria was relatively small.

The Japanese government has worked determinedly to ensure that food exported from Japan is within nationally established protection standards and to engage actively on public safety.[16] All the same, food safety in the aftermath of the accident remains a matter of concern, and consumers are often uncertain. After the provisional regulation monitoring values were revised downward in April 2012, a large number of testing requirements, and sampling techniques, were put in place with the established values. This high level of testing continues unabated today. These tests are performed prior to any domestic or international shipment, and foods that exceed the established regulation levels are restricted from entering agriculture markets. In addition, foods that are eventually distributed to domestic and international markets are also monitored by the Japanese government. Some food had certainly been contaminated, but provided the strong operational and scientific evidence from monitoring efforts, it is not a stretch to suggest that foods consumed in and exported from Japan can be expected to be well below the Codex

Alimentarius Commission's recommendations and below the lower Japanese recommended radiological criteria based on the protection of those living in the affected areas.

Focus and goals of report

Taken together, given what is known about the dynamics of asymmetric information in international trade, it is logical to question what repercussions there were to all traded Japanese agricultural goods, regardless of their origins at the prefecture level, in world markets. The volume of exports was undoubtedly affected by the shocks of the earthquake and nuclear accident that damaged crucial infrastructure at harbours and ports supporting the fishing industry and that rendered crop land unusable. The public reaction and reputational consequences of the nuclear accident were quickly visible and later substantiated in a 2013 survey of 5 000 Japanese individuals produced by the CAA. Although the majority of foods containing radioactive materials proved to be well below the regulatory criteria, 50.9% of responders selected a choice which read; "Even if it is safe below the limit, I would like to have food with as low a content of radioactive materials as possible."[17] From a scientific perspective the radiation risks were low and well documented. The regulatory criteria for radioactive materials that entered into force in April 2012, which were well below those recommended by the Codex Alimentarius Commission, should have forcefully indicated just that.

What is clear from the trade literature is that market imperfections like asymmetric information, which obscure the risk information posed by certain foods while opening up room for persistent reputational consequences, can be addressed by various food security policies. Food security policies simultaneously determine both the supply of safe agriculture and fishery products all the while communicating the existing risk to consumers. Sanitary and Phytosanitary (SPS) measures, which are specifically targeted NTMs, in addition to barring entry

15. Hamada, N., H. Ogino, and Y. Fujimichi (2012), "Safety Regulations of Food and Water Implemented in the First Year following the Fukushima Nuclear Accident", *Journal of Radiation Research* 53.5: 641-71, Web: p. 648.
16. Nuclear Energy Agency (2014), *Framework for the Post-accident Management of Contaminated Food*, OECD, Paris, p. 17.
17. Consumer Affairs Agency, Government of Japan, "Food and Radiation Q & A", Government of Japan. September 2 2013. Web: 30 January 2015, www.caa.go.jp/jisin/pdf/130902_food_qa_en.pdf>. p. 43.

of certain foods have an *information effect* that address asymmetric information by attaching "credence attributes" to food products to ensure "that buyers know what they buy and that it is safe either for human health or the environment."[18] Credence attributes are most often attached to food in the form of labels on the food's packaging. The regulatory criteria for radioactive materials have the potential to function with a similar dynamic. The credence attributes of the policies outlined at the start would reduce the cost of acquiring risk information for imported goods, indicate to consumers that a food product has been inspected for radiation risk by the Japanese government before being put on the internal or export market, or their own domestic authorities upon importation, and that the health risk is very low.

As the OECD has highlighted, in the presence of food risks, well-designed trade related measures that operate in these ways, including those that enhanced border inspection and restricted imports from Japan in 2011, often allow for trade, "while in the absence of measures, […] no trade might take place at all."[19] This is in line with the logic presented in the in the NEA *Framework for the Post-accident Management of Contaminated Food*, which outlined why countries could possibly resort to indiscriminate and complete bans of foods emerging from any future affected country as a sort of last available resource when information is still surfacing.[20] When importing countries are still in the process of gathering information during food safety scares, policy makers often feel great pressure "to impose stringent border inspections at their own expense in order to protect the health and lives of their citizens."[21] At work are two opposing forces, the costs imposed by additional regulations and the benefits to greater information, and the overall effect of these measures "depends upon whether the trade-fostering elements outweigh the trade-hindering elements."[22]

To date the economic and trade related effects associated with radiation protection strategies and regulation monitoring have not been extensively studied, but the need to do so is clear. It is conceivable that the policy priorities outlined at the start that emerged immediately following the Fukushima Daiichi nuclear accident, which included the domestic regulatory criteria for radioactivity in food products and the SPS measures at various borders around the world, together worked to remove risky food from markets, to restrict trade in food goods that posed health risks, and to communicate the overall risk to consumers living in Japan and around the world, thereby reducing informational asymmetries in a way that related studies have previously suggested. By quantifying the economic effects of the two policy priorities used to secure the safety of food following the accident in Japan, it may be possible to broadly outline some cost-benefit analyses to determine the policies that will optimise future radiological protection strategies in post-accident scenarios, in the sense of which option maximises net benefits, and thus improve the nuclear or radiological emergency preparedness worldwide. Identifying optimal radiological protection strategies, in terms of food safety policy, involves the process of isolating trade-offs between costly economic effects, here specifically in terms of foregone trade in food determined to be safe for consumption, and positive welfare effects due to increased radiological protection and safety.

18. van Tongeren, F., J. Beghin and S. Marette (2009), "A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade", *OECD Food, Agriculture and Fisheries Working Papers*, No. 21, OECD, Paris, p. 12.
19. Ibid. p. 13.
20. Nuclear Energy Agency (2014), *Framework for the Post-accident Management of Contaminated Food*, OECD, Paris. p. 38.
21. Ching-Fu Lin (2012), "SPS-Plus and Bilateral Treaty Network: A 'Global' Solution to the Global Food-Safety Problem," Conference on International Health and Trade: Globalization and Related Health Issues, held by the Asian Center for WTO & International Health Law and Policy in August 2011 in Chinese Taipei, p. 709.
22. Clougherty, Joseph A. and Michał Grajek. (2009) "ISO 9000: New Form of Protectionism or Common Language in International Trade?" *European School of Management and Technology*, *Working Paper No. 09-006*, p. 13.

Understanding the intricate overlap between the radiological science, consumer responses to various food safety issues, and food safety policies is of critical importance if effective food safety policy and risk communication strategies are to be developed and implemented in the future. With this in mind, this report sets out to address the following:

To quantitatively investigate both the effects of non-tariff trade measures NTMs/SPS measures erected at import borders and the Japanese change in radiological criteria for radionuclides in food used following the Fukushima accident. The particular emphasis is on whether these measures have an information effect and if they serve in any noticeable capacity to address asymmetric information. These measures may need to be revisited if a significant and sustained drop in the export volume was witnessed following the Fukushima accident, which would partially indicate a strong negative variable factor of asymmetric information.

To more systematically enumerate the costs and benefits of strategies used to protect individuals from radiation exposure, using an evidence-based approach that would yield a solid basis for a mutual exchange and identification of least-cost solutions for future accidents. The purpose here being not to diminish or marginalise any recommended food safety measures, or to evaluate those taken by the Japanese government, but rather to examine if the measures taken in fact served in efficient ways to communicate the existing level of risk to consumers. Is there evidence to suggest a strong motive for countries facing an emergency exposure situation in the future to attempt to use accident-specific regulatory criteria?

To examine and better isolate the effects of the Great East Japan Earthquake and subsequent nuclear accident on Japanese exports. For clarity again, this report does not investigate domestic demand or consumer confidence within Japan. Were trade flows restored once regulatory criteria for radionuclides in food were lowered, when emergency NTMs/SPS measures were put in place, and in some cases later removed? (Note that quantitatively evaluating the NTMs/SPS measures is limited, while the analysis of the radiological criteria for radionuclides is more robust).

Only two accidents have escalated to a level requiring national and international attention, co-operation, and intervention to prevent radiation exposure to large groups of people. Today, safety prevention measures are continuously scrutinised and updated while contingency plans for accidents are re-examined and modified. To that extent, the most recent accident in Japan presented new challenges that warrant revisiting previous thinking.

Section II: Background to methodology and approach

The demand for and heightened scrutiny of food security measures has grown considerably in the last decade at least partially by the concurrent development of rising incomes in emerging markets and the ever increasing amount of services, investment, people, information, and goods crossing national boundaries. As a result, this report finds a foundation in an extensive body of previous research that has attempted to weigh the balance of costs in enhanced food security measures, typically measured in whether regulations serve as trade-fostering or trade-hindering elements, and at what level the measures are successful in providing the intended protection. A great majority of these studies find their analytical starting point in two distinct places, which will be taken up in succession below. This report takes its cue from many of these same analytical methods and choice of variable inputs but also charts its own course given the specific priority of augmenting radiological protection strategies for the future.

First, many previous studies estimate the impact of non-tariff measures (NTMs), and specifically the sub-category of Sanitary and Phytosanitary (SPS) measures focused to bar entry of additives, contaminants, toxins, or disease-carrying organisms, on trade flows. In these instances, research often attempts to construct what trade patterns "would have existed in the absence of the measure in question."[23] Achterbosch, et al. (2009), for example, present on-going research on regulations related to maximum residue levels (MRLs) for pesticides and the impact that European Union regulations have on fresh fruit from Chile. Wei et al. (2012) similarly suspect that "an increase in 2007 [of] regulated pesticides may partially account for the decline in China's tea exports in 2009" to the European Union.[24] MRLs constitute policy measures similar to radiological criteria for radioactive materials, but their frequency of use and scope is considerably greater. Clougherty et al. (2009) empirically investigate the impact of the ISO 9000, a set of international standards related actually to general quality management standards and not to food safety, on bilateral trade flows from 1995-2005 for 91 nations. Most important for the outlines of this report however, and the continued discussion of asymmetric information, Clougherty et al. demonstrate how the domestic implementation of these standards can increase the competitiveness of a home-nation's products in world markets by signalling quality and safety to importers. According to the research of the report, in terms of the same *information effect* outlined in relation to food safety above, the domestic adoption of standards represents a mechanism by which knowledge is disseminated more easily to foreign importers. They conclude that export opportunities grow as transparency and clarity are enhanced and the cost of acquiring information on the import side is reduced. Here again, the overall effects outlined in

23. OECD (2003), *The Impact of Regulations on Agro-food Trade; The Technical Barriers to Trade (TBT) and Phytosanitary Measure (SPS) Agreements*, OECD, Paris, p. 79.
24. Wei, Guoxue, Jikun Huang, and Jun Yang (2012), "The Impacts of Food Safety Standards on China's Tea Exports", *China Economic Review* 23.2: 253-64. Web: p. 257.

these studies "depends upon whether the trade-fostering elements outweigh the trade-hindering elements."[25]

Other studies centralise overall social and economic costs in related analyses that question how domestic production or public health would be affected "if [a] disease or pest were allowed to enter" within domestic borders.[26] See for example, Costello et al. (2007), Orden et al. (1996), Pimental (2005), Calvin et al. (2008), and Harrington et al. (1987). The OECD has before explored methods that include a QALYs (Quality Adjusted Life Years) approach, which is most often used in the medical and public-health fields. The costs of alternative food security policies are compared to the health changes as a result of entry of harmful pathogens measured over two dimensions: the quality of life (morbidity) and the length of life (mortality).[27] In essence, these studies place a value on the reduced possibility for illness or death due to harmful pathogens as a result of regulations. From the standpoint of enhancing radiological protection strategies, these approaches seem attractive given the potential for a more interdisciplinary integration of radiological science with economics, but limitations to these studies are plain. Notably, although biological and epidemiological evidence suggests that radiation can be lethal or cause cancer or leukaemia at large exposures, at low doses of radiation (low generally considered to be 100 mSv or less) there is no definitive scientific evidence that it does. Recall that even with generous assumptions, consumers living in affected countries but outside the most exposed areas and in importing countries are extremely unlikely to fall victim to significant exposures. By consequence, there is no possible way of weighing the public health risk with low dose exposure in imported foods, based on the same two dimensions of morbidity and mortality, with regulations.

Because the principal subject of this report is radiological protection strategies, the focus on economic costs borne from food security policies is most important within the context of the *information effect*. To see if policies serve in any noticeable capacity to address the dynamics of asymmetric information outlined previously it is best to look at whether policies are more trade-fostering or trade-hindering. As a result, the structure of this report veers slightly away from those methodologies listed above. If these dynamics are addressed, and consumers are less *uncertain* of the risk involved and the consequent implications for a reputational backlash are reduced, these policies should prove to be more trade fostering.

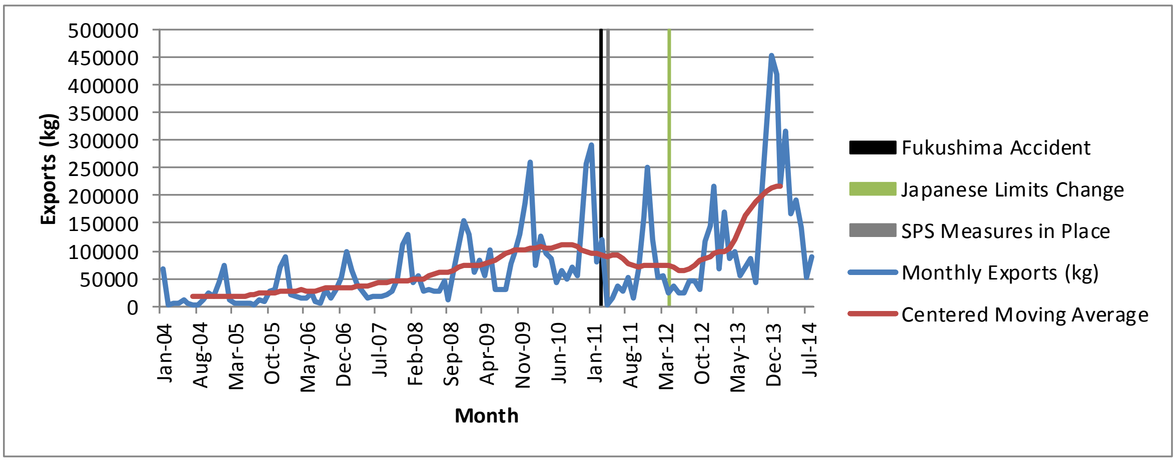
The OECD has demonstrated before that the most "quantifiable" aspects of food security measures are those that can be tied to *changes* that relate to "risk assessment, harmonisation, regionalisation, and justification of stricter-than-international standards."[28] The two policy priorities outlined in the beginning of this report that emerged in the aftermath of the Fukushima accident thus provide an ideal area for quantitative investigation. First, in April 2012 the Japanese government entered into force binding radiological criteria for radioactive materials to determine which foods could circulate in domestic and international markets, which supplemented the provisional radiological criteria set immediately after the accident. These values were lower than those outlined in the Codex General Standard for Contaminants and Toxins in Food and Feed (CODEX STAN 193-1995), thereby representing a policy change to "stricter-than-international standards." Second, in the one to two years following the accident, several WTO member states that had previously implemented SPS trade related measures in

25. Clougherty, Joseph A. and Michał Grajek. (2009) "ISO 9000: New Form of Protectionism or Common Language in International Trade?", European School of Management and Technology, Working Paper No. 09-006, p. 13.
26. OECD (2003), *The Impact of Regulations on Agro-food Trade; The Technical Barriers to Trade (TBT) and Phytosanitary Measure (SPS) Agreements*, OECD, Paris, pp. 79.
27. van Tongeren, F., J. Beghin and S. Marette (2009), "A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade", *OECD Food, Agriculture and Fisheries Working Papers*, No. 21, Paris, p. 16.
28. OECD (2003), *The Impact of Regulations on Agro-food Trade; The Technical Barriers to Trade (TBT) and Phytosanitary Measure (SPS) Agreements*, OECD, Paris, p. 85.

response to the accident, in line with the demands of the WTO, subsequently removed them. The moments when they were removed represent the removal of a trade barrier.

By examining to what degree overall exports for Japan were affected by the earthquake and nuclear accident, and by isolating the volume of exports after the radiological criteria for radioactive materials were revised and SPS measures were removed, a sharper image of the reputational effects associated with traded food in a post-nuclear scenario will become clearer, as will whether these measures had any detectable *information effects*. Figure 1 illustrates the thinking behind this report. In the figure, it appears that for the volume of Japanese apple exports to Hong Kong there is in fact a considerable decline beginning at the time of the earthquake and nuclear accident, outside the normal seasonal fluctuations, and that this decline in export volume begins to turn positive at around the same time that the Japanese government revised their radiological criteria.

Figure 1: Japanese apple exports to Hong Kong



Source: Official Statistics of Japan, publicly available from the Japanese Ministry of Internal Affairs and Communications

Data and analytical limitations

As the research process for this report unfolded, the initially targeted data and analytical approach had to revised and narrowed. In addition, a considerable number of economic developments in Japan over the last several years and the unanticipated, ambiguous, and wide array of trade policy responses following the 2011 accident (see Annex C) made definitive conclusions difficult to find. These drawbacks however open the door to follow-up research. For analytical reasons, this report focuses on the monthly data of Japanese exports. Because of broader macro trends, the analysis zeros in on the changes in export volumes following the accident and the shift to stricter Japanese radiological criteria for radioactive materials. The following limitations and guiding factors will be more thoroughly outlined, in succession, below:

Data limitations
Framework limitations
Other structural factors guiding analysis, including,
Diminished Japanese output
Damage to infrastructure caused by earthquake and nuclear accident
Appreciation of Japanese yen
Wide array of Sanitary and Phytosanitary (SPS) measures used by trading partners

Data limitations:

From a data standpoint, in its initial conception, this report was intended to make use of monthly or yearly export data from Japan following the 2011 nuclear accident and also from Germany following the 1986 nuclear accident at the Chernobyl Nuclear Power Plant in the former USSR. In 1986, a radioactive plume extended across much of Europe that resulted in significant depositions on German agricultural goods. The motivation was that any lessons driving the development of radiological protection strategies moving forward must be based on the relevant experience of both these large-scale incidents. Unfortunately, tracing the data from Germany proved to be a more insurmountable hurdle given that the information relates to events so distant in the past.

Framework limitations:

The focus on data of Japanese exports proved irreconcilable with the initially envisioned analytical framework. The scope of this report would generally demand a "gravity model" framework, which has become the bedrock model to investigate bilateral agricultural trade flows (See again Achterbosch, et al., Wei et al., and Clougherty et al. above). The gravity model "is an adaptation to economics of Newton's Law of gravity, stating that the volume of trade between two countries depends positively on their economic masses and negatively on the distance between them."[29] Variables can be added to the model to account for specific food security measures. With the model presented in Table 2, the exports of Japan would have been analysed using econometric methods, specifically an ordinary least squares (OLS) log-linear model with fixed effects, using as independent variables the Gross Domestic Product (GDP) of Japan, the GDP of the importing partner, the distance between the two countries, the exchange rate, and several dummy variables to indicate if Japan has a Preferential Trade Agreement (PTA) with any individual partner and, most crucially, when radiological criteria were changed and SPS measures implemented and removed.

Table 2: Gravity model envisioned for analytical framework

$$Ln(Exports_{Japan}) = \beta_0 + \beta_1 Ln(GDP_{Japan}) + \beta_2 Ln(GDP_{Partner}) + \beta_3 Ln(Distance_{KM}) +$$

$$+ \beta_4 Ln(ExchangeRate_{YEN/Dollar}) + \beta_5 Ln(PTA) + \beta_6 Ln(\text{Japanese values})$$
$$+ \beta_7(\text{SPS Measures}) + \varepsilon$$

Because the Fukushima nuclear accident was recent relative to the current analysis, monthly aggregated export data were gathered to more accurately track changes over time. At this micro level, unfortunately, zero values for the dependent variable of Japanese exports were common, not only because Japan is primarily an importing nation, but also not all commodities are exported every month. The frequency of zero values was so large that the use then of the specified model would likely have rendered results that would have been "severely biased."[30] Although Silva et al. (2006) give robust arguments for the use of a different econometric model, specifically a pseudo-maximum likelihood estimator, which may have solved this bias, an additional problem comes that GDP data is aggregated yearly, thereby presenting mixed-frequency data with monthly export data. For these reasons, a piecewise econometric model was used separately for each commodity and each Japan-export partner pair combination. One unifying model equation proved to be elusive. Outside the realm of analytical limitations, other

29. Baller, S. (2007), "Trade Effects of Regional Standards Liberalization", *Policy Research Working Papers*, No. 4124, World Bank, Washington, DC. p. 12.
30. Silva, J.M. C. Santos, and Silvana Tenreyro (2006), "The Log of Gravity", *Review of Economics and Statistics* 88.4: 641-58, Web: p. 643.

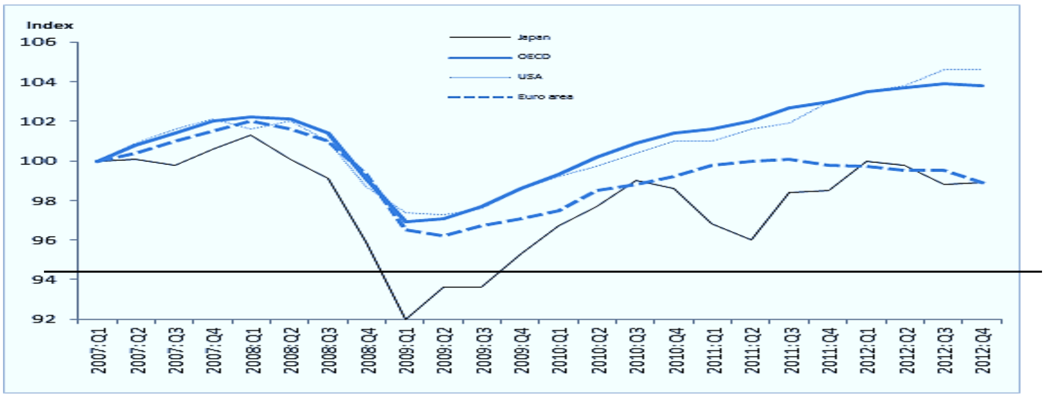
broad macroeconomic trends of the last several years had to be carefully considered in order to accurately situate the analysis.

Other structural factors guiding analysis:

Output: Although Japan remains a strong economy with undoubtedly one of the world's highest standards of living, the financial collapse of 2008 and the Great East Japan Earthquake and subsequent nuclear accident of 2011 both slowed growth and outlook.[31] Any analysis of the country's exports must be done so within this context. The country's success is built primarily upon the dynamic growth of its manufacturing and technology. Because the country is a geographically small and densely populated nation, the scale of its agriculture imports drastically outweighs its exports, providing less robust data. The nuclear accident did however bring to light that agriculture continues to carry a powerful cultural force in the country today.[32] Since the financial crisis, Japan has experienced three recessions (Figure 2).[33] The country's strong initial recovery from the earthquake stalled by mid-2012, leaving overall economic output 2½% below the peak recorded in 2008 prior to the global financial crisis. Any detected and precipitous decline in Japanese exports can presumably, in part, be attributed to the country's overall decline in output. At the same time, although overall exports did fall sharply by a 0.5% drop in 2011, the year of the nuclear accident,[34] the drop was a result of Japan's falling production levels and its concentration in capital goods, intermediate goods, and other discretionary consumer products. That drop was not influenced heavily by a decline in traded agriculture goods.[35]

Figure 2: Japan shocks since 2008

Real GDP levels in an index with the first quarter of 2007 representing 100



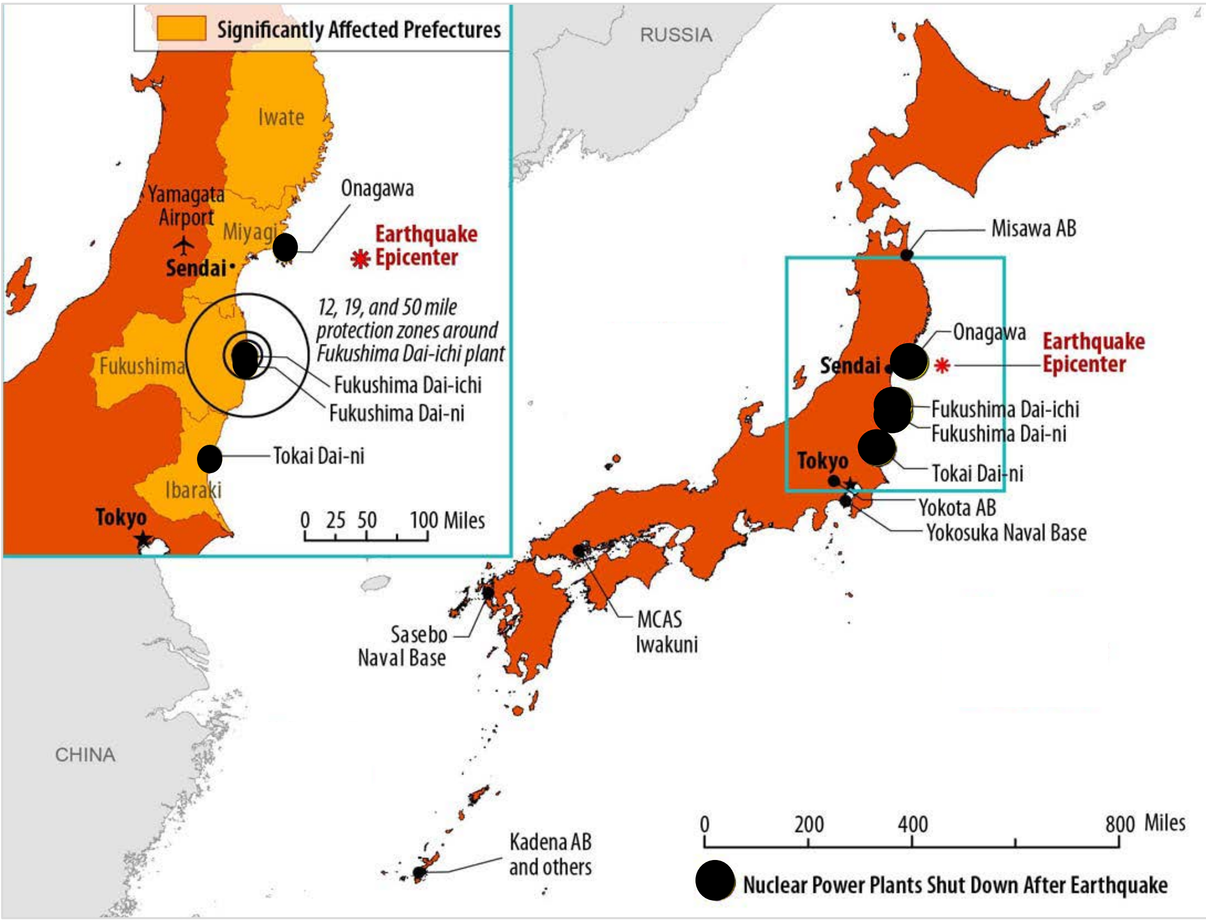
Source: OECD Economic Surveys: Japan 2013, citing OECD Economic Outlook Database.

Infrastructure Damage: Complicating analytical matters further is the fact that critical infrastructure was damaged by the Great East Japan Earthquake, radioactive fallout rendered many acres of land unusable, and the Japanese authorities, for safety purposes, outlined a large area of the Pacific Ocean off the East Coast of the country as a no fishing zone (Figures 3, 4). "Catastrophic damages" to fishing vessels and harbour facilities were reported immediately in the prefectures of Iwate, Miyagi, and Fukushima and "other damages" were also reported in

31. OECD (2013), *Economic Surveys: Japan*, OECD, Paris, p. 13.
32. OECD (2008), *The Evaluation of Agriculture Policy Reforms in Japan*, OECD, Paris, p. 11.
33. OECD (2013), *Economic Surveys: Japan*, OECD, Paris, p. 13.
34. WTO Secretariat (2012), *World Trade Report 2012*, p. 18.
35. Thorbecke, W. (2012), "Estimating Trade Elasticity's for World Capital Goods Exports", *RIETI Discussion Paper Series*, 12-E-067, The Research Institute of Economy, Trade and Industry, Tokyo.

Hokkaido and Aomori, Ibaraki, Chiba, Kanagawa, Aichi, Mie, Wakayama Tokushima, Kochi, Oita, Miyazaki, Kagoshima, and Okinawa prefectures.[36]

Figure 3: Map of affected areas, Japan



Source: Johnson, Renee (2011), "Japan's 2011 Earthquake and Tsunami: Food and Agriculture Implications" *Congressional Research Service* 7-5700 (2011): n. pag. CRS Reports for Congress, 13 April 2011. Web: 9 February 2015, www.crs.gov.

Provided the scale of the damage, the Japanese government launched a ten-year reconstruction programme following the earthquake, tsunami and nuclear accident that focused specifically on the prefectures of Iwate, Miyagi and Fukushima (three of the eight most affected prefectures) in the Tohoku region. The Japanese government has indicated that 99.6% of the people killed or missing following the Great East Japan Earthquake came from those prefectures, and 96% of the houses that were destroyed were located in these areas.[37] The analysis of Japanese exports must also heavily factor in that a decline in export volume can be attributable to a loss of production possibilities. More will be said in the analysis.

36. Johnson, Renee (2011), "Japan's 2011 Earthquake and Tsunami: Food and Agriculture Implications" Congressional Research Service 7-5700: n. pag. CRS Reports for Congress, *Congressional Research Service*, 13 April 2011, Web: 9 February 2015, www.crs.gov, p. 3.
37. OECD (2013), *Economic Surveys: Japan*, OECD, Paris, p. 13.

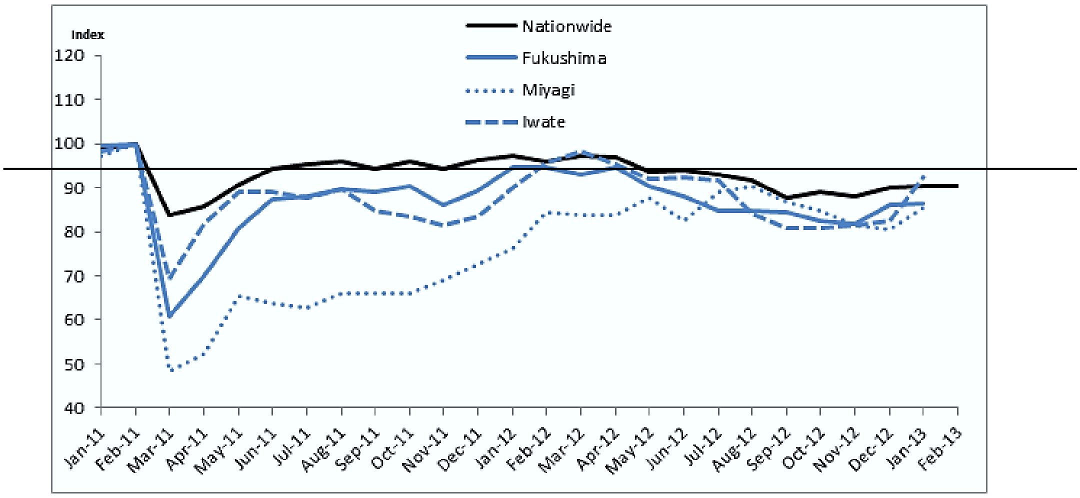
The need to account for infrastructure damage also demonstrates why the use of monthly export data aggregated at the country level is thus acutely appropriate. If data taken from the prefecture level had been used for this analysis, the possibility of analytically separating any reputational repercussions posed on exports from the loss in production possibilities would have been impossible.

The related and diminished production possibilities at the prefecture level posed by the more burdensome radiological criteria to farmers would also have been difficult to distinguish. When the Japanese government instructed the Ibaraki and Chiba prefectures to suspend shipments of bamboo shoots that were harvested in the cities of Itako, for example, or Shitake mushrooms from three cities in Ibaraki because they exceeded the new government safety standards for radiation levels, Japanese farmers openly questioned, ""I wonder how I should make a living."[38] As Table 3 reveals, the impact of the Great East Japan Earthquake and related nuclear accident on production is much more pronounced at the prefecture level but is considerably more muted at the national level. The subject of infrastructure damage will be more explicitly addressed in Section IV: Analysis.

In much the same vein, analytical concerns about including seafood products in this report, which stem from the fact that it is impossible to pinpoint where exactly any individual fish or fishing load was hauled in and made landing, can also be addressed using country level data because the focus remains on the reputational backlash to exports emerging from the country as a whole as the source. Regardless of whether any individual fish was actually caught in Japanese waters or Chinese or the Republic of Korea waters, or, for example, regardless of whether any individual fish was brought into a port on the South-western coast of Japan, far from the accident, any reputational consequence guided by the *uncertainty* that consumers have about Japanese food products would be driven by the fact that the good is perceived to be "Japanese".

Figure 4: The impact of the Great East Japan Earthquake on industrial production

Seasonally adjusted with February 2011 = 100



Source: OECD Economic Surveys: Japan 2013, citing Ministry of Economy, Trade and Industry, Iwate prefecture, Miyagi prefecture and Fukushima prefecture.

38. The Asahi Shinbum/Asia (2012), "Tougher food safety standards of radiation levels creates hardship for many farmers", 07 April 2012. Web: 11 February 2015, http://ajw.asahi.com/article/behind_news/social_affairs/AJ201204070058.

Table 3: Estimated damage from the Great East Japan Earthquake and Fukushima nuclear accident

	避難指示地域 Evacuation Directive Area (20 km from Fukushima)		屋内退避地域 Sheltering Indoors Area (20-30km from Fukushima)		合計 Total	
	戸数 Number of farms affected	面積 頭数 Total area/units	戸数 Number of farms affected	面積 頭数 Total area/units	戸数 Number of farms affected	面積 頭数 Total area/units
米 Rice	9 286	10 728 ha	5 646	5 307 ha	14 932	16 035ha
野菜 Vegetables	1 864	586 ha	1 492	306 ha	3 356	892ha
葉たばこ Tobacco	16	9 ha	1 159	898 ha	1 175	907ha
牛 Beef	280	3 385 units	341	10 360 units	621	13 745 units
豚 Pork	8	31 486 units	9	12 854 units	17	44 340 units
鶏 Chicken	17	63 300 units	17	126 200 units	34	189 000 units
競走用馬、乗馬 Horse	1	23 units	5	83 units	6	106 units
飼料 Feed	-	1 223 ha	-	1 487 ha	-	2 710 ha
しいたけ Shitake Mushroom	4	3 Tons	1	7 Tons	5	10 Tons

Source: Japanese Ministry of Agriculture Forestry and Fisheries.

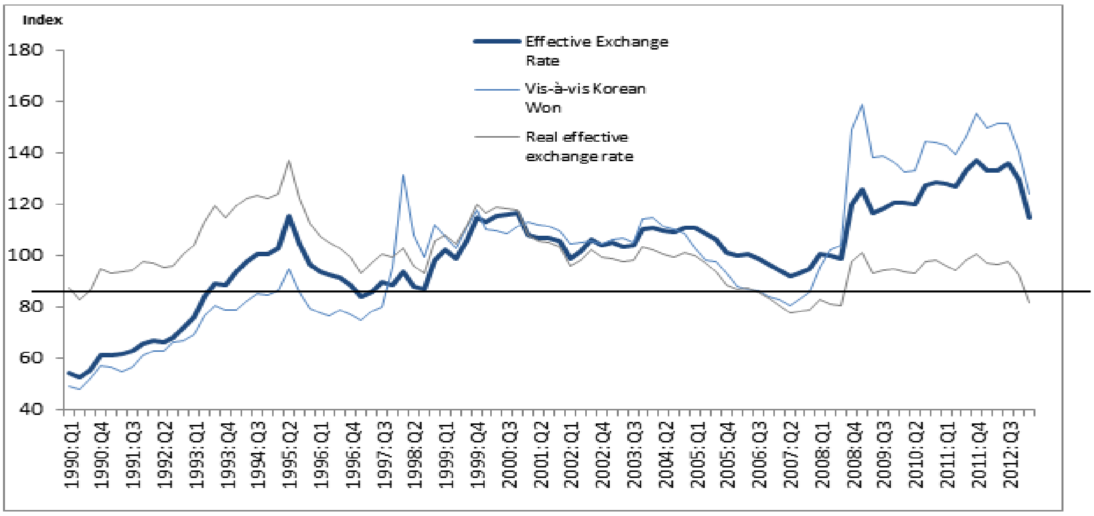
Exchange Rate: Several other critical factors played into Japan's decline in output and exports after 2011. Most importantly, the country's exports suffered from a strong currency. In mid-2012, for example, the Japanese yen was 45% above its 2007 level in nominal effective terms and 24% in real terms, which according to the OECD reflected large capital inflows to Japan, a country which served as a "safe haven" during global financial turbulence (Figure 5).[39] According to the OECD 2013 *Economic Survey of Japan*, the yen appreciated by 82% over the course of several years relative to the Korean won, all before the accident, which is crucial given the competition between Japanese and Korean products in world markets.[40]

It is often said that a currency is overvalued when its exchange rate makes domestic goods more expensive relative to similar goods sold abroad. A country's currency is undervalued in the opposite case. Provided this backdrop, the exchange rate could not be excluded outright from this report's analysis.

39. OECD (2013), *Economic Surveys,: Japan*, OECD, Paris, p. 13.
40. Ibid, p. 16.

Figure 5: Exchange rate of the Japanese Yen

Average of 1990-2012=100



Note: An increase in any line denotes a stronger currency (an exchange rate appreciation). The *Effective Exchange Rate* is average of 49 countries with which Japan trades, as opposed to bilateral exchange rates between two countries, such as the exchange rate of the yen again the Korean won show in the figure. *Real Effective Exchange Rates* adjust for inflation differences between Japan and its trading partners. A rise in the real effective exchange rate implies that Japan loses price competitiveness.

Source: *OECD Economic Surveys: Japan 2013*, citing *OECD Economic Outlook* Database and Bank of Japan.

SPS Measures: Lastly, and perhaps most critically, concerns about data consistency also plagued efforts to more thoroughly quantitatively investigate the effects of SPS measures on the volume of exports in the overall search to find the *information effect* tied to the two food security policy priorities implemented following the nuclear accident. As a result, this report focuses primarily on whether the changing radiological criteria by the Japanese government served to communicate risk, reduce asymmetric information, and stem the tide of reputational repercussions. Czubala et al. (2007), in a seminal work on European Union product standards and their effect on African textiles and clothing exports, note that interpretation and reporting at the WTO of Technical Barriers to Trade (TBT), another sub-category of NTMs, and SPS measures is hardly uniform. They note, for example, that "Belgium has lodged 207 TBT notifications since 1995, whereas Ireland has apparently not submitted any." In their view, "notifications data [does not] always provide an accurate picture of the standards environment in all Members".[41] Similarly, after the Fukushima accident, there were substantial difference in the number of prefectures and categories of food products covered by each country's SPS measures (Table 8).

Annex C gives overview of why quantitatively investigating SPS measures in this report's overall analysis would create some complexity. The non-tariff trade related measures implemented by countries following the accident are not only non-uniform and difficult to verify but their varying degrees of scope and coverage diminish the possibility to describe them collectively with one variable. Additionally, recall that the most "quantifiable" aspects of food

41. Czubala, W., B. Shepherd, and J.S. Wilson (2007), "Help or Hindrance? The Impact of Harmonized Standards on African Exports", *Policy Research Working Papers,* No. 4400, World Bank, Washington, DC, p. 8.

security measures are those that can be "tied to changes that relate to risk assessment, harmonisation, regionalisation, and justification of stricter-than-international standards".[42] As the research for this report unfolded, it became clear that a majority of countries that implemented SPS measures still have them in place, barring any attempt to isolate what happens to exports after those measures are removed. The SPS measures component may not factor instrumentally into the quantitative model of this report, but they will have to be addressed in unison with the results of the empirical analysis. Additional studies may be interesting once a majority of SPS measures have been removed.

The overall picture from Annex C substantiates several points from the NEA *Framework for the Post-accident Management of Contaminated Food*. This component may also provide a path for additional research in the future, and more to this effect will be outlined in the conclusion. International trade experience has time and again demonstrated the difficultly in aligning the expectations for food safety between importing nations and exporting nations in food safety incidents. Often, as the NEA made clear, trading partners have difficulty in "ascertaining the level of protection that [food safety] measures must meet in order to be recognised." Exporters frequently do not have the domestic capacity to meet the level of scientific proof demanded by importers as an "objective" demonstration of safety.[43] On the opposing side of the trade relationship, importers can suffer from a lack of familiarity with an exporting country's food safety regulatory system and "its effectiveness in addressing risk."[44] As a result, both sides are predisposed to a lack of confidence in the level of safety commitment at the other end. This discussion is not to suggest that these dynamics were necessarily present following the Fukushima nuclear accident in 2011, but given the diverse picture in Annex C, perhaps questions of whether the pursuit of greater harmonisation of food safety and trade related measures is warranted.

42. OECD (2003), *The Impact of Regulations on Agro-food Trade; The Technical Barriers to Trade (TBT) and Phytosanitary Measure (SPS) Agreements*, OECD, Paris, p. 85.
43. Prévost, Denise (2010), "Sanitary, Phytosanitary and Technical Barriers to Trade in the Economic Partnership Agreements between the European Union and the ACP Countries," ICTSD EPAs and Regionalism Program, p. 35.
44. Ibid, p. 36.

Section III: Data and model

The choices of which Japanese export partners and which specific commodities to narrow in on for the purposes of this study were made in the following way. First, in order to determine which commodities would provide the most robust results, the data for monthly Japanese exports to the rest of the world for each HS 6-digit defined commodity were compared using data from the United Nations Commodity Trade Statistics Database (COMTRADE) of the United Nations Conference on Trade and Development (UNCTAD). The Harmonized Commodity Description and Coding System, also known as the Harmonized System (HS) of tariff nomenclature, is an internationally standardised system of names and numbers to classify traded products. The system first assigns goods to sections via 2-digits, and then proceeds to assign these goods to specific chapters, headings, and subheadings using 4-digits, 6-digits, and 8-digits respectively that build on the previously level. The 6-digit level is a highly specified level for traded products, though not the highest, which allows an analysis of specific goods rather than more general "types" or "categories" of foods.

Subsequently, with the most exported commodities in-hand, export country destinations were then selected using the combined elements of whether they served as destinations for these commodities, for at least one month, in a majority of the last five years and if they had reported emergency SPS measures to the WTO following the nuclear accident. The selections underscore what the NEA confirmed in the *Framework for the Post-accident Management of Contaminated Food*, namely that patterns of trade in agricultural goods can best be characterised by regional or bilateral clusters given the constraints of distance and time. The biggest destinations for Japanese goods are in East Asian. In the end, monthly Japanese export data was compiled from the Official Statistics of Japan, publicly available from the Japanese Ministry of Internal Affairs and Communications, for **eleven** commodities, for **twenty-five** export destinations, across **ten** years (2004-2014) (See Table 4).

Database available upon request at:
www.e-stat.go.jp/SG1/estat/OtherList.do?bid=000001008800&cycode=1.

Estimation methods

Recall that the primary aim of this report, after reviewing all analytical limitations, is to quantitatively investigate the change in volume of Japanese exports after the accident and after the change in radiological criteria for radionuclides in order to highlight whether the action had an *information effect,* in any noticeable capacity, serving to address asymmetric information and ameliorate reputational repercussions to Japanese food products. To do so, a two-step process was followed; first, that sought to establish whether there were significant and sustained drops, or "structural breaks", in the export volumes following the accident for any specific commodity within any Japan-export partner combination, which would indicate a strong contributing variable factor of asymmetric information; and second, that subsequently isolated the export trends following the change in radiological criteria a year later. Did the change in radiological criteria, which were officially entered into force well below the values outlined in Codex General Standard for Contaminants and Toxins in Food and Feed (CODEX STAN 193-1995), result in any demonstrable trade-fostering effects?

To accomplish these ends, an econometric method, and more precisely a **piecewise linear regression**, was implemented for each commodity and for each Japan-export partner combination. As its starting point, this regression analysis approach sets out assuming that the dependent variable functions differently with the independent variables in specified segments, segments that start and end at specific boundaries or "knots."[45] Here it is assumed that the volume of Japanese exports, measured in kilograms, has a specific linear trend across time, measured monthly between the years 2004 and 2014. It is assumed that this trend changes in March 2011, presumably negative to reflect the Great East Japan Earthquake and Fukushima nuclear accident, and then again in April 2012, positively if the change in radiological criteria was trade fostering. The technique is to estimate the change in slope (kg exported/month) beginning at each knot, and then to test the hypothesis that there is indeed a "structural break" in the regression at these two knots by noting the statistical significance of the estimated differential slope coefficient.

In the final regressions, the monthly export data were aggregated to the quarterly level and converted to a centred moving averaged to remove any effects caused by seasonality. The exchange rate was also factored in as an independent variable, for reasons highlighted previously, using the quarterly yen value of the US dollar and data from OECDStats. A visual of the method used is presented in Figure 5, and the trend line with structural breaks at both designated knots is clear. The results of the regression analysis are presented in Table 5.

45. Gujarati, Damodar N. (2004), *Basic Econometrics*, Vol. 4. New York: McGraw-Hill.

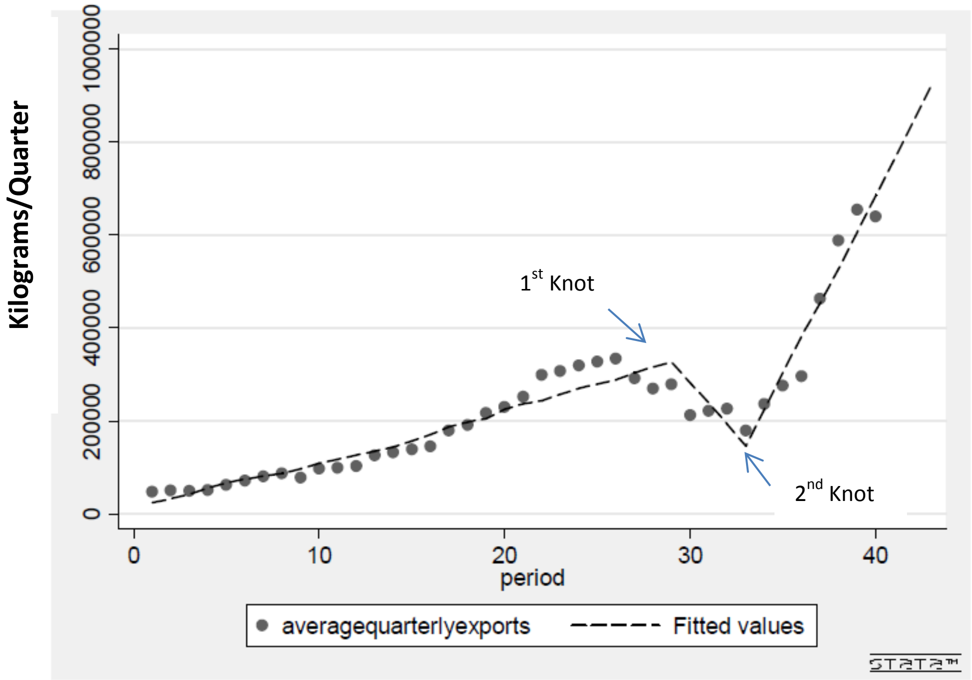
Table 4: Commodities and export destination partners

Export Partner Destinations	Reported Emergency SPS Measures to WTO
Australia	Yes
Bahrain	Yes
Belgium	Yes
Brazil	Yes
Canada	Yes
China	
France	Yes
Germany	Yes
Hong Kong-China	
Indonesia	
Italy	Yes
Malaysia	
Mexico	
New Zealand	
Oman	Yes
Philippines	Yes
Republic of Korea	Yes
Russia	
Saudi Arabia	Yes
Singapore	
Chinese Taipei	Yes
Thailand	Yes
United Kingdom	Yes
United States	
Vietnam	

Commodity Description	HS Code
Apples, fresh	080810
Arrowroot, salep, etc. fresh or dried and sago pith	071490
Bovine cuts boneless, fresh or chilled	020130
Milk and cream powder sweetened < 1.5% fat	040229
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder	120991
Pacific salmon, frozen (excl. of 0303.11; excl. fillets/other fish meat of 03.04/livers & roes)	030319
Rice, semi-milled or wholly milled	100630
Scallops other than live, fresh or chilled	030729
Spices, not else ware specified	091099
Tuna Skipjack, stripe-bellied bonito, frozen, whole	030343
Wheat or meslin flour	110100

Figure 6: Piecewise regression model for Japanese apple exports to Hong Kong

(Showing knots at April 2011 and April 2012).



Period (1=January 2004, 43=August 2014)

Table 5: Results of data and model

Box 1: How to read Table 5

The results for this study have been presented by commodity and by Japanese export partner in Table 5. At the outset, to properly understand the results, it is imperative to reiterate that the hypothesis at the outset was first that a negative structural break of the export of each commodity was likely to have taken place in April 2011, the first month following the Fukushima accident. Assuming that the process of revising radiological criteria downward subsequently contributed to an informational effect in exported goods, a second and positive structural break should then have been witnessed in April 2012, the first month following the revised criteria.

Narrowing the field (Column 1):

To accurately evaluate this dual pillared hypothesis, the piecewise regression analysis was run for each commodity using only those export partners, of the twenty-five nations that were examined, for which there was at least 50% non-zero values in the Japanese monthly export data. Those with at least 50% non-zero values are listed in column 1.

No change (Column 2):

If no structural break of statistical significance was observed for the export of a single commodity to a specific export partner, that export partner is listed in column 2.

Time of accident change (Columns 3-4):

If a statistically significant structural break in a single commodity to a specific export partner was identified at the time of the accident, the export partner is listed in column 3. The change in the quarterly export of that commodity, measured in kilograms, to the specified export partner relative to the previous period is then listed in column 4. Put another way, the coefficients listed represent the change in the slope from the first time interval (January 2004-March 2011). A negative coefficient indicates a negative structural break, and a positive coefficient indicates the opposite. (Note again: Here it's change in quarterly exports because monthly data were aggregated to account for seasonality).

Time of radiological criteria change (Columns 5-6):

The same exact process outlined for Columns 3-4 are then repeated again in Columns 5-6, but this time to account for the moment when the radiological criteria were revised by the Japanese.

The exchange rate of Japanese Yen (Column 7):

If the exchange rate played a statistically significant role in the monthly export of a specified commodity to an individual export partner, that is indicated in column 7.

Coefficient of determination (R2) (Column 8):

Column 8 highlights the coefficient of determination for the model for each commodity and Japan-export partner combination. R2 is a statistic that will give some information about the goodness of fit of a model. In regression, the R2 coefficient of determination is a statistical measure of how well the regression line approximates the real data points. An R2 of 1 indicates that the regression line perfectly fits the data.

Table 5: Results of data and model

	Import countries with enough data	No structural break	Structural break time of accident	Change in quarterly export (slope) from previous period (kg)		Structural break Japanese limit change	Change in quarterly export (slope) from previous period (kg)		Significant exchange rate effect		R^2
	1	2	3	4		5	6		7		8
Apples	China		China	-19167.71	***	China	18571.34	***	Yes	**	0.72
	Hong Kong		Hong Kong	-55864.04	***	Hong Kong	125310.10	***	-	-	0.95
	Indonesia	Indonesia									
	Russia	Russia									
	Singapore	Singapore									
	Chinese Taipei		Chinese Taipei	-819168.40	***	Chinese Taipei	949104.70	***	Yes	***	0.87
	Thailand		Thailand	-5492.92	**	-	-		Yes	**	0.71
Arrow root	Singapore		Singapore	-31135.28	***	*Zero Value*	-		Yes	***	0.9
	Chinese Taipei		Chinese Taipei	-221715.70	***	*Zero value*	-		Yes	***	0.94
	Thailand	Thailand									
	United States		United States	-100518.60	***	*Zero value*	-		Yes	*	0.96
Bovine	Hong Kong		Hong Kong	-2191.14	**	-	-		-	-	0.94
	United States	United States									
Oil seeds	Australia	Australia									
	Brazil	Brazil									
	Canada	Canada									
	China	China									
	France	France									
	Hong Kong	Hong Kong									
	Indonesia	Indonesia									
	Malaysia	Malaysia									
	New Zealand	New Zealand									
	Philippines	Philippines									
	Korea		Korea	-1597.26	*	-	-		-	-	0.94
	Singapore		-	-		Singapore	857.53	***	-	-	0.69
	Chinese Taipei		Chinese Taipei	-1957.12	***	Chinese Taipei	1675.16	**	-	-	0.94
	Thailand	Thailand									
	United Kingdom	United Kingdom									
	Viet Nam		Viet Nam	1042.45	***	Viet Nam	-1029.66	***	Yes	***	0.71

Note: *, **, *** indicate statistically significant at the 10%, 5 percent, 1 percent level, respectively.

Table 5: Results of data and model *(cont.)*

	Countries with enough data	No structural break	Structural break time of accident	Change in quarterly export (slope) from previous period (kg)	Structural break Japanese limit change	Change in quarterly export (slope) from previous period (kg)	Significant exchange rate effect	R^2
	1	2	3	4	5	6	7	8
Pacific Salmon	China		China	-2117806.00 ***	*Zero Value*	-	- -	0.89
	Korea	Korea						
	Chinese Taipei		Chinese Taipei	164809.50 ***		-219191.6 ***	Yes ***	0.74
	Thailand		Thailand	-181576.60 ***	Thailand	170288.4 **	- -	0.88
	Viet Nam		Viet Nam	-208038.10 ***	*Zero Value*	-	Yes ***	0.97
Rice	France		France	-1673.25 ***	France	2286.56 ***	Yes ***	0.81
	Germany		Germany	-1069.17 **	Germany	2054.86 ***	Yes ***	0.94
	Hong Kong	Hong Kong						
	Russia		Russia	-1094.42 *	-	-	- -	0.73
	Singapore		Singapore	10325.51 *	-	-	Yes ***	0.97
	Chinese Taipei		Chinese Taipei	-5699.26 **	-	-	Yes ***	0.84
	Thailand		Thailand	577.56 ***	-	-	Yes ***	0.89
	United Kingdom		-	-	United Kingdom	2154.24 ***	Yes ***	0.94
	United States	United States						
Scallops	Australia	Australia						
	Canada	Canada						
	China	China						
	Hong Kong	Hong Kong						
	France	France						
	Indonesia	Indonesia						
	Malaysia	Malaysia						
	New Zealand	New Zealand						
	Korea		Korea	-57484.53 ***	Korea	43535.17 ***	Yes **	0.98
	Singapore		Singapore	-7691.68 ***	Singapore	8591.45 ***	Yes **	0.89
	Chinese Taipei		Chinese Taipei	-35612.07 ***	Chinese Taipei	25877.35 ***	Yes **	0.81
	Thailand		Thailand	-2812.31 ***	Thailand	5902.40 ***	Yes ***	0.72
	United States	United States						
	Viet Nam		Viet Nam	-117221.70 ***	Viet Nam	146672.40 ***	Yes ***	0.76

Note: *, **, *** indicate statistically significant at the 10%, 5%, 1% level, respectively.

Table 5: Results of data and model *(cont.)*

	Countries with enough data	No structural break	Structural break time of accident	Change in quarterly export (slope) from previous period (kg)	Structural break Japanese limit change	Change in quarterly export (slope) from previous period (kg)	Significant exchange rate effect	R^2
	1	2	3	4	5	6	7	8
Skipjack Tuna	Indonesia	Indonesia						
	Malaysia	Malaysia						
	New Zealand	New Zealand						
	Philippines	Philippines						
	Thailand	Thailand						
	Viet Nam	Viet Nam						
Spices	Australia	Australia						
	Canada	Canada						
	France	France						
	Germany	Germany						
	Hong Kong	Hong Kong						
	Indonesia	Indonesia						
	Malaysia	Malaysia						
	New Zealand	New Zealand						
	Korea	Korea						
	Singapore	Singapore						
	Chinese Taipei		Chinese Taipei	1599.39 *	Chinese Taipei	-7303.45 ***	- -	0.78
	United Kingdom	United Kingdom						
	United States		United States	-4826.53 ***	-	-	Yes ***	0.8
Wheat	China		China	-97945.70 ***	*Zero Value*		Yes ***	0.93
	France	France						
	Hong Kong		Hong Kong	1549170.90 ***	Hong Kong	-264253.00 **	- -	0.95
	Indonesia		Indonesia	-109735.49 ***	-	-	- -	0.75
	Korea	Korea						
	Singapore		-	-	Singapore	-482425.45 ***	Yes ***	0.69
	Chinese Taipei		Chinese Taipei	91433.49 *	-	-	Yes ***	0.75
	Thailand		Thailand	161217.90 ***	-	-	- -	0.87
	United Kingdom	United Kingdom						
	United States	United States						
	Viet Nam		Viet Nam	346322.10 **	-	-	Yes ***	0.84

Note: *, **, *** indicate statistically significant at the 10%, 5%, 1% level, respectively.

Section IV: Analysis

At the time of the Great East Japan Earthquake and Fukushima nuclear accident, Japan's overall agricultural output, measured at the farm level, totalled about USD 70 billion annually, while its fisheries output accounted for roughly USD 14 billion. Nationwide principal commodity production was in fish and seafood, rice, vegetables, fruits and nuts, and dairy and poultry products.[46] Although, largely as a result of its high standards of living and dense population, Japan was and remains the largest net agro-food importer in the world, the twin crisis generated enough of a concern about overall food security that the Japanese government in April 2011, "had made strong overtures to the Japanese people to be judicious in their good purchases." Consumer hoarding, rolling blackouts, and the lack of fuel were identified as potential fallout ramifications of the accident that could wreak considerable havoc on Japan's food supply.[47] The overall picture of Japan's food supply then and now has since become clearer and less bleak as the country shifts from an emergency to existing exposure situation.

The overall picture detailed in the results presented in Table 5 is all but uniform, highlighting the limits to any definitive conclusions related to the original aims guiding this report and the need for a more nuanced analysis. More granular inferences have to be sacrificed to more general conceptual insights. While not starkly apparent, several broad and important trends seep through. To properly evaluate their significance, within the context of refining food security measures for future accidents, these trends, reflected in the coefficients presented in Columns 4 and 6, must be carefully weighed against the other critical factors previously reviewed that may have been instrumental in fostering Japanese trade or hindering it in the years since the 2011 nuclear accident.

Chief among those factors, the critical damage and related radiological fallout on Japanese crop land and fishing infrastructure inflicted by the Great East Japan Earthquake and Fukushima accident which severely limited production possibilities at the prefecture level (Table 6). At the same level are the SPS trade related measures implemented at import borders to either restrict foods emerging the most affected prefectures or that require certificates of origin to indicate that goods are Japanese (See Table 8). Recall from Section I that at work with SPS measures are two opposing forces, the costs imposed by additional regulations and the benefits to greater information to consumers. The overall trade effect of these measures "depends upon whether the trade-fostering elements outweigh the trade-hindering elements."[48] These factors may not have been included explicitly in the quantitative analysis but they cannot be forgotten.

The existence of infrastructure damage or SPS measures complicates the possibility of isolating the role of asymmetric information and the role of the radiological criteria levels in export volumes evident in Table 5, but several clues serve to elevate the impact that these coefficients represent. First, the production contributions of the affected prefectures to overall Japanese production in most goods are generally small. Second, the SPS measures in fact provide a degree of insight. A multitude of countries had, or continue to have, partial or complete bans on food imported from the 8-10 highest risk prefectures. By consequence, if these economies are still importing a certain good at any volume after March 2011, the product is clearly produced to some degree outside the affected Japanese prefectures and the trade fostering or inhibiting effects would largely not be the result of any SPS measures. In that case, the role of asymmetric information and consumer uncertainty may have played a role.

46. Johnson, Renee, (2011), "Japan's 2011 Earthquake and Tsunami: Food and Agriculture Implications." Congressional Research Service 7-5700 n. pag. CRS Reports for Congress, Congressional Research Service, 13 April 2011, Web: 9 February 2015, www.crs.gov, p. 1.

47. United States Department of Agriculture, Foreign Agriculture Service, "March 18 Update – Japan Food and Agriculture", *Agriculture Situation*, JA1023; 21 April 2011, Web: 10 January 2015, p. 2.

48. Clougherty, Joseph A. and Michał Grajek (2009), "ISO 9000: New Form of Protectionism or Common Language in International Trade?" European School of Management and Technology, Working Paper No. 09-006, p. 13.

Numerous other factors could have conceivably played a part in the changing volumes of Japanese exports for the chosen commodities, including the growing or waning economic activity within the borders of the export partners examined during this report (See again the original analytical framework in Table 2 that included GDP) or even more longer-term structural developments. It is unlikely that slowing economic activity in any importing country however would significantly reduce the demand for Japanese exports for one commodity and not for another. The exchange rate, which was more or less "controlled" for in the piecewise regressions by its inclusion in the model (Table 5, Column 7), likewise proved not to be inconsequential, as is apparent. To get a true sense of the *uncertainty* that plagued consumers following the Fukushima accident, and the consequent repercussions that that may have posed to Japanese exports, the results presented in Table 5 will be outlined in a two phased discussion below, separated by the analysis of exports of agriculture goods and the fisheries exports second, keeping the links to all these variables looped together.

Table 6: Profile of heavily damaged prefectures of twin crisis

	Population (million)	Total area (km^2)	Flooded area (km^2)	GDP (Billion USD)	Value of agriculture production (Billion USD)
Iwate	1.3	15 278	58	38.2	2.6
Miyagi	2.3	6 862	327	70.5	2
Fukushima	2	13 782	112	66.3	2.6
Japan	128.1	377 946	561	4 419.7	88.9

Source: OECD-FAO Agricultural Outlook 2011-2020 citing Ministry of Agriculture, Fisheries; Cabinet Office; Geospatial Information Authority of Japan

At the outset, the non-uniformity of the results in Table 5, at the broadest level of analysis, does serve to reaffirm, as stipulated in the NEA *Framework for the Post-accident Management of Contaminated Food*, that although the rare occurrence of a large-scale nuclear accident situation may result in the contamination of a relatively large geographic area (e.g. the area touched by fallout from the Chernobyl accident), the number of food products affected by radioactive activity is most likely to be limited. In the same vein, worldwide consumer *uncertainty,* within the overall context of asymmetric information, appears to be of greater importance in relation to the exports of some commodities and not to others. As expected, the Japanese exports in several commodities drop off precipitously to never recover (See exports of Arrowroot and Pacific Salmon), most likely as a result of the earthquake and nuclear accident, while in several examples exports show similar drops but then new life following the Japanese government's decision to revise its radiological criteria for traded foods (See Apple exports to Hong Kong and scallops exports to Singapore). All the while, in other cases, no structural change in exports was detected (See exports in spices). In others still, a structural change was identified at points in time other than those predicted. Provided this backdrop, what patterns, if any, can be found?

Agricultural goods:

To isolate any rippling effects of asymmetric information, visible in Table 5, stemming from the nuclear accident on Japanese agriculture exports and to further weed out the effects of the Japanese change in radiological criteria for radionuclides, with an emphasis on whether they had an *information effect*, recall first that Japan is a land scarce country, "where only 30% of area is suitable for agriculture or urban use."[49] Not only is that small relative to other OECD countries,

49. OECD (2014), *Agricultural Policy Monitoring and Evaluation 2014: OECD Countries*, OECD, Paris, p. 129.

but the overall importance of agriculture in the economy has continuously diminished over the last several decades, and it remained relatively low at 1.2% in 2012 with its share in overall employment limited at 3.5%. Further, the share of agro-food exports on total exports remains less than 1%.[50] On a practical level, these particular structural factors render a less robust dataset, but on another level, these factors demonstrate the "thinness" of overall market for agricultural goods produced in Japan. Traded goods were likely more vulnerable to a shock produced by the twin crisis, which is why the Japanese government showed noteworthy concern in the spring of 2011 about food security. In evaluating agriculture commodity markets, the term "thinness" typically refers to the volume of trade in any particular good relative to overall production, and a greater production volume can mitigate the effects of an exogenous shock, in this case such as changes to supply.[51] Of course, Japan's level of support to agriculture remains almost three times higher than the OECD average and its support is done in the most "trade distorting forms of support,"[52] which could have potentially guarded against this vulnerability. But what would this support have done to maintain production levels, and related export levels, in the face large scale and unanticipated damaged or contaminated crop area? What level of damage was inflicted on the most affected prefectures and could that have been a cause for a drop in exports witnessed in Table 5?

Table 7: Agricultural and fisheries output, and shares in selected prefectures, 2007

	All Japan	Aomori Share	Iwate Share	Miyago Share	Fukushima Share	Ibaraki Share	Total Share
Marine fishery catch (1000 mt.)	4 397	4%	3%	6%	2%	4%	20%
Marine aquaculture (1000 mt.)	1 242	2%	1%	3%	0%	N/A	7%
Agriculture output (100 billion yen)	83	0%	0%	0%	0%	0%	0%
Crops output (100 billion yen)	57	0%	0%	0%	0%	0%	0%
Vegetables (100 million yen)	21	0%	0%	0%	0%	0%	0%
Rice (1000 mt.)	8 823	7%	7%	9%	10%	10%	42%
Soybeans (1000 mt.)	262	0%	0%	0%	0%	0%	1%
Livestock (100 billion yen)	25	0%	0%	0%	0%	0%	0%
Dairy cattle (1000 head)	1 533	0%	1%	1%	0%	1%	3%
Beef cattle (1000 head)	2 890	1%	3%	2%	2%	1%	9%
Pigs (1000 head)	9 745	9%	10%	5%	5%	14%	43%
Layers (million chickens)	185	0%	0%	0%	0%	0%	1%
Broiler shipments (million chickens)	630	1%	2%	0%	0%	0%	4%

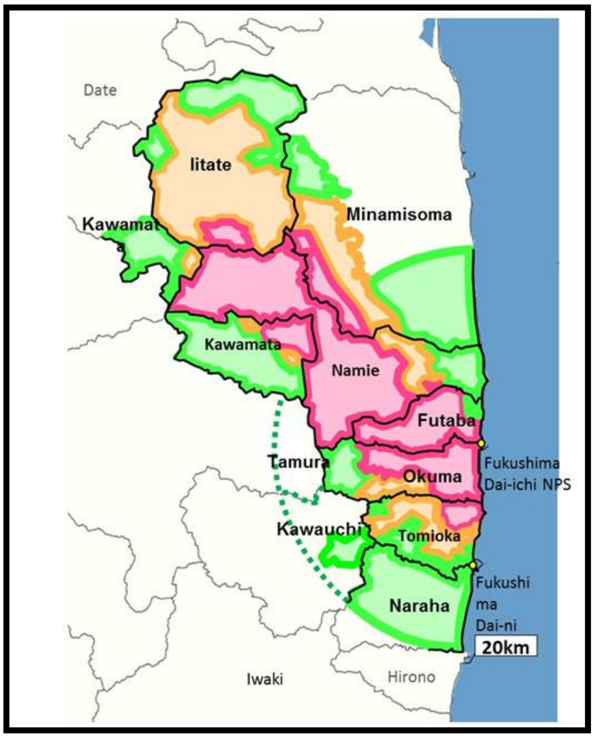
Source: USDA, Economic Research Service (ERS), "Japan: Current Issues in Japanese Agriculture," Table 2, www.ers.usda.gov/Briefing/Japan/currentissues.htm.

Ultimately, the overall damage to the agriculture sectors in the prefectures affected by the twin crisis was never estimated to be significant, from a nationwide perspective, but even if it had been, the effect on overall Japanese exports in certain commodities would have been limited. After acknowledging where SPS measures are in place and that the exchange rate too

50. Ibid, p. 129.
51. Liapis, p. (2012), "Structural Change in Commodity Markets: Have Agricultural Markets Become Thinner?", *OECD Food, Agriculture and Fisheries Papers*, No. 54, OECD, p. 8.
52. OECD (2014), *Agricultural Policy Monitoring and Evaluation 2014: OECD Countries*, OECD, Paris, p. 130

played a significant role, these details elevate the possible importance of asymmetric information and the consumer responses in importing countries to the total volume of exports in these goods. In April 2011, the Japanese Ministry of Agriculture, Forest, and Fisheries (MAFF) released an assessment of damage to cultivated land, estimating that the total area of flooded farmland was "23 600 ha over six coastal prefectures as of March."[53] In the Miyagi prefecture, one of the hardest hit by the tsunami, 11% of its total agricultural land was indeed damaged, but together, the flooding water affected "less than 3% of the [...] agricultural land" among the total in the six most affected prefectures and overall only about 1% of all Japanese cultivated land.[54] From the standpoint of radiological contamination, although a central circle of a 20 km radius from the Fukushima plant was designated as the "stay-away evacuation zone" while a surrounding annular area of between 20 and 30 km was designated as the "indoor evacuation zone,"[55] which constituted a large areas where production was interrupted (See Figure 7), none of these prefectures contribute significantly to the country's overall production in those goods (See Tables 6, 7). After reviewing nationwide export patterns and the infrastructure damage, discussions which both elevate the role that information asymmetry could have played, what do the results reveal?

Figure 7: Current evacuation area (January 2015)



Source: Japanese Ministry of Economy, Trade and Industry

53. OECD-FAO (2011), *OECD-FAO Agricultural Outlook 2011-2020,* OECD and FAO. http://dx.doi.org/10.1787/agr_outlook-2011-en>.p. 32.
54. Ibid, p. 31-32.
55. Hamada, N., H. Ogino, and Y. Fujimichi, "Safety Regulations of Food and Water Implemented in the First Year following the Fukushima Nuclear Accident", *Journal of Radiation Research* 53.5 (2012): 641-71. Web: p. 642.

Bovine, oil seeds, spices, rice, wheat:

The volume in Japanese exports in bovine cuts (HR code 020130), oil seeds (HR code 120991), spices (HR code 091099), wheat (HR code 110100) and rice (100630) showed no demonstrable changes at or discernible patterns across the time of the accident or at the time that the Japanese revised their radiological criteria. The patterns in monthly rice exports actually show considerable increase to some export partners, in line with longer term patterns predicted by the OECD and FAO. In some ways, the results of these five goods thereby undercut the initial hypotheses of this report that the asymmetry in information would generally affect all Japanese food exports in a negative way. Meanwhile, other trends contribute to a more intricate picture.

Of these five, the fact that no detectable volume changes were witnessed for rice at first seems the most perplexing. In Japan, "rice is the staple food, and its intake and production are greater than other foodstuffs,"[56] and the country seems acutely associated with rice as a result. Provided the level of attention given by the Japanese government to demonstrating to its domestic population that rice was well below radiological criteria, it is logical to think that rice must have endured a reputational backlash in export markets in the aftermath of the twin crisis. What is known, at minimum, is that as a result of infrastructure damage or prohibiting SPS measures, no sizeable export volume loss should have been suffered. As the OECD and FAO have highlighted, the rice harvest "was completed well before the tsunami struck." In addition, only 1.2% of Japan's paddy rice fields were directly affected by the twin crises, so the damage to rice production was considered "quite limited."[57] But reasons for a muted response at the level of international trade rooted in asymmetric information are identifiable when considering that the overall volume of rice exports is hardly forceful. Rice production mainly services domestic demand and not international demand. Border measures, for example, including a tariff of 341 yen per kilo of rice, which amounted to a 780% tariff rate in 2012, do much to isolate farmers from international competition.[58] With such little relative penetration into regional foreign markets which have their own sizeable rice production, it is likely that consumers were never buying much Japanese rice relative to their overall monthly rice consumption in the first place.

The trend for the first four of these products, in a different way, while not supporting the report's original thesis, cannot be understated either. Neither bovine, oil seeds, spice nor wheat is produced in large relative volumes in the most affected prefectures. In addition, the SPS trade measures that had been erected at the border of Japan's major export markets, which include Hong Kong (accounting for 21% of the total), the US (16%), Chinese Taipei (11%), Mainland China (10%), the Republic of Korea (8%), the EU (5%) and Singapore (3%), mainly cover "milk and milk products, vegetables and fruit, seafood and meat."[59] By consequence, for oil seeds, spices, and wheat, which fall outside of this SPS coverage (proving once more that they are not produced in large volumes in the affected prefectures), significant trend changes in volume would have pointed more directly to the effects of asymmetry in information, but in the end there were no trends that did so.

56. Hamada, N., H. Ogino, and Y. Fujimichi, "Safety Regulations of Food and Water Implemented in the First Year following the Fukushima Nuclear Accident" *Journal of Radiation Research* 53.5 (2012): 641-71. p. 647.
57. OECD-FAO (2011), *OECD-FAO Agricultural Outlook 2011-2020*, OECD and FAO. http://dx.doi.org/10.1787/agr_outlook-2011-en>, p. 31.
58. OECD (2013), *Economic Surveys: Japan*, OECD, Paris, p. 19
59. Research Office, Hong Kong Legislative Council Secretariat, "Food Control Measures After the Fukushima Accident", Research Issue Brief No. 3 (2013): n. pag. December 2013. Web: 12 February 2015. www.legco.gov.hk/research-publications/english/1314rb03-food-control-measures-after-the-fukushima-accident-20131224-e.pdf, p. 3.

Oil seeds and spices were far and away the highest volume exports of all eleven that were examined, both in terms of kilograms per month and number of export destinations, which at first seems like a plausible cause for their resilience to any reputational backlash or other unexplained factors. Perhaps with a certain and large enough threshold demand for Japanese goods in any of these export partner destinations, a smaller number of only the most concerned consumers truly alter their consumption patterns out of concern for radiation safety. It is conceivable that if any such dynamic were present that it would actually function in the opposite way and that concerns for safety would cause large drops for exports of the largest volume. From another angle, and speaking very generally again, none of these high volume goods is typically identified as a standout Japanese "specialty", which could make the information asymmetry dynamic in safety understanding more one of *unknowing*, in the sense that the consumer is not even considering radiation safety at the time of purchase, versus one of *uncertainty*, where the consumer thinks there is could be a risk but he or she does not know how serious it is. These two particular concepts of "volume" and "association" are of elevated interested in the sections to come.

Apples and arrowroot:

The peculiar patterns exhibited by exports in apples (HR code 080810) and arrowroot (HR code 071490) in Table 5, by contrast, are incredibly important. The analysis of the volume of exports in both is more complex than most others because both were produced in the affected prefectures and both were targets of SPS measures worldwide. Prior to the accident, apples from the Fukushima prefecture were known to have been of distinct quality. Likewise, a directive from the European Commission, for example, states that "arrowroot should be included in [the] list" for which sampling and analyses would be required before exports to its common market.[60] Regardless, consumer *uncertainty* does seem to have played a role in determining the overall export level in both.

The structural breaks in exports of arrowroot at the time of the accident to three of the four biggest export destinations are not only statistically significant, but the change in volume exported per quarter to Singapore, Chinese Taipei, and the United States, three of the four countries with enough data, is considerable. Provided the coverage of SPS measures in these countries, and particularly Singapore who only targets its food safety trade measures on food from the Fukushima prefecture (Table 8), the distinct drop in exports can likely be partially attributed to consumer *uncertainly*, unless all Japanese arrowroot is produced in Fukushima, which is unlikely. The results further beg the question of why the exports never recover while also diminishing any role that the change in radiological criteria played.

While demonstrating a similarly distinct and significant drop following the twin crisis like the exports in arrowroot, the exports of Japanese apples additionally showed a robust recovery immediately following the change in Japanese radiological criteria levels. The results for this commodity seem most in-tune with the original hypothesis of this report. The healthy volume of exports to Chinese Taipei and China, who both implemented some of the strictest SPS measures in both commodity coverage and prefecture origination rules, simultaneously indicates that a good portion of apples is produced outside the affected prefectures while again elevating the possibility that information asymmetry and the change in radiological criteria were influential. The hypothesised trend in exports, which were expected to drop following the twin crisis but show signs of recovery after the change in radiological criteria levels, seems to fit best with the export destination pair countries that import the largest volume. Indonesia, Russia, and Singapore had no structural breaks in imports of Japanese apples, but the historic volume of

60. The European Commission, Commission Implementing Regulation (EU) No 495/2013; amending Implementing Regulation (EU) No 996/2012, imposing special conditions governing the import of feed and food originating in or consigned from Japan following the accident at the Fukushima nuclear power station, Official Journal of the European Union; 29 March 2013.

Japanese apples imported by these countries pales in comparison to the levels witnessed in China, Hong Kong, Chinese Taipei, and Thailand, who did show structural breaks (See Annex A). Of more interest still are the combined facts that, first, those export destination countries whose import patterns seem most aligned with the expected trend are all regional partners, and, second, as mentioned, apples were proudly produced in Fukushima, one of the most affected prefectures, prior to the accident. While no overwhelmingly determinative conclusions can be drawn, it is indeed curious to note. Consumers paying the most attention to radiological food safety after the accident, after the Japanese consumers themselves, were likely consumers in neighbouring countries and the products that would be of concern to them were likely products that were well-known to be a Japanese "specialty." These concepts of "volume" and "association" again seep through, and the line of thinking will be further substantiated in the next section on fisheries goods.

Table 8: Japanese prefectures under distribution/import restriction
(As of December 2013)

Prefectures covered	Japan[1]	Hong Kong	China	Chinese Taipei	Korea	Singapore	United States	European Union
Number of prefectures	14	5	10	5	13	1	14	Not applicable
- Fukushima (福島)	✓	✓	✓	✓	✓	✓	✓	
- Chiba (千葉)	✓	✓	✓	✓	✓		✓	
- Gunma (群馬)	✓	✓	✓	✓	✓		✓	
- Ibaraki (茨城)	✓	✓	✓	✓	✓		✓	
- Tochigi (櫪木)	✓	✓	✓	✓	✓		✓	
- Miyagi (宮城)	✓		✓		✓		✓	
- Iwate (岩手)	✓				✓		✓	
- Aomori (青森)	✓				✓		✓	
- Nagano (長野)	✓		✓		✓		✓	
- Saitama (埼玉)	✓		✓		✓		✓	
- Shizuoka (靜岡)	✓				✓		✓	
- Yamanashi (山梨)	✓				✓		✓	
- Yamagata (山形)	✓						✓	
- Niigata (新瀉)	✓		✓				✓	
- Tokyo (東京)			✓					
- Kanagawa (神奈川)					✓			
- Akita (秋田)								

Note: (1) For reference, Japan prohibits six categories of food from 14 prefectures from domestic distribution and export.

Source: Research Office, Hong Kong Legislative Council Secretariat, "Food Control Measures After the Fukushima Accident." Research Issue Brief No. 3 (2013): n. pag. December 2013, Web: 12 February 2015, www.legco.gov.hk/research-publications/english/1314rb03-food-control-measures-after-the-fukushima-accident-20131224-e.pdf.

Fisheries:

The results presented in Table 5 for fisheries goods are similarly not straightforward and equally non-uniform to those of the agricultural goods, but the decline in exports for pacific salmon (HR code 030319) and scallops (HR code 030729), two of the three fisheries goods examined, does partially indicate that the aftermath of the twin crisis may have been more significant for fisheries goods. A significant drop in exports for fisheries goods was expected given the large media attention, in Western Europe and the United States, fixated in the last several years on the risks posed to consumers specifically by these Japanese products.[61] The heightened attention is undoubtedly rooted in the fact that the leading Japanese food exports include "fish and other animal products" at about 40% of the total (Table 9).[62] This fixation is a likely cause for consumer *uncertainty*.

The non-uniformity of these results are perhaps encouraging in the sense that a country reeling from the aftermath of a nuclear accident does not necessarily have to anticipate a uniformly large wave of reputational backlash against its well-known exports, *ipso facto*, as a result of a contamination of a relatively large domestic geographic area. The dynamics that can be outlined in this report are much more commodity specific. Without overwhelmingly harmonious evidence, it is however ambiguous if this non-uniformity in export patterns is the result of consumers not paying raised attention to Japanese goods or if any initial concern was partially mollified by Japanese actions in the aftermath of the accident. Several general observations are still warranted.

Table 9: Japan's agriculture imports, exports and net trade (2010)

HS Category	Imports	Share	Exports	Share	Net trade
	(USD million)	(%)	(USD million)	(%)	(USD million)
Fish and seafood	11 695	20%	1 292	28%	(10 404)
Animal and meat products	9 403	16%	142	3%	(9 262)
Prepared meat and fish	5 263	9%	655	14%	(4 608)
Fats and oils	1 309	2%	141	3%	(11 690)
Dairy, eggs, honey	1 334	2%	47	1%	(1 287)
Fresh fruits, vegetables	4 865	8%	141	3%	(4 724)
Grains, baking products	13 410	23%	711	15%	(12 698)
Sugar and cocoa	1 826	3%	138	3%	(1 688)
Beverage, water	2 865	5%	368	8%	(2 497)
Prepared foods	3 006	5%	57	1%	(2 949)
Floriculture, spices, misc.	4 350	7%	1 001	21%	(3 348)
Total	59 326	100%	4 693	100%	(56 633)

Source: USDA, Economic Research Service (ERS), "Japan: Current Issues in Japanese Agriculture," Table 1, www.ers.usda.gov/Briefing/Japan/currentissues.htm.

61. Harris, Richard, "Nuclear Tuna Is Hot News, But Not Because It's Going To Make You Sick." NPR. NPR, 29 May 2012, Web: 16 February.
62. Johnson, Renee (2011), "Japan's 2011 Earthquake and Tsunami: Food and Agriculture Implications" Congressional Research Service 7-5700 n. pag. CRS Reports for Congress. Congressional Research Service, 13 April 2011, Web: 9 February 2015, www.crs.gov, p. 2.

Once more, the process of isolating the trends presented in Table 5 and the effects on Japanese exports posed by asymmetric information, or the dynamic by which consumers resisted the purchase of Japanese imported goods based on *uncertainty* related to radiological risk, and isolating any potential *information effect* that the change in radiological criteria level played requires situating the results in the wider spectrum. Similar limits, based on larger macroeconomic trends, also come to analysing fisheries goods as they did to other Japanese agriculture goods. Surprisingly to some, Japan is actually a significant net importer of fisheries products, although in the years prior to the accident the level of imports had been trending lower. Exports in fisheries goods recorded their strongest rate of growth between 2010 and 2011, "both in value and volume terms," which may account for some loss of growth in the years after.[63] It is difficult to sustain such momentum. In 2011, exports were 0.42 million metric tonnes, up from 0.14 million in 1998, while the value of the exports in 2011 was JPY 174 billion, an increase of JPY 22 billion relative to 1998.[64] On the other side, Japanese imports of fish and fishery products, once sharply increasing, have been decreasing recently. These facts again dim the prospects of singling out the role of asymmetric information and the role of the changing radiological criteria levels in export volumes, but they also provide helpful hints as to the overall picture. China, for example, is the largest source for Japanese exports of fish and fishery products, making export trends to China for pacific salmon, scallops, and skipjack tuna all the more important.

Here again, limits to export possibilities following the twin crisis were substantial. Unlike the comparatively little damage done to the broader Japanese agriculture production possibilities, MAFF released a preliminary report in 2011 on the impact of the twin crisis on fisheries with a much more serious tone. They stated that the fishing boats and ports facilities in the three most affected prefectures of Iwate, Miyagi, and Fukushima, which embody several major fishing ports located along the northern eastern Pacific coast, had "been devastated." These three prefectures in aggregate accounted for "11.7% (513 kt) of Japan's total capture fisheries production (4.4Mt) in 2008."[65] With the addition of the Aomori and Ibaraki prefectures, these five most affected prefectures are estimated to account for about one-fifth of Japan's total marine fisheries and aquaculture production by volume.[66] In equal measures, the Great East Japan Earthquake and Fukushima Accident damaged around 29 000 fishing boats and 319 fishing ports in Japan, accounting for roughly 10% of the respective national totals.[67] These percentages of the national total, while larger than those of agriculture goods, still permit some observations in the data.

In addition to the physical destruction posed by the tsunami, the related release of radioactive substances from the Fukushima Daiichi Nuclear Power Plant made institutions like the Fukushima Prefectural Federation of Fisheries Cooperative Associations to voluntarily stop fishing operations in the waters off of Fukushima immediately on 15 March 2011. A portion of fishing activities in the neighbouring prefectures of Miyagi and Ibaraki were also suspended, but most of those were lifted within two years of the accident. Trial fishing has begun for testing purposes in the waters off of Fukushima. The national government, in co-ordination, also instituted legally binding sales prohibitions on certain marine products caught in the waters off Fukushima prefecture based on food safety requirements. Some species-specific prohibitions on

63. OECD (2013), *Review of Fisheries: Policies and Summary Statistics*, OECD, Paris, p. 322
64. Ibid. p. 322.
65. OECD-FAO (2011), *OECD-FAO Agricultural Outlook 2011-2020*, OECD http://dx.doi.org/10.1787/agr_outlook-2011-en>, p. 31.
66. Johnson, Renee (2011) "Japan's Earthquake and Tsunami: Food and Agriculture Implications" Congressional Research Service 7-5700: n. pag. CRS Reports for Congress, Congressional Research Service, 13 April 2011, Web: 9 February 2015, www.crs.gov, p. 5.
67. Fisheries Agency of Japan (2014a), *The Great East Japan Earthquake's impact on fisheries and future measures*, (in Japanese) Web: 13 February 2015, www.jfs.maff.go.jp.

sales and marketing were even introduced regardless of the actual measured levels of radioactive substances. The combined actions absolutely diminished export possibilities.

On the international side, SPS trade related measures were also adopted by an assortment of countries around the world, most of which were reported to the WTO. Trade barriers such as these can also be a source for trade flow losses.

Pacific salmon, scallops, and skipjack tuna:

Among pacific salmon, scallops and skipjack tuna, no detectable volume changes were witnessed for skipjack tuna, but the particular patterns exhibited by exports in pacific salmon and scallops in Table 5, like those of apples and arrowroots, are difficult to outright dismiss as insignificant. The analysis of the volume of exports in both is again scrambled by the large-scale infrastructure damage and strict SPS measures at importing borders, but consumer uncertainty does seem to have played a partial role in determining the overall export level in both. The fact that China and the Republic of Korea had any volumes of imports in both pacific salmon and scallops from Japan across the years since the accident gives some indication that landings continued unabated in both goods, landings completed from waters outside the prefectures that were targeted by SPS measures and Japanese sale prohibitions.

The hypothesised trend in exports, which were expected to at minimum drop following the twin crisis, seems to best fit with the export destination pair countries that import the largest volume. The "structural break" evident in pacific salmon exports to China and Singapore is particularly stark. Even if a very large portion of pacific salmon production came from the most affected prefectures prior to the accident, portions which would have subsequently diminished by way of both Japanese and Chinese actions, the drop off of exports per month from a peak in 2010 at 2 500 000-5 000 000kg per month to near zero exports per month cannot be glossed over. The details of the exports in scallops, while vaguer, could underscore the same point. For scallops, "structural breaks" are seen in less than half of the export destination partners, but those breaks come for partners with a much greater imported volume. Even then, the volume for scallops to those countries pales in comparison to the volume of salmon exported to China.

Overall

The monthly volume in Japanese exports between the years 2004-2014 for the eleven agriculture and fisheries goods collectively revealed less overwhelmingly demonstrative changes across the time of the accident or at the time that the Japanese revised their radiological criteria than was anticipated. In some ways, the results undercut the initial hypotheses that the asymmetry in information would generally affect all exports in a negative way and that the change in radiological criteria levels would send forceful messages to consumers. As demonstrated, however, an analysis of monthly export volumes cut individually across commodities slowly carves out the importance of the concepts of "export volume" and "market association." As stated, no definitively conclusive statements can be made to this effect, but the line of thinking generated by this report is that perhaps it is most plausible that any drop in exported goods as a result of asymmetric information in a post-accident scenario can likely be spotted in those goods that are most associated with the accident country, and that the association is likely strengthened by a greater traded volume of the most associated goods. It is logical that an *information effect* provided by radiological criteria limits, which would attach "credence values" to goods, is likely not relevant for goods not overwhelmingly associated as originating with the accident country. More analysis is required to substantiate these claims, and it is also probable that consumers are not being passed any risk information since radiological criteria are not listed on exported goods.

Section V: Conclusions

In 2013, the NEA developed a framework for the post-accident management of food in an attempt to rationalise the radiological criteria developed to protect those eating food coming from areas affected by radiological contamination, brought on by a radiological or nuclear accident or a malicious act. The framework identified strengths in the existing national and international regimes for food safety and international trade by examining in detail for the most recent accident existing international trade law, domestic policies, and national and international practice. By examining the overlap, strengths, and gaps in trade and food safety co-operation, the NEA hoped to begin to further understand the governance challenges presented by a future nuclear accident in an increasingly connected world. The report made note of the fact that future work was needed to further outline what motivates extended "trade restrictions against a nation affected by a nuclear accident," and how to better synchronise "the actions of exporters, in all food safety related situations, with the expectations and demands of importers concerning food quality and safety."[68]

One of the principle governing challenges that will be presented by a future nuclear accident will come in choosing which safety policy and risk communication strategies are to be implemented. In a follow-up to the NEA's initial framework suggestion, this report subsequently identified the potential consequences of asymmetric information in internationally traded food in a food safety situation where attributes of a certain food product are *unknown* to the consumer, typically before any relevant food safety incident has been identified, or they are *uncertain* to the consumer, a dynamic witnessed most often after any food safety incident has been identified. The two food security priorities at the heart of this report, embodied in the non-tariff Sanitary and Phytosanitary (SPS) trade related measures and the domestically implemented radiological criteria, have the potential to address that asymmetric information by attaching "credence attributes" to food products to ensure "that buyers know what they buy and that it is safe either for human health or the environment." By quantitatively investigating food security priorities, this NEA report has taken the first step in systematically enumerating the effects of strategies used to protect individuals from radiation exposure, using an evidence-based approach, which, if continued, will yield a more solid basis for making domestic and international trade protection choices with regard to challenges that future accidents may pose.

The results of the analysis were less robust than was hoped for, but the non-uniformity in the outcome is at minimum encouraging to the extent that officials and regulators facing an emergency exposure situation do not necessarily have to anticipate a uniformly large wave of reputational backlash against well-known internationally traded goods, *ipso facto*, as a result of a contamination of a relatively large domestic geographic area. The results of this report, at the broadest level of analysis, affirm to some degree that the number of food products affected by radioactive activity in the rare occurrence of a large-scale nuclear accident situation will most likely be limited. For internationally traded goods, worldwide consumer *uncertainty,* within the overall context of asymmetric information, appears to be of greater importance in relation to the exports of some commodities and not to others.

Despite this first step in identifying future challenges, several issues will need to be addressed in the future. Among those issues is the need for detailed micro-investigations into consumer confidence at the *domestic* level following a large-scale radiological contamination accident. Numerous examples of weak consumer confidence were well documented in Japan,

68. NEA (2014), *Framework for the Post-accident Management of Contaminated Food*, OECD, Paris, pp. 9.

and extensively reported on by newspapers and other media, particularly in relation to fisheries products from the radiation-affected areas. An asymmetric information dynamic, as presented in this report, can shake the confidence of consumers worldwide, but it should be noted that the actions of the Japanese government to lower radiological criteria levels for food were most likely motivated by both the need to restore domestic faith in food products, as well as with international trading partners. A clearer picture of how domestic consumers react to such an accident will further elucidate the numerous costs and benefits of various food security strategies. Most crucially, as the NEA stipulated in its framework document, the food security measures taken in post-accident scenarios for domestically distributed and exported foods will be and must be intricately linked.

Of equal importance to future studies is the need to further examine the potential risk communication component of radiological limits to internationally traded food items. For a host of reasons, little evidence was found to suggest that the Japanese change in radiological criteria played a heavy hand in assuaging consumers in importing countries of their *uncertainty,* if that dynamic was present, about Japanese goods. Radiological criteria, as a policy, may have a greater potential to address that asymmetric information by attaching more explicit "credence attributes" to food products in order to ensure "that buyers know what they buy and that it is safe either for human health or the environment." The first question is to what degree the policies creating radiological criteria were partially implemented to do so. As mentioned, the change in criteria was most likely driven by concerns at the domestic level. Moreover, the actual mechanism by which the risk information of any food product is passed to the consumer is unclear. Under U.S. trade law, and the general requirements under the Tariff Act of 1930 (19 U.S.C. 1304), for example, all imported articles must be marked with the English name of the country of origin. Under the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 *et seq.*) some food labels must contain even more specified information.[69] Both requirements are SPS measures, and most countries that imported goods from Japan following the accident had similar requirements. There is no indication however that radiological information was passed directly to consumers, but instead that radiological risk was communicated via certifications of inspection or origin at the point of entry (Annex C). If the change in criteria levels had an *information effect*, the mechanism providing the information would likely have been the media. Perhaps more direct risk communication to consumers is warranted.

References

Achterbosch, T.J., A. Engler, M.-L. Rau, and R. Toledo (2009), "Measure the measure: the impact of differences in pesticide MRLs on Chilean fruit exports to the EU", Paper presented at the International Association of Agricultural Economists Conference, Beijing, China, 16-22 August.

Agreement on the Application of Sanitary and Phytosanitary Measures, April 15, 1994, Marrakesh Agreement Establishing the World Trade Organisation, Article 5.5 – Results of the Uruguay Round vol. 1, 33 I.L.M. 1125, 1153.

The Asahi Shinbum/Asia (2012), "Tougher food safety standards of radiation levels creates hardship for many farmers", 07 April 2012. Web: 11 February 2015, http://ajw.asahi.com/article/behind_news/social_affairs/AJ201204070058.

Baller, S. (2007), "Trade Effects of Regional Standards Liberalization", Policy Research Working Papers, No. 4124, World Bank, Washington, DC.

69. Johnson, Renee (2011), "Japan's 2011 Earthquake and Tsunami: Food and Agriculture Implications." *Congressional Research Service* 7-5700: n. pag. CRS Reports for Congress, *Congressional Research Service*, 13 April 2011. Web: 9 February 2015, www.crs.gov, p. 12.

Büthe, Tim (2008), “The Globalization of Health and Safety Standards: Delegation of Regulatory Authority in the SPS Agreement of the 1994 Agreement Establishing the World Trade Organisation”, *Law and Contemporary Problems* 71.1, the Law and Politics of International Delegation: 219-55. Print.

Buzby, Jean (2003), “International Trade and Food Safety: Economic Theory and Case Studies.” *Agricultural Economic report No. (AER-828)*. United States Department of Agriculture, Economic Research Division, Washington DC.

Calvin, Linda, Barry Krissoff, and William Foster (2008), “Measuring the costs and trade effects of phytosanitary protocols: A US–Japanese apple example”, *Applied Economic Perspectives and Policy* 30.1: 120-135.

Canadian Ministry of Health, “Canadian Guidelines for the Restriction of Radioactively Contaminated Food and Water Following a Nuclear Emergency: Guidelines and Rationale” Minister of Public Works and Government Services Canada, 31 July 2008. Web: 03 October 2014.

Carpenter, Julia, and Rick Tinker (2012), “Assessment of the Impact on Australia from the Fukushima Dai-ichi Nuclear Power Plant Accident”, *Australian Radiation Protection and Nuclear Safety Agency*, Technical Report 162.

Ching-Fu Lin (2012), “SPS-Plus and Bilateral Treaty Network: A ‘Global’ Solution to the Global Food-Safety Problem,” *Conference on International Health and Trade: Globalization and Related Health Issues*, held by the Asian Center for WTO & International Health Law and Policy in August 2011 in Chinese Taipei.

Clougherty, Joseph A. and Michał Grajek (2009), “ISO 9000: New Form of Protectionism or Common Language in International Trade?”, *European School of Management and Technology*, *Working Paper No. 09-006*.

Consumer Affairs Agency, Government of Japan, “Food and Radiation Q & A.” 2 September 2013, Web: 30 January 2015. www.caa.go.jp/jisin/pdf/130902_food_qa_en.pdf>.

Costello, Christopher, Michael Springborn, Carol McAusland, and Andrew Solow (2007), “Unintended Biological Invasions: Does Risk Vary by Trading Partner?” *Journal of Environmental Economics and Management* 54.3: 262-76.

Czubala, W., B. Shepherd, and J.S. Wilson (2007), “Help or Hindrance? The Impact of Harmonized Standards on African Exports”, Policy Research Working Papers, No. 4400, World Bank, Washington, DC.

The European Commission (2011), “Commission Implementing Regulation (EU) No 297/2011; Imposing Special Conditions Governing the Import of Feed and Food Originating in or Consigned from Japan following the accident at the Fukushima Nuclear Power Station”, *Official Journal of the European Union*; 26 March 2011.

The European Commission (2012), Commission Implementing Regulation (EU) No 284/2012; Imposing Special Conditions Governing the Import of Feed and Food Originating in or Consigned from Japan following the accident at the Fukushima Nuclear Power Station and Repealing Implementing Regulation (EU) No 961/2011, *Official Journal of the European Union*; 30 March 2012.

The European Commission (2013), Commission Implementing Regulation (EU) No 495/2013; amending Implementing Regulation (EU) No 996/2012, imposing special conditions governing the import of feed and food originating in or consigned from Japan following the accident at the Fukushima nuclear power station, *Official Journal of the European Union*; 29 March 2013.

Fisheries Agency of Japan (2014a), The Great East Japan Earthquake's impact on fisheries and future measures, (in Japanese) Web: 13 February 2015.

Gobierno de Chile (2011), Exenta N. 335; Dispone Exigencia de Certificación de Ausencia de Contaminación por Radionúclidos en Alimentos Importados Desde Japón. Subsecretaria de Salud Pública División Políticas Publicas Saludables y Promoción; 20 May 2011.

Hamada, N., H. Ogino, and Y. Fujimichi (2012), "Safety Regulations of Food and Water Implemented in the First Year following the Fukushima Nuclear Accident" Journal of Radiation Research 53.5 (2012): 641-71. Web.

Harrington, Winston, and Paul R. Portney (1987), "Valuing the benefits of health and safety regulation" *Journal of Urban Economics* 22.1: 101-112.

Harris, Richard (2012) "Nuclear Tuna Is Hot News, But Not Because It's Going To Make You Sick" NPR. NPR, 29 May 2012. Web: 16 February 2015. www.npr.org/blogs/thesalt/2012/05/30/153925233/nuclear-tuna-is-hot-news-but-not-because-its-going-to-make-you-sick>.

Japanese Ministry of Agriculture (2013), Forestry, and Fisheries "FY 2012 Annual Report on Food, Agriculture and Rural Areas in Japan", FY 2012 Annual Report, Web: 03 October 2014.

Johnson, Renee (2015), "Japan's 2011 Earthquake and Tsunami: Food and Agriculture Implications" Congressional Research Service 7-5700 (2011): n. pag., CRS Reports for Congress, Congressional Research Service, 13 April 2011, Web: 9 February 2015, www.crs.gov.

Kyodo (2011), "French Find Caesium in Shizuoka Tea" Japan Times RSS, Japan Times,18 June 2011, Web: 02 February 2015, www.japantimes.co.jp/news/2011/06/19/national/french-find-cesium-in-shizuoka-tea/.

Ministère de l'agriculture, de l'agroalimentaire et de la forêt de France (2014), « La gestion du risque radiologique alimentaire » n.d. Web: 03 October 2014. https://agriculture.gouv.fr/La-gestion-du-risque-radiologique.

Liapis, p. (2012), "Structural Change in Commodity Markets: Have Agricultural Markets Become Thinner?" OECD Food, Agriculture and Fisheries Papers, No. 54, OECD, Paris.

Madigan, D. J., Z. Baumann, and N. S. Fisher (2012), "Pacific Bluefin Tuna Transport Fukushima-derived Radionuclides from Japan to California" Proceedings of the National Academy of Sciences 109.24: 9483-486.

Nedumpara, James J. and Geetanjali Harish Sharma (2012), "Trade Monitoring Policy Report of Japan 2011-2012". Center for International Trade and Economic Laws (CITEL), O.p. Jindal Global Law School.

NEA (2014), *Framework for the Post-accident Management of Contaminated Food*, OECD Paris.

OECD (2003), *The Impact of Regulations on Agro-food Trade; The Technical Barriers to Trade (TBT) and Phytosanitary Measure (SPS) Agreements*, OECD, Paris.

OECD (2008), *The Evaluation of Agriculture Policy Reforms in Japan*, OECD Paris.

OECD (2013), *Economic Surveys: Japan,* OECD, Paris.

OECD (2013), *Review of Fisheries: Policies and Summary Statistics*, OECD, Paris.

OECD (2014), *Agricultural Policy Monitoring and Evaluation 2014: OECD Countries*, OECD, Paris.

OECD-FAO (2011), *OECD-FAO Agricultural Outlook 2011-2020*, OECD and FAO. http://dx.doi.org/10.1787/agr_outlook-2011-en.

OECD-FAO (2013), *OECD-FAO Agricultural Outlook 2013-2022, OECDand FAO*, www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2013_agr_outlook-2013-en.

OECD-UNCTAD (2011), “Reports on G20 Trade and Investment Measures (Mid-October 2010 to April 2011”, OECD and FAO. http://unctad.org/en/Docs/unctad_oecd2011d5_summary_en.pdf.

Orden, David, and Euardo Romano (1996), “The avocado dispute and other technical barriers to agricultural trade under NAFTA”, Paper present at the conference of NAFTA and Agriculture: Is the Experiment Working.

Pimentel, David (2005), “Environmental consequences and economic costs of alien species”, *Invasive plants: ecological and agricultural aspects*, Birkhäuser Basel, 269-276.

Prévost, Denise (2010), “Sanitary, Phytosanitary and Technical Barriers to Trade in the Economic Partnership Agreements between the European Union and the ACP Countries,” ICTSD EPAs and Regionalism Program, pp. 35.

Progress to Date; Food Safety." Japanese Reconstruction Agency, n.d. Web: 03 October 2014. www.reconstruction.go.jp/english/topics/2013/03/food-safety.html.

República de Colombia (2011), Resolución Numero 0000342,. Ministerio de Agricultura y Desarrollo Rural, Ministerio de la Protección Social, 16 August 2011.

Republic of the Philippines (2011), Fisheries General Memorandum Order No. 001, Series of 2011. Bureau of Fisheries and Aquatic Resources, 29 March 2011.

Research Office, Hong Kong Legislative Council Secretariat, Food Control Measures After the Fukushima Accident” Research Issue Brief No. 3 (2013): n. pag. December 2013, Web: 12 February 2015, www.legco.gov.hk/research-publications/english/1314rb03-food-control-measures-after-the-fukushima-accident-20131224-e.pdf.

Silva, J.M. C. Santos, and Silvana Tenreyro (2006), “The Log of Gravity”, *Review of Economics and Statistics* 88.4: 641-58.

Thorbecke, W. (2012), “Estimating Trade Elasticity’s for World Capital Goods Exports”, RIETI Discussion Paper Series, 12-E-067, The Research Institute of Economy, Trade and Industry, Tokyo.

United States Department of Agriculture, Economic Research Service (ERS), “Japan: Current Issues in Japanese Agriculture,” www.ers.usda.gov/Briefing/Japan/currentissues.htm.

United States Department of Agriculture, Foreign Agriculture Service “Canada, Actions Taken Regarding Food Imports from Japan”, Trade Policy Monitoring, CA11016; 08 April 2011, Web: 03 October 2014.

United States Department of Agriculture, Foreign Agriculture Service, “HK Bans Certain Japanese Food Items due to Detection of Radiation” Trade Policy Monitoring, HK1109; 24 March 2011, Web: 03 October 2014.

United States Department of Agriculture, Foreign Agriculture Service, “March 18 Update – Japan Food and Agriculture” Agriculture Situation, JA1023; 21 April 2011, Web: 10 January 2015.

United States Department of Agriculture (2011), Foreign Agriculture Service, “Russia Bans Imports of Japanese Foods Products” Trade Policy Monitoring, RS1119; 20 March 2011. Web: 03 October 2014.

United States Department of Agriculture, Foreign Agriculture Service (2011), "Thai FDA Implements Safety Measures on Japanese Food Imports", Trade Policy Monitoring, TH1050; 20 April 2011, Web: 03 October 2014.

United States Food and Drug Administration (2014), "FDA Response to the Fukushima Dai-ichi Nuclear Power Facility Incident", n.d. Web: 03 October 2014. www.fda.gov/newsevents/publichealthfocus/ucm247403.htm.

van Tongeren, F., J. Beghin and S. Marette (2009), "A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade", OECD Food, Agriculture and Fisheries Working Papers, No. 21, Paris.

Wei, Guoxue, Jikun Huang, and Jun Yang (2012), "The Impacts of Food Safety Standards on China's Tea Exports", China Economic Review 23.2 (2012): 253-64.

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Australia, G/SPS/N/AUS/261 (14 April 2011).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Brazil; Revision, G/SPS/N/BRA/734/Rev. 1 (26 April 2011).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Bahrain, G/SPS/N/BHR/115 (18 July 2011).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Brunei Darussalam, G/SPS/N/BRN/3 (09 May 2011).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures; Revision, Brunei Darussalam, G/SPS/N/BRN/3/Rev.1 (29 November 2012).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures; Addendum, Chile, G/SPS/N/CHL/359/Add.1 (31 October 2011).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Colombia, G/SPS/N/COL/226 (13 September 2011).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Kingdom of Saudi Arabia, G/SPS/N/SAU/13 (28 April 2011).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures; Addendum, Kingdom of Saudi Arabia, G/SPS/N/SAU/13 (19 December 2012).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Chinese Taipei, Penghu, Kinmen, and Matsu, G/SPS/N/TPKM/231 (30 May 2011).

WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Summary of the Meeting of 16-17 October 2013, G/SPS/R/73 (15 January 2014).

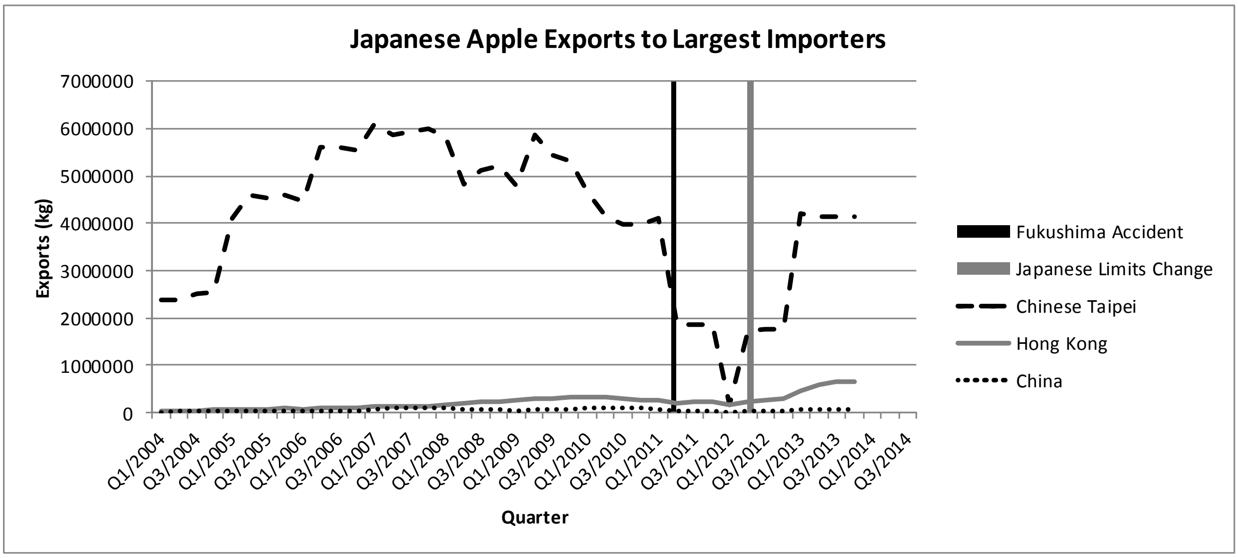
WTO Secretariat (2012), *World Trade Report 2012*.

"諸外国・地域の規制措置"（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries. www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf

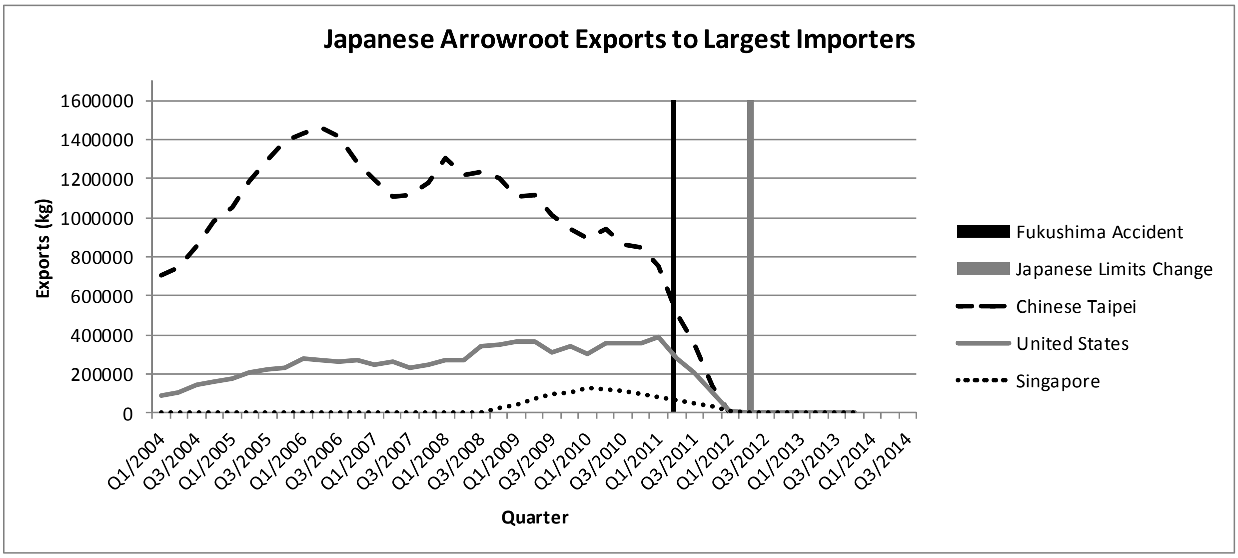
ANNEX A:

Export trends to largest export destinations

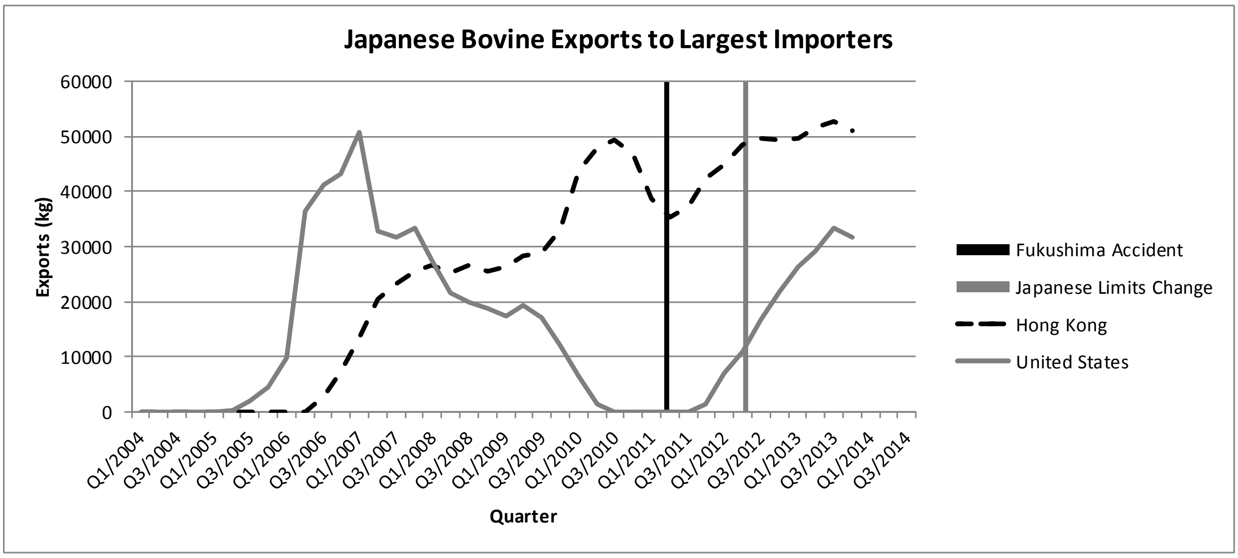
Apples, fresh (HR Code 080810)



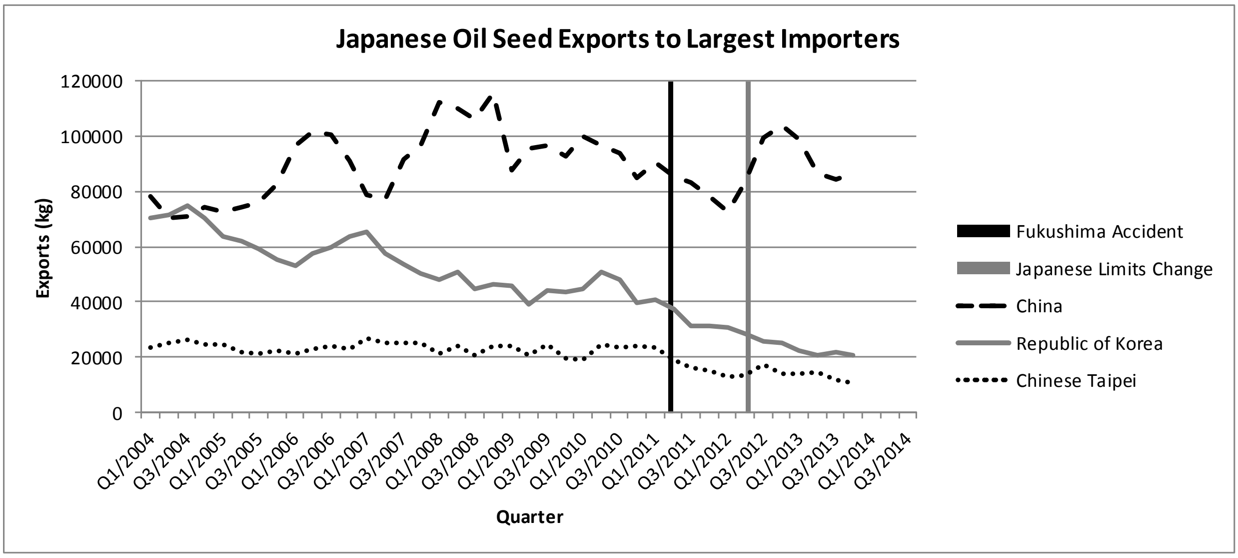
Arrowroot, salep, etc. fresh or dried and sago pith (HR Code 071490)



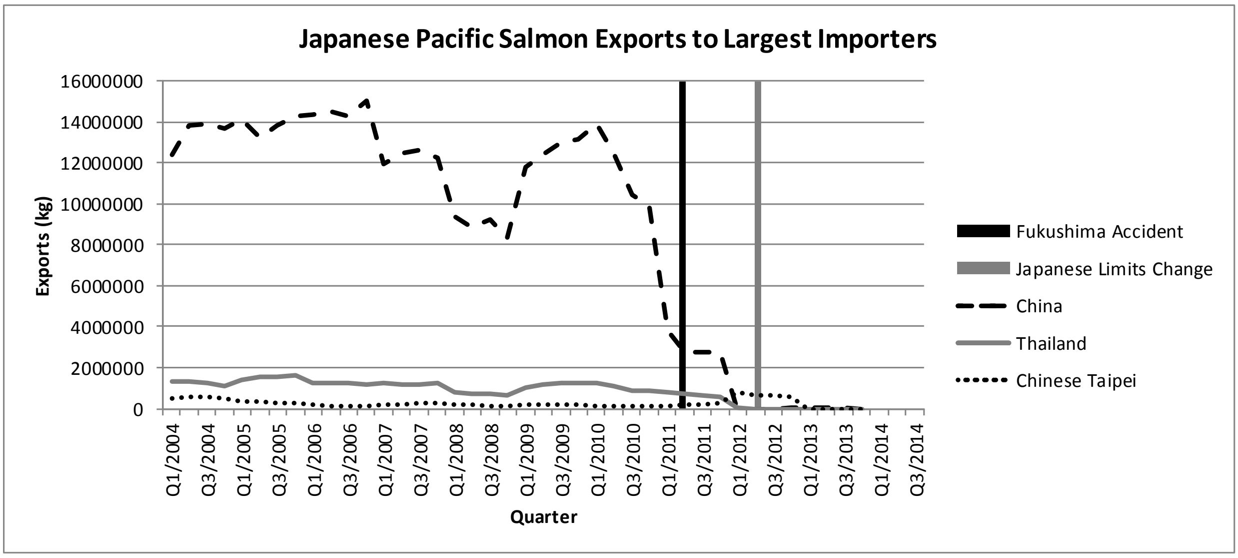
Bovine cuts boneless, fresh or chilled (HR Code 20130)



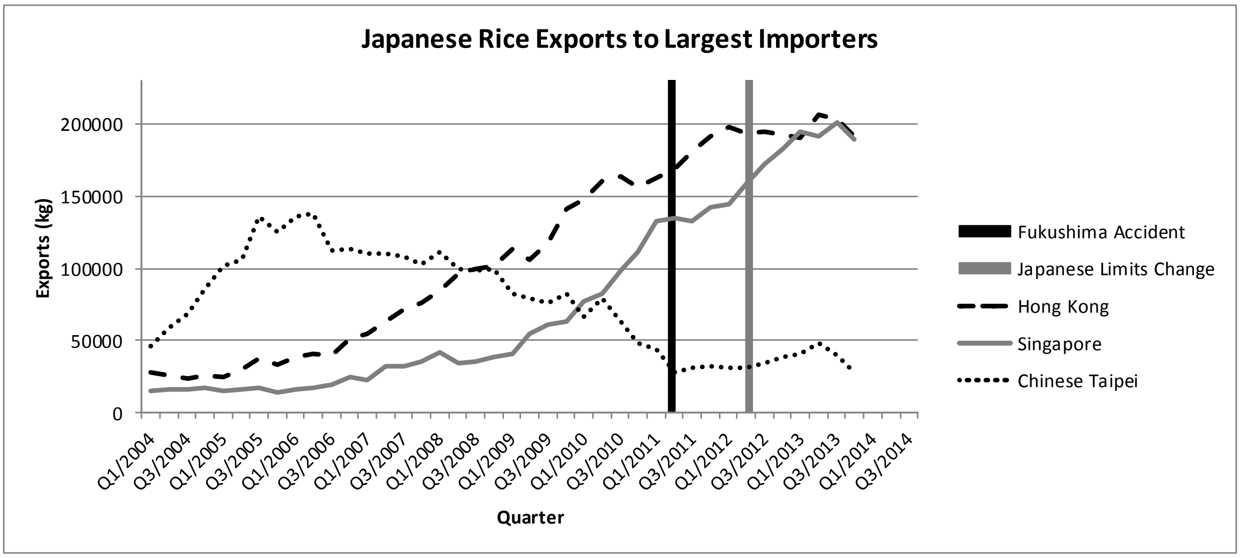
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants (HR Code 120991)



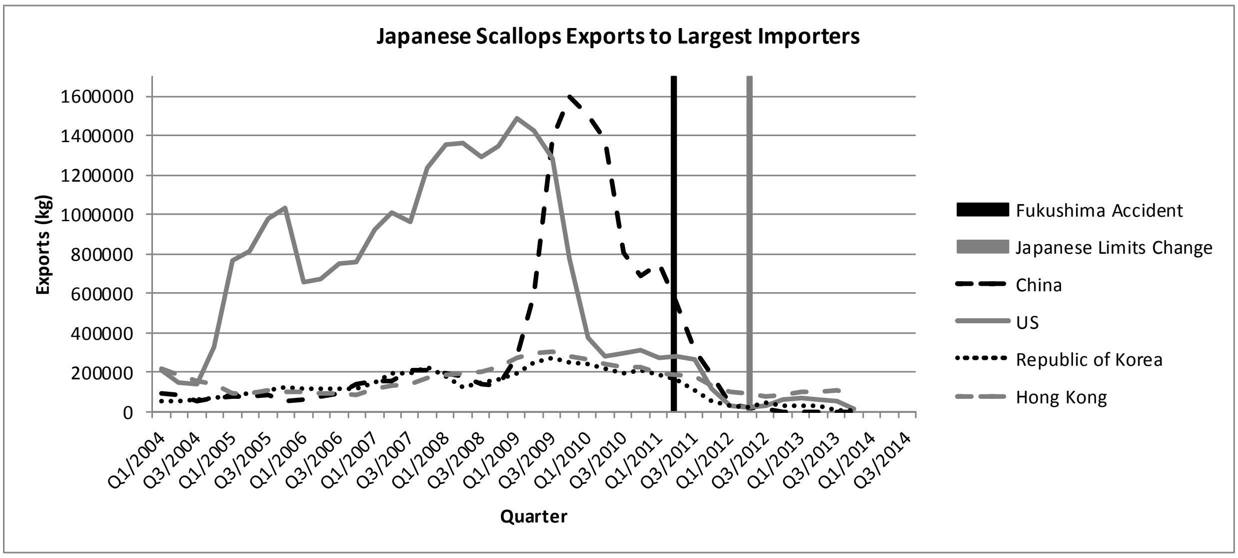
Pacific salmon, frozen (HR Code 030319)



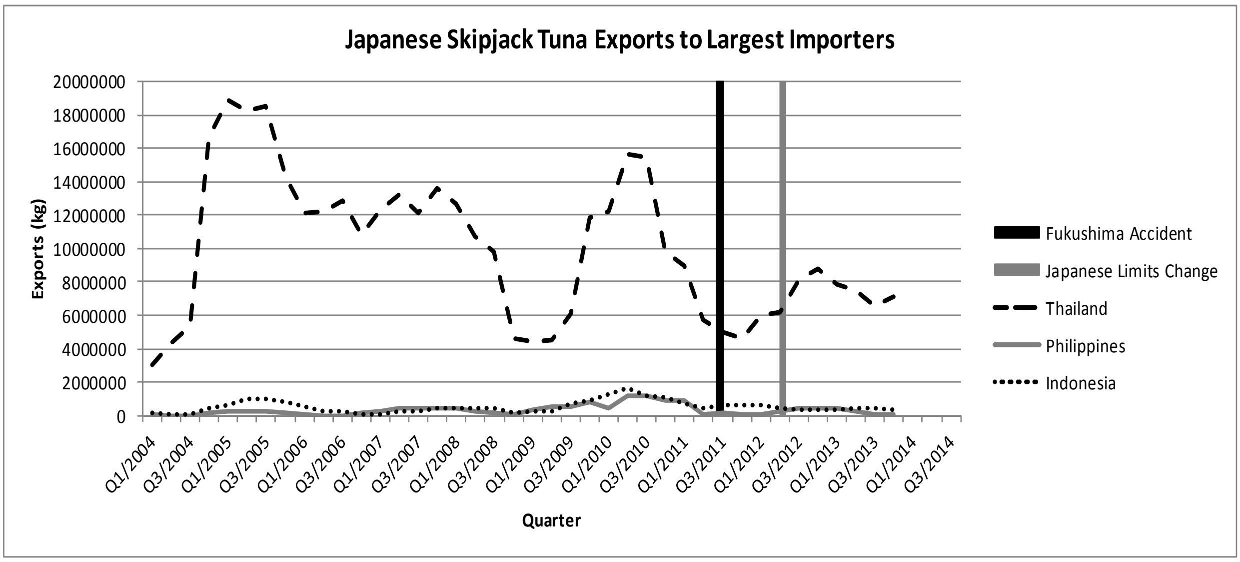
Rice, semi-milled or wholly milled (HR Code 100630)



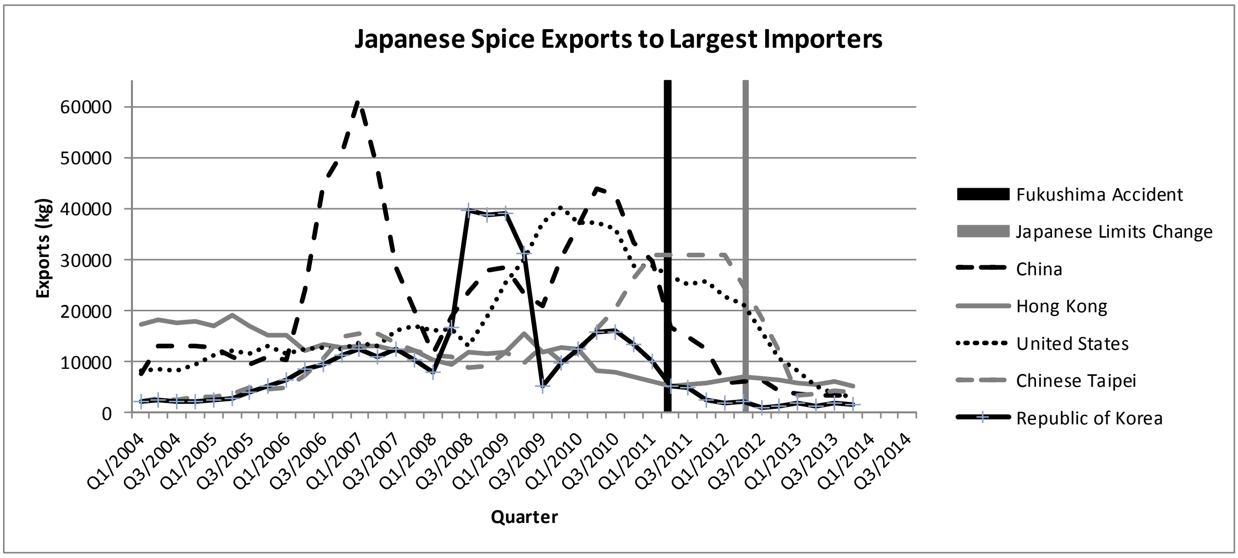
Scallops other than live, fresh or chilled (HR Code 030729)



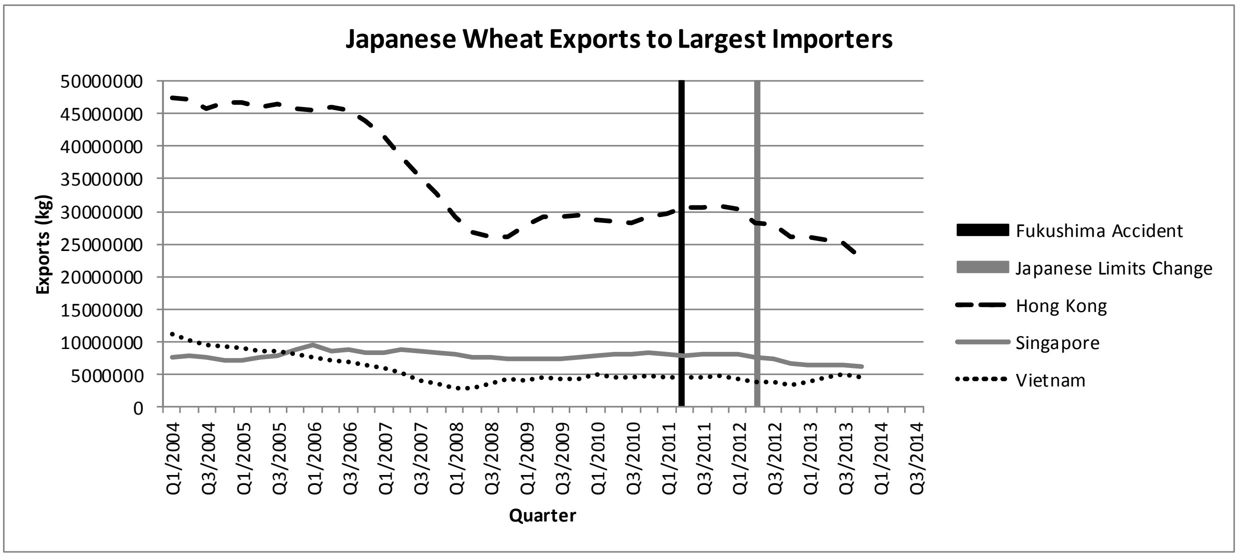
Tuna Skipjack, stripe-bellied bonito, frozen, whole (HR Code 030343)



Spice, not else ware specified (HR Code 091099)



Wheat or meslin flour (HR Code 110100)

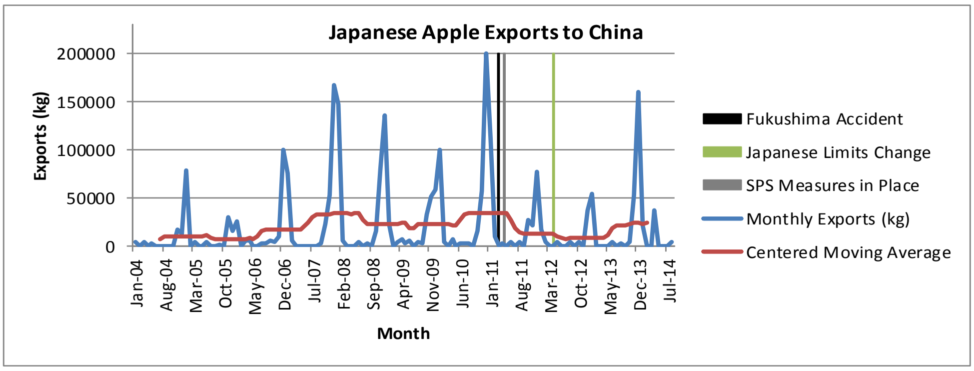


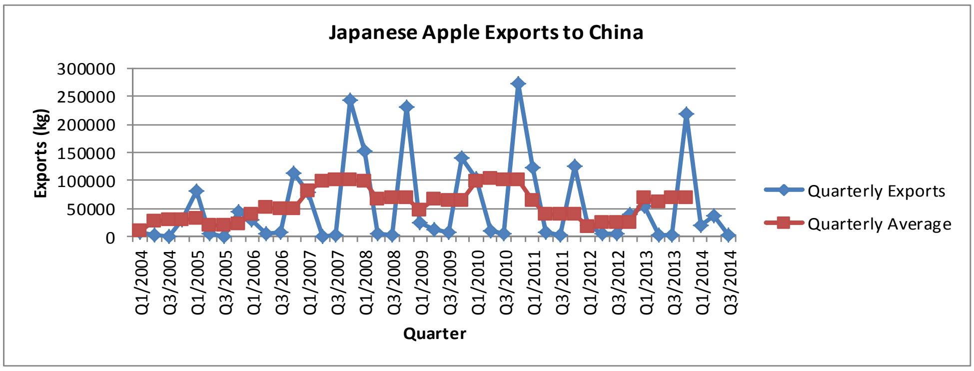
ANNEX B

Export volumes by commodity to export partners

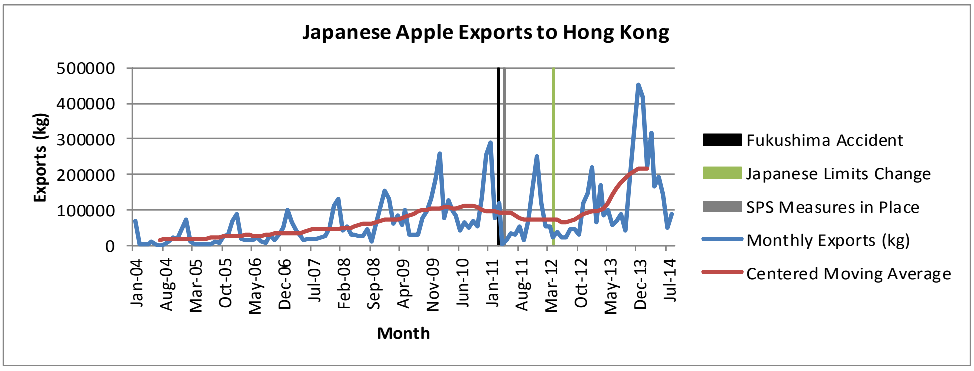
Apples, fresh (HR Code 080810)

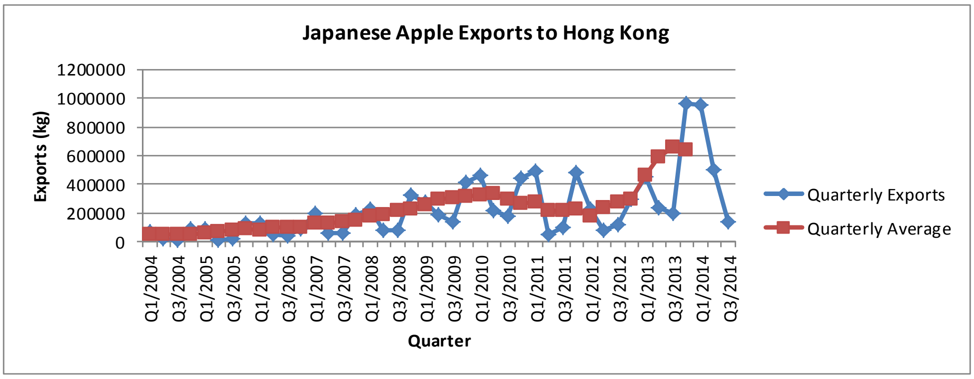
i. China





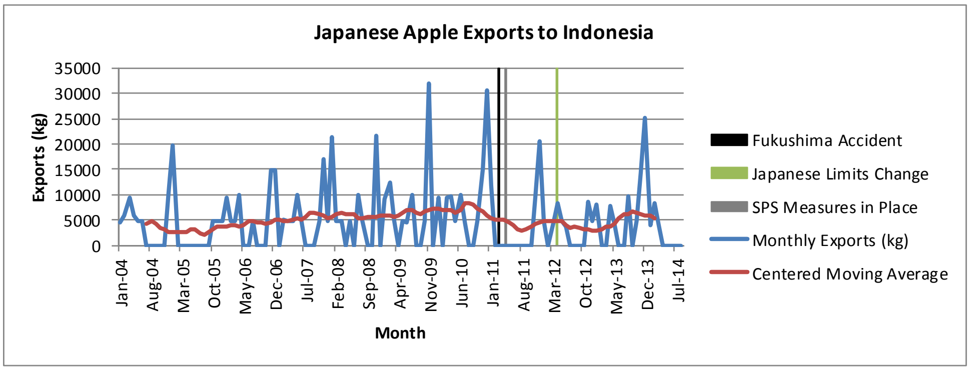
ii. Hong Kong

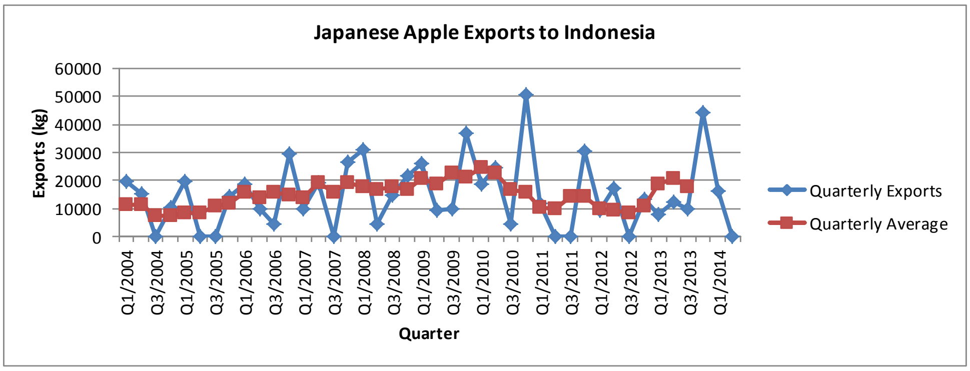




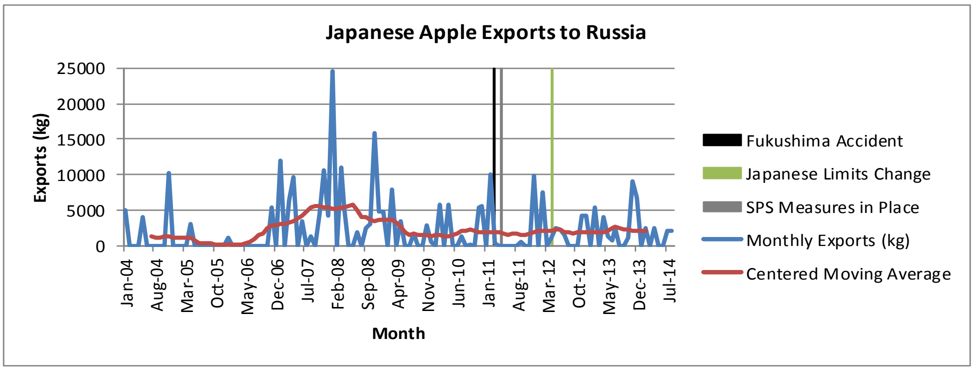
Apples, fresh (HR Code 080810)

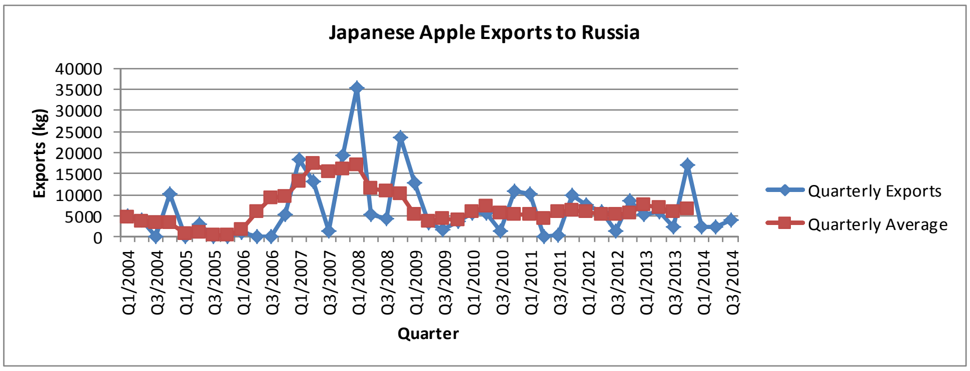
iii. Indonesia





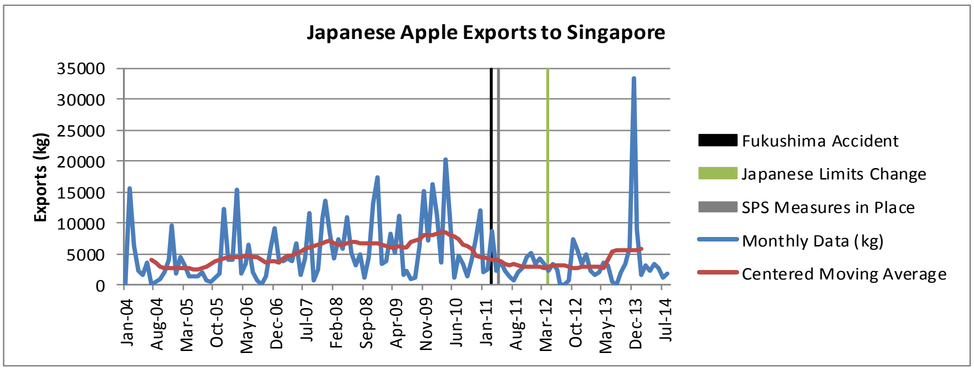
iv. Russia

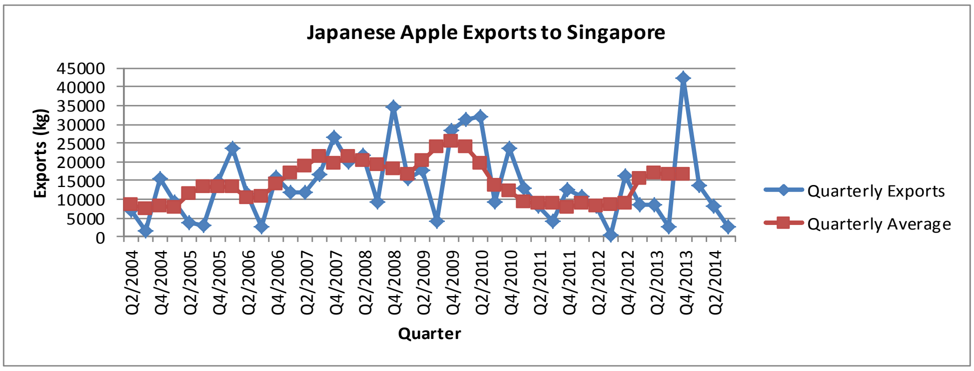




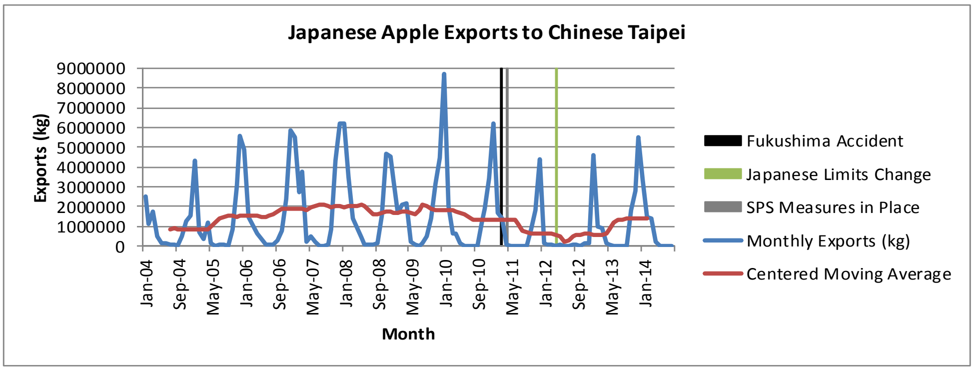
Apples, fresh (HR Code 080810)

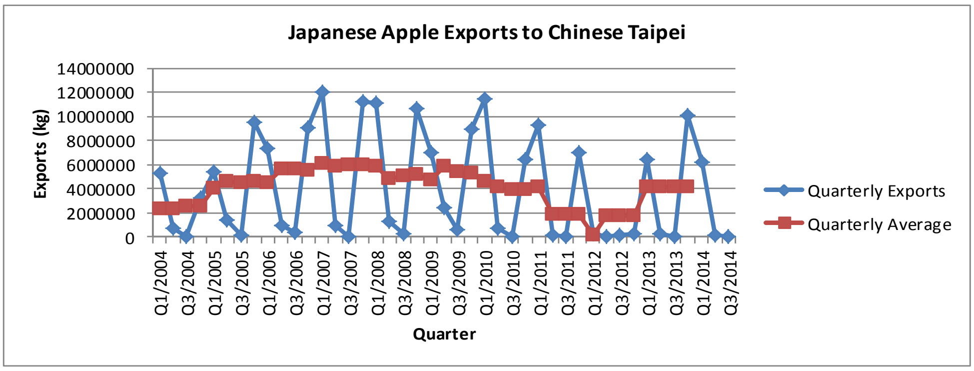
v. Singapore





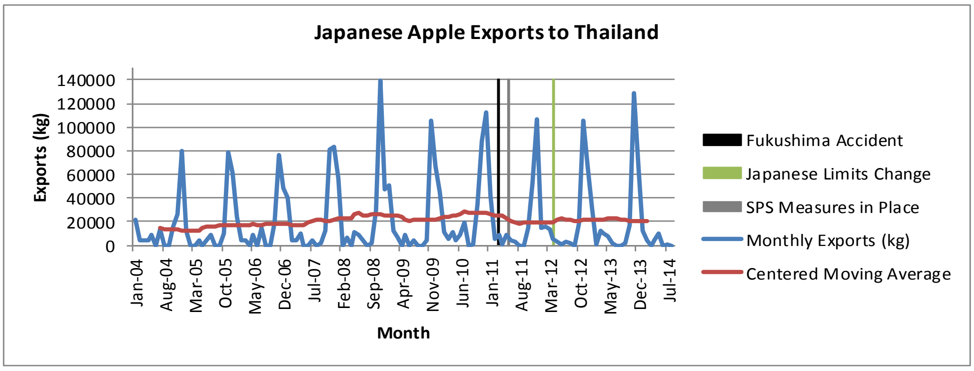
vi. Chinese Taipei

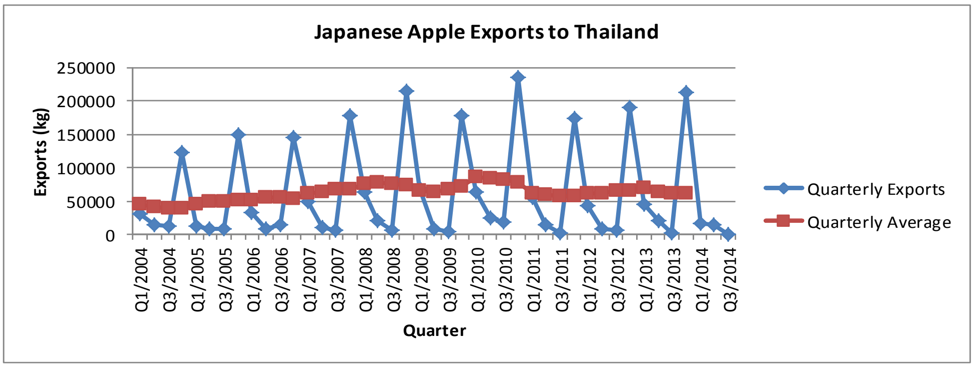




Apples, fresh (HR Code 080810)

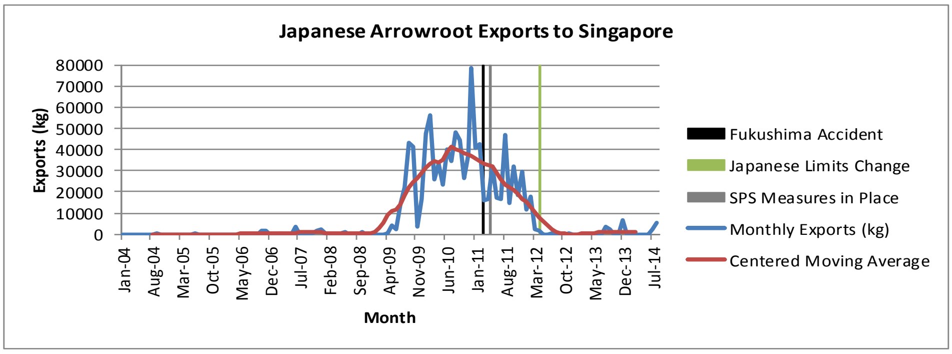
vii. Thailand

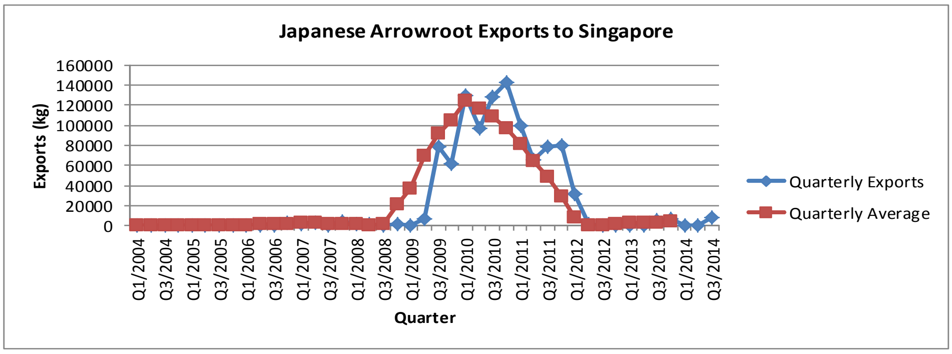




Arrowroot, salep, etc. fresh or dried and sago pith (HR Code 071490)

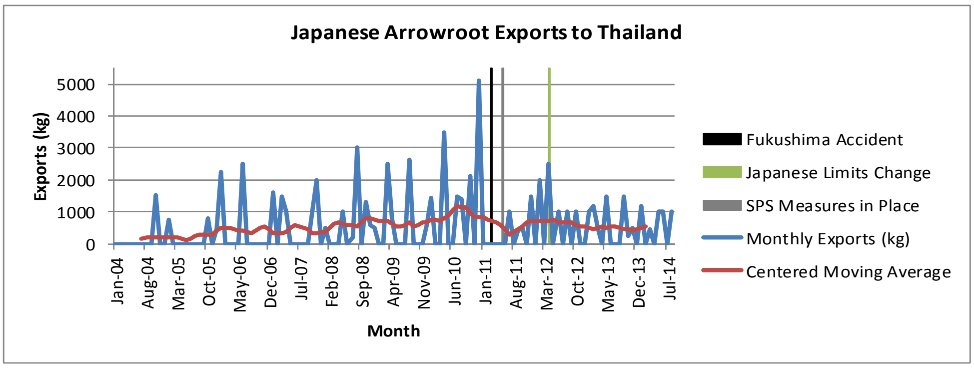
i. Singapore

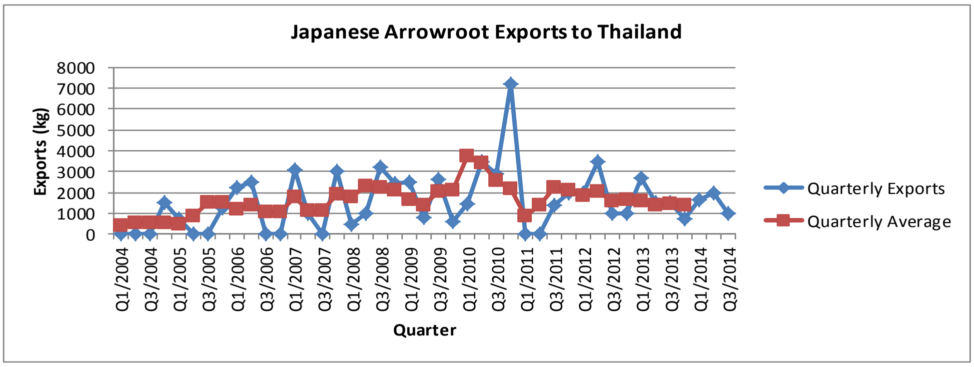




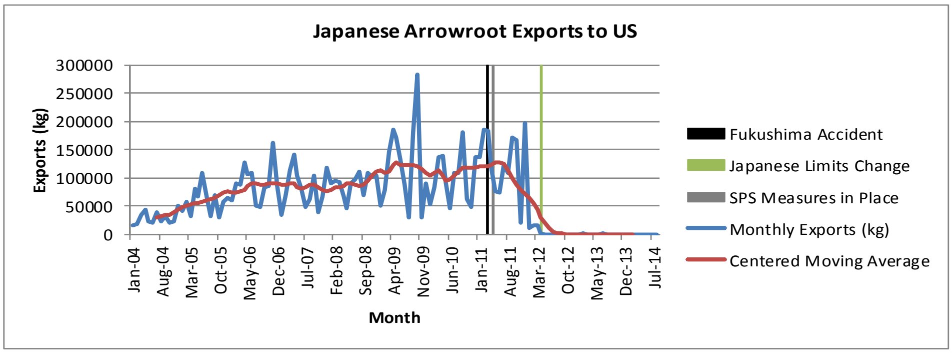
ii. Chinese Taipei

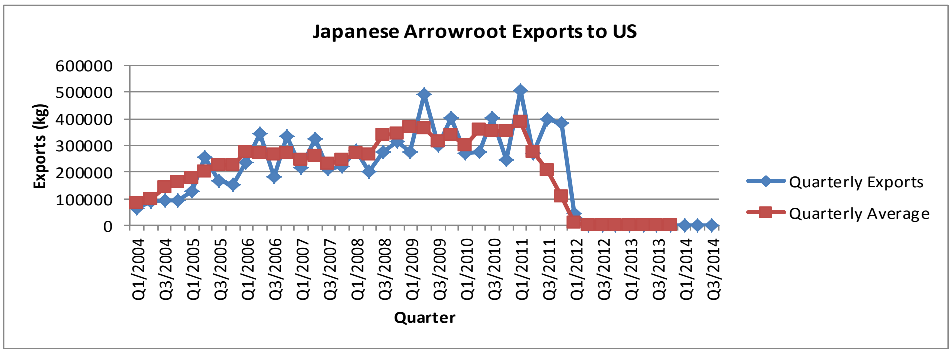
iii. Thailand





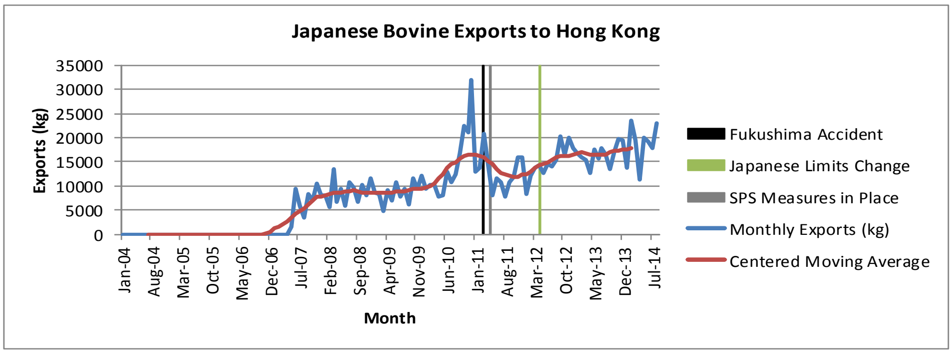
iv. United States

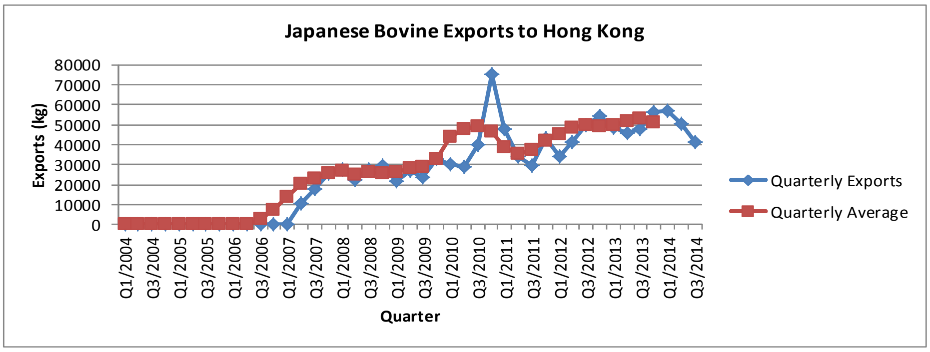




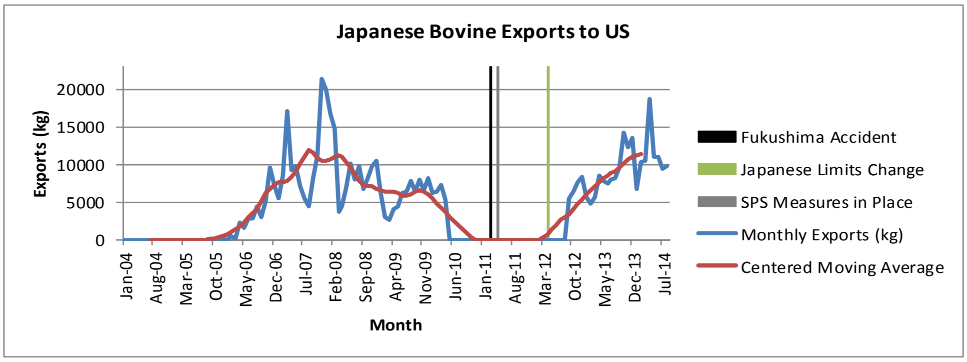
Bovine cuts boneless, fresh or chilled (HR Code 20130)

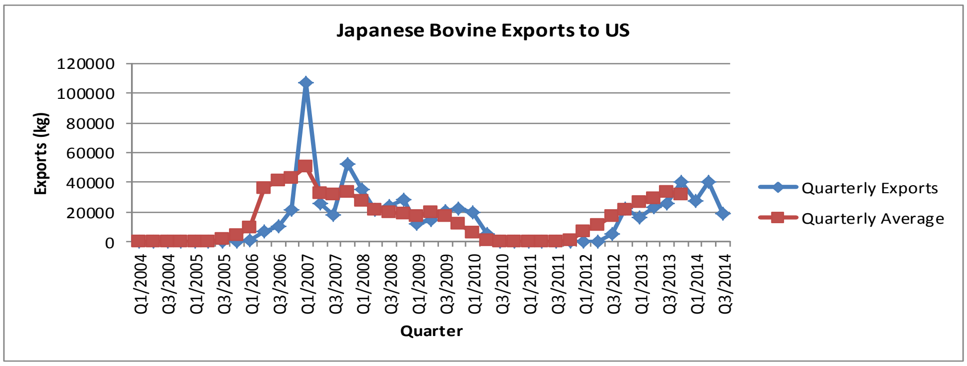
i. Hong Kong




Japanese Bovine Exports to Hong Kong
80000
70000
60000
50000
40000
30000
20000
10000
0
Exports (kg)
Q1/2004
Q3/2004
Q1/2005
Q3/2005
Q1/2006
Q3/2006
Q1/2007
Q3/2007
Q1/2008
Q3/2008
Q1/2009
Q3/2009
Q1/2010
Q3/2010
Q1/2011
Q3/2011
Q1/2012
Q3/2012
Q1/2013
Q3/2013
Q1/2014
Q3/2014
Quarter
Quarterly Exports
Quarterly Average

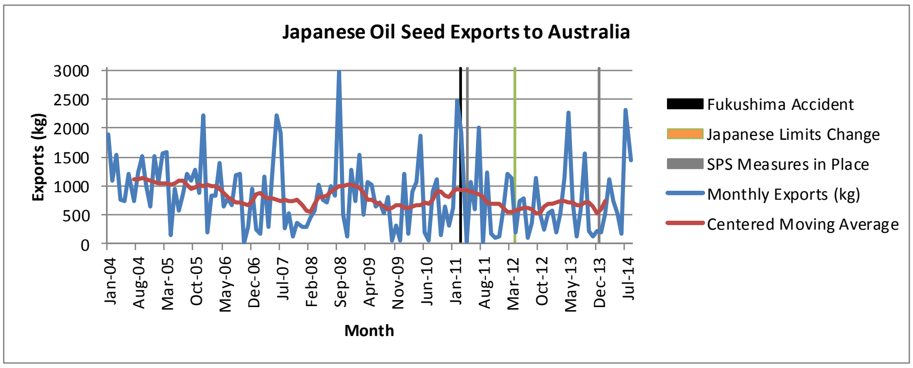
ii. United States

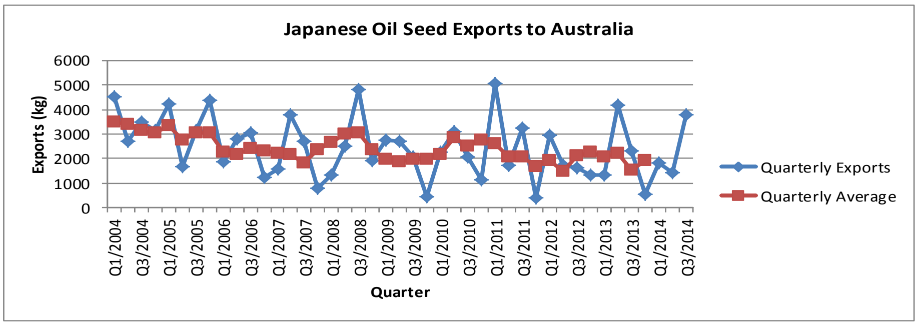




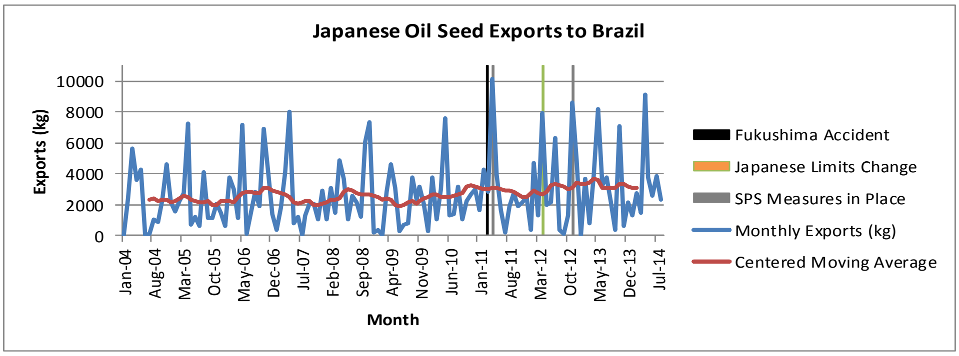
Oil seeds and oleaginous fruits; plants (HR Code 120991) miscellaneous grains, seeds and fruit; industrial or medicinal

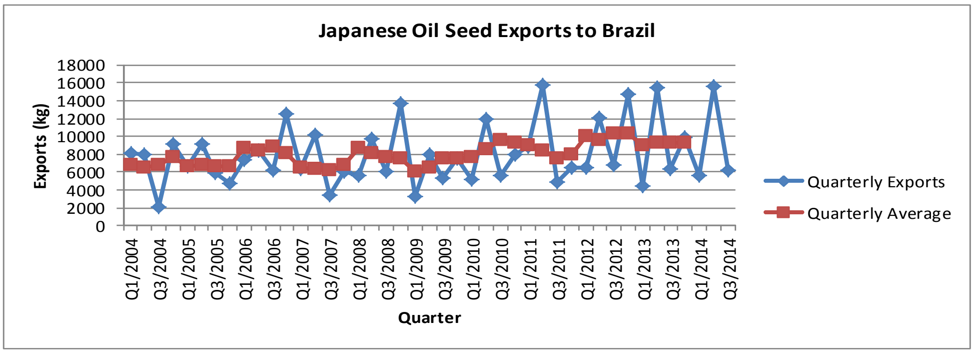
i. Australia





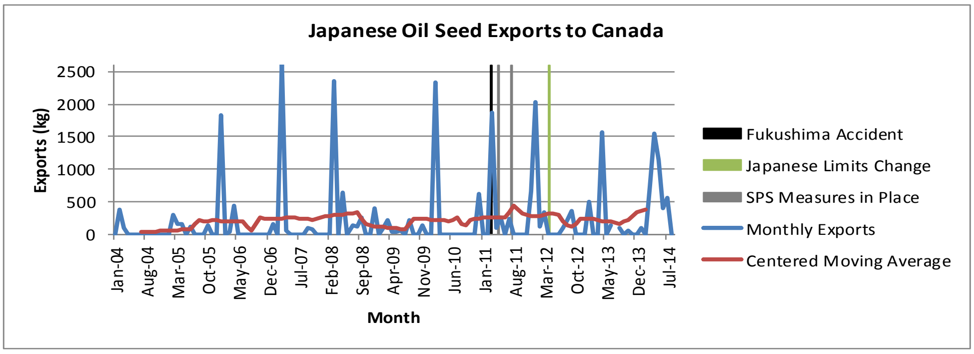
ii. Brazil

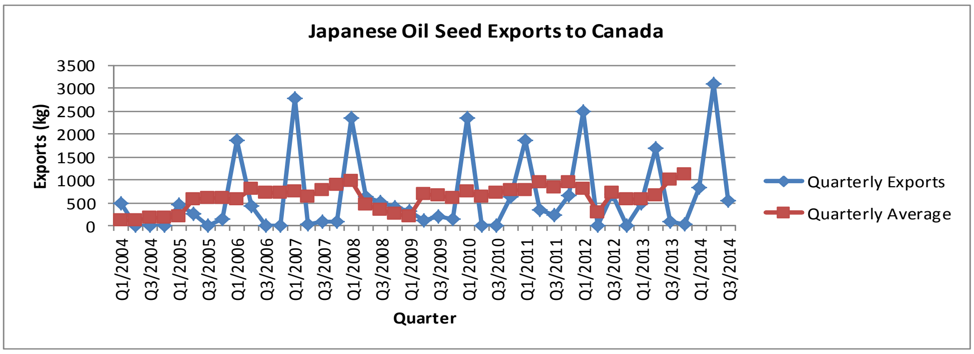




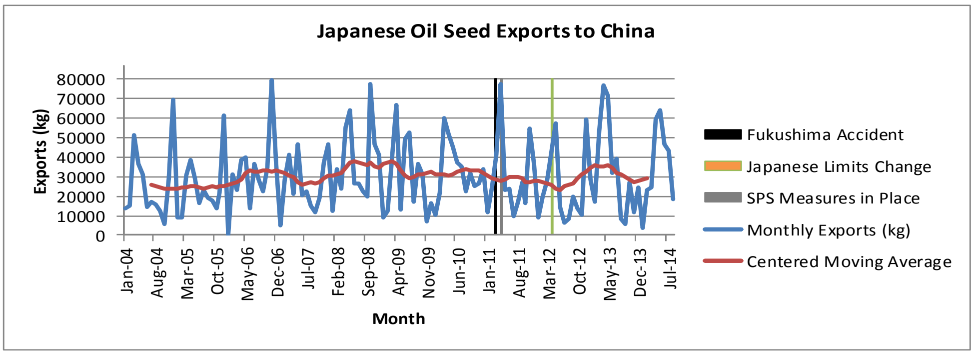
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants (HR Code 120991)

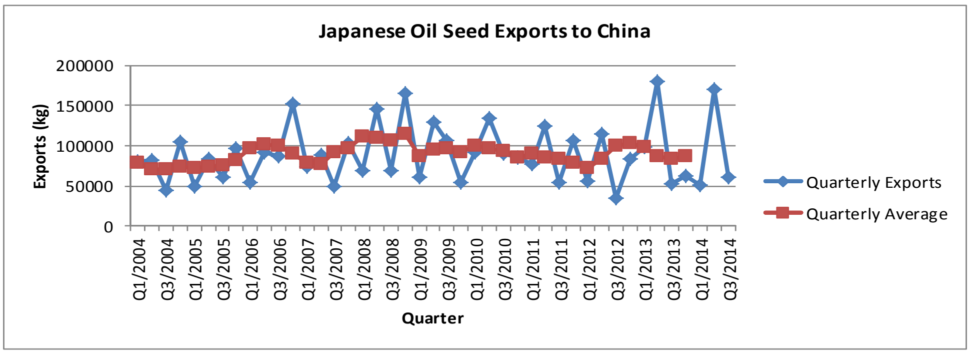
ii. Canada





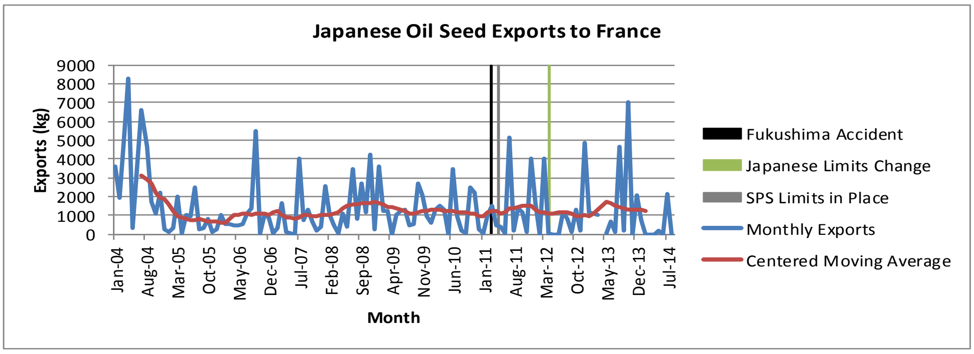
iii. China

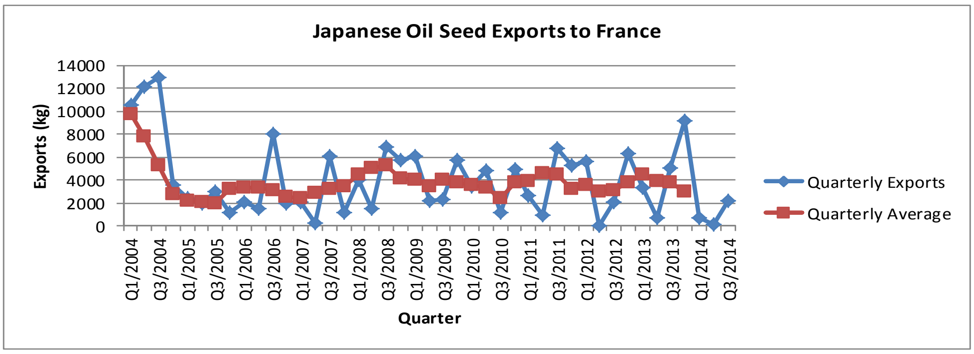




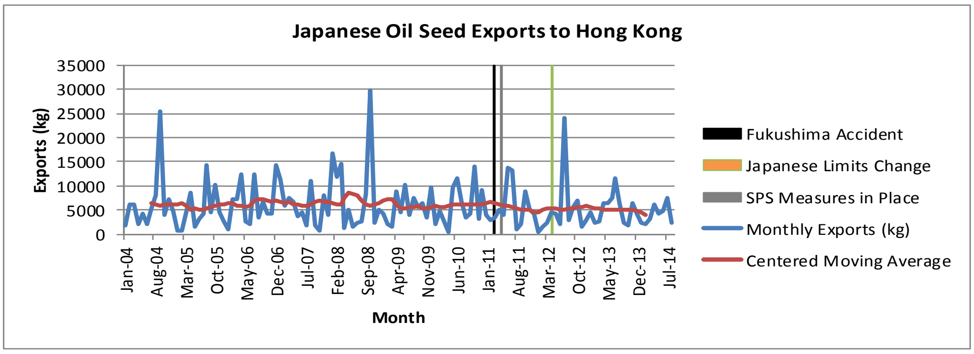
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants (HR Code 120991)

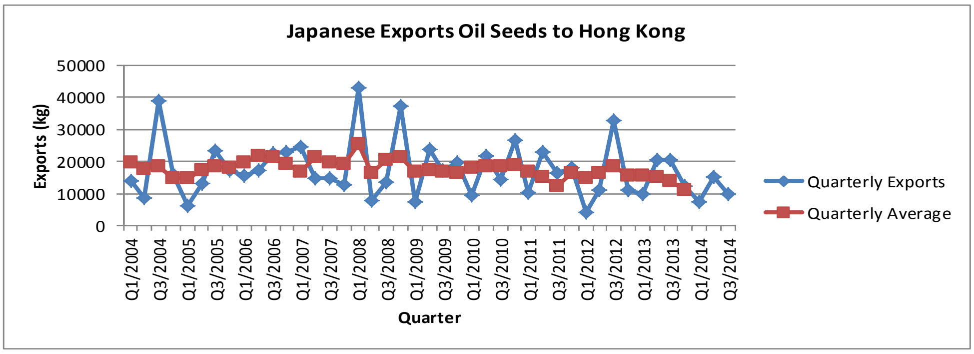
iv. France





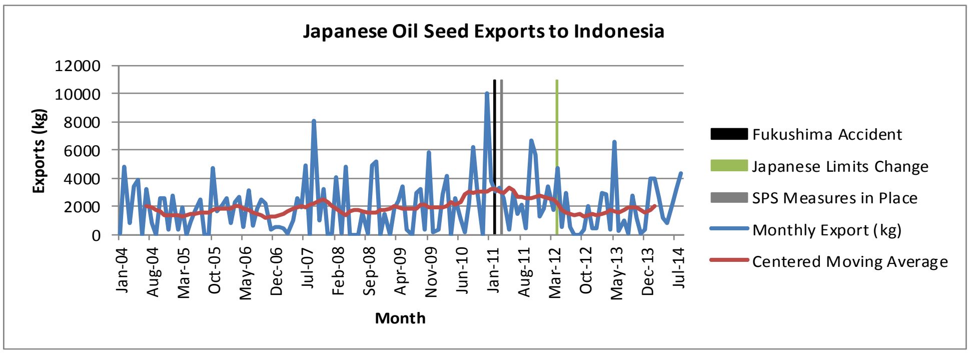
v. Hong Kong

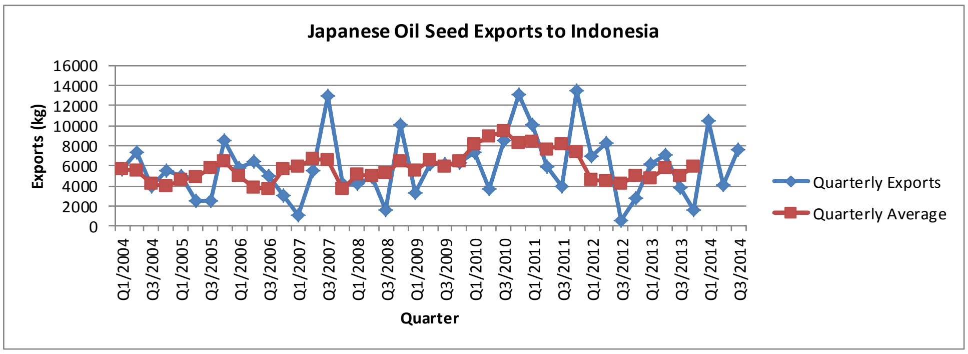




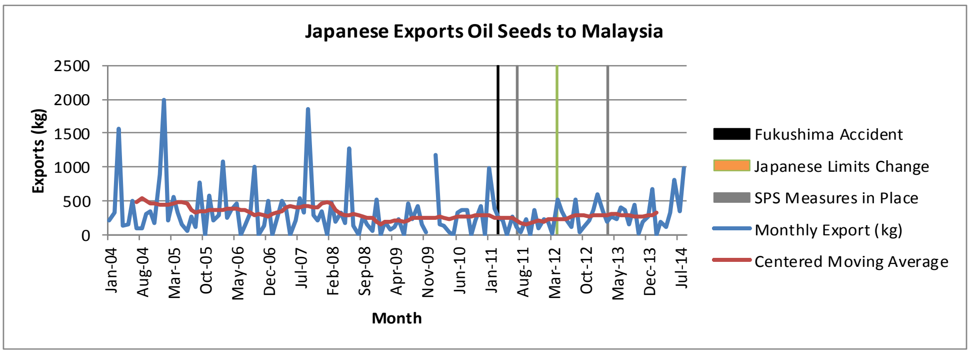
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants (HR Code 120991)

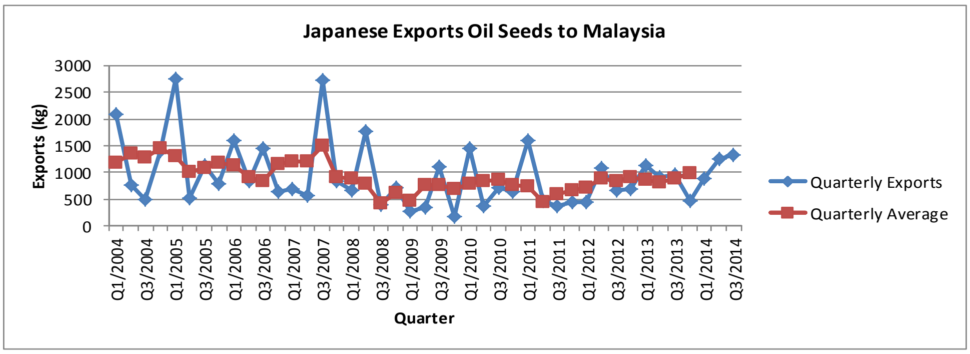
vi. Indonesia





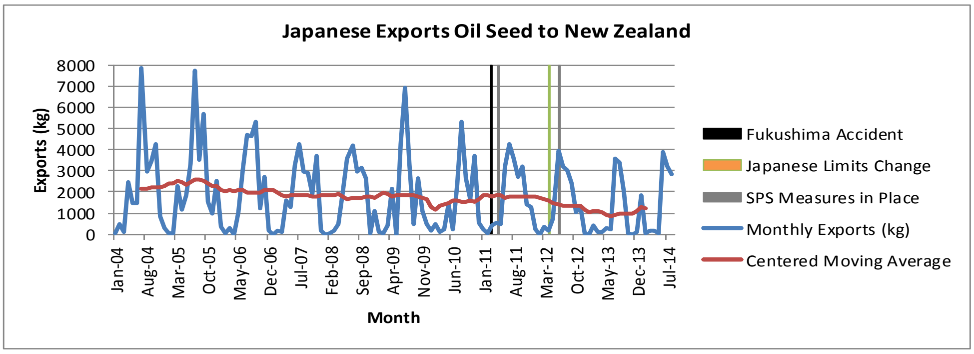
vii. Malaysia

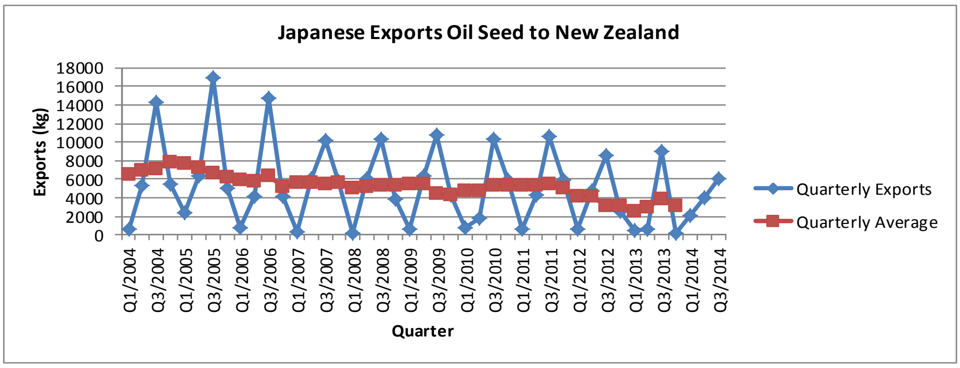




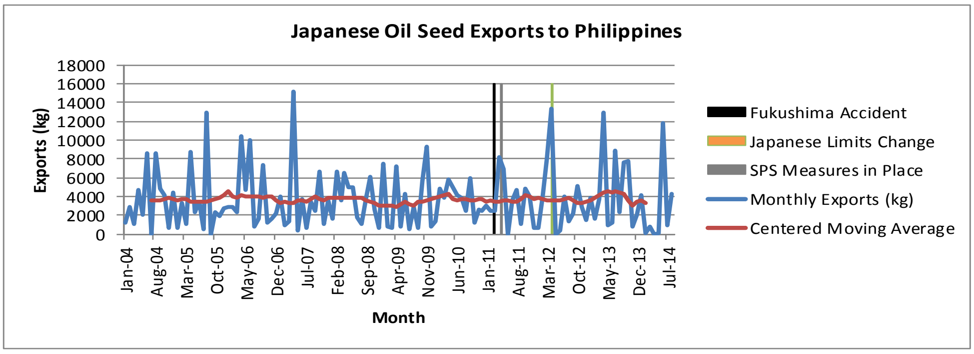
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants (HR Code 120991)

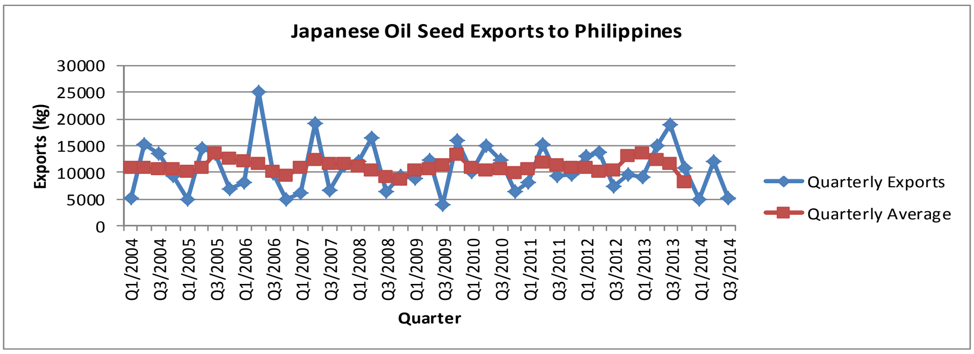
vii. New Zealand





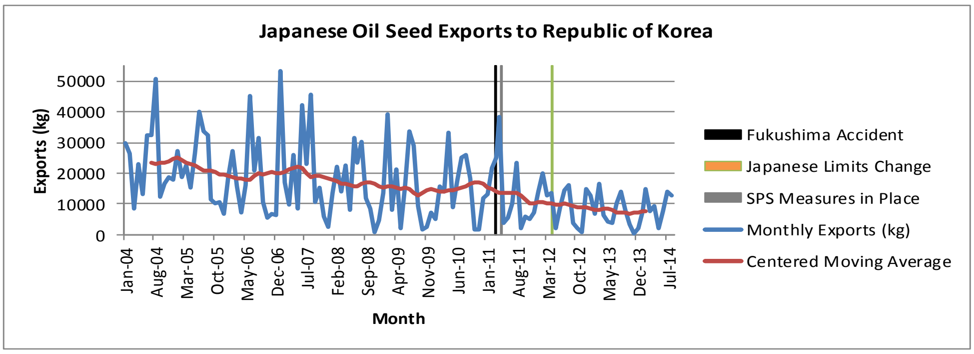
ix. Philippines

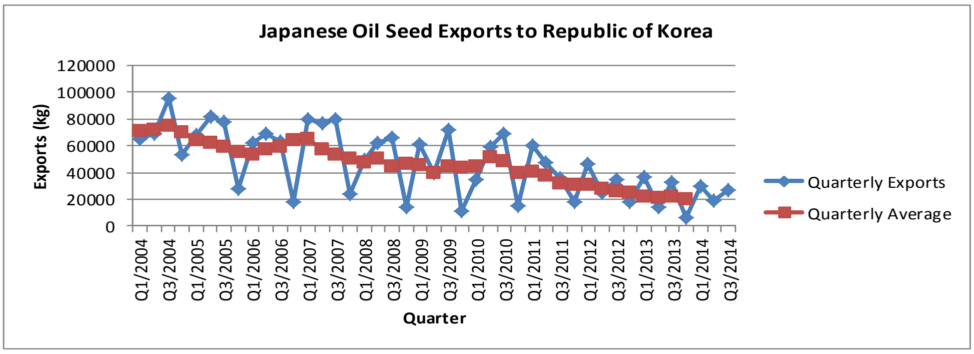




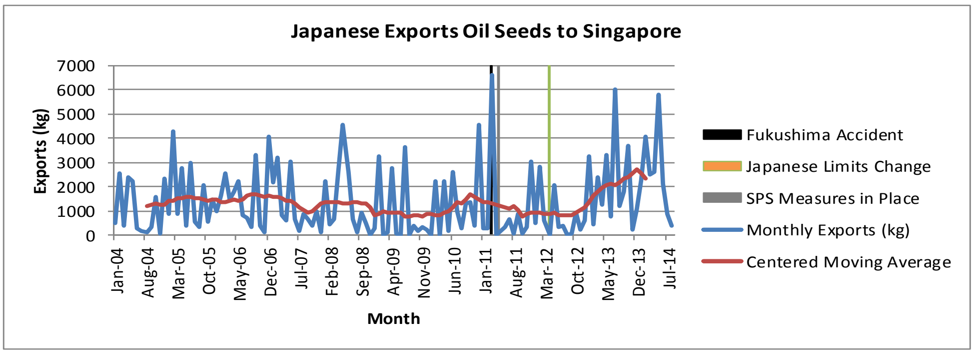
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants (HR Code 120991)

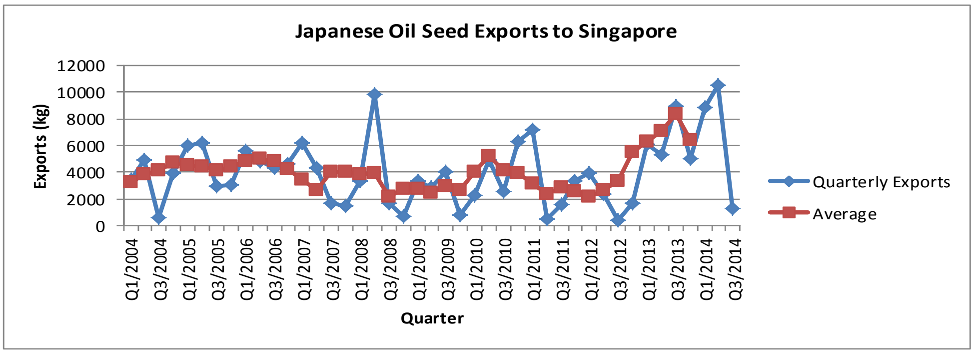
x. Republic of Korea





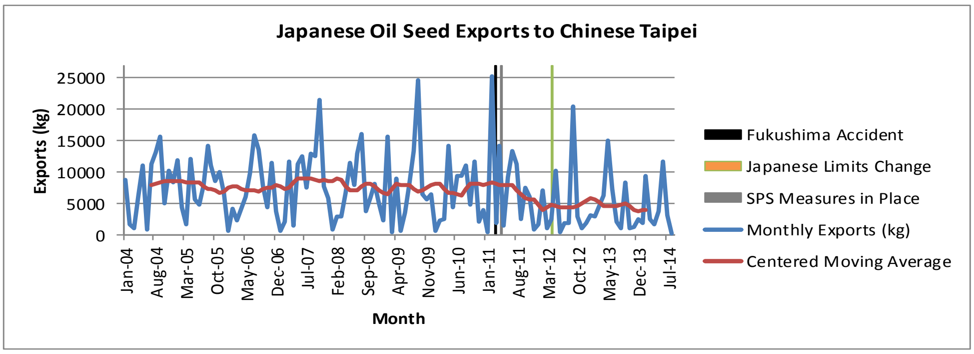
xii. Singapore

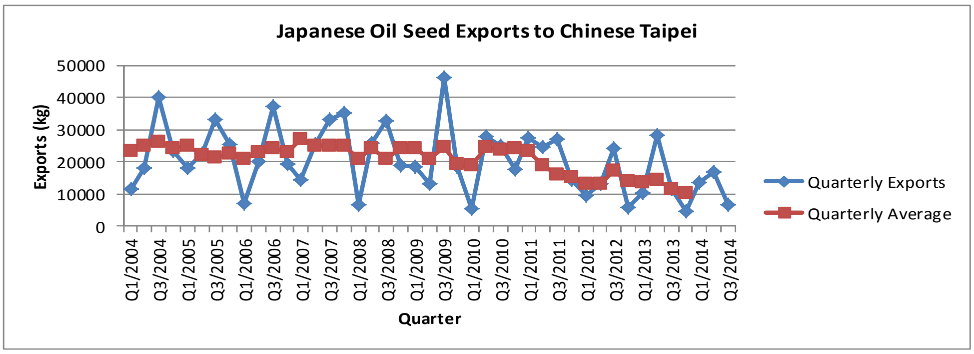




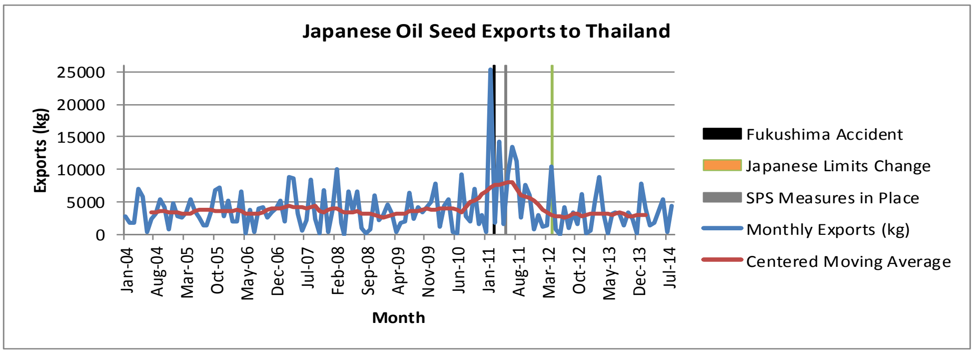
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants (HR Code 120991)

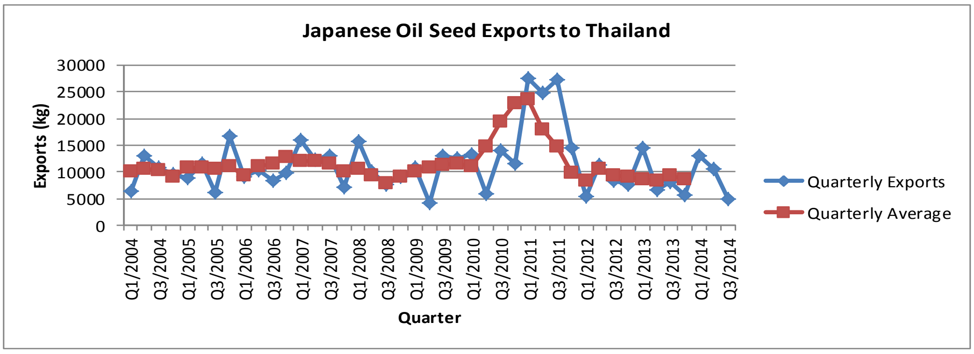
xiii. Chinese Taipei





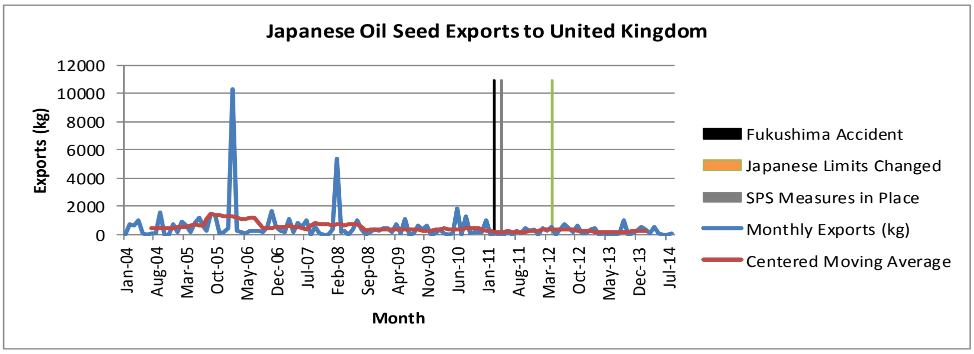
xiv. Thailand

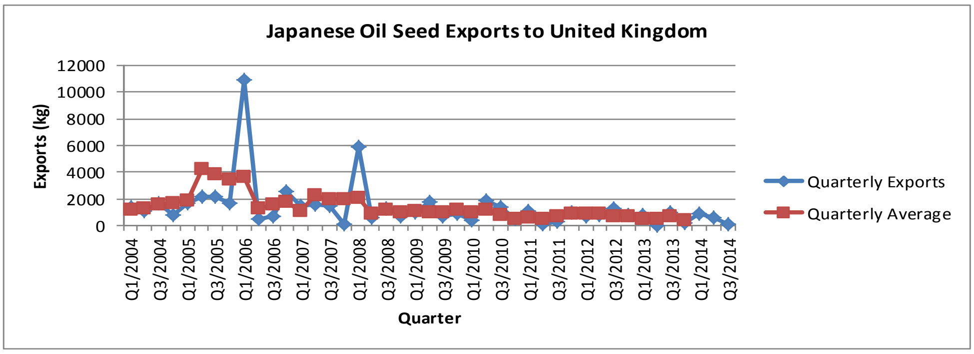




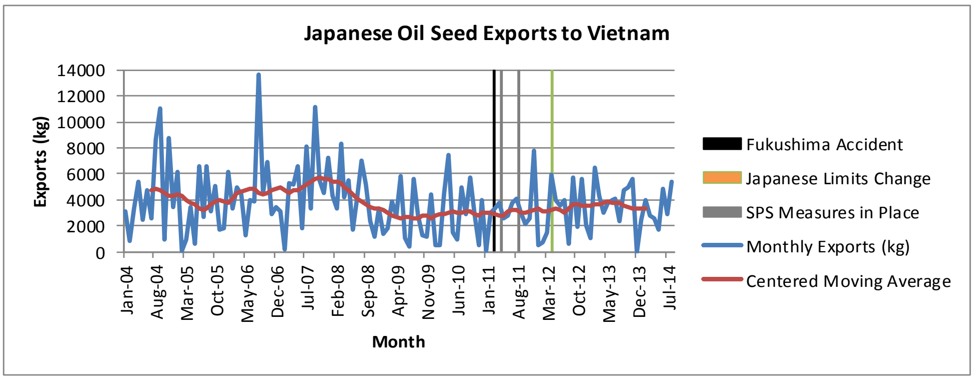
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants (HR Code 120991)

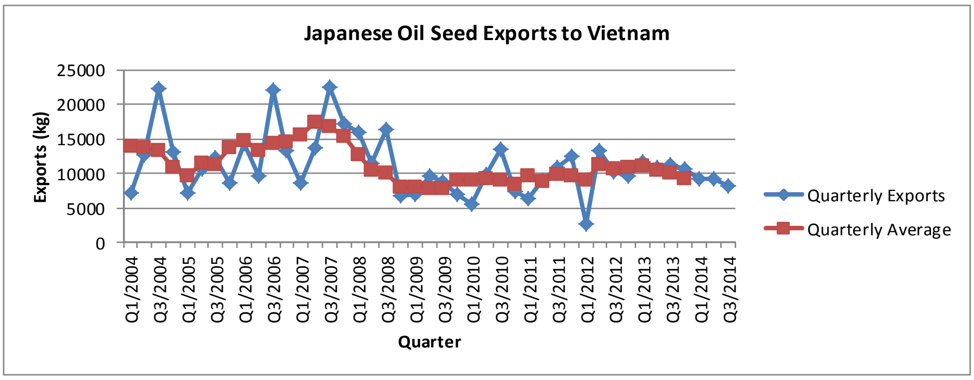
xv. United Kingdom





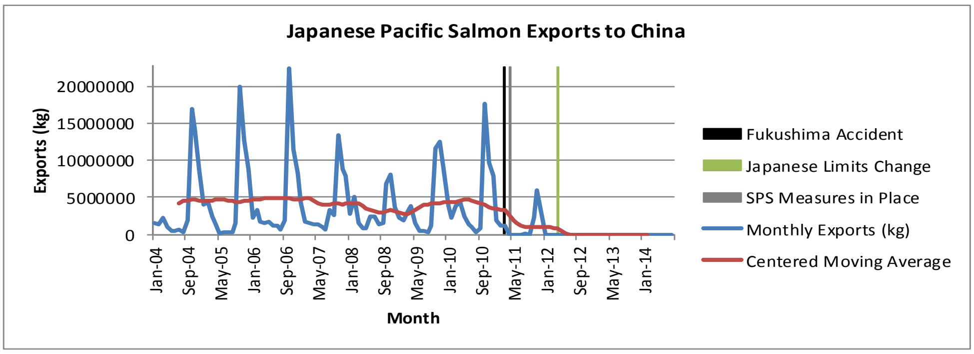
xvi. Viet Nam

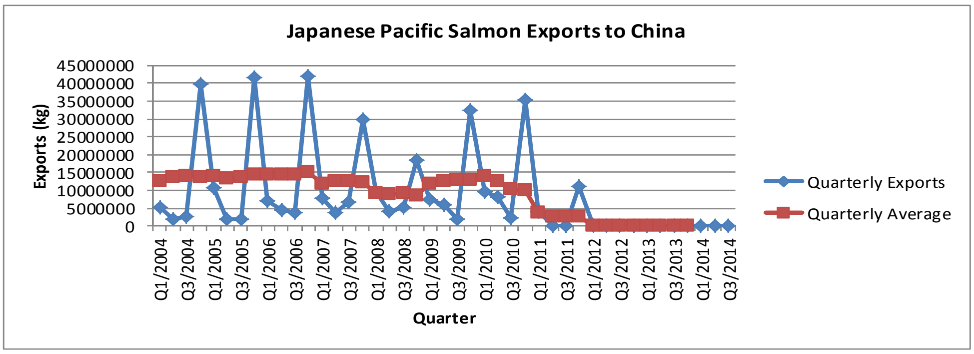




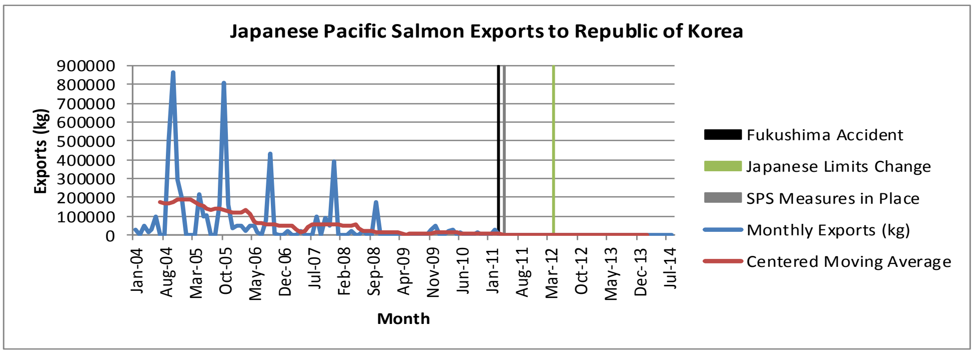
Pacific salmon, frozen (HR Code 030319)

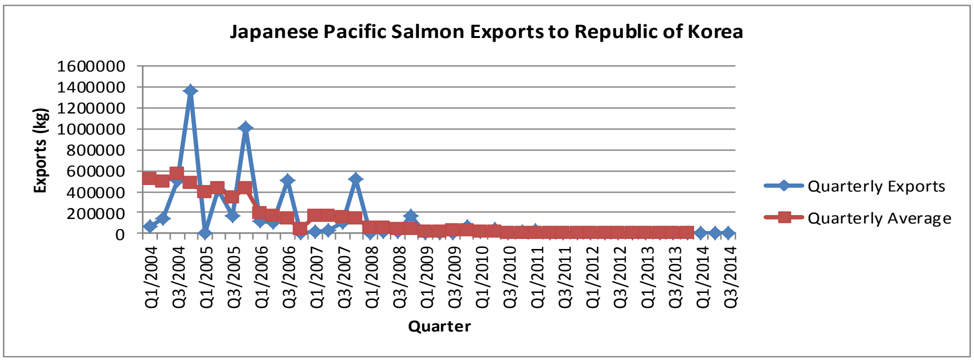
i. China





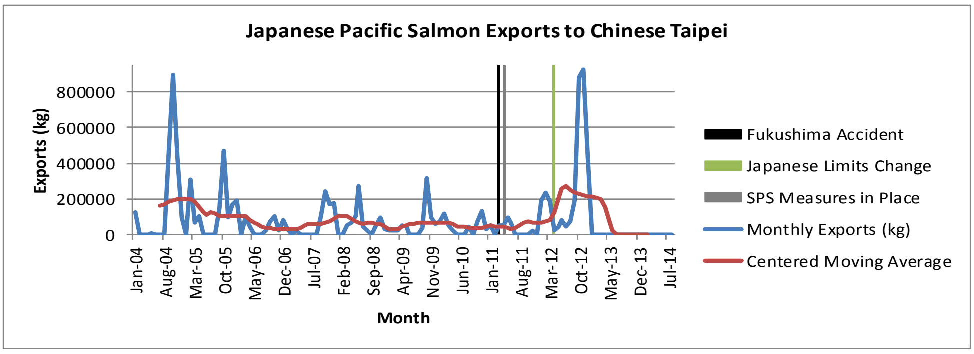
ii. Korea

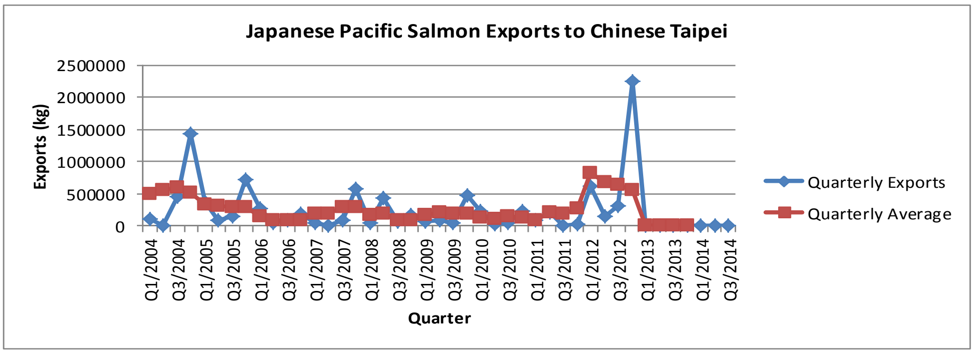




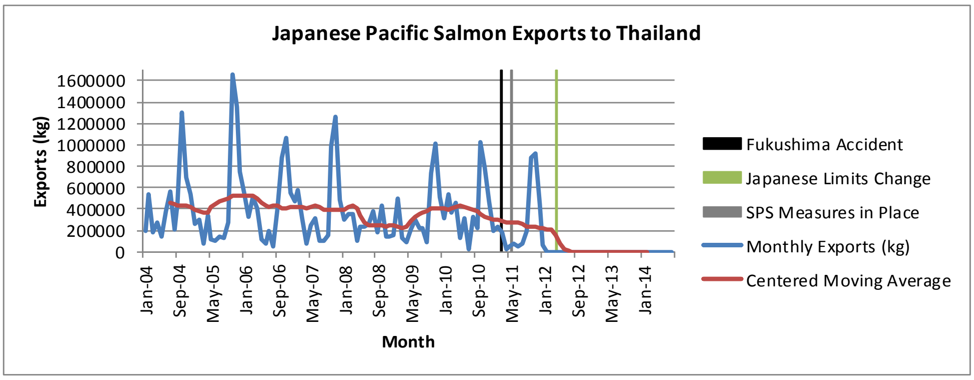
Pacific salmon, frozen (HR Code 030319)

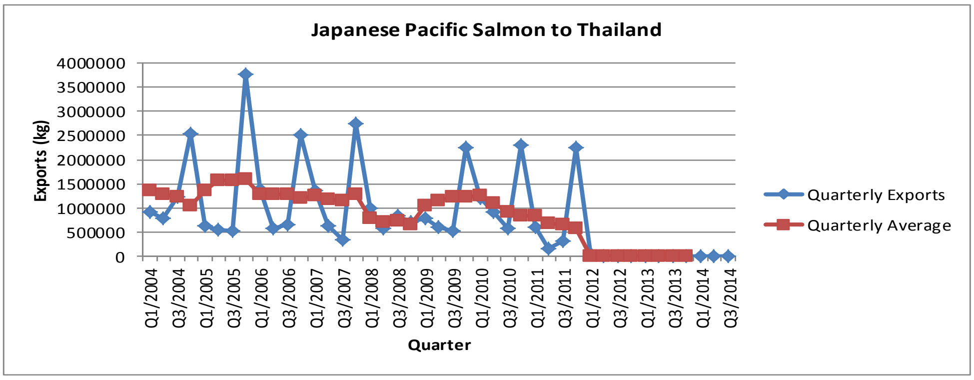
iii. Chinese Taipei





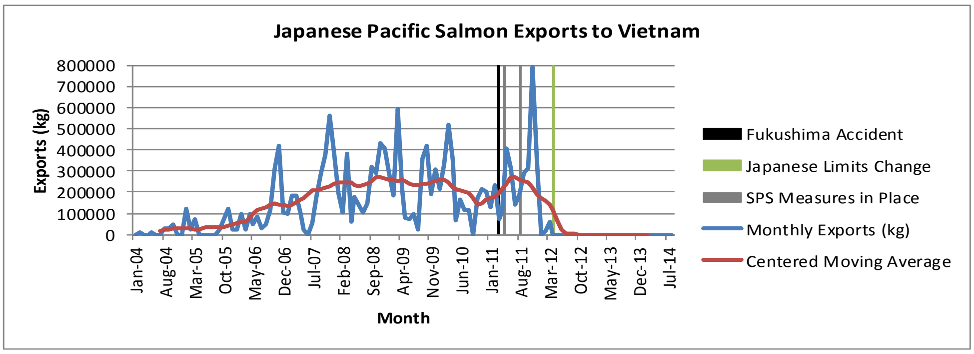
iv. Thailand

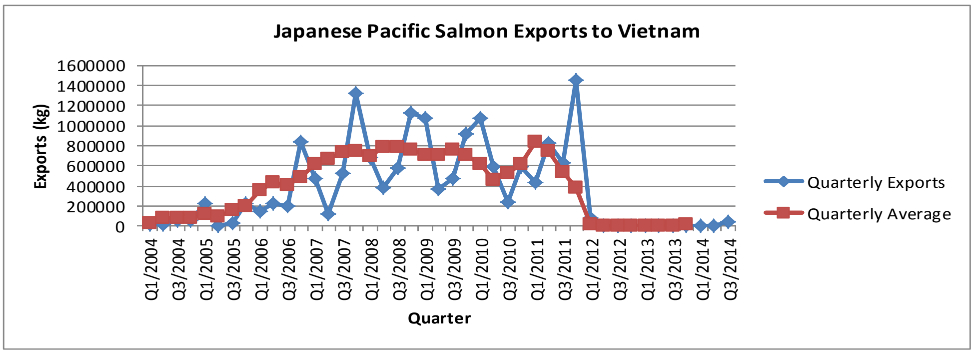




Pacific salmon, frozen (HR Code 030319)

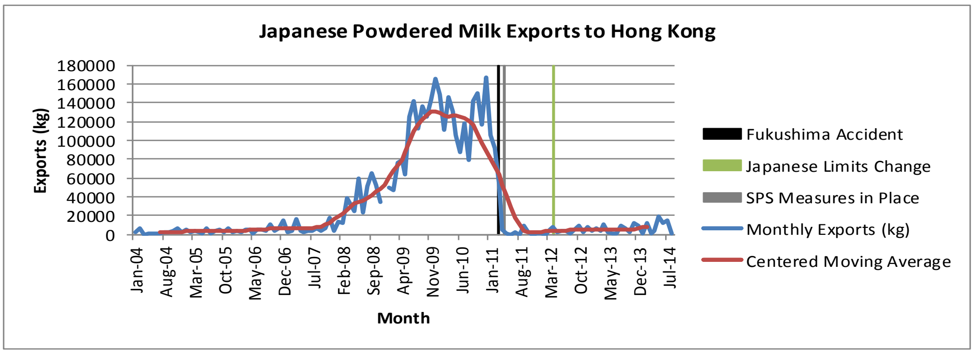
v. Viet Nam

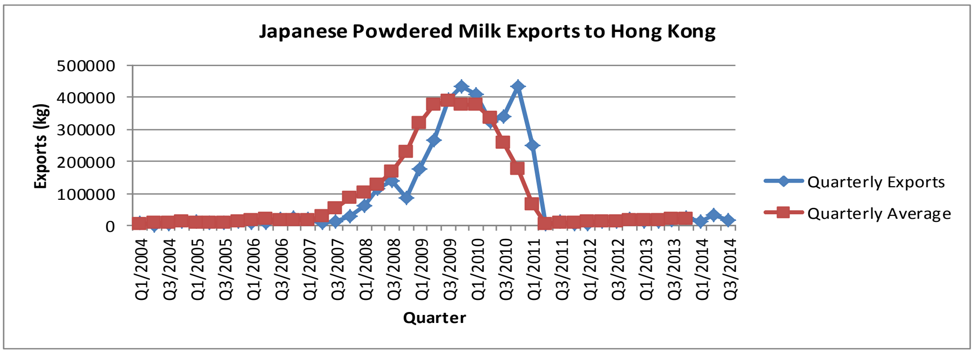




Milk and cream powder sweetened < 1.5% fat (HR Code 040229)

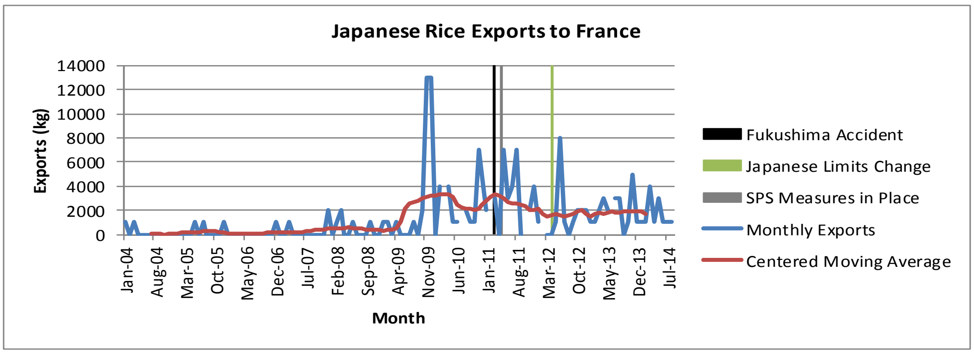
i. Hong Kong

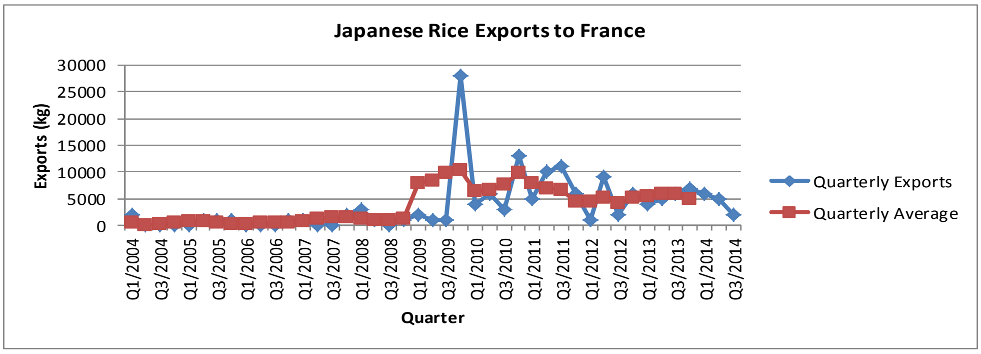




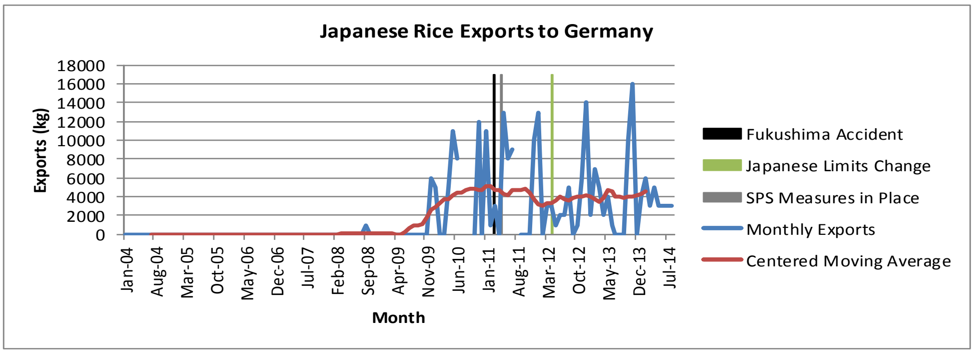
Rice, semi-milled or wholly milled (HR Code 100630)

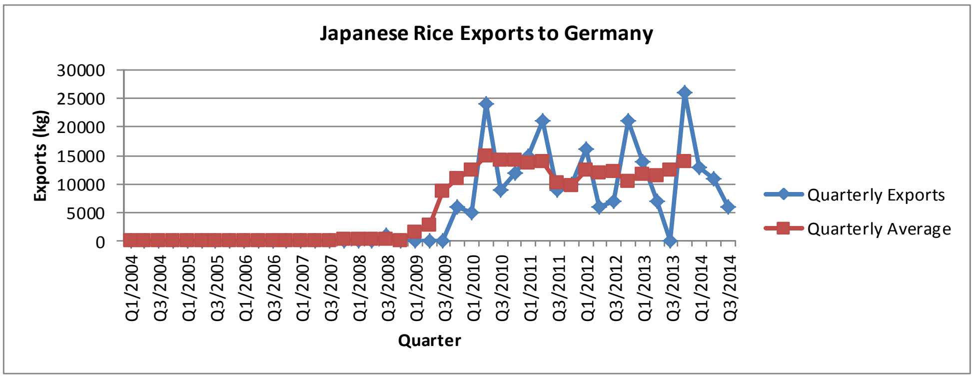
i. France





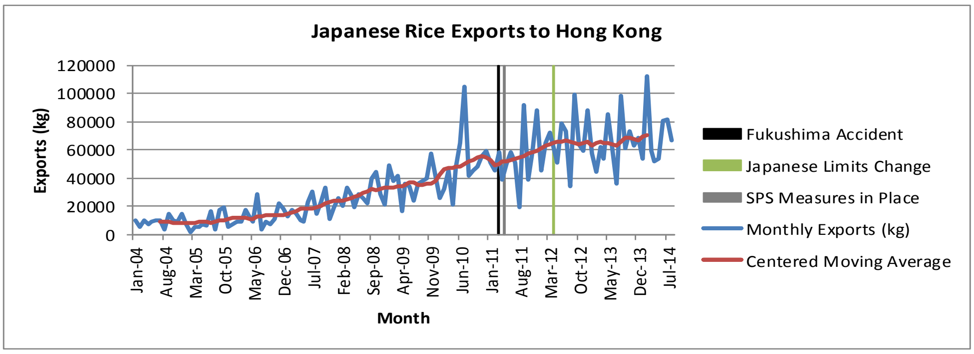
ii. Germany

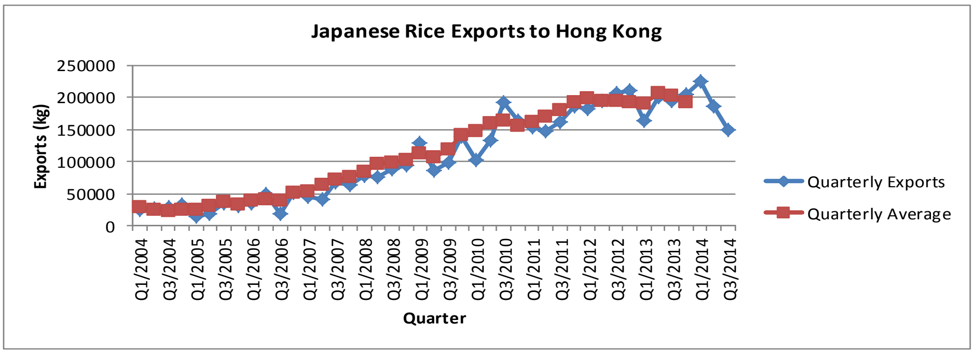




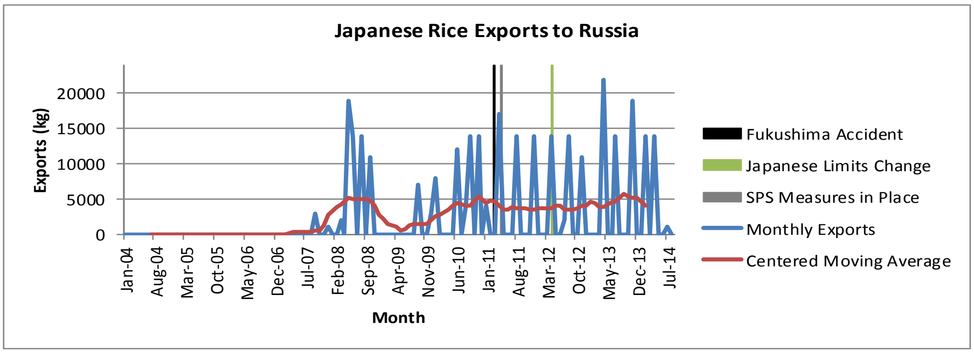
Rice, semi-milled or wholly milled (HR Code 100630)

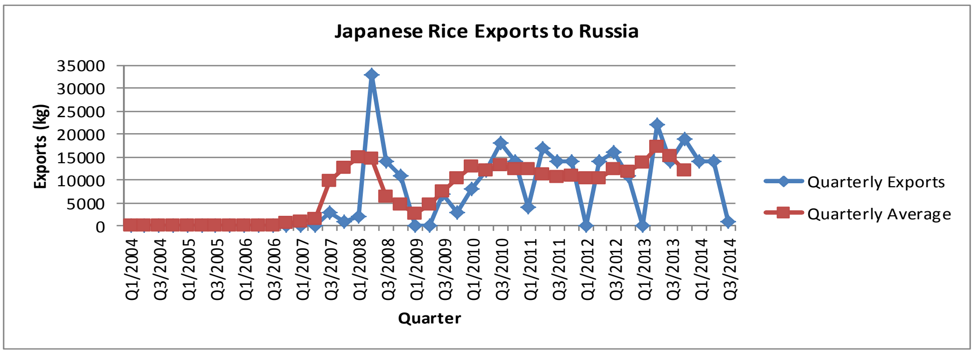
iii. Hong Kong





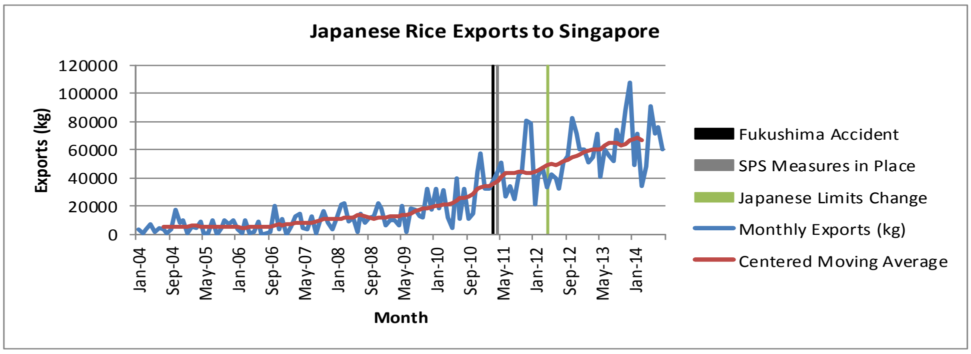
iv. Russia

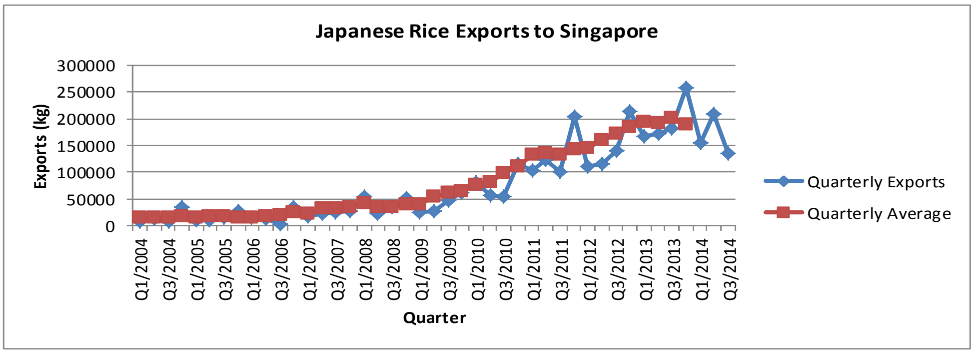




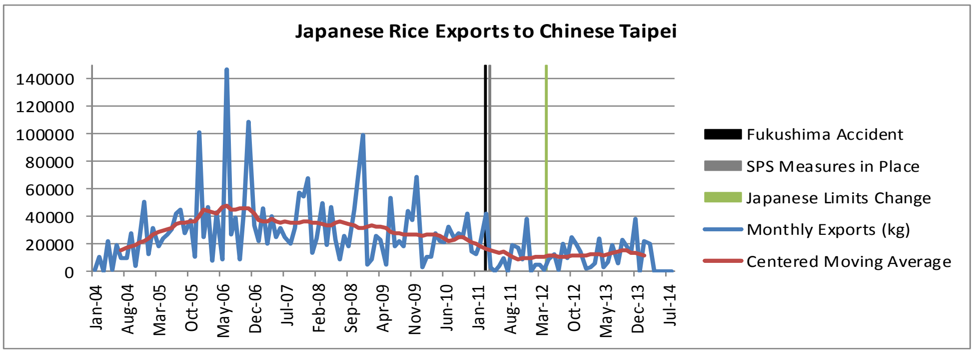
Rice, semi-milled or wholly milled (HR Code 100630)

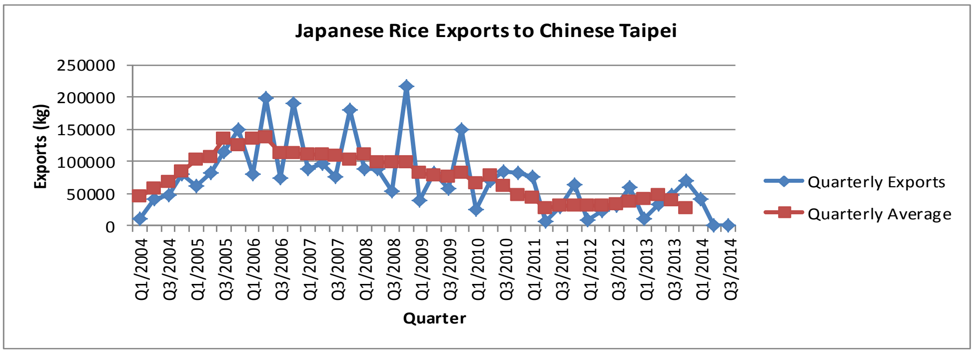
v. Singapore





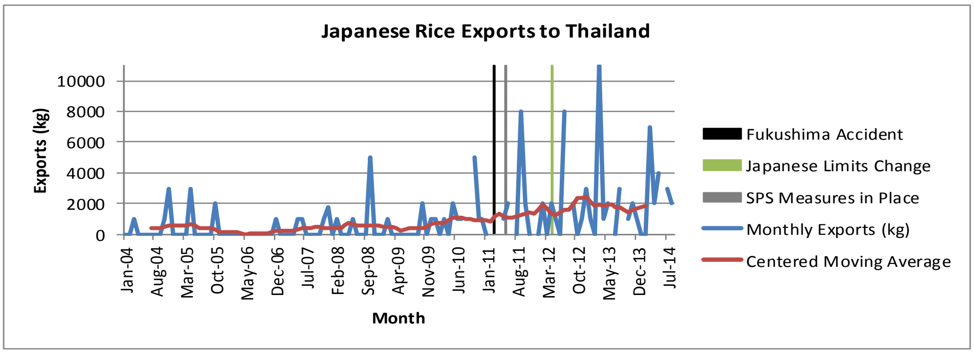
vi. Chinese Taipei

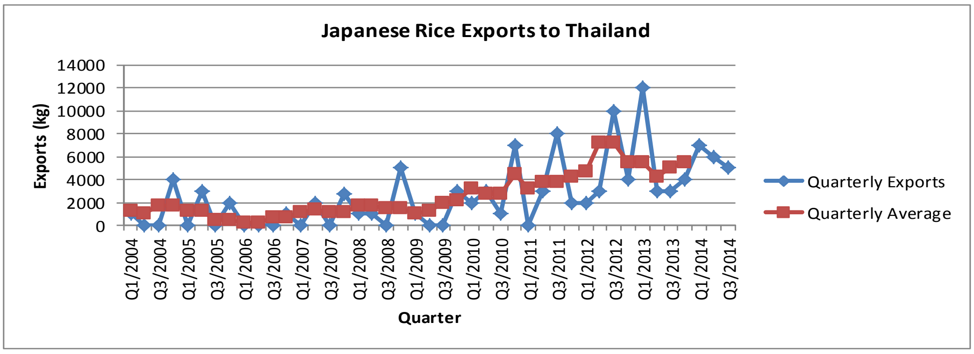




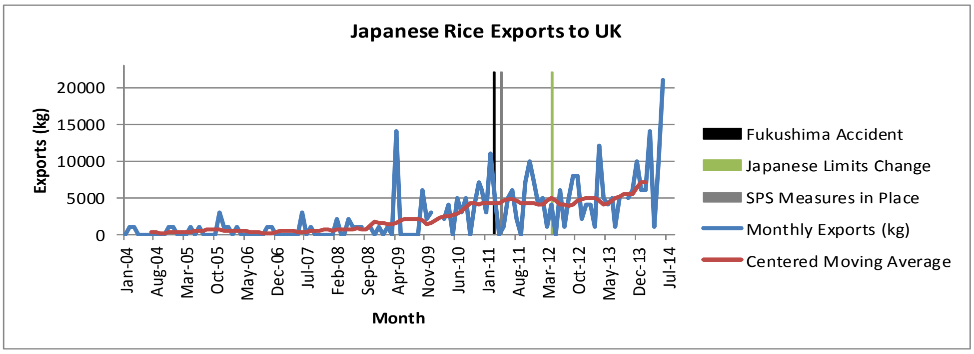
Rice, semi-milled or wholly milled (HR Code 100630)

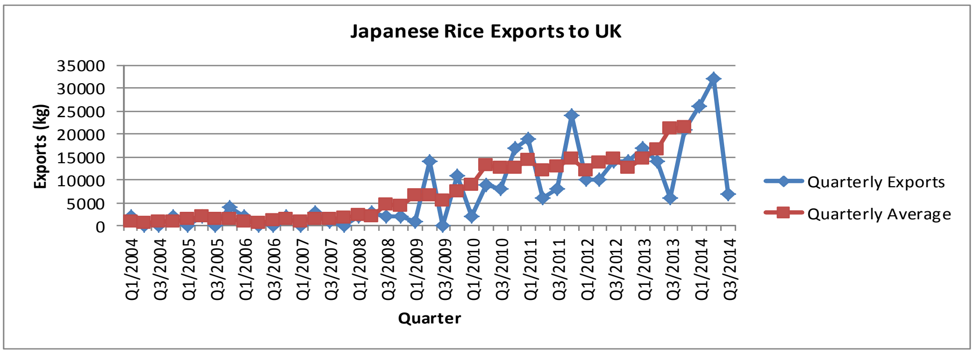
vii. Thailand





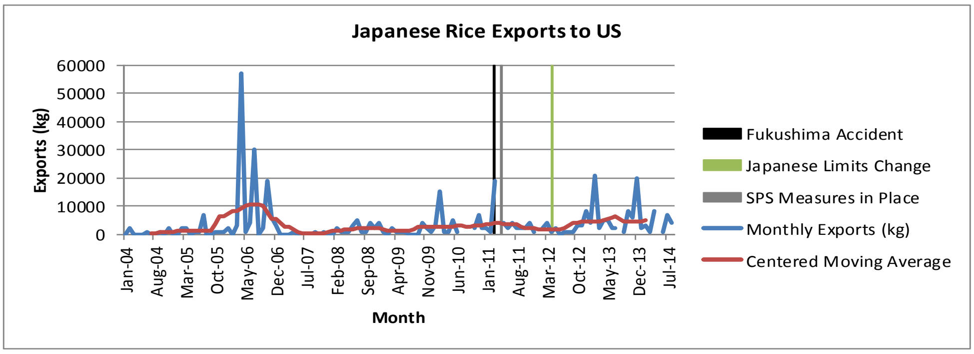
viii. United Kingdom

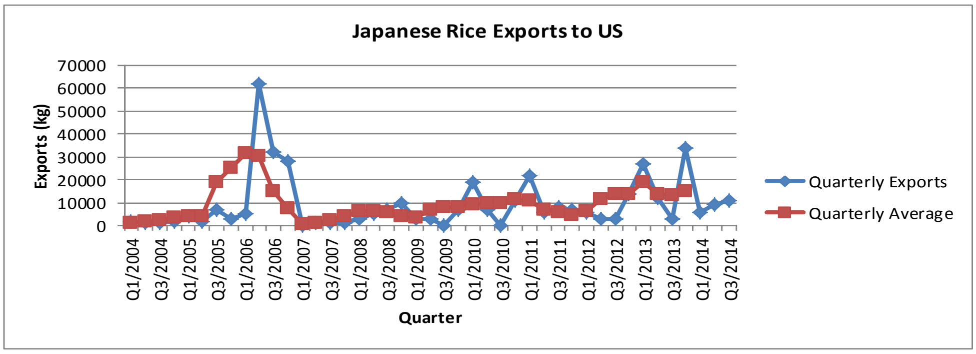




Rice, semi-milled or wholly milled (HR Code 100630)

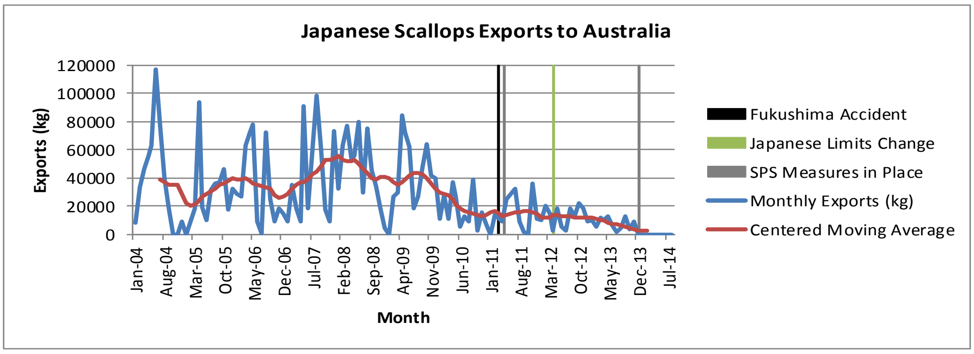
xi. United States

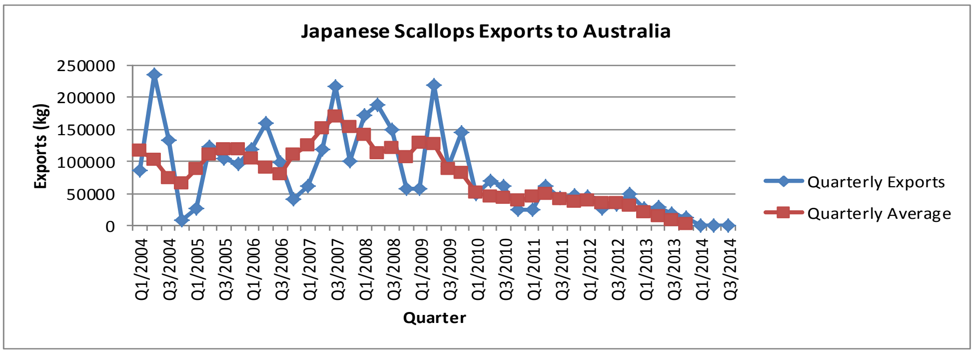




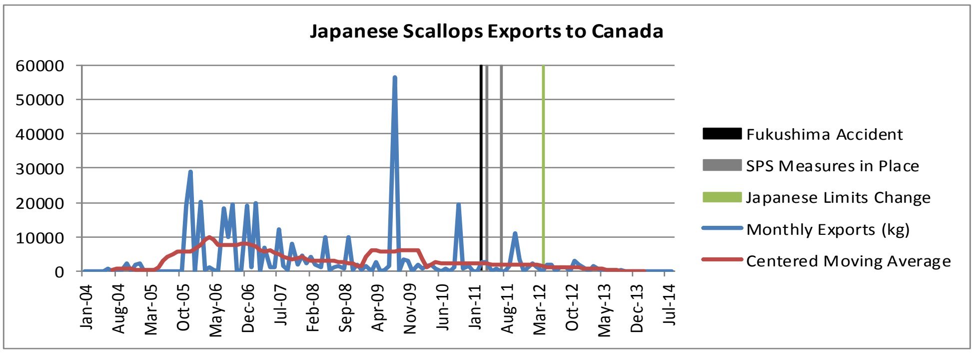
Scallops other than live, fresh or chilled (HR Code 030729)

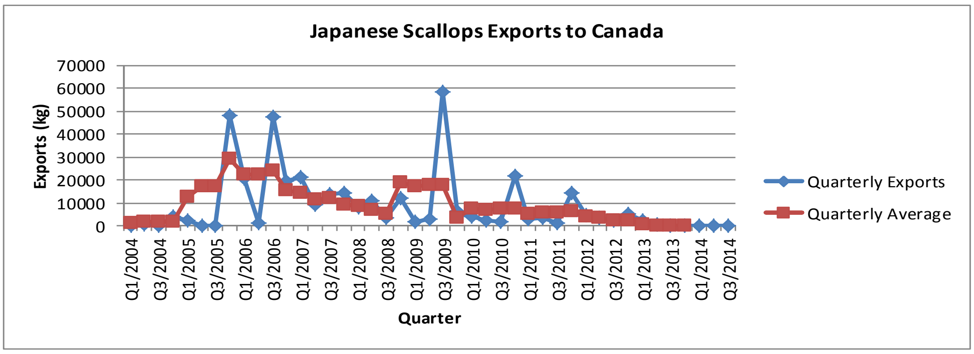
i. Australia





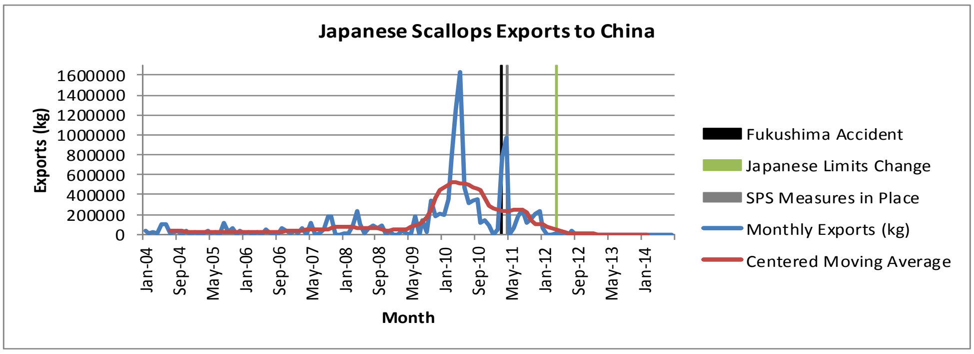
ii. Canada

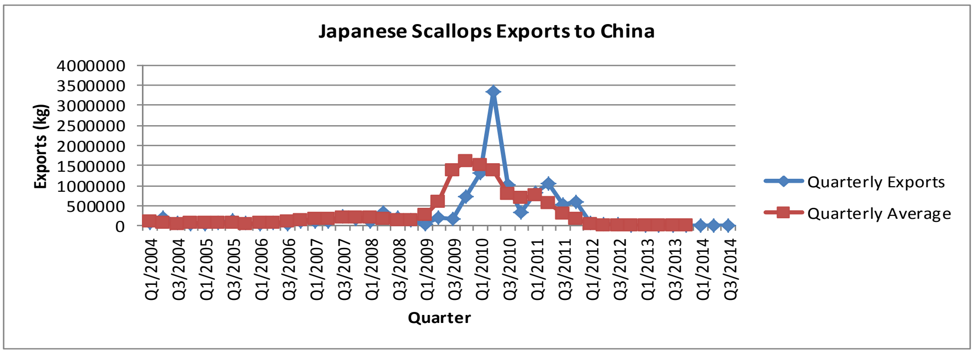

Japanese Scallops Exports to Canada
60000
50000
40000
30000
20000
10000
0
Jan-04
Aug-04
Mar-05
Oct-05
May-06
Dec-06
Jul-07
Feb-08
Sep-08
Apr-09
Nov-09
Jun-10
Jan-11
Aug-11
Mar-12
Oct-12
May-13
Dec-13
Jul-14
Fukushima Accident
SPS Measures in Place
Japanese Limits Change
Monthly Exports (kg)
Centered Moving Average


Japanese Scallops Exports to Canada
Exports (kg)
70000
60000
50000
40000
30000
20000
10000
0
Q1/2004
Q3/2004
Q1/2005
Q3/2005
Q1/2006
Q3/2006
Q1/2007
Q3/2007
Q1/2008
Q3/2008
Q1/2009
Q3/2009
Q1/2010
Q3/2010
Q1/2011
Q3/2011
Q1/2012
Q3/2012
Q1/2013
Q3/2013
Q1/2014
Q3/2014
Quarter
Quarterly Exports
Quarterly Average

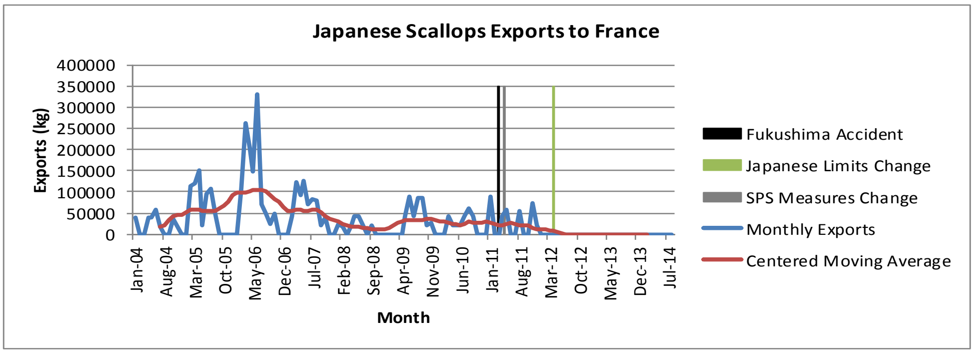
Scallops other than live, fresh or chilled (HR Code 030729)

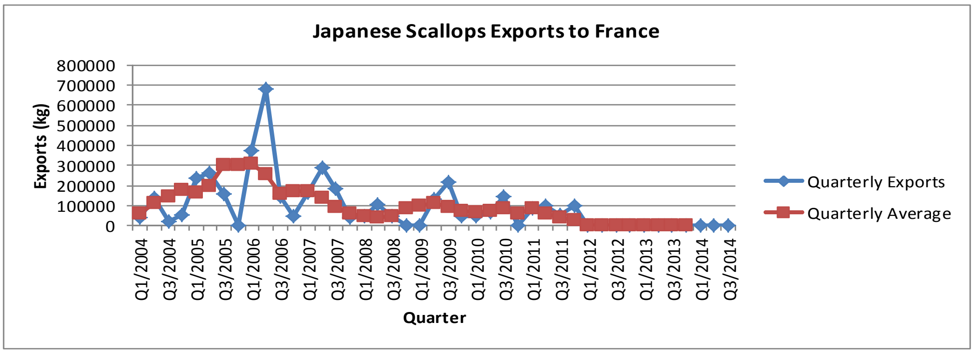
iii. China





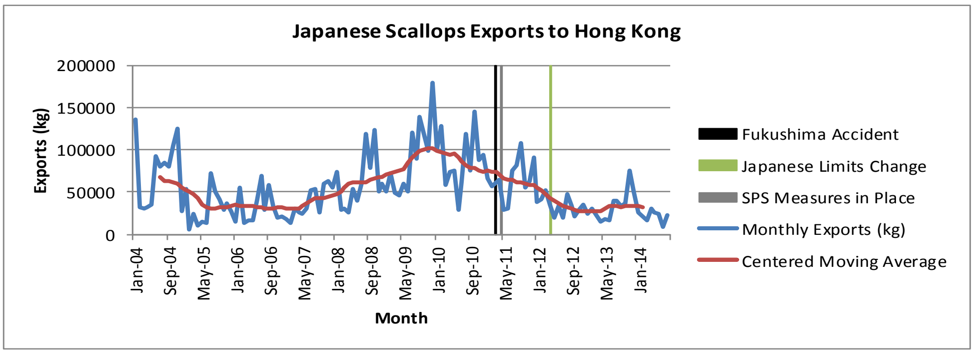
iv. France

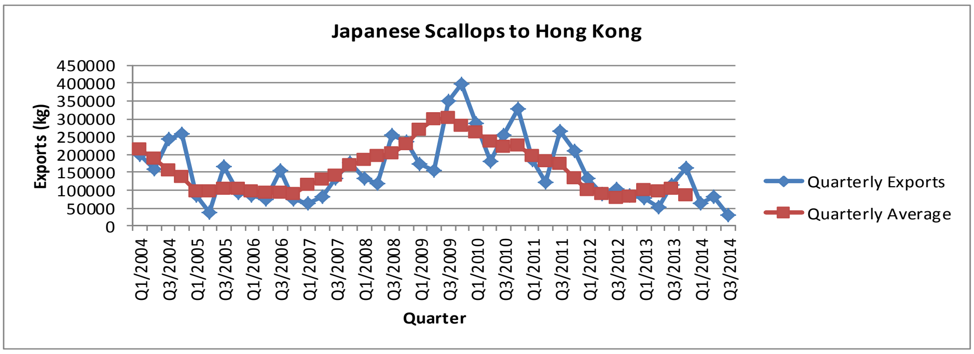




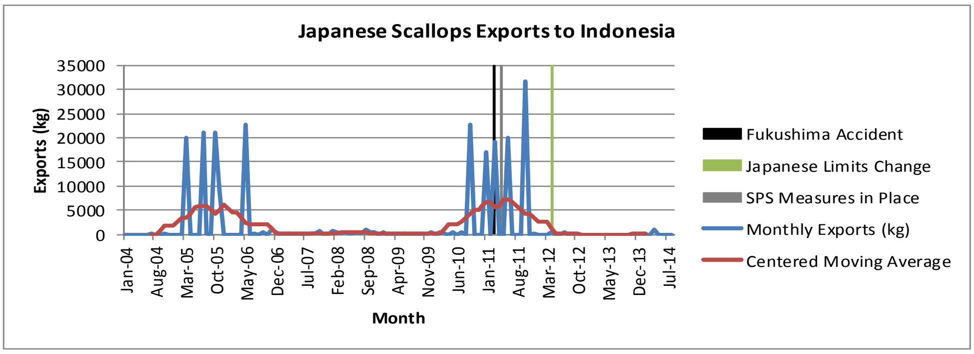
Scallops other than live, fresh or chilled (HR Code 030729)

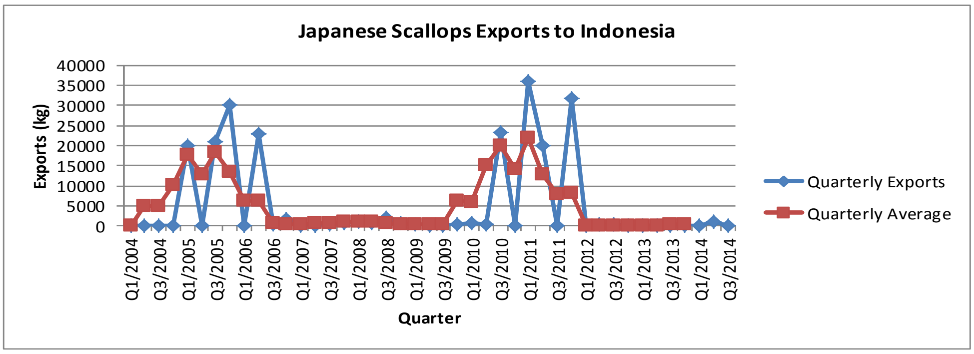
v. Hong Kong





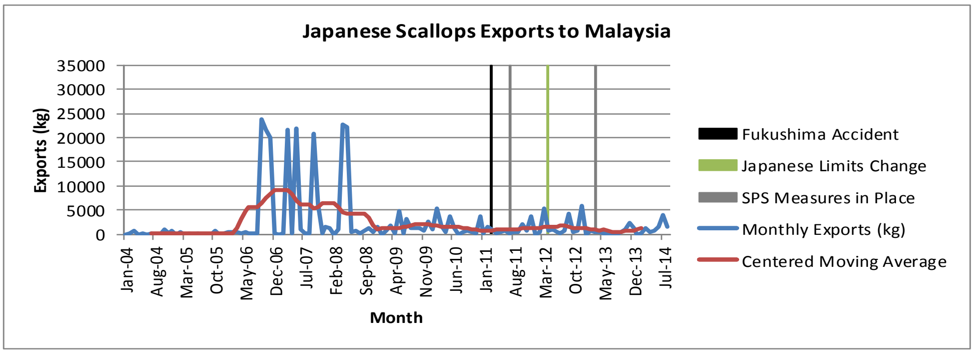
vi. Indonesia

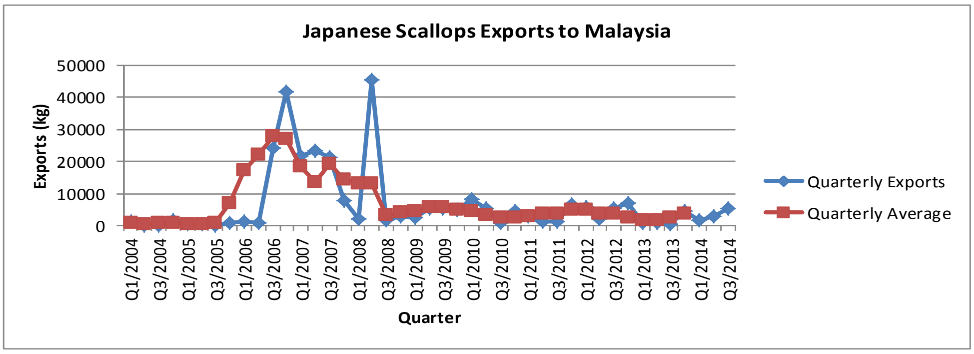




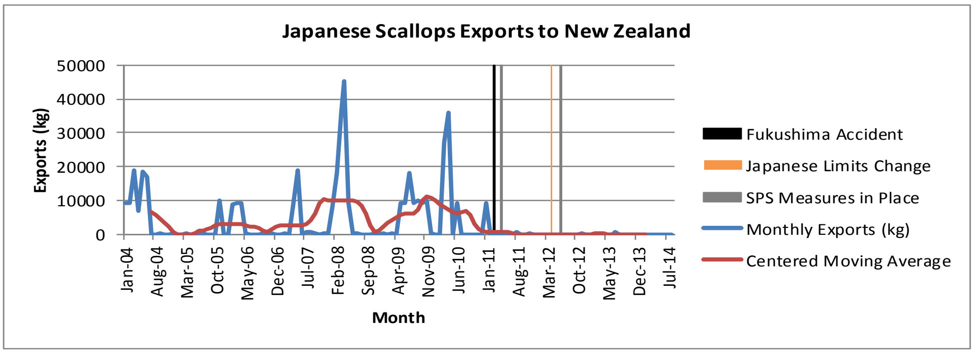
Scallops other than live, fresh or chilled (HR Code 030729)

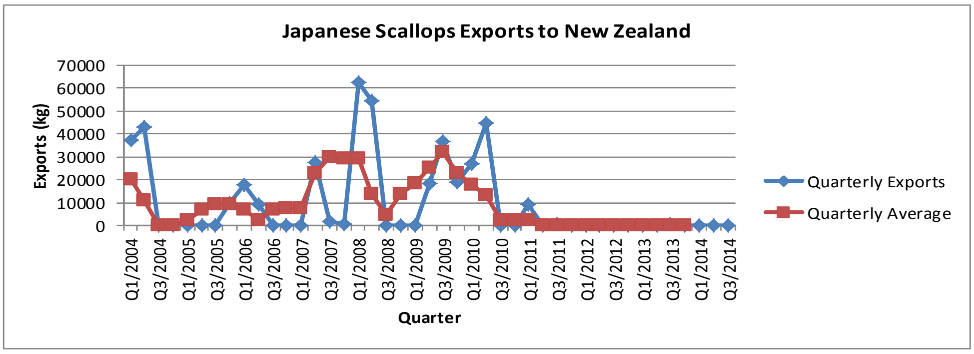
vii. Malaysia





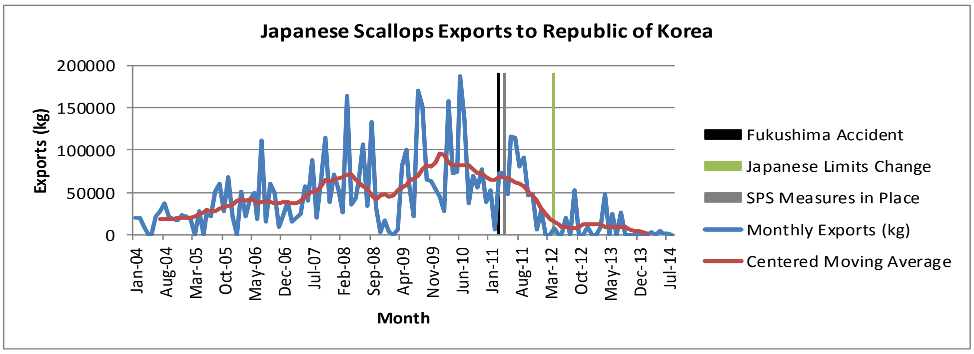
viii. New Zealand

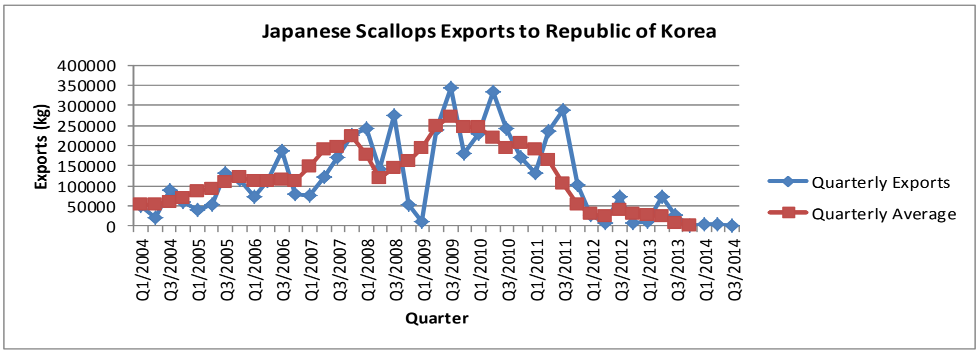




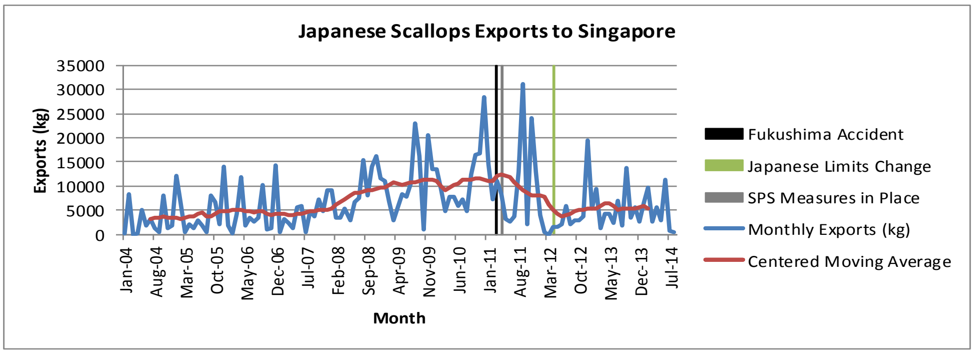
Scallops other than live, fresh or chilled (HR Code 030729)

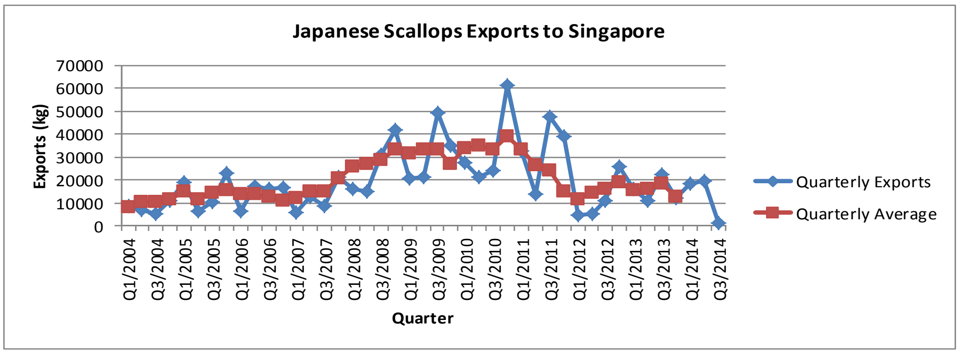
ix. Korea





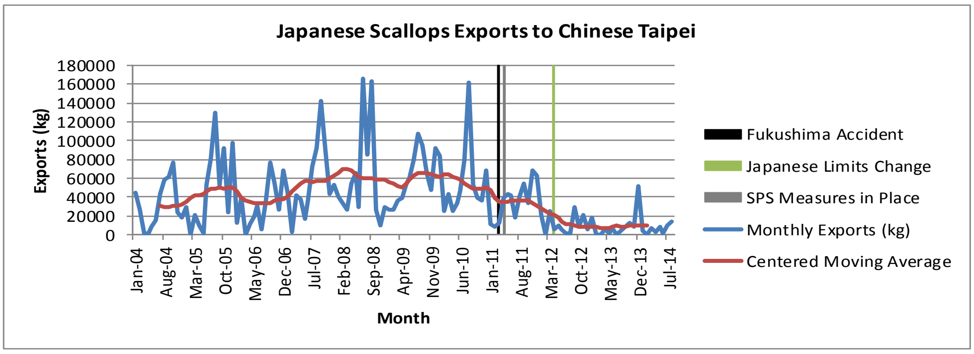
x. Singapore

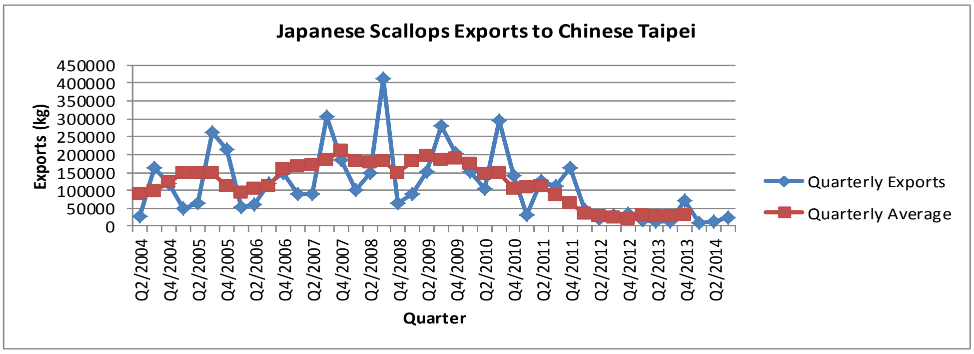




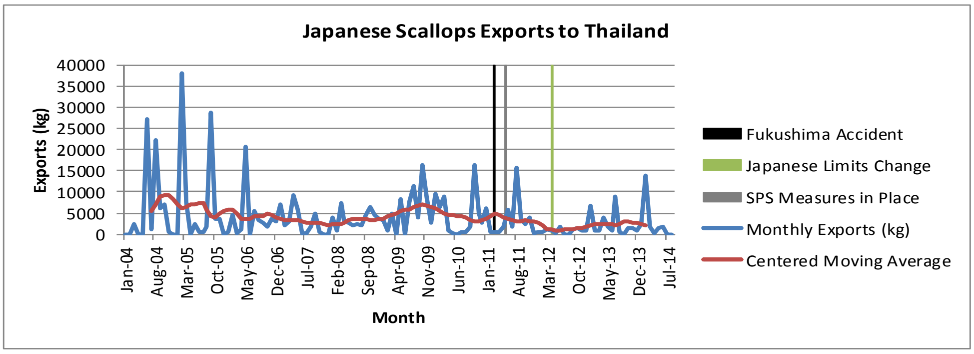
Scallops other than live, fresh or chilled (HR Code 030729)

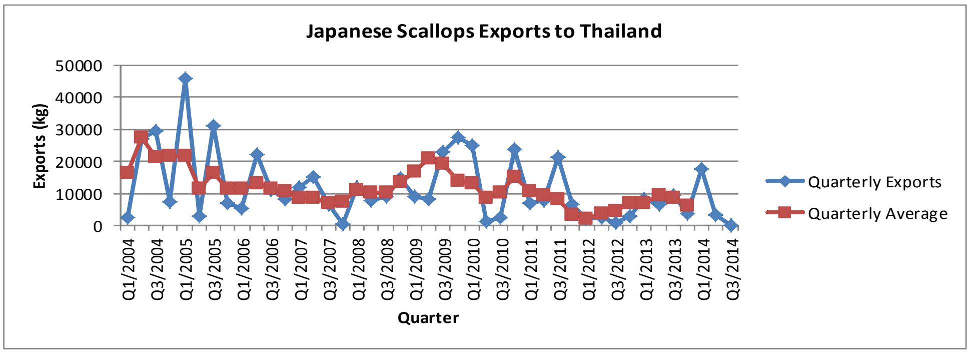
xi. Chinese Taipei





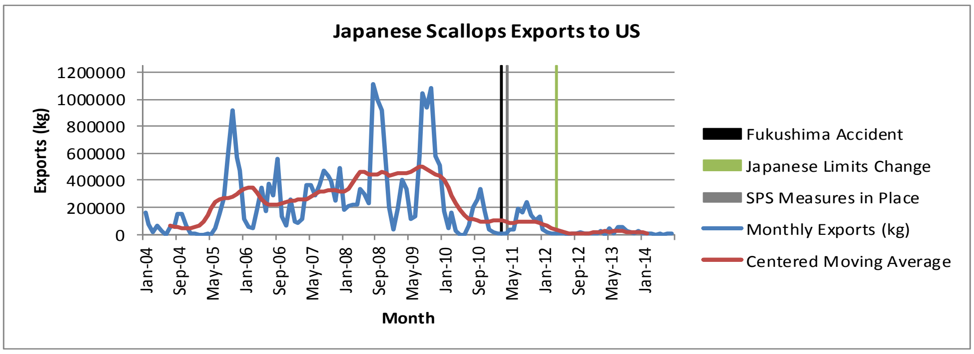
xi. Thailand

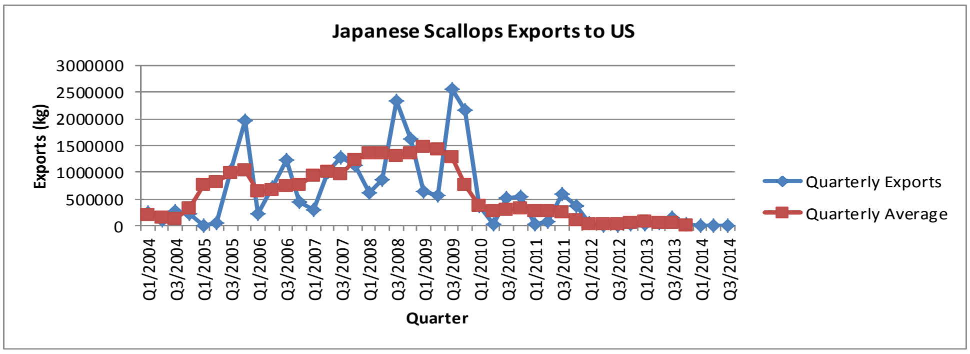




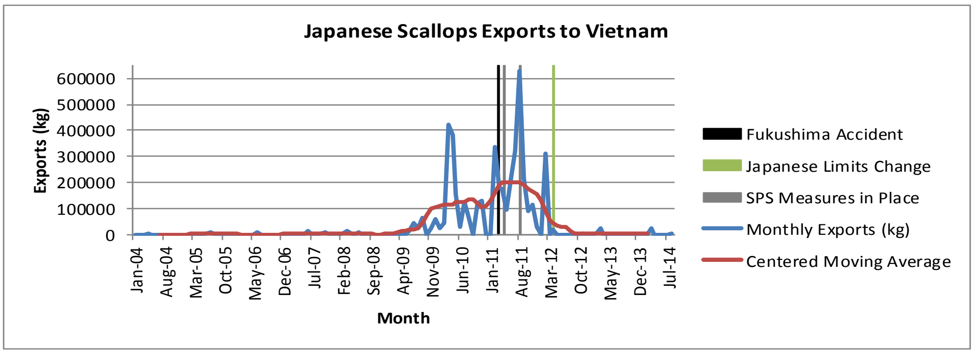
Scallops other than live, fresh or chilled (HR Code 030729)

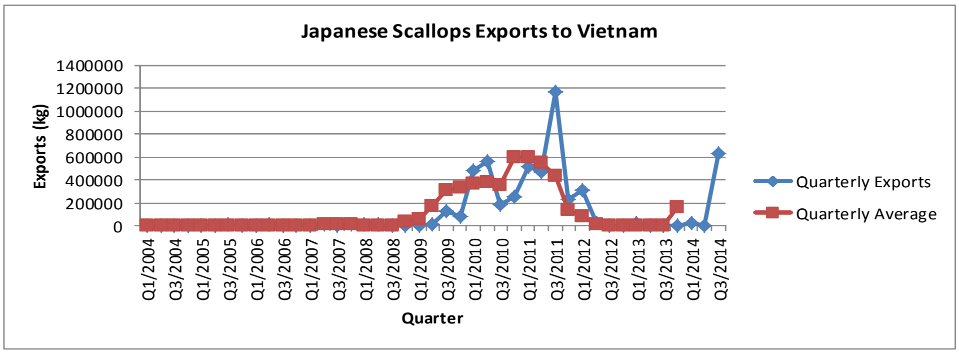
xii. United States





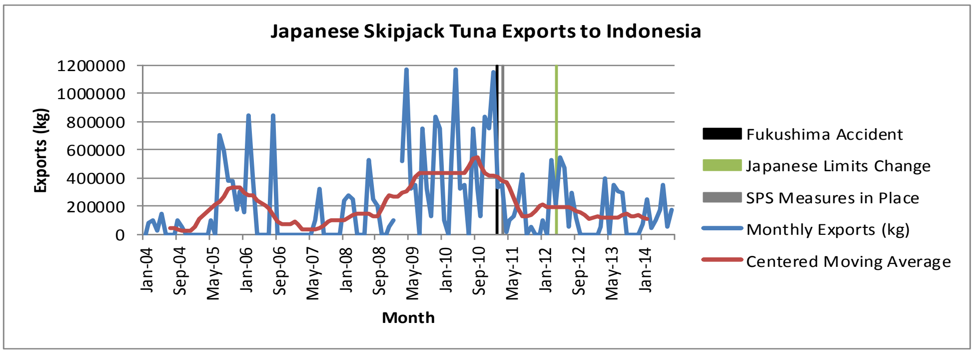
xiii. Viet Nam

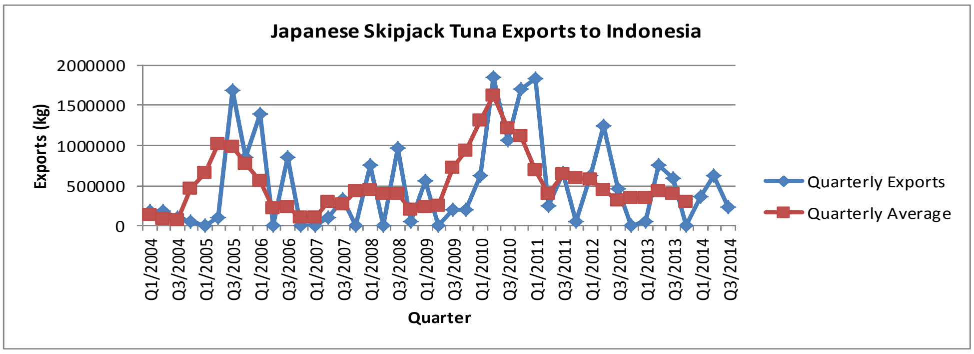




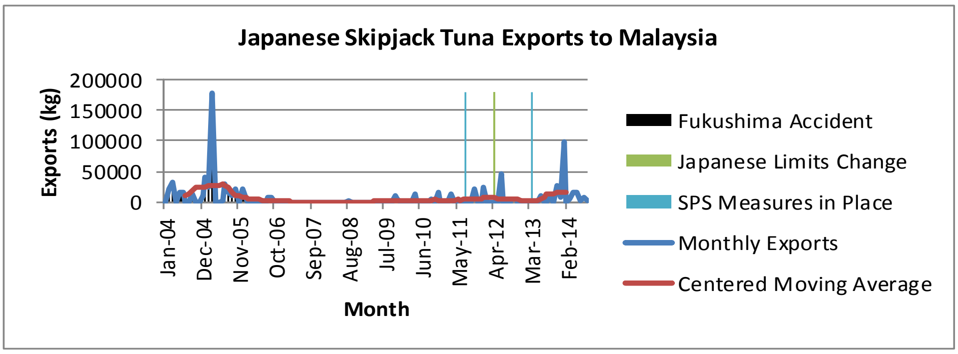
Tuna Skipjack, stripe-bellied bonito, frozen, whole (HR Code 030343)

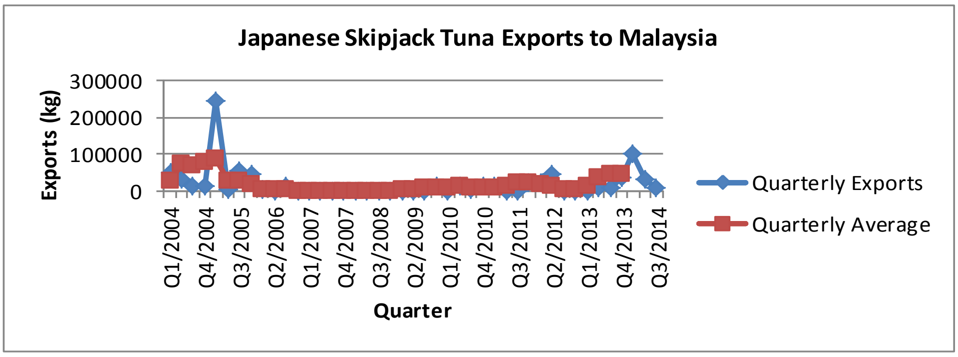
i. Indonesia





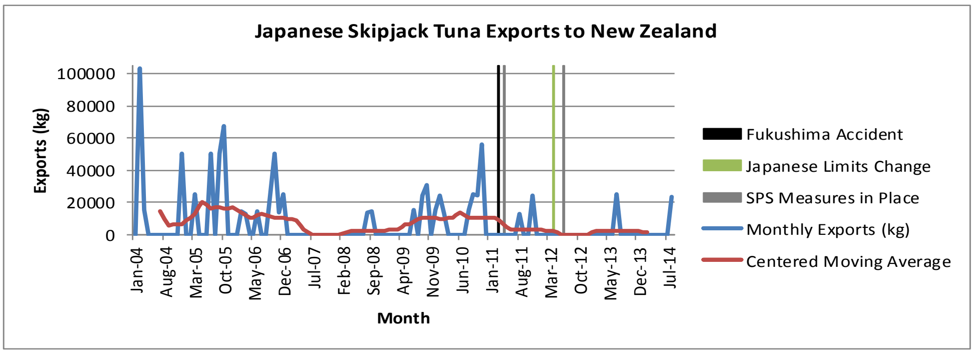
ii. Malaysia

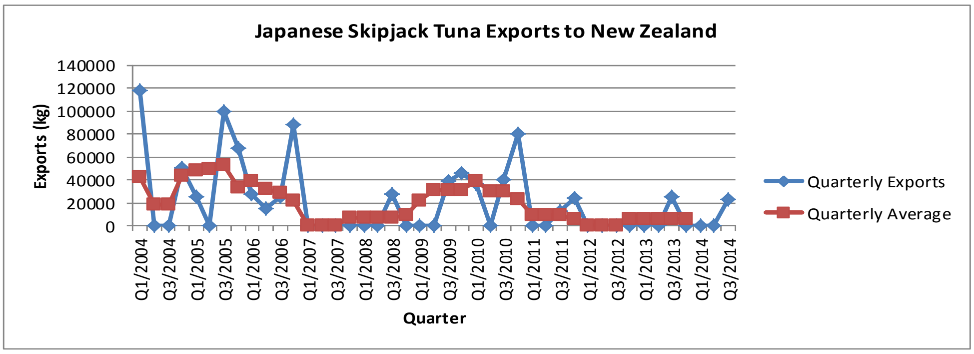




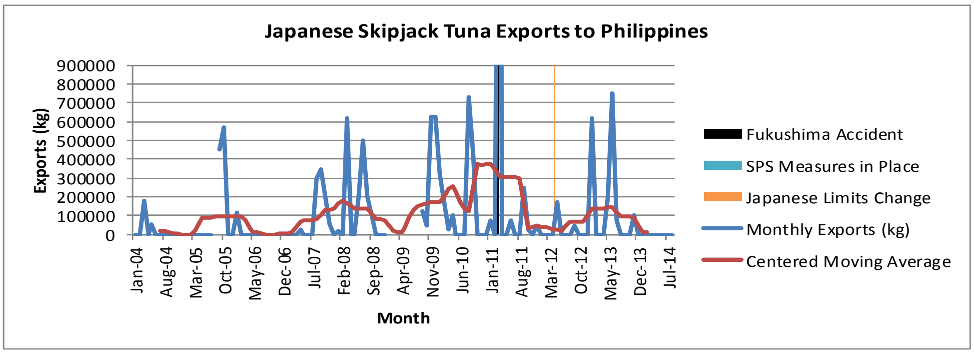
Tuna Skipjack, stripe-bellied bonito, frozen, whole (HR Code 030343)

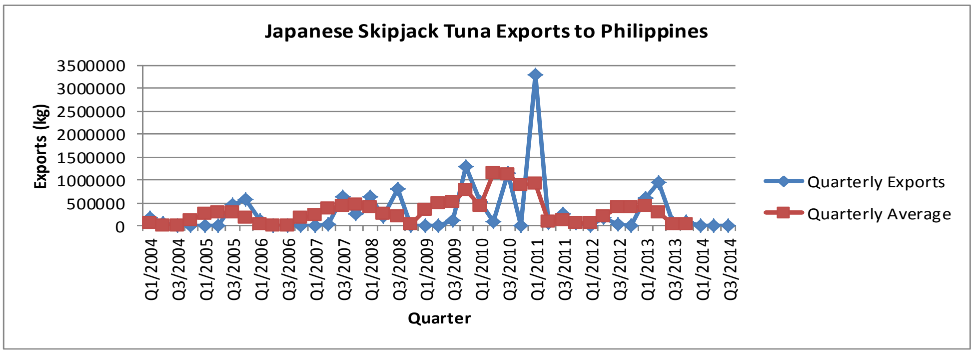
iii. New Zealand





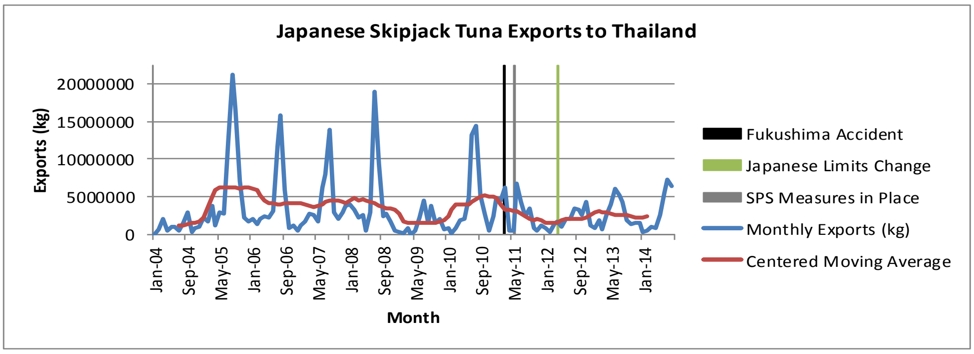
iv. Philippines

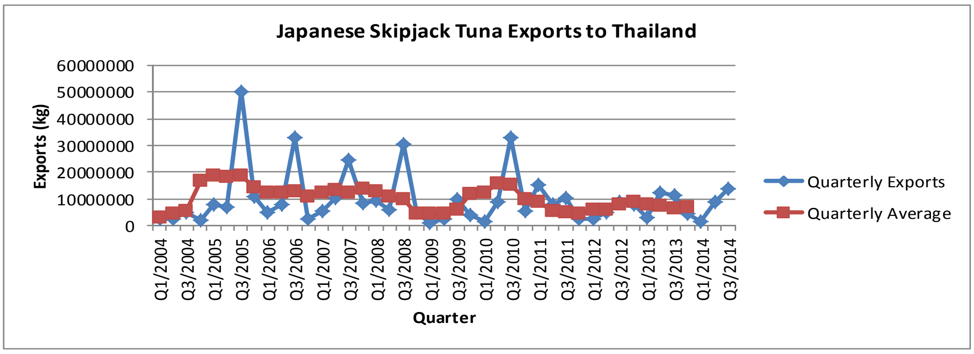




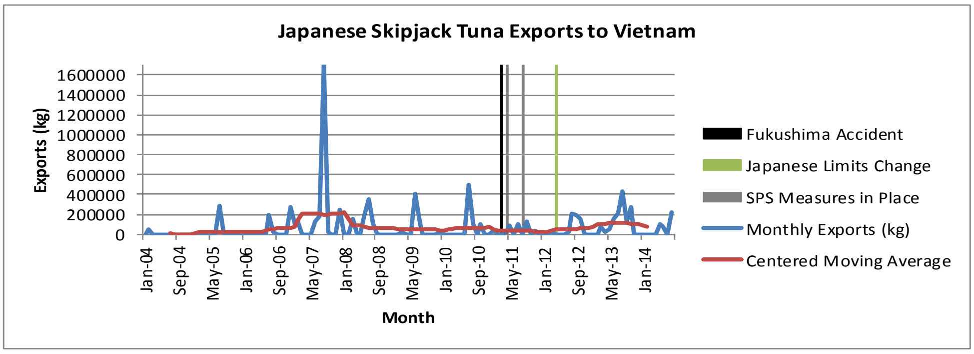
Tuna Skipjack, stripe-bellied bonito, frozen, whole (HR Code 030343)

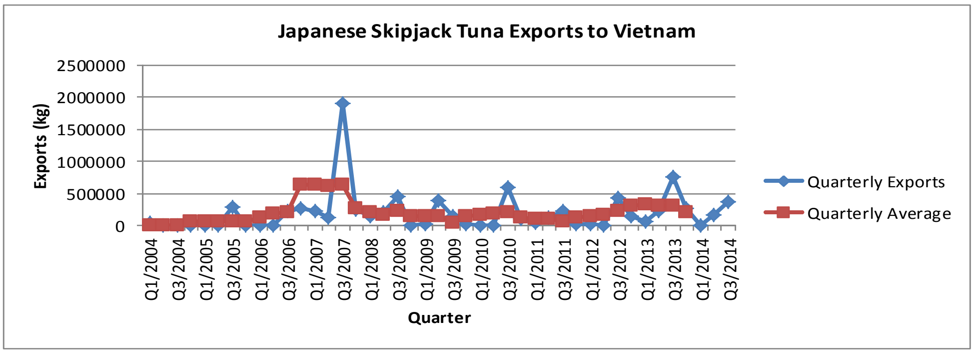
v. Thailand





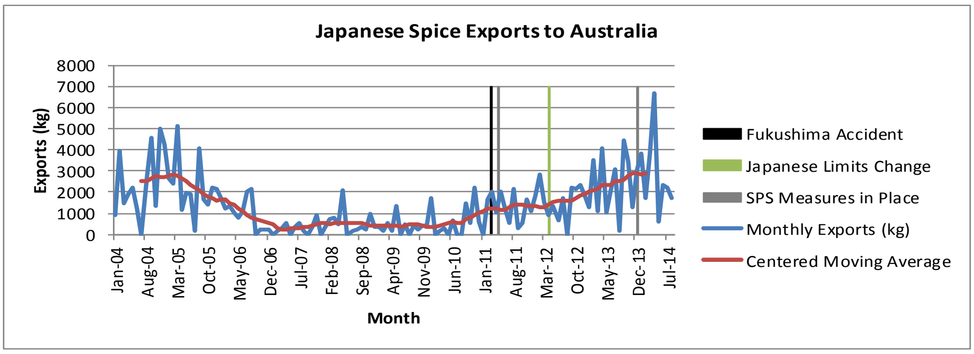
vi. Viet Nam

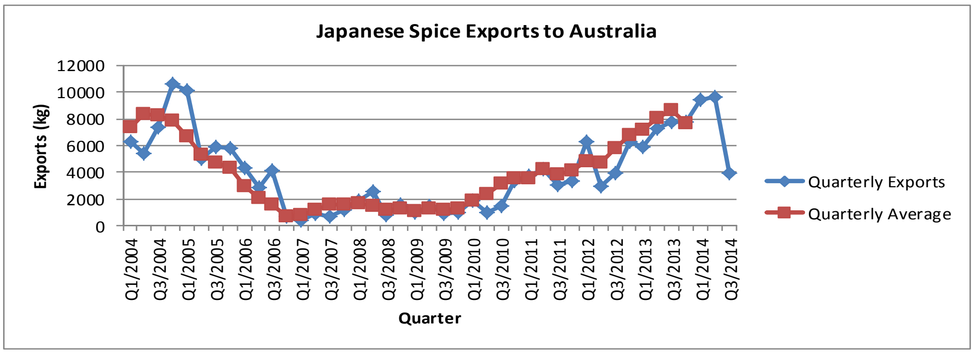




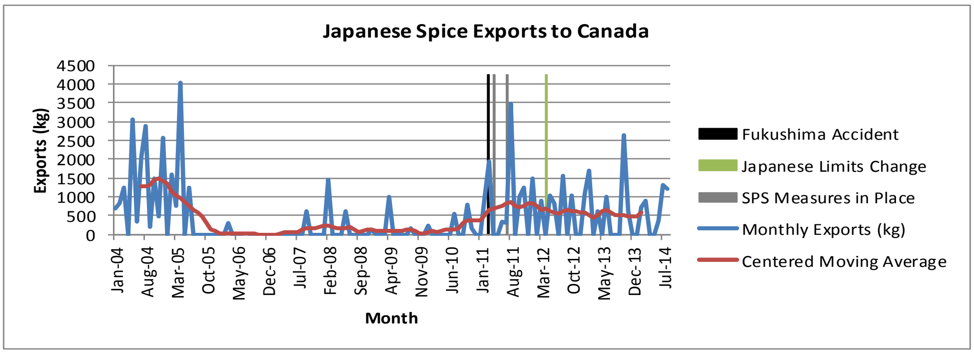
Spice, not else ware specified (HR Code 091099)

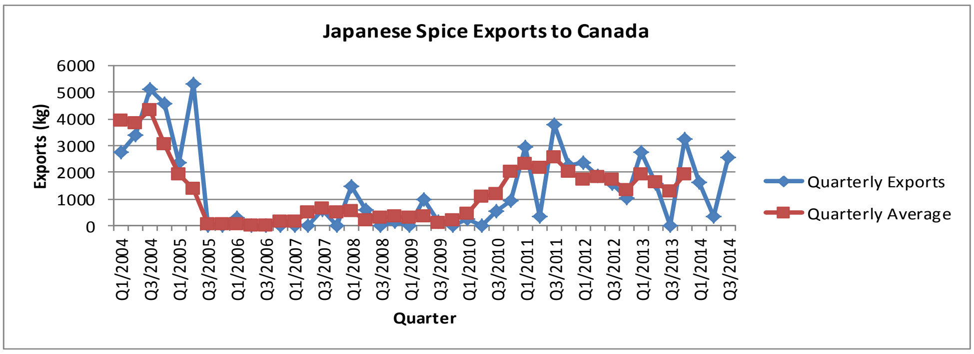
i. Australia





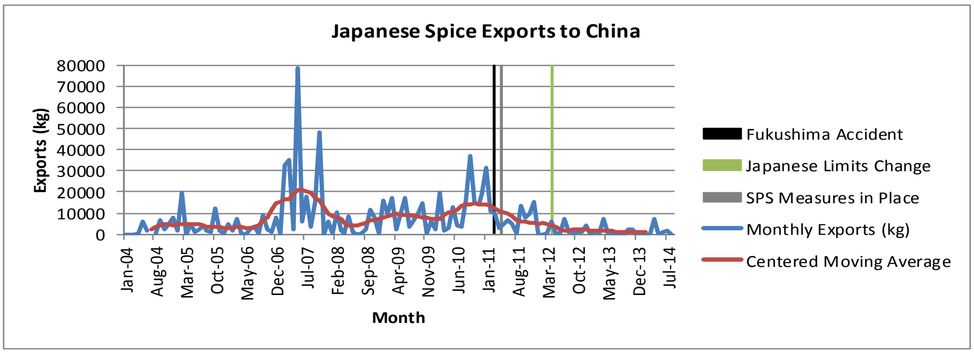
ii. Canada

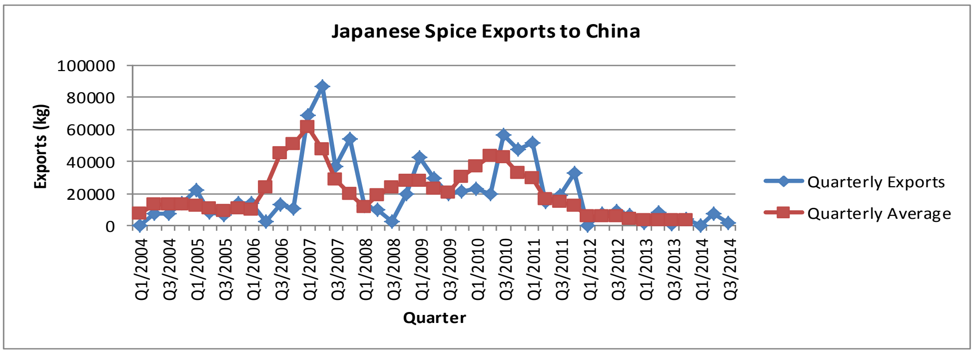




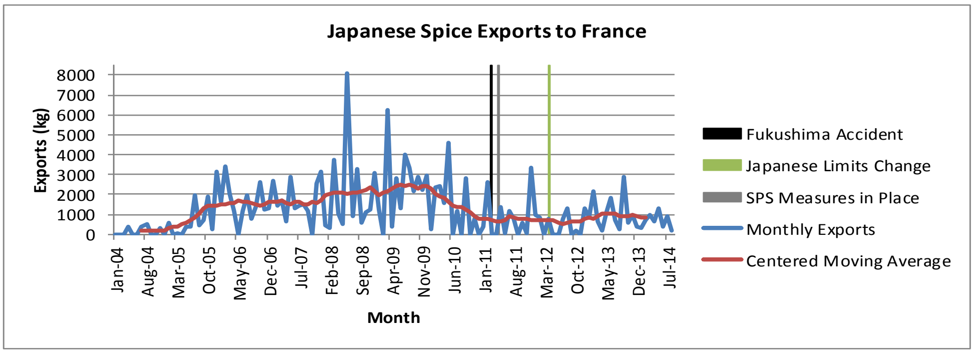
Spice, not else ware specified (HR Code 091099)

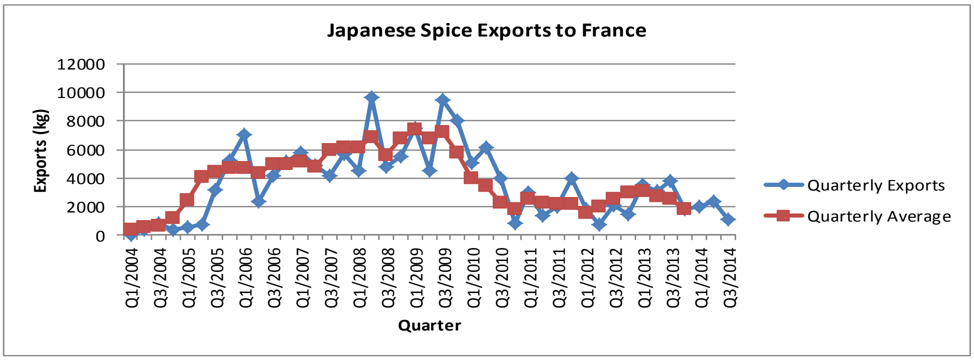
iii. China





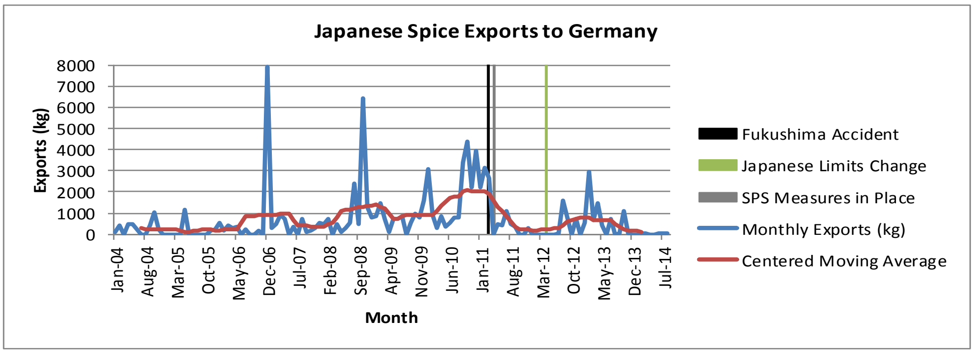
iv. France

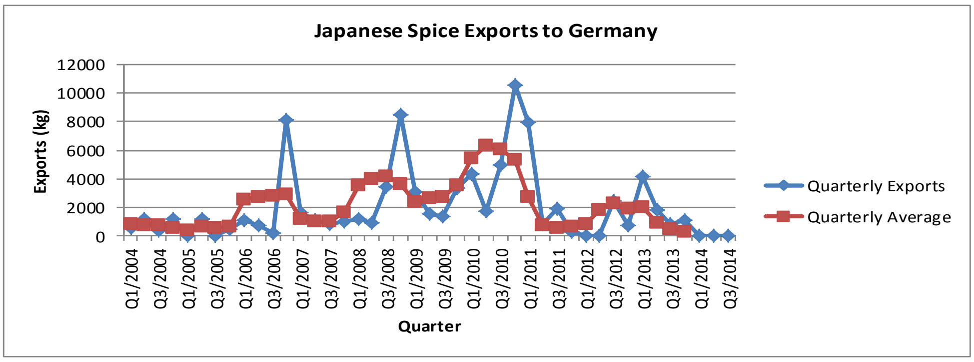




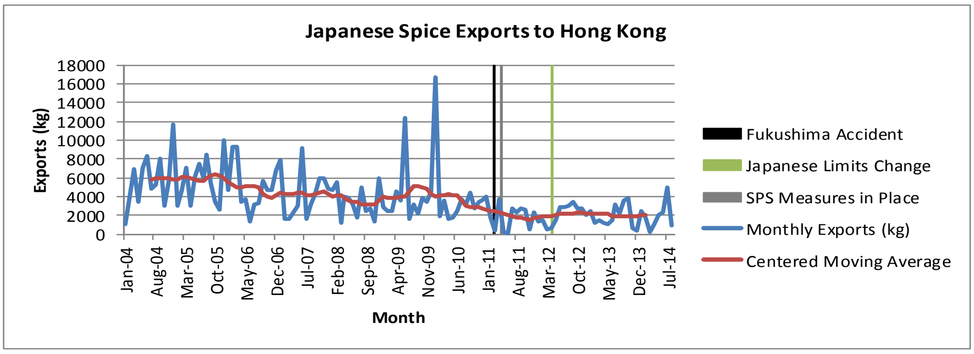
Spice, not else ware specified (HR Code 091099)

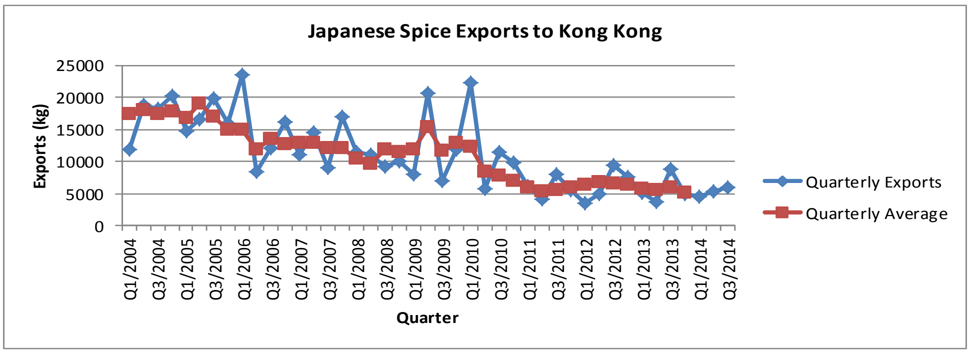
v. Germany





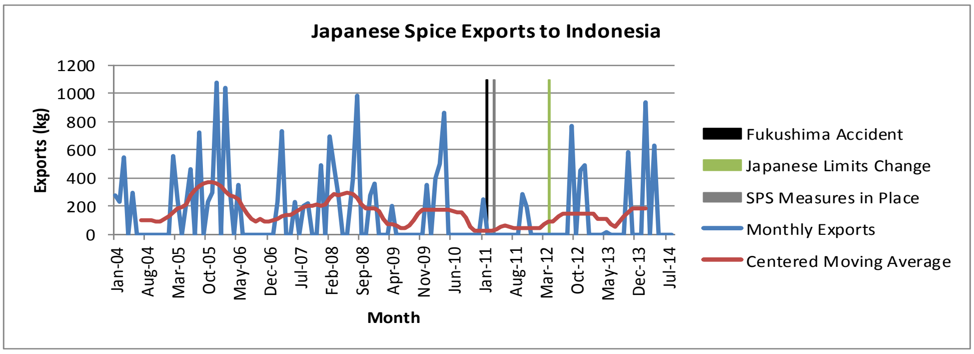
vi. Hong Kong

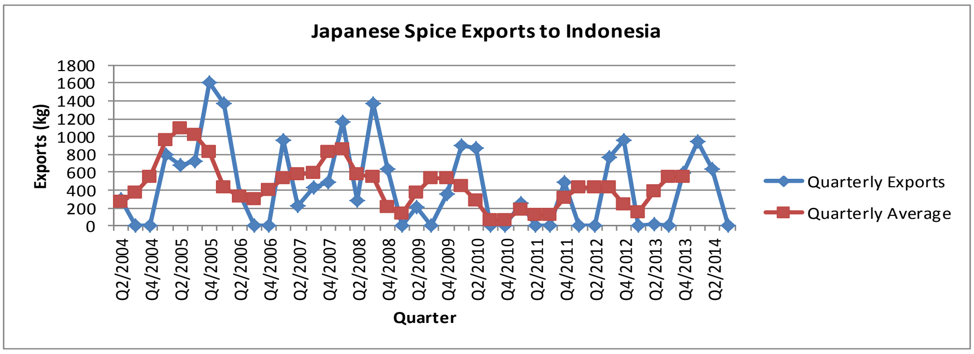




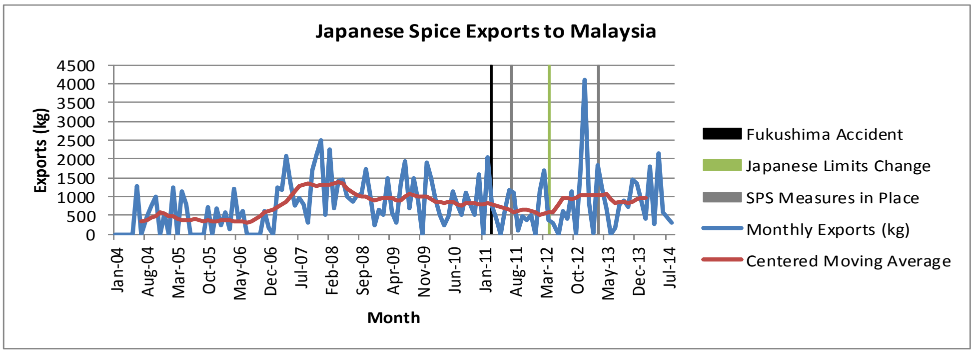
Spice, not else ware specified (HR Code 091099)

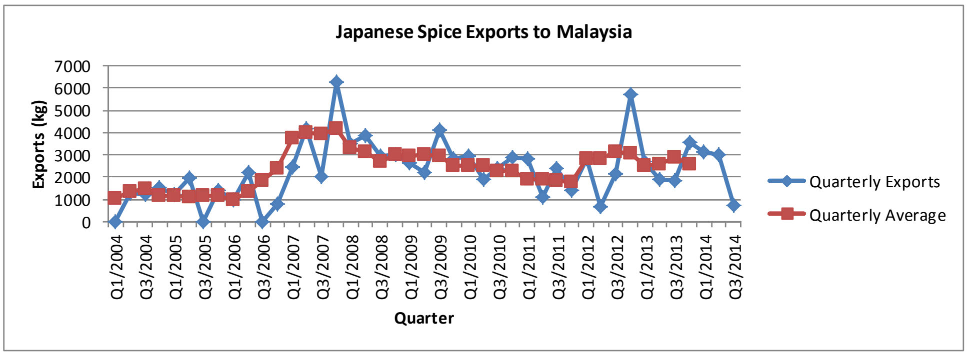
vii. Indonesia





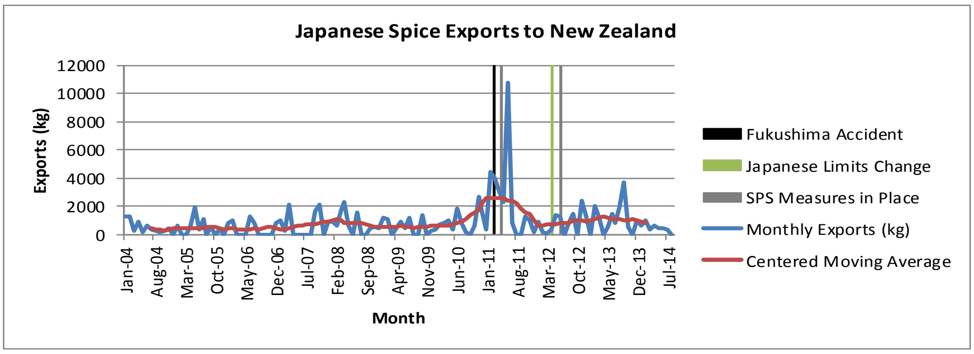
viii. Malaysia

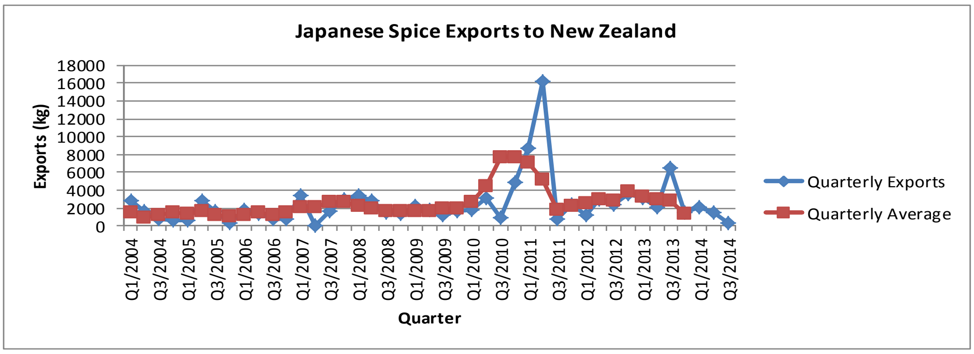




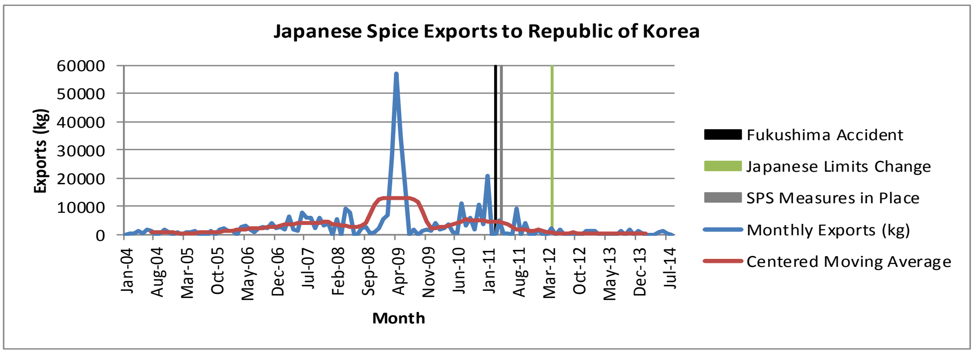
Spice, not else ware specified (HR Code 091099)

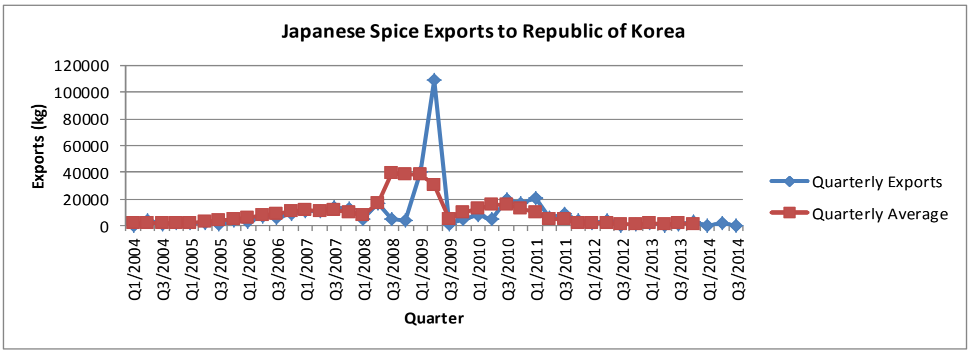
ix. New Zealand





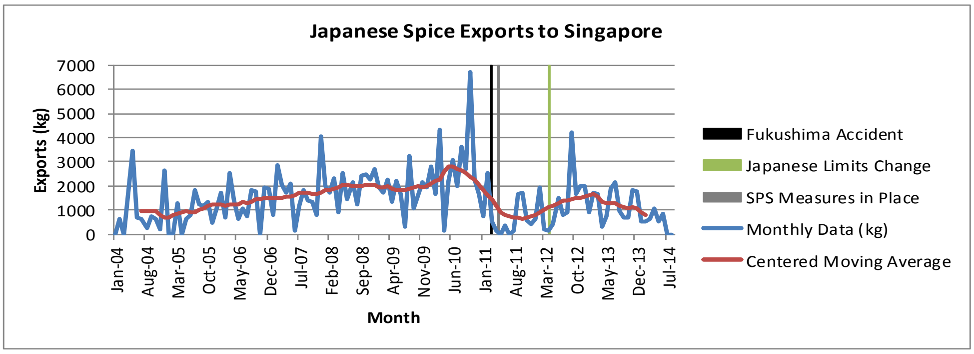
x. Korea

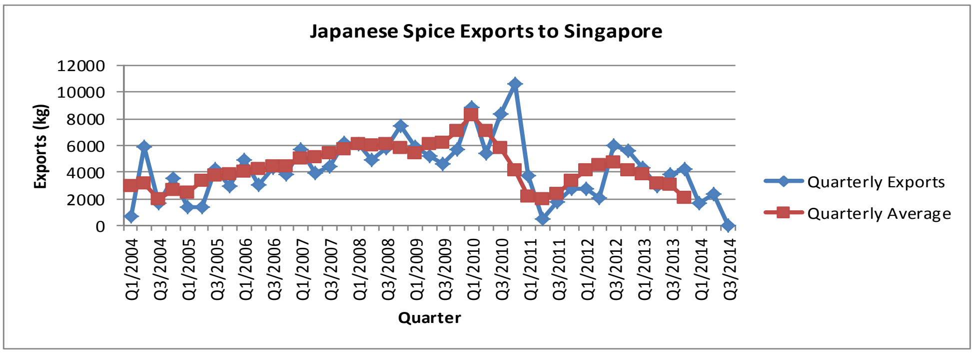




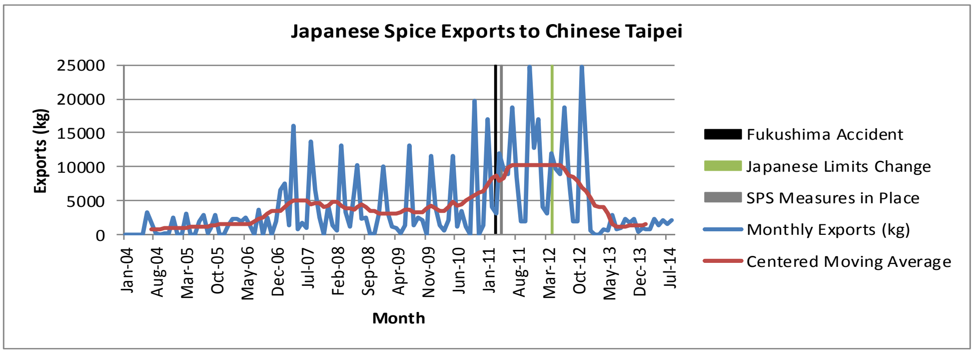
Spice, not else ware specified (HR Code 091099)

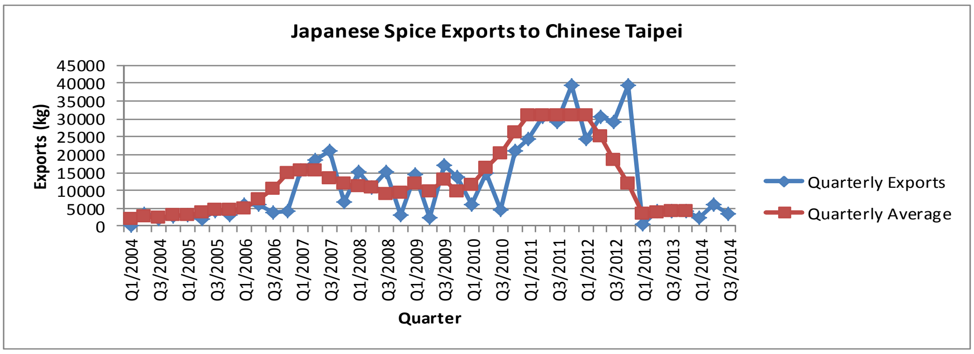
xi. Singapore





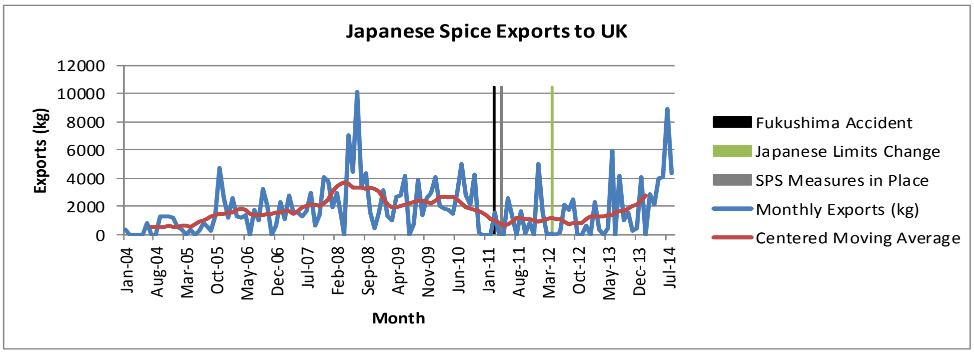
xii. Chinese Taipei

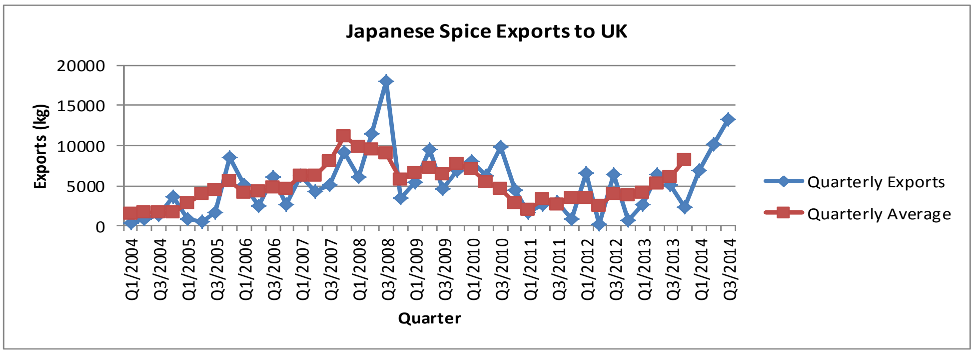




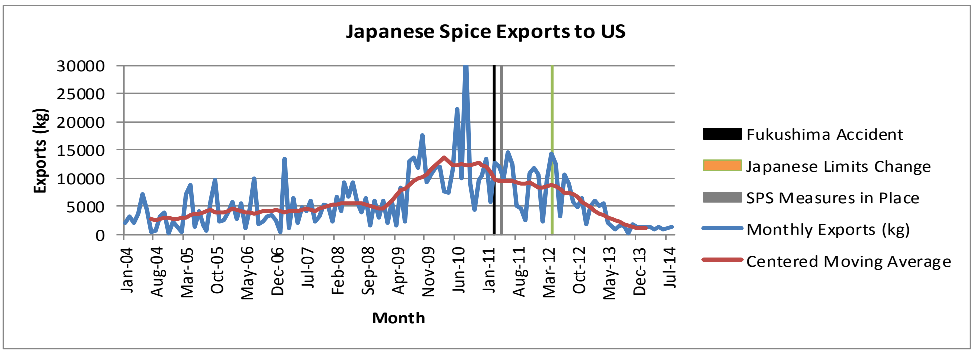
Spice, not else ware specified (HR Code 091099)

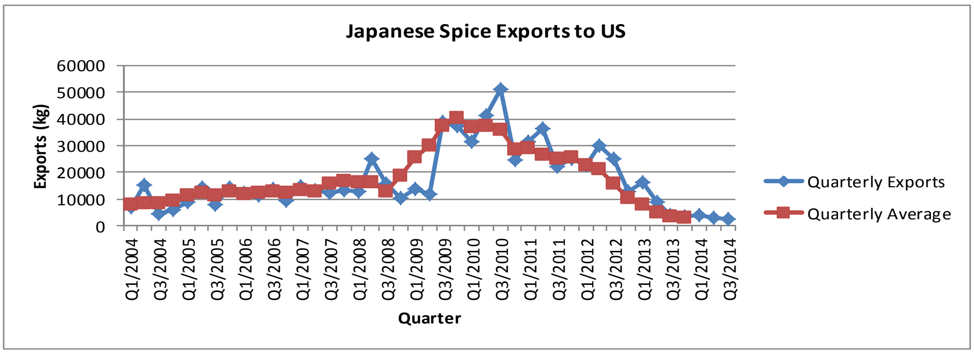
xiii. United Kingdom





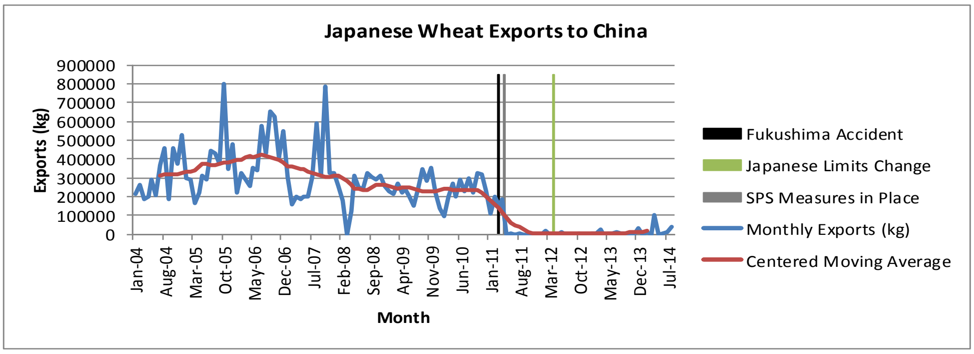
ivx. United States

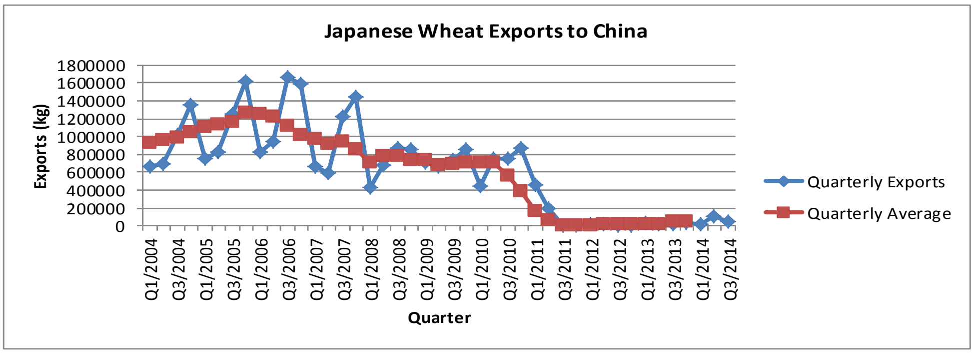




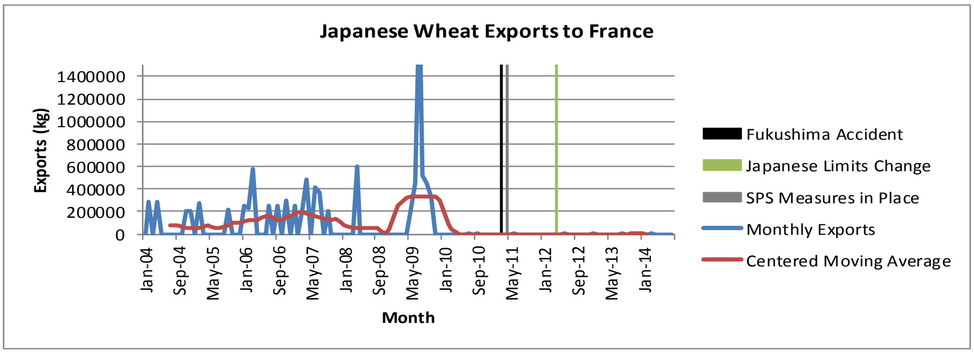
Wheat or meslin flour (HR Code 110100)

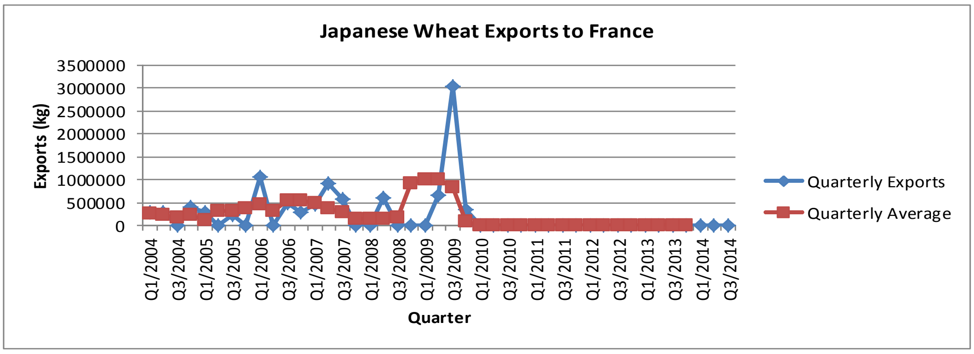
i. China





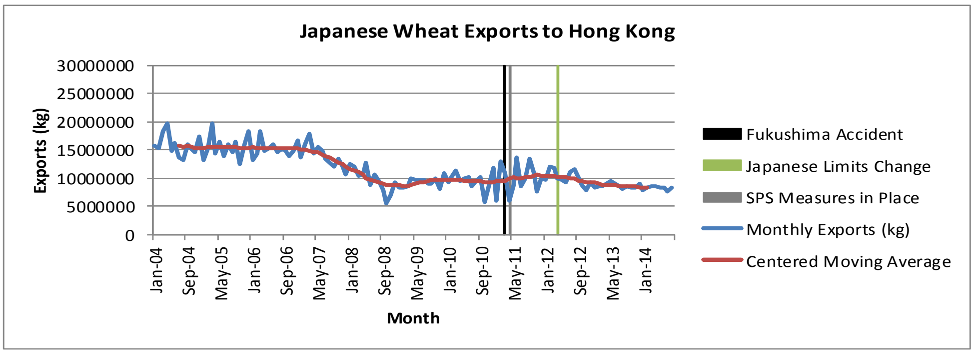
ii. France

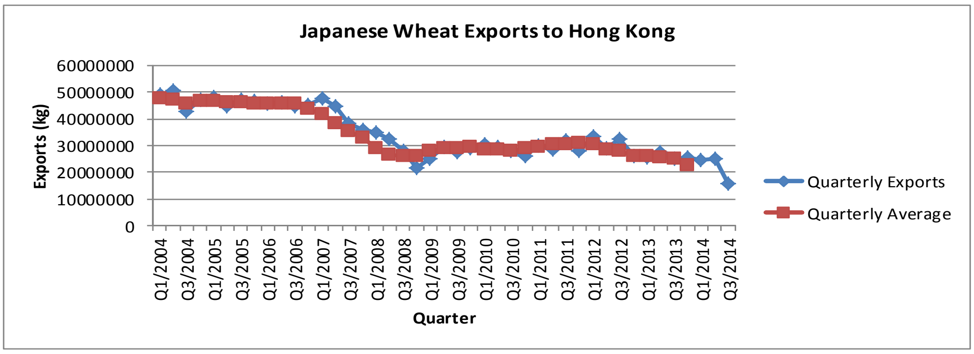




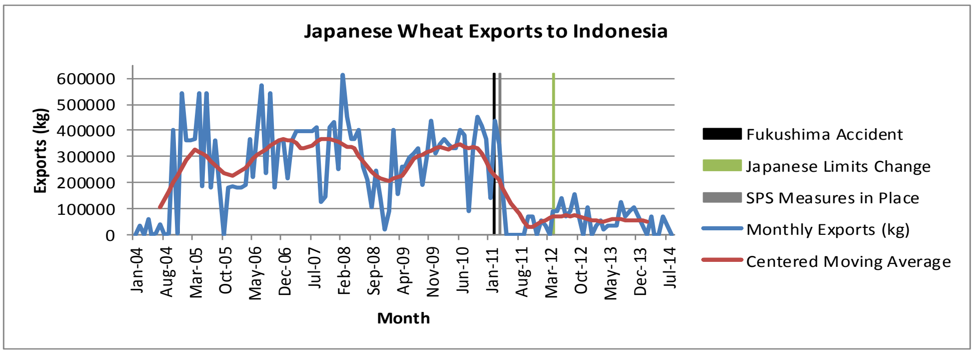
Wheat or meslin flour (HR Code 110100)

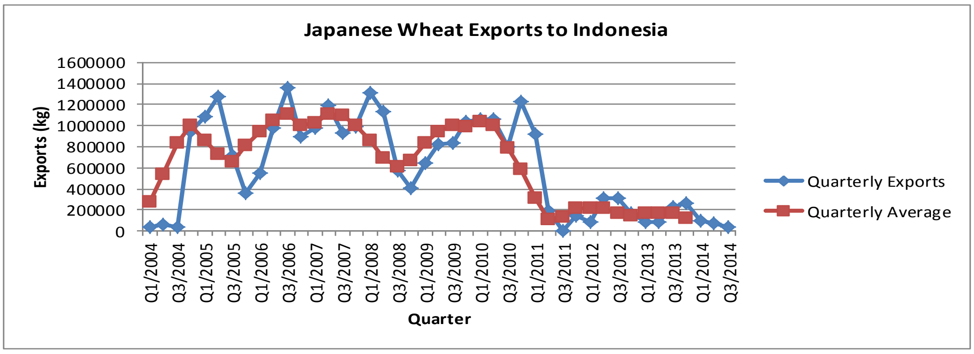
iii. Hong Kong





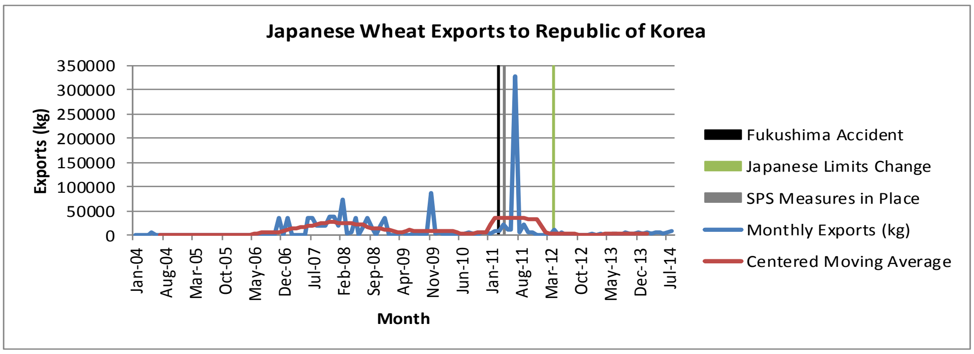
iv. Indonesia

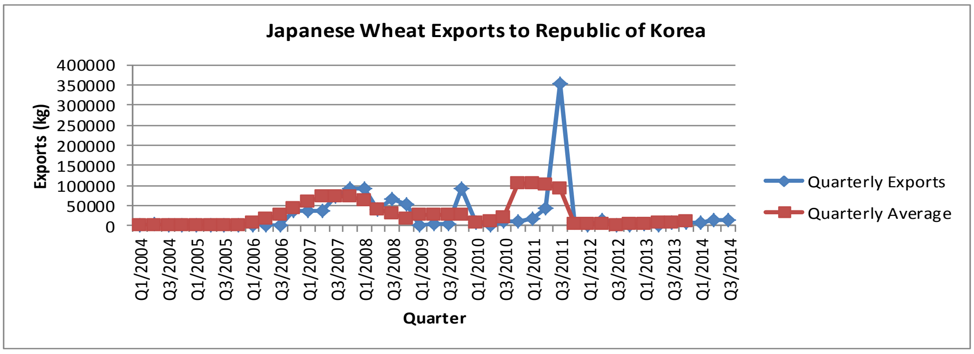




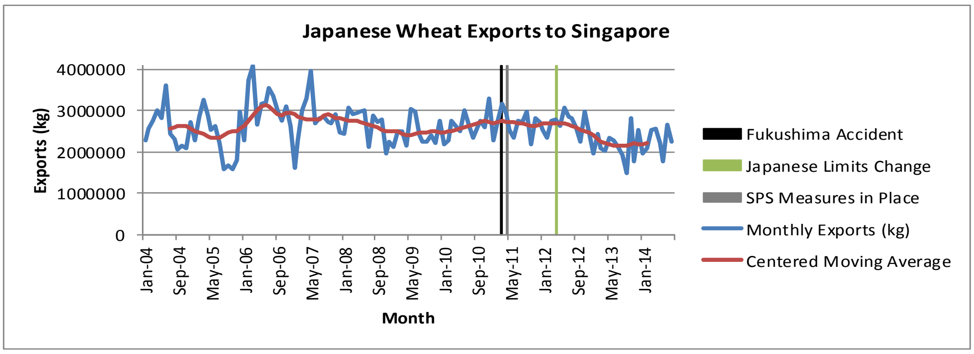
Wheat or meslin flour (HR Code 110100)

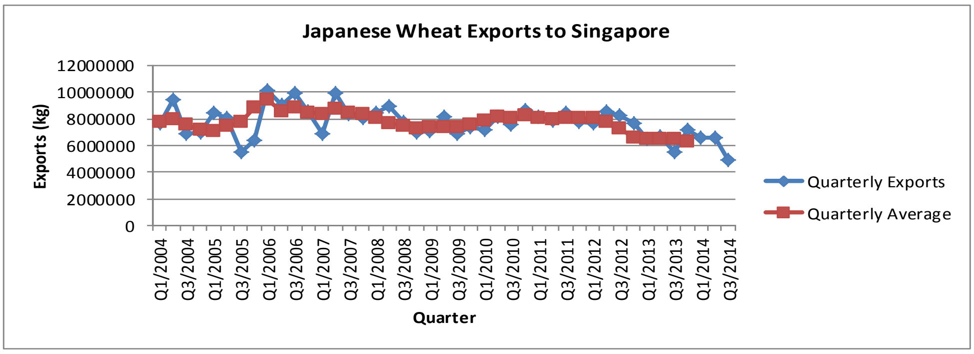
v. Korea





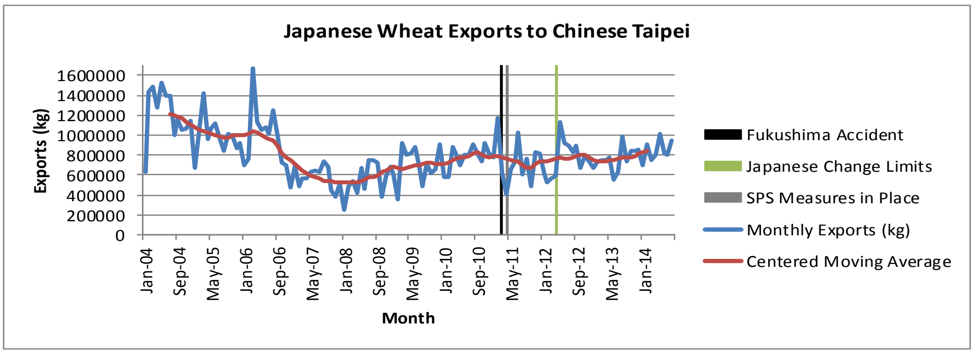
vi. Singapore

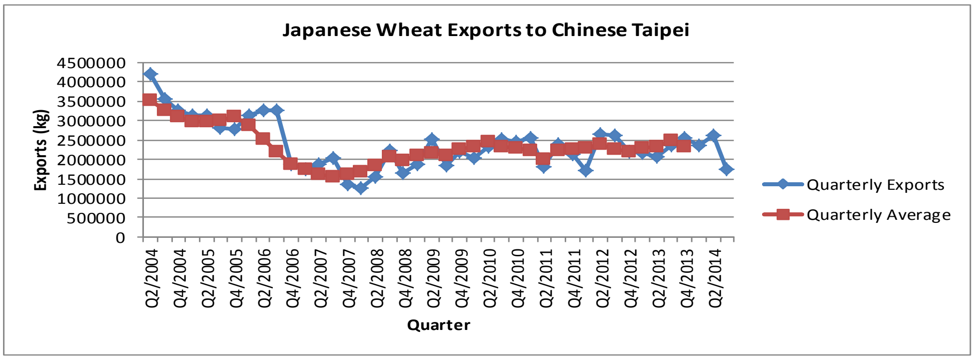




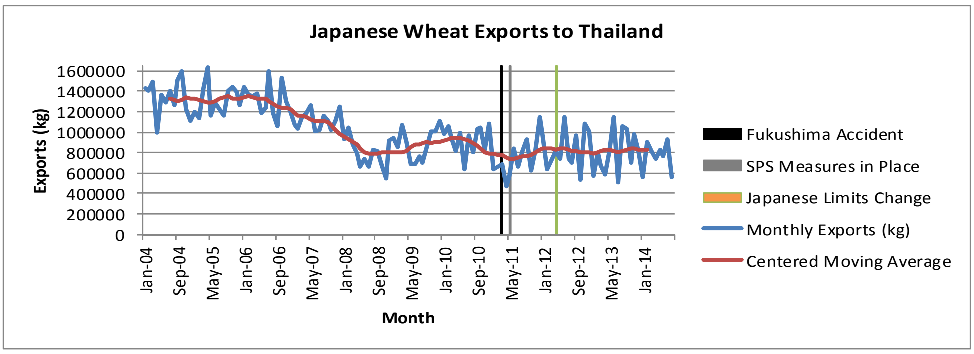
Wheat or meslin flour (HR Code 110100)

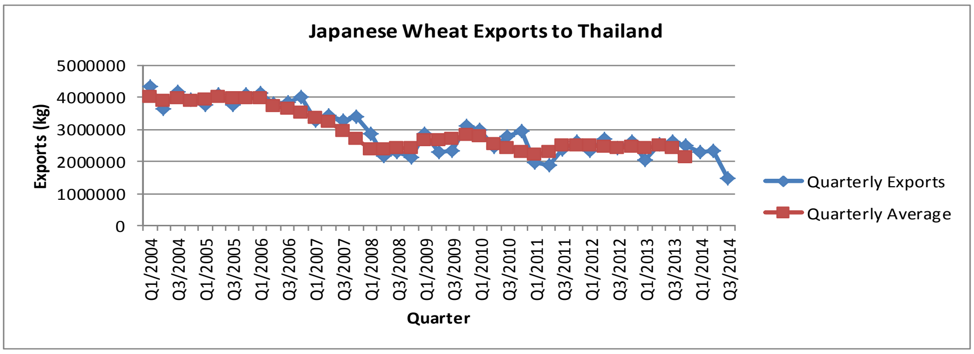
vii. Chinese Taipei





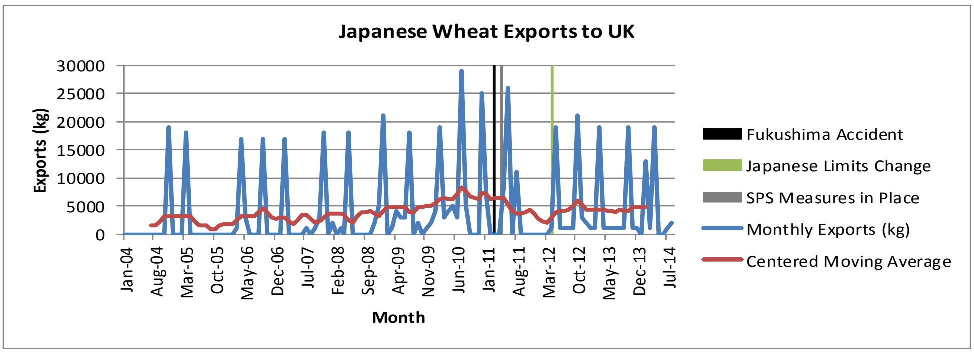
viii. Thailand

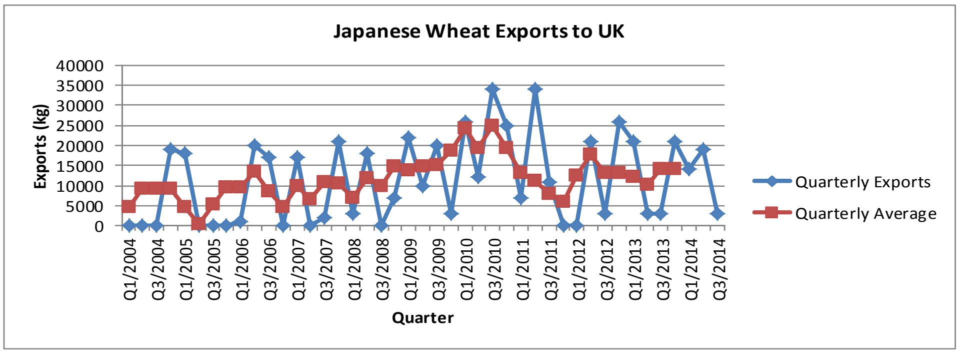




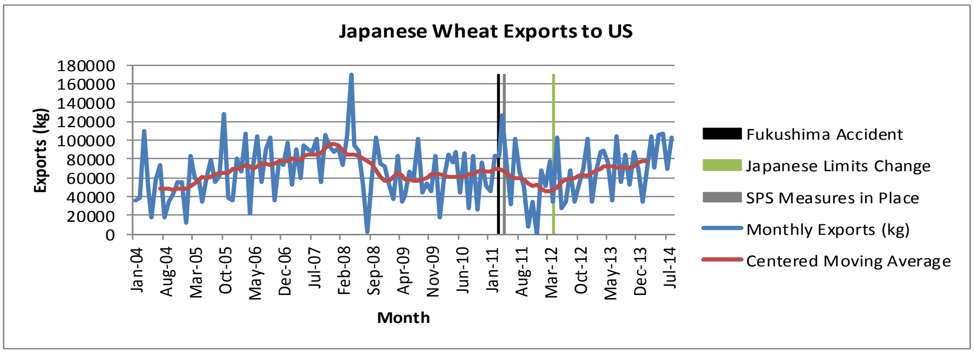
Wheat or meslin flour (HR Code 110100)

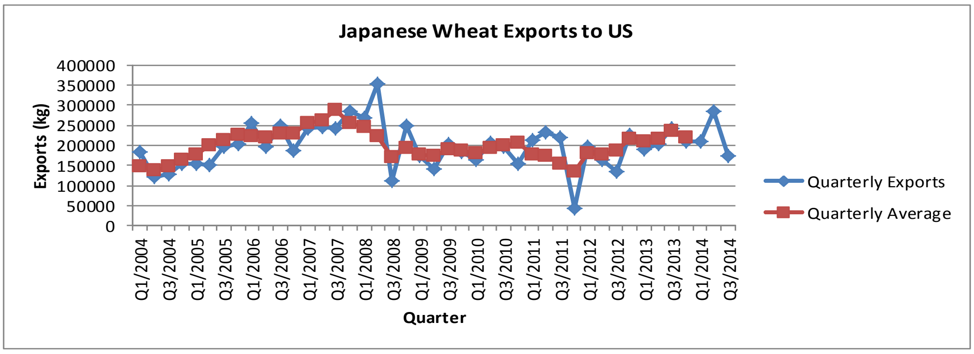
ix. United Kingdom





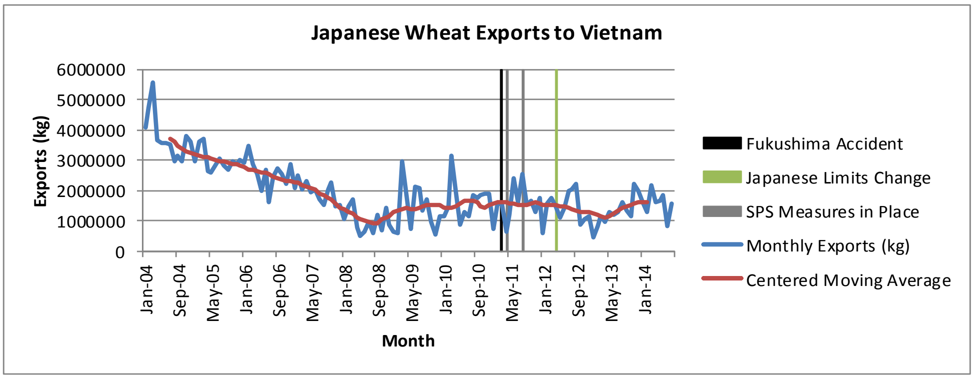
x. United States

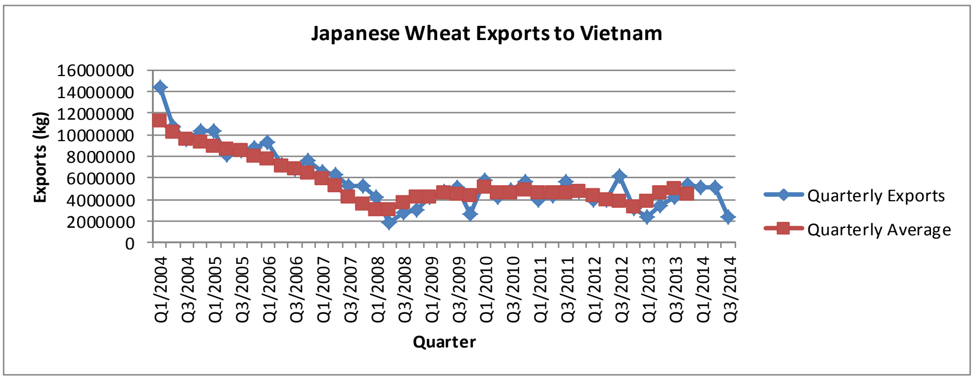




Wheat or meslin flour (HR Code 110100)

xi. Viet Nam





ANNEX C:

Sanitary and phytosanitary (SPS) measures per country

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Australia[§]	**Australian quarantine and inspection service imported food notice 05/11** - Imported foodstuffs tested for radionuclide content using high resolution gamma spectrometry. Prepared samples were counted for a minimum time of 4 hours. In some cases, counting times extended to achieve the desired reporting limit of 2 Bq/kg	Seaweed, fresh and frozen seafood (excluding fish based pastes and sauces), milk and milk products and fresh fruit and vegetables	YES	2011.04.12[1]	2014.01.23[2]	300 Bq/L (1000 Bq/kg)	200 Bq/kg (1000 Bq/kg)[3]	2012.03.01	**Less than 1% of total imports** (1.5% of Japanese agricultural exports)	-
Argentina	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[4]	All food and food products	NO	No info	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Bahrain	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by *Codex* (Certification of inspection).	All food items, except otherwise accompanied with an official certificate of normal radiation levels	YES	2011.04.07[5]	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Bolivia	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by *Codex* (Certification of inspection).[6]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Brazil	**Resolution - RDC N° 15 (8 April 2011) -** Food imported from Gunma, Ibaraki, Tochigi, Miyagi, Yamagata, Niigata, Nagano, Yamanashi, Saitama, Tokyo, and Chiba are required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex (Certification of inspection) (as of 2014.05.23)[7]	All food and food products	YES	2011.04.08	2012.12.07	1000 Bq/kg	1000 Bq/kg	-	**About $12 million, less than 2% of total imports**	-
Brunei	(1) Complete import ban on all products from Fukushima prefecture (as of 2014.05.23) (2) Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex (Certification of inspection), except for Fukushima prefecture (as of 2014.05.23)	Fresh agricultural and fish products; processed foods	YES	2011.03.29[8]	2012.10.10 (Not removed, adjusted)[9]	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	ǂ PTA with Japan (ASEAN)
Canada§	All shipments of food and animal feed from Fukushima, Gunma, Ibaraki, Tochigi, Miyagi, Yamagata, Niigata, Nagano, Yamanashi, Saitama, Tokyo, and Chiba must be accompanied by a signed attestation from the importer indicating that: products did not originate from the affected areas in Japan. Products that were produced, grown, processed, packaged or stored in any of the affected areas after March 11, 2011 have been tested for residual activity by a laboratory acceptable to the Government of Canada.[10]	Milk products, fruits, and vegetables from areas of Japan affected by the ongoing nuclear crisis (Japanese prefectures of Fukushima, Gunma, Ibaraki, and Tochigi)	NO	2011.03.25	2011.06.13	300 Bq/kg	1000 Bq/kg[11]	-	**Less than 1% of total imports**	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Chile	**Extenta N. 335** - A health certificate from Japanese competent authorities must accompanied food from Japan.[12]	Cereals, roots, tubers, vegetables, fruit, meat and meat products, milk and milk products, fish and shellfish and products thereof, and baby and infant foods	YES	2011.05.20	2011.09.30[13]	1000 Bq/L	Cereal 600, Roots 2000, Vegetables 1500, Fruit 1500, Meat 3000, Fish 3500 Bq/kg	-	-	ǂ PTA with Japan Japan-Chile Economic Partnership Agreement (EPA)
China	(1) Complete import on all products from Miyagi, Fukushima, Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo, Niigata, and Nagano prefectures (2) Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex, except for above prefectures (as of 2014.05.23)	All food and food products	NO	2011.04.08[14]	2011.05.25	330 Bq/kg	Meat/Fish 800 Bq/kg, Vegetables 201 Bq/kg[15]	-	($406 Billion in 2014, Represented 9% of all Japanese Exports)	23 May 2011, China eased the restrictions on the import of agricultural products from two prefectures far from Japan's stricken Fukushima plant, post the restrictions imposed in the wake of earthquake[16]
Chinese Taipei	**FDA food no.1001300991**: Temporarily suspension of inspection applications for all imported food items produced in the Fukushima, Ibaraki, Tochigi, Gunma and Chiba prefectures of Japan.[17]	All food and food products	YES	2011.03.26	-	370 Bq/kg	370 Bq/kg[18]	-	($610 Billion in 2014 Represented 13.6% of all Japanese exports)	-
Colombia	**Resolution No. 3421** - Certificate from Japanese must accompany each food consignment from designated prefectures certifying that the food imported from Japan is free of radionuclides contamination, or within the permissible contamination levels according to international standards. Certificates must contain, "Name or feed or food, the batch, quantity, Prefecture, port of origin, harvest season, place of embarquement, identification of transporter, name of producer, name of laboratory"	Animal feed and food for human consumption	YES	2011.08.22	2012.08.22[19]	500 Bq/kg	500 Bq/kg[20]	-	-	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Congo	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[21]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Ecuador	No information	All food and food products	NO	-	2013.04.03[22]	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Egypt	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[23]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
European Union*[§]	**(EU) No. 297/2011 -** All products must be accompanied by a declaration that: product has been produced before 11 March 2011, doesn't originate from Fukushima, Gunma, Ibaraki, Tochigi, Miyagi, Yamagatam Niigata, Nagano, Yamanashi, Saitama, Tokyo, Chiba, and is not above radionuclide levels outlined in Erratum No 3954/87 (1987). Consignments must be notified of arrival two working days prior, test of 10% of consignments carried out, and any kept for testing must be kept under control for 5 days.[24]	All feedstuffs and foodstuff originating from Japan, excluding products which left Japan before 28 March 2011 and products which were harvested or processed before 11 March 2011	YES	2011.03.24	-	1000 Bq/kg (50 Bq/kg)	1250 Bq/kg (100 Bq/kg)[25]	2012.03.29	($222 Billion in 2014 Represented 4.9% of all Japanese exports)	The transitional measures for beef have no relevance for the import into the Union as the import of beef from Japan into the Union is not allowed
France[§]	Following commission implementing regulation (EU) No 297/2011 in force since 26 March. French authorities have decided to maintain a control rate of 100 % on all foodstuffs of animal originally produced	All feedstuffs and foodstuff originating from Japan, excluding products which left Japan	YES	2011.03.30	-	1000 Bq/kg (50 Bq/kg)	1250 Bq/kg (100 Bq/kg)	2012.03.29	-	Added because French government maintains a control rate of 100%, which is not included in EU regulations

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
	after March 11 and fresh products (salads, vegetables, fruits, etc.) from Japan.[26]	before 28 March 2011 and products which were harvested or processed before 11 March 2012								
Guinea	No information	All food and food products	NO	-	2012.06.22[27]	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Hong Kong	Order from Director of Food and Environmental Hygiene (**Section 78B of the Public Health and Municipal Services Ordinance**) - Food and Environmental Hygiene Department (FEHD) prohibits imports harvested, manufactured, processed or packed on or after March 11 from Fukushima, Ibaraki, Tochigi, Gunma and Chiba. Some products will be excluded from the ban if they are certified by the competent authority of Japan that the radiation levels do not exceed Codex Guideline Levels[28]	All food and food products	NO	2011.03.24	-	50 Bq/kg	100 Bq/km	-	($986 Billion in 2014 Represented 21.9% of all Japanese exports)	-
India	Sample inspections related to imported Japanese goods occasionally carried out by federal authorities[29]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	ǂ PTA with Japan
Indonesia	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[30]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	-	ǂ PTA with Japan (ASEAN)
Iran	Sample inspections related to imported Japanese goods occasionally carried out by federal authorities[31]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Iraq	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[32]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Israel	Sample inspections related to imported Japanese goods occasionally carried out by federal authorities.[33]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Kuwait	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[34]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Lebanon	(1) Complete import ban on all products emerging from most affected prefectures (undeclared individual prefectures) (2) Certification of inspection or origin from Japanese government for all the Japanese products, except from affected prefectures.[35]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Macao	(1) Complete import ban on vegetables, fruits, meat, eggs and seafood from Fukushima prefecture. (2) Complete import ban on select food items from Miyagi, and Ibaraki, Tochigi prefectures (3) Require certification of inspection for some food (vegetable, fruits, milk, meat, egg and seafood) from Yamanashi and Yamagata prefecture.[36]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Malaysia	(1) Certification of inspection required for importing products from all prefectures in Japan. (2) Food products harvested and processed in 8 prefectures of Fukushima, Gunma, Ibaraki, Tochigi, Miyagi, Kanagawa, Saitama, and Chiba require total inspection in Malaysia.[37]	All food and food products	NO	2011.07.01	2013.03.01	1000 Bq/kg**	1000 Bq/kg**	-	-	‡ PTA with Japan (ASEAN)
Mauritius	Sample inspections related to imported Japanese goods occasionally carried out by federal authorities.[38]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Mexico[§]	-	All food and food products	NO	-	2012.01.01	1000 Bq/kg**	1000 Bq/kg**	-	-	‡ PTA with Japan
Morroco*	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[39]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Nepal	Sample inspections related to imported Japanese goods occasionally carried out by federal authorities.[40]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
New Zealand	-	Milk and other dairy products; meat and offal of mammals and poultry; fresh green vegetables; tea; seaweed; fruit and root vegetable crops	NO	2011.03.31	2012.07.15	1000 Bq/kg**	1000 Bq/kg**	-	-	-
Oman	(1) Certification of inspection or origin from Japanese government for all the Japanese product (as of 2014.05.23) (2) Sample inspections carried out for fresh foods, fruits, and milk (as of 2014.05.23)[41]	Fresh/ processed food and animal feed	YES	-	-	1000 Bq/kg**	1000 Bq/kg**	-	-	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Pakistan	Sample inspections related to imported Japanese goods occasionally carried out by federal authorities.[42]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Peru	No information	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	≠ PTA with Japan
Philippines	**Fisheries General Memorandum Order No. 001 (2011) -** Clearance for importation of fish and fishery products originating from Japan shall be accompanied by results of laboratory examination from the competent authority of Japan showing that the fish or fishery product to be imported conforms with the guidance levels	Fish and Fishery Products (HS Chapter 03 and HS Code 1604) Meat, dairy products, live animals, and animal feed products, Plants, Planting Materials, and Plant products (HS Codes 06, 07, 08, 09, 10, 17, and 24)	YES	2011.03.29	-	1000 Bq/kg	1000 Bq/kg[43]	-	-	(According to Japanese Government) (1) Certification of inspection required from Japanese government for beef, vegetables, fruits, plants and seeds from Fukushima prefectures (as of 2014.05.23) (2) Certification of origin required from Japanese government for products emerging from non-affected prefectures (as of 2014.05.23) (3) Complete import ban on select fish
Polynesia	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[44]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Qatar	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[45]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Russia[§]	(1) Complete import ban on all food product imports from the six most affected prefectures, including 242 fish processing companies. (2) Complete import ban on a food imports from the six most affected prefectures.[46]	All food and food products	NO	2011.03.24	-	1000 Bq/kg**	1000 Bq/kg**	-	(Seafood imports amounted to 57,000 tons ($58 million) in 2010, roughly 6% total seafood exports of Japan. Japan the 9th biggest exporter to Russia)	(According to Japanese Government) (1) Certification of inspection required from Japanese government for all food from Fukushima, Ibaraki, Tochigi, Chiba and Tokyo prefectures (2) Sample inspections for all food except for that emerging from above areas (3) Complete import ban of all seafood from Aomori, Iwate, Miyagi, Yamagata, Fukushima, Ibaraki, Chiba and Niigata (4) Sample inspections for all the seafood except from above listed prefectures
Saudi Arabia	**Notice of Executive Order of Saudi Food and Drug Authority Ref. No. 73/32** - (1) Temporary ban of import of foodstuffs originated from five prefectures in Japan (Fukushima, Ibaraki, Tochigi, Gunma, Fukushima Dai-ichi), or from any other contaminated areas to be declared by the Japanese Government.(2) A health certificate from Japanese competent authorities must accompanied each food consignment certifying that the food products imported from Japan is free of radionuclides contamination, or if present shall be within the permissible contamination levels according to international standards.	All food and food products	YES	2011.04.16[47]	2012.10.16[48]	1000 Bq/kg	1000 Bq/kg	-	**Less than 1% of total imports**	(According to Japanese Government) (1) Certification of inspection required from Japanese government for all Japanese products (as of 2014.05.23) (2) Sample inspections for all products (as of 2014.05.23)
Serbia	No information	All food and food products	NO	-	2011.07.01[49]	-	-	-	**Less than 1% of total imports**	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Singapore	(1) Complete import ban for beef, milk, eggs, vegetables, fruits, and tea from Fukushima prefecture(2) Certification of inspection from Japanese for specified products (Ibaraki, Tochigi, Gunma :beef, milk, vegetable, fruits, seafood; Sautma: Chiba; Tokyo, Kanagawa: vegetables, fruits; Hizuoka: tea)(as of 2014.05.23)(3) Certification of origin required from Japanese government for some food (4) Sample inspections occasionally carried out	Beef, milk, eggs, fruits, tea, vegetables, seafood	NO	-	2012.04.04 (Not removed, adjusted)[50]	1000 Bq/kg**	1000 Bq/kg**	-	-	2012.04.04; Exports allowed with requirement for radioactive material test certificates ǂ PTA with Japan (ASEAN)
Republic of Korea[§]	Ban on imports from eight prefectures and additional testing and certification requirements in all cases where radioactive Caesium was detected, even in quantities below the Korean limit of 100 Bq/kg. Applied exclusively to Japanese products; Korean and other trading partners' products could be distributed as long as the radioactive Caesium level remained below 100 Bq/kg.	Imported fish, bivalves, molluscs, algae, and feed from Japan	YES	2011.03.19	-	370 Bq/kg (50 Bq/kg)	370 Bq/kg (100 Bq/kg)	2013.09.09	($350 Billion Represented in 2014 7.8%% of all Japanese exports)	(According to Japanese Government) (Restrictions very complex; mix of import bans, inspection certifications, and certifications of origin). (1) Complete import ban on all seafood from Fukushima, Miyagi, Iwate, Aomori, Gunma, Tochigi, Ibraki, and Chiba prefectures beginning from September 2013. (2) Certification of inspection required (including Pu, Sr) in cases where Caesium was detected. (3) Limits changed (370Bq/kg--> 100Bq/Kg) from September 2013.
Switzerland[§]	-	-	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	ǂ PTA with Japan (Includes SPS and TBT chapters)

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
Thailand	**Thai FDA TH1050 -** No ban instituted, but FDA issued new regulations prescribing a new set of standards for radioactive contamination in foods, and requiring an import certificate from the Japanese authorities to ensure that the food is safe. The new regulation applies to food originating from 12 prefectures. Every shipment originating from these prefectures requires an import certificate.[51]	Import requirement for food with risk from radionuclide contamination (ICS Code 67.040)	YES	2011.04.12	2012.04.04 (Not removed, adjusted)[52]	500 Bq/kg	500 Bq/kg	-	**3% of Thai agricultural imports (2010)** (Japan is one of the top-three major exporters of fish and seafood to Thailand. Represented 5.9% of all Japanese exports in 2014)	(According to Japanese Government) (1) Certification of inspection required for all foods from Miyagi, Fukushima, Ibaraki, Tochigi, Gunma, Chiba, Kanagawa and Shizuoka prefectures. (2) Certificate of origin required for all foods, except from prefectures listed above. 2012.04.04; Tokyo removed from testing requirements ǂ PTA with Japan (ASEAN)
Turkey[§]	All goods from Japan are required to pass through assigned customs points equipped with radiation control devices and should be subjected to radiation controls; Certificate of conformity of Turkish Atomic Energy Authority in terms of radioactivity content for all agricultural products and foodstuffs originated and/or imported from Japan is required to complete custom procedures.	-	NO	2011.03.24	-	1000 Bq/kg**	1000 Bq/kg**	-	-	(According to Japanese Government) Sample inspections related to imported Japanese goods occasionally carried out by federal authorities (As of 2014.05.02)
UAE	Food imported from Japan required to submit a statement from the Japanese "competent" authority, accompanied by laboratory analysis report showing that the levels of radionuclide levels are within limits set by Codex and the exact origin of all products. *Sometimes country does inspection by themselves.[53]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-
Ukraine	Sample inspections related to imported Japanese goods occasionally carried out by federal authorities.[54]	All food and food products	NO	-	-	1000 Bq/kg**	1000 Bq/kg**	-	**Less than 1% of total imports**	-

Import country	SPS measure description	Covered products	Reported to WTO	Date applied	Date removed	Limits for radioactive caesium, milk and dairy (adjusted)	Limits for radioactive caesium, general foodstuffs (Adjusted)	Date of adjustment	Percent of imports japanese goods	Other related info
United States[§]	On March 22, 2011, FDA issued an **Import Alert 99-33 -** All milk and milk products and vegetables and fruits produced or manufactured from the four Japanese prefectures of Fukushima, Ibaraki, Tochigi and Gunma will be detained upon entry into the United States. They will not be allowed to enter the U.S. food supply, unless shown to be free from radionuclide contamination.[55]	All milk and milk products and fresh vegetables and fruits produced or manufactured from the four Japanese prefectures of Fukushima, Aomori, Chiba, Gumna.	NO	2011.03.22	-	1200 Bq/Kg	1200 Bq/Kg	-	($688 Billion in 2014 Represented 15.3% of all Japanese exports)	(According to Japanese Government) (Restrictions very complex; mix of import bans, inspection certifications, and certifications of origin). http://www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf
Vietnam	-	-	NO	-	2013.09.01	1000 Bq/kg**	1000 Bq/kg**	-	($215 Billion in 2014 Represented 4.8% of all Japanese exports)	ǂ PTA with Japan (ASEAN) (Includes SPS and TBT chapters)

* No additional measures from EU directorate: Austria, Belgium, Czech Republic, Cyprus, Denmark, Finland, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom

ǂ Japan has twelve bilateral PTAs in force (with Singapore, Mexico, Malaysia, Chile, Thailand, Indonesia, Brunei, the Philippines, Switzerland, and Vietnam, India and Peru) and one regional PTA with the ASEAN

** Codex Alimentarius Guideline levels assumed, not otherwise indicated

§ NEA Member States

Notes to the tables

1. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Australia, G/SPS/N/AUS/261 (14 April 2011).
2. 諸外国・地域の規制措置"（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
3. Carpenter, Julia, and Rick Tinker. "Assessment of the Impact on Australia from the Fukushima Daiichi Nuclear Power Plant Accident".
   Australian Radiation Protection and Nuclear Safety Agency, Technical Report 162 (2012)
4. Japan Ministry of Agriculture, Forestry and Fisheries
   www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
5. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Bahrain, G/SPS/N/BHR/115 (18 July 2011).
6. 諸外国・地域の規制措置"（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
7. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Brazil; Revision, G/SPS/N/BRA/734/Rev. 1
   (26 April 2011).
8. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Brunei Darussalam, G/SPS/N/BRN/3
   (09 May 2011).
9. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures; Revision, Brunei Darussalam, G/SPS/N/BRN/3/Rev.1 (29 November 2012).
10. United States Department of Agriculture, Foreign Agriculture Service. "Canada, Actions Taken Regarding Food Imports from Japan." Trade Policy Monitoring, CA11016; 08 April 2011. Web: 03 October 2014.
11. Canadian Ministry of Health. "Canadian Guidelines for the Restriction of Radioactively Contaminated Food and Water Following a Nuclear Emergency: Guidelines and Rationale." Minister of Public Works and Government Services Canada, 31 July 2008. Web: 03 October 2014.
12. Gobierno de Chile. Exenta N. 335; Dispone Exigencia de Certificación de Ausencia de Contaminación por Radionúclidos en Alimentos Importados Desde Japón. Subsecretaria de Salud Pública División Políticas Publicas Saludables y Promoción ; 20 May 2011.
13. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures; Addendum, Chile, G/SPS/N/CHL/359/Add.1 (31 October 2011).
14. OECD-UNCTAD (2011), "Reports on G20 Trade and Investment Measures (Mid-October 2010 to April 2011", OECD and FAO. http://unctad.org/en/Docs/unctad_oecd2011d5_summary_en.pdf. p. 53.
15. "Progress to Date; Food Safety." Japanese Reconstruction Agency, n.d. Web: 03 October 2014. https://www.reconstruction.go.jp/english/topics/2013/03/food-safety.html.

16. Nedumpara, James J. and Geetanjali Harish Sharma, “Trade Monitoring Policy Report of Japan 2011-2012”. Center for International Trade and Economic Laws (CITEL), O.p. Jindal Global Law School, 2012. p. 47.
17. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Taiwan, Penghu, Kinmen, and Matsu, G/SPS/N/TPKM/231 (30 May 2011).
18. United States Department of Agriculture, Foreign Agriculture Service. "Taiwan: Actions Taken Regarding Food Imports from Japan." Trade Policy Monitoring, TW11006; 13 April 2011. Web: 03 October 2014.
19. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Colombia, G/SPS/N/COL/226 (13 September 2011).
20. República de Colombia. Resolución Numero 00003421. Ministerio de Agricultura y Desarrollo Rural, Ministerio de la Protección Social; 16 August 2011.
21. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
22. Ibid.
23. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
24. The European Commission. Commission Implementing Regulation (EU) No 297/2011; Imposing Special Conditions Governing the Import of Feed and Food Originating in or Consigned from Japan following the accident at the Fukushima Nuclear Power Station. Official Journal of the European Union; 26 March 2011.
25. The European Commission. Commission Implementing Regulation (EU) No 284/2012; Imposing Special Conditions Governing the Import of Feed and Food Originating in or Consigned from Japan following the accident at the Fukushima Nuclear Power Station and Repealing Implementing Regulation (EU) No 961/2011. Official Journal of the European Union; 30 March 2012.
26. "La gestion du risque radiologique alimentaire." Ministère de l’agriculture, de l’agroalimentaire et de la flore en France, n.d. Web: 03 October 2014. https://agriculture.gouv.fr/La-gestion-du-risque-radiologique.
27. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
28. United States Department of Agriculture, Foreign Agriculture Service. "HK Bans Certain Japanese Food Items due to Detection of Radiation." Trade Policy Monitoring, HK1109; 24 March 2011. Web: 03 October 2014.
29. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
30. Ibid.
31. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
32. Ibid.

33. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
34. Ibid.
35. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
36. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
37. Nedumpara, James J. and Geetanjali Harish Sharma, “Trade Monitoring Policy Report of Japan 2011-2012”. Center for International Trade and Economic Laws (CITEL), O.p. Jindal Global Law School, 2012. p. 87
38. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
39. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
40. Ibid.
41. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
42. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
43. Republic of the Philippines. Fisheries General Memorandum Order No. 001, Series of 2011. Bureau of Fisheries and Aquatic Resources; 29 March 2011.
44. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
45. 諸外国・地域の規制措置”（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
46. United States Department of Agriculture, Foreign Agriculture Service. "Russia Bans Imports of Japanese Foods Products." Trade Policy Monitoring, RS1119; 20 March 2011. Web: 03 October 2014.
47. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures, Kingdom of Saudi Arabia, G/SPS/N/SAU/13 (28 April 2011).
48. WTO Secretariat, Committee on Sanitary and Phytosanitary Measures, Notification of Emergency Measures; Addendum, Kingdom of Saudi Arabia, G/SPS/N/SAU/13 (19 December 2012).
49. 諸外国・地域の規制措置（平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.
50. Japanese Ministry of Agriculture, Forestry, and Fisheries. "FY 2012 Annual Report on Food, Agriculture and Rural Areas in Japan". FY 2012 Annual Report (20130. Web: 03 October 2014.
51. United States Department of Agriculture, Foreign Agriculture Service. "Thai FDA Implements Safety Measures on Japanese Food Imports." Trade Policy Monitoring, TH1050; 20 April 2011. Web: 03 October 2014.

52. Japanese Ministry of Agriculture, Forestry, and Fisheries. "FY 2012 Annual Report on Food, Agriculture and Rural Areas in Japan". FY 2012 Annual Report 2013. Web: 03 October 2014.

53. 諸外国・地域の規制措置 (平成 26 年 5 月 23 日現在), Japan Ministry of Agriculture, Forestry and Fisheries www.maff.go.jp/j/export/e_info/pdf/kisei_all_140530.pdf.

54. Ibid.

55. "FDA Response to the Fukushima Dai-ichi Nuclear Power Facility incident." United States Food and Drug Administration, n.d. Web: 03 October 2014 www.fda.gov/newsevents/publichealthfocus/ucm247403.htm.