Research on Aquacultural Trade and Policy
- Three Essays on China's Aquatic Product Trade

by

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Abstract

This dissertation consists of three chapters, discussing the issue of international aquatic product trade. The purpose of first chapter is to determine the effects of American antidumping duty on China's shrimp market by using the Equilibrium Displacement Model (EDM). In this chapter, the change of price and production in China's domestic market and in the world market after the imposition of antidumping duty, as well as the welfare consequences were discussed. Antidumping tariff imposed by U.S. have reduced the shrimp price in China's domestic market. It also reduced the quantity of Chinese shrimp exports to U.S. For welfare effect analysis, both Chinese producers and U.S. consumers were hurt by this policy. However, U.S. producers and government are gained, and their gains can be used to offset losses to U.S. consumers.

Further, the discussion about whether subsidy on fishery industry should be cancelled is severe at the moment. The second chapter takes consideration of the welfare of producers and consumers on both retail level and farm level to find out the effectiveness of subsidy. The result in this chapter indicates that the subsidy increase leads to the increase in all levels of producers and consumers' welfare. It influences consumers' welfare more significantly than it does on producers.

Lastly, Japan is one of the largest shrimp importing countries. It is also the major shrimp export market to China. However, competition in Japan's shrimp import market is severe and China's shrimp lack competitive power on this market. The third chapter used

source-differentiated CBS model to analyze Japan’s shrimp import market. The estimation of Japan's shrimp import demand uncovers the situation of Japan's shrimp import market. Further, it discovers China’s frozen shrimps do not have strong competitiveness in Japan’s market, while shrimp products do. In addition, suggestion is put forth for producers and policy makers.

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1.1 Introduction

The imposition of antidumping duty aims to increase the price of the imported commodity in the importing country so that the producer in the importing country is protected. When the imported commodity is sold at an unfair price that is below the cost of production, certain countries will impose a punitive tariff. It is arguable whether antidumping tax is effective among economists.

The purpose of this research is to determine the efficacy of antidumping measures on Sino-U.S. shrimp trade, especially its influence on Chinese domestic shrimp market. Shrimp is a major aquatic product in the American market. Eighty-seven percent of shrimp consumption in the American market depends on import. China used to be the largest export country to U.S. The export amount to U.S. occupies 43% of its total export. However, this situation changed after the imposition of antidumping tax in 2004. In November 2004, United States International Trade Commission decided to impose the antidumping duty on import shrimp from China at an average rate of 112.8%. Nevertheless, Chinese shrimp producers started to export shrimp to other countries such as Japan and European Union (EU), which were also the major consumer of Chinese shrimp. Therefore, the issue is whether the levy of antidumping tariff on Chinese shrimp producer has positive effects on U. S., and as an export country whether China expensed any loss from this policy and eventually who bears the burden of the antidumping tariff.

Shrimp trade between China and U.S. once occupied an important agricultural trade position. Antidumping duty changed the situation. The existing literature on U.S. antidumping duty has not focused on the significant market between China and U.S. There is no research on the welfare consequences for China and U.S. due to antidumping duty. These will be discussed

in detail in the literature review. This paper is expected to use Equilibrium Displacement Model (EDM) to determine the effects of antidumping duty on China and U.S. shrimp market. To what extent China should care about the antidumping duty will also be discussed. Considering the relevance between antidumping duty and welfare, if the overall welfare in China is increased through the antidumping duty, then it is unnecessary for the Chinese government to pay special attention to the duty. Moreover, the changes caused by antidumping duty on the market of both sides and who undertakes most of the consequences will be discussed. Thus, all the parties that participate in the shrimp market in China and the U.S. will be concerned with these issues. This research paper will explicitly provide the impact of the antidumping duty on Sino-U.S. shrimp market and will further analyse the welfare consequences on both sides.

This paper uses a partial equilibrium model of China and U.S. shrimp market to evaluate the effects of antidumping tariff. In this model, China is defined as an export country while U.S. and rest-of-world (ROW) are defined as importing countries and regions. It starts from graphical analyse and modeling, substituting in relevant data and parameters to scale the result. Then it indicates the welfare effects on both exporting and importing countries. At last, there is the final result to sum up the paper.

1.2 Literature Review

There are several literature describing global the antidumping cases. The literature focuses on the effect of the antidumping policy on the U.S. and the impact on the exporting country. Keithley and Poudel (2008) researched the effect of antidumping duties on U.S. southeast shrimp market. The study shows that in order to protect domestic shrimp industry, the U.S. intended to assist capture fishery with loan and loan guarantee, however, it didn't work. Then, a tariff bill was

introduced. The antidumping petition aided U.S. domestic shrimp industry to survive. At the same time, the charged countries shifted their shrimp export to other countries while non-charged countries exported their shrimp to U.S. The analysis presented in this article suggests that antidumping duties have provided only marginal protection to the domestic industry.

Nevertheless, Sharp and Zantow (2005) illustrates the injury of antidumping to U.S. shrimp market. They found that importing and exporting countries were essentially equal causes of injury to the shrimp industry. They applied a simultaneous equations approach to study the injury of antidumping duty. It was concluded that antidumping policy hurts the consumer and producer in both countries. The respondent countries, which are charged, will shift out from the U.S. while non-respondent countries will export more to the host country. Eventually, the price of shrimp in the U.S. will still be low. Therefore, the producers in the U.S. benefit little from the antidumping duty.

The papers mentioned above pay more attention to the U.S. market, and consider this problem in a global market. They discovered the impact of antidumping duty on U.S. market, and tried to evaluate whether it works or not. However, there is no research focusing on Sino-U.S. partial market that tries to find out whether the antidumping influence China domestic market. Also, welfare analyses of Sino-U.S. policy effects are not complete. It is important to find out the impact of antidumping on China's domestic market since it can help China to understand the total effect of the tariff. In addition, U.S. side will consider more about the policy if they can understand who enjoys welfare gain. It is hoped that the gaps mentioned above will try to be filled in this paper.

To solve the problem, an EDM model will be used in this paper. EDM model was used to solve tariff problems in some research papers, on which this paper is based. The primary

instrument of antidumping is tariff (Kinnucan & Myrland, 2006). The impact of tariff can be inspected in short-term period and long-term period.

In the long-run period analysis, Kinnucan and Myrland (2005) utilized elasticities that were derived from the EDM to estimate the income growth and tariff impact on salmon price, production and trade flows. By using this model, Kinnucan and Myrland evaluated the export issues that were relevant to Norway in 2002 and 2005. They found that safeguard tariff has little effect on protecting importing countries and increasing the price of particular goods. The efficacy of punitive tariff was only on reducing the export amount of taxed suppliers. As to the benefits for the demanders, there were little. That is to say, antidumping duty is not the best option for countries to solve trade dispute and reach a win-win situation. It may also cause countries to levy retaliatory duties for nothing but retaliation. This is may lead to a collapse of the world free market pattern. In the long-run period, none of the countries will benefit from utilizing this instrument.

Further, for a short-term period, Kinnucan and Myrland (2006) used partial equilibrium model to examine whether antidumping duty is an effective measure in the EU salmon trade. The authors tested marketing fee on exports and imports. This method was applied in an earlier trade argument between Norway and the EU (Bull & Brittan, 1997 cited as in Kinnucan & Myrland, 2006). It was proved by Kinnucan and Myrland that this measure could raise the salmon price in both Norway and the EU. The reason is that the marketing fee leads to an increase in product demand as both the promotion and tariff impact cause the supply to decrease simultaneously. Thus, the price in the importing country rises. Therefore, in a short-term period, the tariff helps producers in EU earn more revenue.

My paper focuses on the antidumping duty's influence on China's shrimp market. Tariff plays an important role in preventing dumping from other countries. In the paper, the duty and the welfare issue are addressed by using equilibrium displacement model (EDM).

Even though tariff is harmful for U.S. welfare in the long-term, the U.S. imposes antidumping tariff on China's export. The effects of antidumping policy include the changes of prices, trade flows and producer welfare change. To test these effects, EDM is applied. The American scholar, Gardner (1975), put forward the theory of the earliest agricultural price transmission. Gardner used a balanced mobility model (Equilibrium Displacement Model), which was developed by Muth (1965), to analyze the prices of agricultural products transmission in a perfectly competitive market conditions. Under the assumption that the constant returns to scale, technology exists in business corporations, two price- transmission elasticity formulas were inferred. This paper will investigate the effects of antidumping duty on China's welfare.

Moreover, there are several papers discussing welfare effects. Executing antidumping tariff is originally aimed to protect the beneficiaries of world trade. However, the trade protectionism uses antidumping tariff to protect its own business, which leads to a loss in the importing country (Blonigen & Prusa, 2003). It is clear that when the governments of importing countries impose antidumping duties, the commodity prices in the importing country will rise. As a result, consumers have to pay a higher price to access goods, which reduce the importing country's consumer surplus while increasing the tax revenue and national producer surplus. The positive welfare influence of an antidumping tax for the importing country will decline, when the equilibrium shifts, and exporting countries changed from negative coping to active evasion. If the cost of U.S. products is higher than that of exporting companies, the antidumping tariff will have negative effects on the social welfare of the U.S. consumers. The high cost makes the price

of the product higher, which reduces the purchasing power of domestic consumers. Due to the antidumping policy, exporting companies are unable to provide lower priced goods. Thus the social welfare of the importing country is worse off, unless the antidumping duty receipts offset cost to consumers.

Similarly, Debaere (2010) confirmed that the antidumping tariff levied by EU would reduce the price on U.S. shrimp market and then led to the decreasing of welfare in U.S. Debaere used a simple model and assumed the exporters were all individuals. The data revealed that the policy change in big countries would affect the price worldwide. It is obvious that as EU or U.S. change their tariff, the world shrimp price will alter as well. Therefore, the increase in tariff will lead to decrease in price, which injures the welfare of home country as well. This research presented the welfare changes by comparing the different policies of EU and U.S. I will also analyze welfare in my research and I will specify it in Chinese situation. Furthermore, the EDM will be applied in my study rather than a simple model. The EDM will provide precise results of the research. EDM can clearly determine the relationship in a partial market.

Seen from the above, there is a gap in the literature. The research about the antidumping duty effects on China and U.S. partial shrimp market is lacked. The market between China and U.S. is really important, but research in these markets is lacking. When this gap is filled, both China and U.S. can see their benefits and losses under the antidumping duty.

1.3 Graphical Analysis

This paper uses EDM to measure price variation and production volume. The situation of import and export between China and U.S. can be demonstrated briefly by Figure 1.1. Figure 1.1 shows the situation of how the antidumping duty influences shrimp export from China to U.S. Before

levying antidumping duty, Q_d^0 and Q_s^0 represent domestic demand and supply amount of China. The difference between these two variables is the total volumes that were exported to U.S. and the ROW. P^0 is the market price before levying antidumping duty.

After antidumping duty is levied, it increases U.S. market price and decreases China's domestic market price as well as the market prices elsewhere. The price of U.S. market is represented as P_{us}, the price in the rest of the world market is P_w. As is illustrated in Figure 1.1, U.S. import price is different from that of the other markets at this time. The price shifts from ED to ED'. Simultaneously, demand and supply of Chinese domestic market move to $Q_d^{'}$ and $Q_s^{'}$, respectively. In other countries' import market, total volumes increase from X_{row}^0 to $X_{row}^{'}$. The changes of producer surplus and consumer surplus are demonstrated in Figure 1.1. Figure 1.1 shows that China's consumer surplus change is area A + area B, which is led by price change. The producer surplus of China is area A + area B + area C + area D. In addition, from the figure, it can be seen that U.S. consumer surplus is area E + area F. Area E refers to the tax that government imposed. The quantitative analysis will be discussed in detail in the followings.

1.4 Model

Assumptions and Structural Model

Equilibrium Displacement Model (EDM) is based on the following assumptions in order to explain the influences on shrimp market in an open economy. First of all, the role of China in this open economy is a net exporter. Although China imports shrimp, the quantity is very little. Thus, the net value is used in this paper. Second, the commodity and the price are homogeneous as a group in the domestic shrimp market. In addition, quantity and price are considered as endogenous variables, and antidumping duty and tariff are regarded as exogenous variables.

Then, the Law of One Price (LOP) holds across all markets, forcing the integration between the domestic market and the export markets. LOP shows that when trade is open and transaction fee is zero, wherever the same products are sold, the price is the same in the same currency. This exporting market can be seen near a perfectly competitive market. Then, LOP holds across markets (Fackler & Goodwin, 2001). Moreover, competitive market clears. The demand is downward sloping, and the supply is upward sloping. U.S market price and supply price is determined by ad valorem antidumping duty.

With these assumptions, equilibrium is given by the following structural model:

1) $Q_d = D(P_d)$ (Domestic demand for China)

2) $Q_s = S(P_d)$ (Total supply of China)

3) $X_{us} = X_{us}(P_{us})$ (Export demand for U.S.)

4) $X_{row} = X_{row}(P_{row})$ (Export demand for ROW)

5) $P_{us} = P_d * T_a$ (Export price for U.S.)

6) $P_{row} = P_d + T_{row}$ (Export price for ROW)

7) $Q_s = Q_d + X_{us} + X_{row}$ (Quantity equilibrium)

Where Q_d is the consumption volume of domestic shrimp market, X_{us} is the amount of shrimp exported to U.S. and X_{row} is the amount of shrimp exported to ROW market. Q_s is the shrimp supply volume in China. P_d is the China's domestic price. P_{us} is the U.S. market price after levying antidumping duty. As U.S. imposed the antidumping duty, T_a is the symbol of the U.S. tariff rate on Chinese shrimp. T_{row} is the tariff on shrimp of the rest of the world.

In this model, domestic price (P_d), domestic demand (Q_d), domestic supply (Q_s), and export demand for U.S. (X_{us}) and ROW (X_{row}) are endogenous variables. The two exogenous variables are the tariff on ROW market (T_{row}) and the antidumping duty on U.S. market (T_a). Exogenous

variables affect supply and demand beyond tariffs and antidumping duties suppression. The definitions and baseline values of variables are shown in Table 1.1.

Equilibrium Displacement Model

The structural model was transformed to percentage changes yields

8) $Q_d^* = \eta_d P_d^*$

9) $Q_s^* = \varepsilon_d P_d^*$

10) $X_{us}^* = \eta_{us} P_{us}^*$

11) $X_{row}^* = \eta_{row} P_{row}^*$

12) $P_{us}^* = P_d^* + T_a^*$

13) $P_{row}^* = P_d^* + T_{row}^*$

14) $Q_s^* = k_d Q_d^* + k_{row} X_{row}^* + k_{us} X_{us}^*$

Variables with star symbol in the above equation represent the percentage change. $k_d = Q_d / Q_s$ means the share of China's domestic shrimp demand from domestic supply. $k_i = X_i / Q_s$ represents the share of China's shrimp export to area i from Chinese shrimp supply. The domestic demand elasticity η_d, and export demand elasticity η_i are negative ($\eta_d < 0, \eta_i < 0$) while the domestic supply elasticity ε_d is positive ($\varepsilon d>0$). By imposing the market clearing conditions, the reduced form of the endogenous variables can be obtained.

15) $P_d^* = \frac{k_{us}\eta_{us}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_a^* + \frac{k_{row}\eta_{row}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_{row}^*$

16) $P_{us}^* = \frac{\varepsilon_d - k_d\eta_d k_{us} - k_{row}\eta_{row}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_a^* + \frac{k_{row}\eta_{row}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_{row}^*$

17) $P_{row}^* = \frac{k_{us}\eta_{us}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_a^* + \frac{\varepsilon_d - k_d\eta_d k_{us} - k_{us}\eta_{us}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_{row}^*$

18) $Q_d^* = \frac{\eta_d k_{us}\eta_{us}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_a^* + \frac{\eta_d k_{row}\eta_{row}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_{row}^*$

19) $X_{us}^* = \frac{\eta_{us}(\varepsilon_d - k_d\eta_d k_{us} - k_{row}\eta_{row})}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_a^* + \frac{\eta_{us} k_{row}\eta_{row}}{\varepsilon_d - k_d\eta_d - k_{us}\eta_{us} - k_{row}\eta_{row}} T_{row}^*$

20) $X_{row}^{*} = \frac{\eta_{row} k_{us} \eta_{us}}{\varepsilon_d - k_d \eta_d - k_{us} \eta_{us} - k_{row} \eta_{row}} T_a^{*} + \frac{\eta_{row}(\varepsilon_d - k_d \eta_d k_{us} - k_{us} \eta_{us})}{\varepsilon_d - k_d \eta_d - k_{us} \eta_{us} - k_{row} \eta_{row}} T_{row}^{*}$

As the tariff of ROW (T_{row}^{*}) is a fixed rate and is not affected by other exogenous variables, this part of the equations can be treated as constants, and will not be discussed. As can be seen from the reduced form equations, all endogenous variables are represented by the elasticities combined with exogenous variables. The price and the quantity can increase or decrease in accordance with the exogenous variables impacts according to the different elasticity signs. Then, Cramer's Rule is utilized to solve the equations and obtain the values of reduced-form elasticities.

1.5 Data and Parameterization

Numerical values for the prices and quantities are listed in Table 1.1. Numerical values for the parameters after determination are listed in Table 1.2.

Data Description

Data for 2003 were used in this paper. Since the antidumping duty has been charged from 2004，the 2003 data can measure the impact of antidumping duty on variables more intuitively. Meanwhile, it could contrast the changes between pre-tax and post-tax. The data were mainly from *Chinese Fisheries Statistics Yearbook*, National Bureau of Statistics of China, FAO-Food and Agriculture Organization of United Nations, and Chinese Academy of Fisheries Sciences. Furthermore, some trade and export information were from *Chinese Agricultural Export Guide.*

China's Domestic Demand Elasticities

There are several articles that discuss the demand elasticity of fishery and aquaculture in China. In Gale and Huang (2007) paper, they considered all quality, quantities and income effects on China's food demand elasticity. The paper used data around year 2003 and analyzed

some food demand elasticities. Compared to other foods, shrimp is more elastic. In U.S. International Trade Commission's public book (2011), suggested using -1 to -3 as the range of U.S. demand elasticity. Cheng and Capps (1988) employed time series method to regress the shrimp demand elasticity which was -0.7. However, the price elasticity of demand for luxury products like shrimp is typically smaller in developed countries than in developing countries. Therefore a small number was chosen in this paper as Chinese shrimp demand elasticity. Finally, in the book of Tan & Xin (2001), the price elasticity of demand of Chinese aquatic products, which was calculated at -2.127? Considering the elements above, -2.127 is a proper demand elasticity of aquatic products. Therefore, in this paper, the shrimp price elasticity of demand in China's domestic market is -2.2.

China's Domestic Supply Elasticities

In this paper, both short-term and long-term effect of antidumping tariff will be considered. For short-term analysis, the supply quantity is difficult to change and will not be considerably influenced by the antidumping duty. Chinese producers need some time to respond to this change in export. Then, the short-term domestic producers supply elasticity is close to 0. In this paper, 0 is chosen as the short-term supply elasticity, which is ε_d.

For long-term analysis, Dey's paper (2004) indicated that Chinese supply elasticity for aquatic products were 0.67. Therefore, 0.67 was chosen as the long-term supply elasticity and was used to estimate the long-term effects.

Import Demand Elasticity for U.S. and Rest of World

The import demand elasticity is properly interpreted as residual demand elasticities. Since residual demand elasticity varies inversely with the quantity share of China's products in the respective importing regions (U.S. and ROW), they can be quite elastic. This paper applies the

method that Kinnucan and Myrland (2005) used in their paper to measure import Demand Elasticity for U.S. and the rest of world. The equations are as follows.

21) $\eta_{us}=((1-k_{us})\varepsilon+\eta)/k_{us}$

22) $\eta_{row}=((1-k_{row})\varepsilon+\eta)/k_{row}$

The ε and η parameters in the equations for the residual demand elasticity are domestic elasticity. To apply the equations, it is determined that the share of domestic consumption in each region originates from import. Moreover, these *k* values are used to compute the residual demand elasticity with assumed values for ε and η. The FAO data were used to calculate the share of domestic consumption in each region and substitute them into the formula.

Based on the above equations and estimated data, it can be concluded that Import Demand Elasticity for U.S (η_{us}) . is -10.23, and Import Demand Elasticity for row (η_{row}) is -13.67.

Export Quantity Shares

According to *Chinese Fisheries Statistics Yearbook, kd*=0.849, *kus*=0.084 and *krow*=0.067. *kd* + *kus* +*krow*=1.

For the parameters, the description is listed in Table 1.2.

1.6 Reduced-Form Elasticities and Tariff Effects [1]

In this section, how the endogenous variables shift due to the changes in exogenous variables will be put forth. Therefore, the effects of levying antidumping duty will be determined. In the paper, it categorizes the discussion into long-term period and short-term period. The short-term refers to insufficient time for producers to respond and adjust production upon changes in economics, in which the domestic supply elasticity is 0 ($\varepsilon_d=0$). From calendar time, short-run

[1] Assume that the tariff of ROW is no change

elasticities are defined to cover a time horizon of approximately one year（Kinnucan and Myrland, 2005）. Lone-run refers to adjusted production.

Short-term Effects

The following is an explanation of how the exogenous variable, the antidumping duty, affects price and quantity at the market. These numerical values represent the percentage change caused by the exogenous variables. Table 1.3 shows the specific value of each term.

The result of first row is the short-term ($\varepsilon=0$) relationship between tariff and endogenous variables. From the result, it can be seen that levying antidumping duty will increase China exported shrimp price to the U.S. market, while decreasing the price in other markets outside U.S. When antidumping duty rises 1%, the price in U.S market will increase 0.76%. Simultaneously, price in China's domestic market and ROW will decrease 0.24%. This result supports the graphical analysis and economic principle discussed earlier. Since U.S. government levies the duty, as an importer, U.S. market price adds up this part of duty which leads to price increase. Hence, the export supply curve shifts to left. 1% of antidumping duty change is split to 0.76% price increase and 0.24% price drop in U.S. import market and market in other countries, respectively.

Due to the increase in price in the U.S. market, the import amount from China decreased. Levying antidumping duty decreases shrimp price in the market of other countries. Therefore, China's domestic consumption and export amount to other countries increase in order to reach a new balance. Eventually, 1% of antidumping duty levy increases China domestic market demand amount by 0.52% and decreases import amount 7.82% from China to U.S. As price changes, a part of the previous export to U.S. turns towards ROW. The 1% of duty change leads to 3.23%

export amount increase to ROW. Considering that it is short-term change, the supply is not affected. The same percentage changing in tariff impacts most on the export amount to the U.S.

Long-term Effects

The relationship between tariff and endogenous variables in the long-term (ε=0.67) is shown by the second row of Table 1.3. The reduced form elasticity points out that a 1% increase in the US tariff will be approximately split between a 0.80% increase in the US price and 0.20% decrease in the domestic and ROW prices. The decrease in China's domestic price causes quantity demand in the China's domestic market to increase by 0.44%, and the quantity supply to decrease by 0.13%. The decrease in ROW price causes the quantity demanded in ROW markets to increase by 2.72%. A 1% increase in the U.S. tariff reduces supply to the U.S. market, resulting in an 8.19% decrease in exports to the US.

All elasticities have the expected signs. In order to restrain import from China, antidumping duty is levied to increase Chinese shrimp price in the U.S. market, which is a major policy goal from the EU's perspective. Thus, the price in the rest of the world decreases, which consequently increases Chinese domestic demand and ROW import amount. The result of reduced-form elasticity illustrates that antidumping duties effect on P_d is P_d^*/T_a^* = -0.24 and P_d^*/T_a^* = -0.20 in short term and long term, respectively. Hence, it is consistent with the theory of tax incidence that long-term has smaller effect than short-term effect (Chang and Kinnucan, 1991). That is to say, a major part of duty is transferred to U.S. consumers when supply becomes more elastic. Comparing the price change in China and U.S. market, it was noted that a considerable part of antidumping duty is transferred to U.S. consumers.

To sum up, from long-run and short-run analysis, the antidumping duty that U.S. levies on Chinese shrimp producers results in an increase in U.S. import market price and a decrease in

China's domestic market and ROW market price. Moreover, because of the changing price, export amount to U.S. decreases while the export amount to ROW increases. The domestic consumption amount rises as well. Consequently, export to U.S. will be transferred to Japan and EU. On the whole, antidumping duty restrains Chinese shrimp exports to U.S. However, from the aspect of Chinese shrimp producers, total demand decrease may not be as much as it assumes to be. Therefore, this paper will discuss this issue from a welfare analysis point of view in the next part.

1.7 Welfare Analysis

The most important issue from the U.S. antidumping duty is an estimate of the loss in producer surplus, and to see whether the antidumping policy works or not. Figure 1.1 shows the dynamical changes by tariff changed. Then, the method provided by Sun and Kinnucan (2001) was used to determine the surplus.

23) $\Delta CS_d = (P^0 - P_W)Q_d^0 + \frac{1}{2}(P^0 - P_W)(Q_d^{'} - Q_d^0)$

24) $\Delta PS_d = (P^0 - P_W)Q_s^{'} + \frac{1}{2}(P^0 - P_W)(Q_s^0 - Q_s^{'})$

25) $\Delta CS_{us} = (P_{us} - P^0)X_{us}^{'} + \frac{1}{2}(P_{us} - P^0)(X_{us}^0 - X_{us}^{'})$

26) $\Delta CS_{row} = (P^0 - P_W)X_{row}^0 + \frac{1}{2}(P^0 - P_W)(X_{row}^{'} - X_{row}^0)$

27) $\Delta Ta = \Delta CS_{us} - \frac{1}{2}(P_{us} - P^0)(X_{us}^0 - X_{us}^{'})$

Where ΔCS_d and ΔPS_d are consumer and producer surplus change in China's domestic market because of imposition of the antidumping duty. ΔCS_{us} is the consumer surplus change in U.S. market due to the levying of antidumping duty. The area E is the duty that is taken by the government, which is represented as ΔTa in formula 5). ΔCS_{row} is ROW consumer surplus

change in this market. In order to simplify the calculation, the above formula is readjusted as follows:

28) $\Delta CS_d = \text{-}P^0 Q_d^0 P_W^* \left(1 + \frac{1}{2} Q_d^*\right)$

29) $\Delta PS_d = P^0 Q_s^0 P_W^* \left(1 + \frac{1}{2} Q_S^*\right)$

30) $\Delta CS_{US} = \text{-}P^0 X_{us}^0 P_{us}^* \left(1 + \frac{1}{2} X_{us}^*\right)$

31) $\Delta CS_{row} = \text{-}P^0 X_{row}^0 P_w^* \left(1 + \frac{1}{2} X_{row}^*\right)$

32) $\Delta Ta = \Delta CS_{US} \text{-} \frac{1}{2} P^0 X_{us}^0 P_{us}^* X_{us}^*$

Both short-term and long-term welfare analysis results are listed in Table 1.4. The factors of surplus incorporate consumer surplus (CS) and producer surplus (PS).

From the result, it can be seen that antidumping duty has positive relation with domestic consumer surplus and negative relation with the U.S. consumer surplus and domestic producer surplus. In the short-run, when tariff increases 1%, domestic consumer surplus increases $9 million. In long-run, the domestic consumer surplus will increase $8 million. There is no big difference. Nevertheless, when a 112.8% antidumping duty is substituted, short-run China's domestic consumer surplus increases $1,328 million and the number is $1,082 million for long-term analysis. It is because when the U.S. raises its tariff to Chinese shrimp, shrimp price in Chinese domestic market decreases, which leads to an increase in demand. Hence, the consumer surplus rises. On the contrary, Chinese producer surplus has a welfare loss. A 112.8% tariff rate will result in Chinese producers loss of $1,209 million in short-term and $945 million in long-term. It is obvious that long-term consumer surplus and producer surplus change is less than that of short-term ones. It is because long-term production producer amount is adjustable. If

producers reduce the production amount, the market price will increase, and the consumer surplus will be less than in short-term.

Furthermore, in the import market from China to U.S., 1% tariff increase leads to $3 million decrease in U.S. consumer surplus. However, this loss of consumer surplus is taken by U.S. government as duty, leaving small part of deadweight loss. That is to say that U.S. consumers and Chinese producers bear the antidumping duty together. When antidumping duty rate is 112.8%, U.S. consumer surplus decreases $1, which amounts to $117 million in short-term and $1,243 million in the long-term. The duty that government imposes is $328 million and $343 million, respectively. Along with the increase of tariff, deadweight loss takes up higher proportion in U.S. consumer surplus loss. To emphasis, the U.S. consumer surplus here is to China and U.S. shrimp trade model rather than the whole U.S. market.

Since antidumping duty reduces the price outside U.S., ROW consumer surplus in this model increases. In the short-run, the ROW consumer surplus increases $229 million. In the long-run, it increases $174million. Both of the situations are at the duty rate of 112.8%.

According to the statistics, China's total welfare increases in both the short-run and long-run. Even though Chinese producers lose in this case, Chinese consumers benefit from this case. Moreover, in U.S. market, the tariff is undertaken by Chinese producers and U.S. consumers. In short term period, Chinese producers bear more of the tariff because the production amount cannot be adjusted effectively in short-run. In long term, as Chinese producers adjust the production amount, U.S. consumers have to undertake more of the duty. Furthermore, from the aspect of this model, there is some deadweight loss in this model, although U.S. government possesses part of consumer surplus loss as tax. Therefore, U.S. consumers and government's welfare is decreasing. Since U.S. producers are not analyzed in this

model, it cannot infer whether the total U.S. welfare is a decrease or an increase in this case. In the short-run, U.S. producers may obtain profit from the increase of U.S. domestic market demand. However, in the long-run, the decreasing part of import from China will be compensated by other countries. Hence, U.S. domestic producers may not benefit as well. In addition, it is obvious that not all stakeholders in U.S. market are profitable.

1.8 Conclusion

In conclusion, this paper is aimed to analyses the impacts of the U.S. antidumping duty on China and U.S. market, especially on Chinese domestic market. This paper discussed antidumping duty effects on price change of China and other countries. It also shows the welfare analysis. From the above, it can be concluded that which party in this case benefit or suffer.

According to the results of the estimation, the antidumping duty has a negative relationship with the export quantity of Chinese shrimp both in a short-term and long-term. In short-term, 1% of tax change causes a 7.82% decrease quantity of export. In long-term, the percentage is 8.19%. In terms of welfare, the U.S. consumer surplus and Chinese producer surplus are both negatively related to antidumping duty. In the short-run, the decrease quantity is $1,117 million and $1,209 million, respectively when the antidumping duty is 112.81%. In the long-run, the producer surplus also have a negatively related with antidumping duty, the quantity of export loss $945 million. However, consumer surplus in other countries is positively related to the antidumping duty. It reaches $174 million when the tax is 112.81%.

From a further long-term period trend, other shrimp exporters will take up Chinese share in U.S. market. The welfare gain of this policy on U.S. consumers will diminish gradually; thereby the profit of U.S. producers will be reduced as well. Moreover, since China occupies a huge

proportion in U.S. import trade, it is not easy for other countries to make up this deficiency. Thus, part of the effect on U.S. consumers and producers will be reserved. In terms of China, the export is influenced most in short-term period. Producers' welfare decreases. After China's producers transfer to other markets and finding new markets, the loss will decrease gradually.

The reason of utilizing EDM model to analyze this case lies in that there is a gap in the previous literature. In previous the literature, there is no research on shrimp antidumping duty in China and U.S. market. There is no research on the determination of the effects of antidumping duty on consumers, producers and their welfare, especially to Chinese domestic consumers and producers. The research results show that, antidumping duty has effects on both China and U.S. market. Particularly, Chinese producers' welfare decreases while China's total welfare increases. Moreover, along with transferring export to other countries, this effect will be weakened. Thus, it is not necessary for China to pay special attention to this antidumping duty. An antidumping duty restrains import and benefits the U.S. domestic producers in the short-run; however, U.S. consumers' welfare is harmed. As for tax income for government, only part of the tax is from Chinese producers, the other part of the tax is from U.S. consumers. Even though these effects will weaken as time goes by, antidumping duty is not the best policy choice to control import. The short-run effects may be efficient, however U.S. government need to seek a better way to solve this issue.

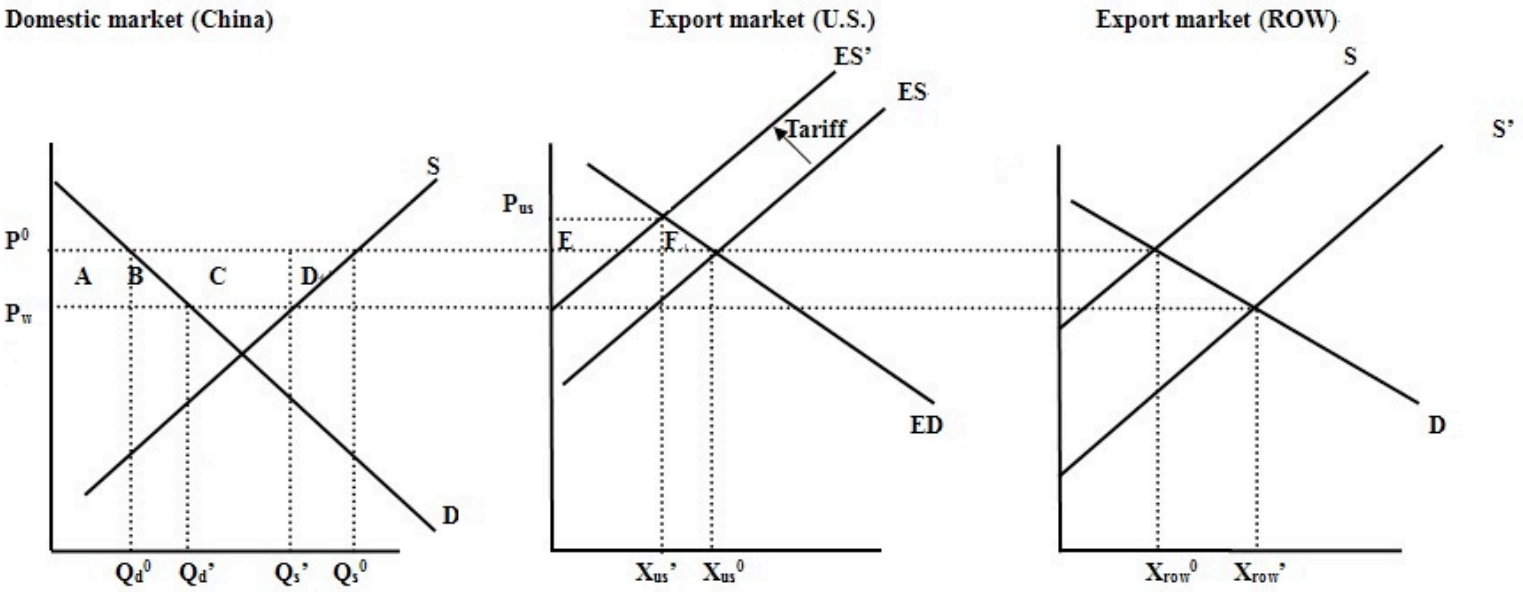

Figure 1. 1 Price and Quantity Effect of an Antidumping Duty between China and U.S.

Table 1. 1 Definition and Baseline Data of the Variables

Variables	Definition	Value
Q_s	Total Production for China	789
Q_d	Domestic Consumption for China	670
X_{us}	Export to U.S.	66
X_{row}	Export to Rest-of-world	53
P_d	Domestic price for China	5.76
P_{us}	Price in U.S.	5.76
P_{row}	Price in ROW	5.76
T_a	Tariff in USA (antidumping duty)	l12.81%

Data source: Chinese Fisheries Statistics Yearbook, National Bureau of Statistics of China, 2003
Note: Prices are expressed in constant US 2003 dollars per kilogram; quantities are raw weight expressed in 1000 metric tons.

Table 1. 2 Description of Parameters

Parameter	Description	Value
ε_d	China's Domestic Supply elasticity	0.67
η_d	China's Domestic demand elasticity	-2.2
η_{us}	Import Demand elasticity for U.S.	-10.23
η_{row}	Import Demand elasticity for ROW	-13.67
k_d	China's Domestic quantity share D/S	0.85
k_{us}	USA's quantity share Xusa/S	0.08
k_{row}	ROW's quantity share Xrow/S	0.07

Table 1. 3 Reduced Form Elasticities with Rise Tariff

Exogenous Variables	Endogenous Variables						
Tariff (T)	**Pd***	**Pu***	**Pr***	**Qd***	**Xu***	**Xrow***	**Qs***
Short-run	-0.236	0.764	-0.236	0.519	-7.817	3.225	0
Long-run	-0.200	0.800	-0.200	0.438	-8.192	2.724	-0.134

Table 1. 4 Welfare analysis

Surplus	**Antidumping tax (short-run)**		
Increase by	**1%**	**10%**	**112.81%**
ΔCS_d(Domestic)	9	93	1,328
ΔCS_{us} (U.S.)	-3	-18	-1,117
ΔCS_{row}(ROW)	1	8	229
ΔPS_d(Domestic)	-11	-107	-1,209
ΔT_a(U.S.)	3	6	328
		(Long-run)	
ΔCS_d(Domestic)	8	79	1,082
ΔCS_{us} (U.S.)	-3	-18	-1,243
ΔCS_{row}(ROW)	1	7	174
ΔPS_d(Domestic)	-9	-90	-945
ΔT_a(U.S.)	3	6	343

Unit: million dollars

2 Chapter 2. Effects of the Subsidy on China's Fishery Industry

2.1 Introduction

According to the statistics of United Nations' Food and Agriculture Organization, the total volume of the world fishing industry was 62 million tons in 1970, 98 million tons in 1990, and 142 million tons in 2004. The steady development of world fishing industry demonstrates that aquatic products have become one of the most essential food sources for people. China has been the largest fishery producing and consuming country of the world since 1989 and it is an important aquatic products export country as well. In 2011, the total amount of fish producing of China reached 15.8 million tons. Recently, there are more discussions about the sustainable development of the fishing industry. Among these, the discussion of subsidy on fishery industry becomes more heated.

Fishing industry, an important industry that relates to people's livelihood, receives policy supports in several countries. Among these policies, subsidy is the most common one. Fishery subsidy attracts social resources, and the purpose to funds fishery departments is increasing incomes of fishing industry or reducing the cost of it. Starting from 2001, the major target of fishing industry in China is to increase fishermen's incomes, enhance international competitiveness, and boost exports. In order to achieve this goal, the government provides the fishing industry with subsidy. Due to the difficulty of subsidizing at farm level, fishery subsidizing always happens in retail. It means that the government provides production subsidy to secondary processing enterprises who are the producer in retail level.

There is discussion about fishing subsidy internationally and domestically in China. There are two major perspectives in terms of its advantages and disadvantages. One of them is that fishing subsidy increases fishermen's incomes, stimulates export, and raises total profit. On the

other hand, there is a sound point of view in recent years that fishing subsidy leads to the over exploitation of fishing resources, which accelerates the deterioration of the fishing environment (Xiao 2005). The international common practice of fishing subsidy also distorts international trade. Additionally, whether the subsidy really goes to fishermen and increases their incomes is also a part of the discussion.

Based on the discussion referred to above, whether fishing subsidy should be continuously used or partially removed becomes a major topic by Chinese government (Xiao, 2005). There are several issues that have been given a lot of attentions from fishermen to Chinese government. International environment and trade organizations are also interested in these issues. These issues include whether the Chinese government should provide fishing subsidy; whether fishermen can benefit from the subsidy; and how the welfare would change. However, the polarized discussion of fishing subsidy emerges in recent years, and there is a large gap in research in this area. The research of Chinese market and the welfare is important.

Therefore, the purpose of this paper is to determine the impacts of fishing subsidy on Chinese fishing market volume, price, trade flows and welfare. Other than this, this paper tries to find the relations among the markets through vertical market levels which are farm level and retail level to discover which market is influenced the most. Further, it will find out whether fishing subsidy benefits fishermen and improves exports.

The outline of this paper is as followings: Section two is literature review. In section three and four, the model used for simulation is given. Section five is about the use of data. Section six discusses the reduced-form elasticities. Section seven analyzes the changes of welfare. Section eight concluded.

2.2 Literature Review

Research on fishing subsidy is always the focus on the fishing industry. In the latest decades, many international organizations all rank it as the "high priority" research topic. These include Asia Pacific Economic Cooperation (APEC), Association of South East Asian Nations (ASEAN), Caribbean Community (CARICOM), Permanent Commission for the South Pacific (CPPS), Food and Agriculture Organization of the United Nations (FAO), Organization for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP), Committee on Trade and Environment (CTE), the World Bank and World Wide Fund for Nature (WWF).

In *Fisheries Subsidies in the Nordic Countries*, Hannesson (2000) investigates and analyzes the fisheries subsidies policies that are implemented in certain Nordic countries in 1990s. The paper analyzes the impact of fisheries subsidies on relevant industry and surrounding environment through the comparison of fishing amount, fishing fleet amount and number of fishermen in the corresponding period. However, the paper does not provide exact conclusion on the influence of fisheries subsidy on fishing volume and fish variety. In preparing for the topic of *Fisheries Subsidies and Sustainable Development* from OECD, Hannesson investigates the short term and long term impacts that would be generated by different types of subsidies under different conditions that are different management mechanisms and varied fish races. The result demonstrates that the influence of fisheries subsidies in the short and long run significantly changes. This is perhaps due to the difference of management mechanism and varied fish races. Hannesson's research mainly focuses on subsidies and fishing management. My paper attempts to evaluate the influence of subsidy on Chinese market and welfare changes.

Sumaila and Munro (2002) in *The impact of subsidies upon fisheries management and sustainability: the case of the North Atlantic* developed an econometric model to conduct research on the effect of subsidy under differentiated management system. According to the adoption of the model and relevant empirical cases, the authors challenge the argument that the fishing repurchase program is to help subsidize resource conservation. Their research also shows that even under the situation that the property is clear, fisheries subsidies have negative influence on sustainable use of resources. Therefore, it rebuts a prevailing view that under effective fishing management systems, governments providing subsidy will not lead to increase in fishing volume. Sumaila and Munro also believe that those commonly recognized as beneficial subsidies will have negative impact under certain conditions. Their research pay more attention to the influence of fishing subsidy on the environment and resource protection. They do not consider the fishing market and the changes on such markets.

In order to investigate the effect of subsidies on fishing volume, fishing cost and economic effects, Arnason (1998) establishes a model. In this research, the author demonstrates that subsidies lead to increase in fishing amount in general. On the contrary, the economic benefits can be negligible. However, in short run, they can probably boost industrial profit.

Other research analyses the relations between subsidies and welfare. Jarvis (2012) analyzes the influence of subsidies on Brazil coffee. The result shows that subsidies increase the price of Brazil coffee and decreases Brazil welfare as a whole. Wu and Zhang (2011) conclude that subsidy policy and anti-subsidy policy will all result in national welfare decreases. They also analyze the cause of the implementation of the policy that induces the decrease of welfare level from the collaborated action perspective.

The subsidy mentioned in literature review is usually farm level subsidy. This subsidy aims to control amount of fishing. The majority of China's fishery is rising. The subsidy is used to promote trade and consumption. Therefore, this paper will exam whether this goal can be achieved by analyzing welfare.

In this paper, EDM (equilibrium displacement model) will be used. EDM model was used to solve the tariff and subsidies problem in provides research papers, to which this paper will refer. Kinnucan and Cai (2010) used the partial-equilibrium model and found out that subsidies for nonprice export promotion can harm domestic consumers by increasing price in the domestic market and by diverting funds from domestic market promotion. Kinnucan and Myrland (2005) utilized elasticities derived from EDM to estimate the income growth and impact of tariff on salmon price, production and trade flows. The results demonstrate the followings: firstly, imports worldwide will grow at about the same pace as world income; and secondly, the tariff will have negative influence on the worldwide trade volume.

After reviewing literature, the influence of fisheries subsidies on trade and welfare in Chinese market can be research deeply. This paper is developed to fill this gap. EDM will be used to determine this problem. This paper will also provide Chinese policy makers and the world organizations with the advantages and disadvantages of fisheries subsidies. Chinese fisherman and consumers can also tell whether this is beneficial to them.

2.3 Graphical Analysis

This paper uses EDM to analyze the variation of volume and price on each market and the change of welfare of each part. As in figure 2.1, it demonstrates a brief market dynamic of aquatic product subsidy. The goods are assumed homogeneous across all markets. The latter two

parts are the change of Chinese aquatic products on domestic and export markets. The first part shows the market dynamic of aquatic product at the farm level market. In this figure, retailers purchase raw fish from farm market and then process them to finished fish products to sell on the domestic and export markets. In this process, fisheries subsidies are implemented on domestic producers. At the same time, importing countries will impose tariff on the exported products.

The paper only focuses on the export market that is shown in the latter two parts, when the farm market and vertical linkage influence are not considered. Excess demand curve (ED) and excess supply curve (ES) determine the export and domestic selling quantity. Under this quantity, the price on retail market is decided by P_R and the tariff shifts up ES curve itself. The domestic producers who can gain the subsidy are the firms who registered in Ministry of Agriculture. When government provides subsidies to domestic producers on retail level, the supply curve shifts down, leading to the decrease in domestic price (P_R) and international price (P_x). This means that domestic welfare increases in this process.

The supply increase in the retail market will lead to demand increase in the farm market. Considering the classification of the market as a whole and the influence of vertical linkage, government provided subsidies for retail producers will increase the demand on farm market. This will lead to increase in price which is retailers' input price. This change will make part of the effects of subsidies on retail market be diluted by farm market. The effect on retail market that is shown in the latter two parts will not be this obvious when considering farm market.

Figure shows the welfare change in each part. Domestic consumers and farm market producers' welfare are all increased. Moreover, the welfare of foreign consumers on export markets also increases. However, government absorbs the majority of welfare losses. The quantitative analysis will be discussed in detail in the followings.

2.4 Model

Assumptions and Structural Model

In this paper, the market will be divided into two levels: retail market and farm market. In the retail market, considering the current situation of China, domestic market and international export market will be considered. In order to explain the influences on shrimp market in an open economy, Equilibrium Displacement Model (EDM) is based on the following assumptions. First, China in this open economy is considered as a net exporter. In fact, China imports fish products, though the quantity is very little. Therefore, this paper uses the net value. Second, commodity and the price are homogeneous in all market. Additionally, endogenous variables are quantity and price, and exogenous variables are subsidy and tariff. Further, there is integration between the domestic market and the export markets because the Law of One Price (LOP) holds across all markets. The supply is upward sloping, and the demand is downward sloping. Moreover, competitive market is clearing.

With these assumptions, equilibrium is demonstrated by the following structural model:

Retail market

1) $Q_D^R = Q_D^R(P_R^D)$ (Domestic demand)

2) $Q_S^R = Q_S^R(P_R^S, P_F)$ (Domestic supply)

3) $Q_X = Q_X(P_R^X)$ (Export demand)

4) $P_R^S = P_R^D \cdot \tilde{S}$ (Domestic supply price)

5) $P_R^X = P_R^D \cdot \tilde{S} \cdot \tilde{T}^{-1}$ (Export price)

6) $Q_S^R = Q_D^R + Q_X$ (Retail market clearing)

Farm market

7) $Q_D^F = Q_D^F(P_F, P_R^S)$ (Demand at farm market)

8) $Q_S^F = Q_S^F(P_F)$ (Supply at farm market)

9) $Q_S^F = Q_D^F$ (Farm market clearing)

Since we need to use price to link two parts of market, equation (2) and (7) will be converted to the following inverse form.

10) $P_R^S = P_R^S(Q_S^R, P_F)$ (Inverse domestic supply)

11) $P_F = P_F(Q_D^F, P_R^S)$ (Inverse demand at farm market)

Where $\tilde{S}$ and $\tilde{T}$ are two exogenous variables. $\tilde{S}$ represents government subsidy and $\tilde{T}$ represents export tariff. In this model Q_D^R, Q_S^R, Q_X, P_R^D, P_R^S, P_R^X, Q_D^F, Q_S^F and P_F are endogenous variables. Q_D^R and Q_D^F are domestic retail and farm level demand respectively. Q_S^R and Q_S^F are domestic retail and farm level supply. Q_X is the export volume at retail level. P_R^D, P_R^S and P_R^X are three retail level prices. P_R^D is domestic demand price, P_R^S is domestic supply price and P_R^X is export demand price. Moreover, P_F is the price on primary farm level market.

Equilibrium Displacement Model

The structural model was transformed to percentage changes:

12) $Q_D^{R*} = \eta_d P_R^{D*}$

13) $P_R^{S*} = \frac{1}{\varepsilon_d} Q_S^{R*} + \rho_f P_F^*$

14) $Q_X^* = \eta_x P_R^{X*}$

15) $P_R^{S*} = P_R^{D*} + S^*$

16) $P_R^{X*} = P_R^{D*} + S^* - T^*$

17) $Q_S^{R*} = k_d Q_D^{R*} + k_x Q_X^*$

Farm level market

18) $P_F^* = \frac{1}{\eta_f} Q_D^{F*} + e_r P_R^{S*}$

19) $Q_S^{F*} = \varepsilon_f P_F^*$

20) $Q_S^{F*} = Q_D^{F*}$

Variables with star referred in above equations represent the percentage change. $k_d = Q_D^R / Q_S^R$ means the rate of China's domestic fish demand to domestic supply. $k_X = Q_X^R / Q_S^R$ represents the rate of China's fish export to Chinese shrimp supply. The domestic demand elasticity η_d, export demand elasticity η_x and farm level demand elasticity η_f are negative ($\eta_d<0$, $\eta_x<0$, $\eta_f<0$) while the domestic supply elasticity ε_d and farm level supply elasticity ε_f are positive ($\varepsilon_a>0$, $\varepsilon_f>0$). The reduced form of the endogenous variables can be obtained by applying the market clearing conditions.

To solve the equations by first writing the model in matrix notation:

21) Ay=Bx

Where A is a 9x9 matrix of parameters corresponding to the endogenous variables. Hence, y is a 9x1 vector and represents the model's endogenous variables. B is a 9x2 matrix of zero and one to indicate the model's exogenous variables. Finally, the x is a 2x1vector containing the exogenous variables S and T. Inverting A and multiplying both sides by A^{-1} yields:

22) y = Cx

where $C = A^{-1}B$ is a 9x2matrix of reduced form elasticities that indicate the price and quantity effect by 1% subsidy. Multiplying these reduced form elasticities by the subsidy gives the simulated price and quantity effects, The measure of elasticities is as the next part.

2.5 Data and Parameterization

Numerical values for prices and quantities are listed in Table 2.1. Numerical values for the parameters are listed in Table 2.2 after determination.

Data Description

This paper uses data collected in 2013. The data were mainly from *Chinese Fisheries Statistics Yearbook*, National Bureau of Statistics of China, FAO-Food and Agriculture Organization of United Nations, and Chinese Academy of Fisheries Sciences. Furthermore, some trade and export information came from *Chinese Agricultural Exports Guide.*

Retail level Domestic Supply Elasticities

In this paper, the elasticities from the literature are used. For retail level domestic supply elasticities, Dey's paper (2004) indicated that Chinese supply elasticity for aquatic products were 0.67. Therefore, 0.67 was chosen as the supply elasticity and was used to estimate the effects.

Retail level Domestic Demand Elasticities

There are several articles discussing the demand elasticity of fishery and aquaculture in China. Compare to other types of foods, fishery product is more elastic. Cheng and Capps (1988) employed time series method to regress the fishery demand elasticity which was -0.7 in that paper. In addition, in Dey et al (2004) paper, the own-price elasticity of demand of aquaculture products in China was -0.8 in rural regions and -0.45 in urban regions. Considering all the papers above and the data from Chinese Fishery statistical yearbook, I use -0.7 as the domestic demand elasticity.

Import Demand Elasticity for foreign countries

The import demand elasticity is properly interpreted as residual demand elasticities. Since residual demand elasticity varies inversely with the quantity share of China's products in the

respective importing regions, they can be quite elastic. This paper applies the method that Kinnucan and Myrland (2005) used in their paper to measure import Demand Elasticity for foreign countries. The equations are as follows:

23) $\eta_x=((1-k_x)\varepsilon+\eta)/k_x$

The ε and η parameters in the equations for the residual demand elasticity are domestic elasticities. Moreover, these k values are used to compute the residual demand elasticities with assumed values for ε and η. The FAO data were used to calculate the share of domestic consumption in each region and substitute them into the formula.

Based on the above equations and data, through the calculation, it can be concluded that import demand elasticity is -1.05.

Farm Level Elasticities and Price Transmission Elasticities

Farm level demand elasticity $\eta_f = \eta_r$ * Pf/Pr. Thus, the demand elasticity at farm level is -0.56, and the supply elasticity at farm level is 0.50.

Price transmission elasticity is the elasticity of the farm price with respect to the retail price. Liu et al. (2011) estimate this elasticity, and they suggest that such elasticity is 0.47 and 0.71 for fish. Therefore, this value will be used as the price transmission elasticity in this case.

Export Quantity Shares

According to *Chinese Fisheries Statistics Yearbook*, $k_d = 0.92$, $k_x = 0.08$ and $k_d + k_x = 1$.

2.6 Reduced-Form Elasticities and Subsidy Effects

From the table 2.3, it can be seen that the focus is on two markets: retail market and farm market. The table is used to show that for every 1% increase in subsidy the percentage change in each parameter. First, the subsidy has positive relationships with domestic demand and supply and

export demand. It can be seen that when the subsidy increases 1%, domestic demand and supply increase 0.273% and 0.294%, respectively. Moreover, one percent subsidy increase leads to 0.417% increase in export demand, which is nearly double domestic demand and supply. Second, subsidy increase has inverse relationship with domestic and export price. One percentage subsidy increase leads to 0.432% decrease in both domestic and export price. However, the 1% increase in subsidy leads to 0.601% increase in supply price. The increase rate is a little higher than the decrease rate.

The relationship between tariff and retail market is varied. First, one percent tariff increase leads to 0.052% domestic demand increase, while it causes 0.043% decrease in supply quantity. The tariff has a significant influence on export quantity because the 1% tariff increase causes 0.814% decrease in export quantity. Secondly, the domestic and supply price decline when tariff increase while export price increases.

As for farm market, the relationship between subsidy and farm market quantity and price is slightly different from that in retail market. First, one percent tariff increase leads to 0.214% increase in both domestic demand and supply quantity. Farm market price increases 0.372% under the same condition, which is a little higher than quantity increase margin. Second, a tariff increase has an inverse relationship with all demand, supply quantity and price in farm market.

The results in the table correspond the expectation in both retail market and farm market. Subsidy has the most significant influence on supply price in retail market. It also influences price at the farm market. Additionally, tariff has the significant influence on exports no matter what quantity or price. Further, the effect of tariff is more significant at retail market than in farm market.

2.7 Welfare Analysis

The most important issue from this paper is an estimate of the loss in producer surplus, and to see whether the subsidy policy works or not. Figure 2.1 shows the changes. Then, the method provided by Sun and Kinnucan (2001) was used to determine the surplus.

24) $\Delta CS_d = P_R^0 Q_D^{R0} P_R^{D^*}(1 + \frac{1}{2} Q_D^{R^*})$ (Domestic consumer surplus)

25) $\Delta PS_d = P_R^0 Q_S^{R0} P_R^{S^*}(1 + \frac{1}{2} Q_S^{R^*})$ (Chinese producer surplus)

26) $\Delta CS_x = P_R^0 Q_X^{R0} P_R^{X^*}(1 + \frac{1}{2} Q_X^{R^*})$ (Foreign consumer surplus)

27) $\Delta CS_f = P_F^0 Q_D^{F0}(V_D\text{-}Q_D^{F^*})(1 + \frac{1}{2} Q_D^{F^*})$ (Farm consumer surplus)

28) $\Delta PS_f = P_F^0 Q_S^{F0} P_F^*(1 + \frac{1}{2} Q_S^{F^*})$ (Farm producer surplus)

29) $\text{GS} = -P_R^0 Q_D^{R0}(P_R^{S^*}\text{-}P_R^{D^*})(Q_D^{R^*} + 1)$ (Government loss)

Where ΔCS_d is the change in Chinese domestic consumer surplus associated with subsidy change; ΔPS_d is the change in Chinese producer surplus; ΔCS_x is the change in foreign consumer surplus; ΔCS_f is the change in farm market consumer surplus; ΔPS_f is the change in producer surplus at the farm market; ΔGS is the change in government loss. $P_R^0 Q_D^{R0}$ is the expenditure of domestic consumer in total at the retail level. $P_R^0 Q_S^{R0}$ is the sum of Chinese producers' revenue. $P_R^0 Q_X^{R0}$ is the expenditure of foreign consumers spending on Chinese aquatic products. $P_F^0 Q_D^{F0}$ is the total expenditure of consumers at the farm level. $P_F^0 Q_S^{F0}$ is the revenue of producers in total at the farm level. $P_R^{D^*}$ is the change in domestic demand price at the retail level. $P_R^{S^*}$ is the change in supply price at the retail level. $P_R^{X^*}$ is the change in export price at the retail level. P_F^* is the change at the farm market price. $Q_D^{R^*}$ is the change in domestic demand at the retail level. $Q_S^{R^*}$ is the change in supply at the retail level. $Q_X^{R^*}$ is the change in export at the retail level. $Q_D^{F^*}$ is the change in demand at the farm market. $Q_S^{F^*}$ is

the change in supply at the farm gate. V_D is the percentage change under the condition that the quantity change is zero at the farm gate.

It can be seen from the table 2.4 that the change in subsidy has positive influence on producers and consumers at the retail level and farm level. However, the subsidy leads Chinese government loss.

The welfare of Chinese producers at the retail level will increase $9.2 million when subsidy increases 1%. Chinese consumers will obtain $15.6 million under the same condition, which is larger than that obtained by Chinese producers. As for foreign consumers, the increased welfare is worth $13.2 million, which is a little less than that of Chinese consumers. The producers and consumers' welfare at the farm level are relatively small when compared to the retail level for Chinese producers and Chinese consumers. However, at the farm level, producers gain more welfare than consumers do, which is an opposite situation as that at the retail level. Furthermore, the difference of welfare between producers and consumers are much less at the farm level than at the retail level.

The welfare loss for Chinese government when subsidy increases 1% is $52.1 million. This is the only party that experiences losses according to the result of table 2.4.

Overall, both producers and consumers at the retail level and farm level benefit from the subsidy. Among them, Chinese consumers at the retail level obtain the largest welfare. However, Chinese government loses welfare with an increase of subsidy.

2.8 Conclusion

The importance of fishery industry to people's lives leads to the discussion of how to fostering sustainably fishery industry development. Among the discussion, the issue of subsidy is put

forth. This paper aims to find out whether subsidy should be continued implemented or be cancelled.

This paper finds out that subsidy stimulates domestic demand, domestic supply and export quantity at the retail level. When subsidy is increasing, these three variables increase as well. Especially the export quantity, its rate of increase is the largest among the three variables. Because of the increase in export, the price on domestic market and export market will decrease. At the farm level, when subsidy increases, domestic demand, supply and price all increase.

In terms of welfare, at both the retail level and farm levels, producers and consumers benefit from the subsidy. To be specific, consumers at the retail level gain more welfare than producers. Moreover, foreign consumers also benefit a lot from the subsidy. Only Chinese government has a negative welfare amount when subsidy increases.

It can be seen that the subsidy assists consumers to obtain welfare more effectively than producers. However, producers still can benefit from the subsidy.

Therefore, based on the research of this paper, it suggests that subsidy could still be implemented. The reasons are as follows. First, this policy could motivate producers to cultivate aquatic products. Hence, it stimulates the economic growth indirectly. Second, due to the welfare increase to both producers and consumers, the public could benefit from this policy. Third, since the producers obtain less welfare than consumers do, they may not be interested in expanding their fishery business quickly. Therefore, the fishery industry could develop sustainably.

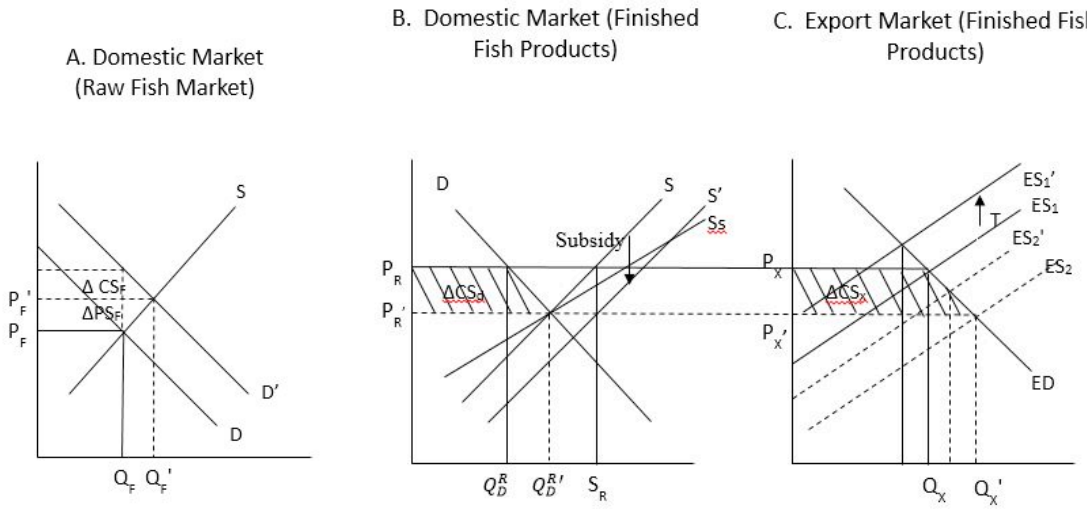

Figure 2. 1 Price and Quantity Effect of a Subsidy

Table 2. 1 Definition and Baseline Data of the Variables

Item	Definition	Value (billion dollars)
$\mathbf{P_R^0 Q_S^{R0}}$	Total revenue of retail level producers in 2014	25.13
$\mathbf{P_R^0 Q_D^{R0}}$	Domestic retail level consumer expenditure in 2014	21.86
$\mathbf{P_R^0 Q_X^{R0}}$	Foreign consumer expenditure on Chinese aquatic products in 2014	3.27
$\mathbf{P_F^0 Q_D^{F0}}$	Total expenditure on farm market products in 2014	19.37
$\mathbf{P_F^0 Q_S^{F0}}$	Total revenue of farm market producers in 2014	19.37

Source: Chinese Yearbook of Fishery Statistics (2013) and Report of Ministry of Agriculture of China.

Table 2. 2 Description of Parameters

Parameter	Description	Value
η_d	Domestic demand elasticity	-0.7
ε_d	Supply elasticity	0.67
η_x	Foreign country import demand elasticity	-1.05
η_f	Demand elasticity at farm level	-0.56
ε_f	Supply elasticity at farm level	0.50
e_f	Price transmission elasticity	0.71
e_r	Price transmission elasticity	0.47
k_d	Domestic quantity share	0.92
k_x	Export quantity share	0.08

Table 2. 3 Reduced Form Elasticities

	Subsidy	Tariff
Retail market		
$\mathbf{Q_D^{R*}}$	+ 0.273	+ 0.052
$\mathbf{Q_S^{R*}}$	+ 0.294	- 0.043
$\mathbf{Q_X^{*}}$	+ 0.417	- 0.814
$\mathbf{P_R^{D*}}$	- 0.432	- 0.063
$\mathbf{P_R^{X*}}$	- 0.432	+ 0.891
$\mathbf{P_R^{S*}}$	+ 0.601	- 0.063
Farm market		
$\mathbf{Q_D^{F*}}$	+ 0.214	- 0.041
$\mathbf{Q_S^{F*}}$	+ 0.214	- 0.041
$\mathbf{P_F^{*}}$	+ 0.372	- 0.078

Table 2. 4 Welfare Effects of Change in Subsidy

surplus	1% change in subsidy
Chinese producers' surplus	0.0092
Chinese consumers' surplus	0.0156
Farm producers' surplus	0.0089
Farm consumers' surplus	0.0067
Foreign consumers' surplus	0.0132
Chinese government subsidy	-0.0521

Note: the unit is Billion Dollars

3 Chapter 3. Estimation of Japan Demand for Import Shrimp: Shrimp Trade Analysis between Japan and China

3.1 Introduction

Aquatic products contain high nutrition. Due to the continual increase in living standards, the demand for aquatic products is expanding globally. Shrimp possesses an important status amongst the whole aquatic product range. It is also the most important trading commodity within the international aquatic products trade[2]. In the past ten years, the scale of world shrimp trading has expanded constantly (figure 3.1).

China is the second largest shrimp product producing country and the fourth largest exporting country in the world. The major exporting markets are Japan, the United States and European Union. In 2006, China was the largest shrimp producing country in the world with a production of 2,720,000 tons. China's shrimp products are competitive in the international market; however, it has not been able to become the largest exporter (FAO data). In recent years, countries like Thailand and Ecuador have gradually increased their market share and market scale; threatening China's market position in this lucrative trade. China's shrimp market is an export-orientated market which relies heavily on international trading. Forty percent of cultured shrimps are used for exported. Thus, the international market is of paramount importance to China (Wu, 2009).

Japan is the world's largest aquatic product importing country. It is China's traditional exporting market and also one of the most important shrimp product export markets. However, shrimp products exported from China to Japan have been declining since 2007. This has been exploited by Vietnam's as it has increased its market share within the Japanese shrimp market

[2] The only two seafood commodities traded in futures markets are frozen white and black tiger shrimps on the Minneapolis Grain Exchange (MGE). (Martinez-Garmendia, J., & Anderson, J.L, 1999 (19), 957-990)

(Figure 3.2). As one of the largest shrimp consuming countries, Japan has a long history in the shrimp fishing industry. The highest yield was 90,000 tons. Yet, due to the decline in natural resources and increasing labor costs, Japan's volume of shrimp fishing only remains at 23,000 tons at the moment. As a result, this has led to the increased demand for imported shrimps (UN Comtrade & FAO data) (Figure 3.3-3.5). There are several issues that need to be considered, which would be essential for China's shrimp products to become competitive in Japanese market. It is important to understand whether Japan's shrimp product export demand is saturated. It is important to know why other countries' market shares increase constantly. In addition, it is important to realize whether consumers' preferences have been transferred.

Much of the previous research has focused on aspects such as the total world shrimp supply, importing price, exchange rate and even the influence of culture on shrimp demand. However, there is little study on issues such as whether consumers will have preferences on shrimps from different sources. Wang and Reed (2014), use a two-stage model estimated U.S. elasticities about the shrimp. It is important to know whether Japanese consumers' alteration on shrimp product expenditure will impact China's export.

Therefore, the purpose of this paper is to satisfy the research gap on Japanese consumers' preferences for shrimps from different sources and the comparison of China's shrimp products with that of other countries. In addition, through the analysis of Japan's import demand, the ways to improve competitiveness of Chinese products will be investigated. It will also provide necessary evidence for other countries' policy makers for export and production by solving these problems.

This paper will use a source-differentiated model to estimate the total expenditure of importing shrimp products that are from different sources, the expenditure elasticity of different

types of shrimp products and the own-price elasticities and cross-price elasticities. Thus, it will provide a better understanding in Japanese consumers' demand pattern and preferences for China's shrimp products. Lastly, there will be holistic analytical features of shrimp products on Japanese market in that will provide assistance to China's shrimp product export.

3.2 Literature Review

There is a lot of research in the world regarding import demand elasticities and aquatic product markets in international trade. In studying international trading commodities, researchers focus more on import demand than domestic demand. There is more research on aquatic products than on shrimp products specifically. Wessells & Anderson (1992) conducted an analysis of aquatic product market demand. They mainly used research information to analyze marketing, evaluation and aquatic product safety. There is little analysis of relationship between price and quantity. Asche et al. (1997) analyzed the demand of fresh salmon, frozen salmon and smoked salmon in European Union. They utilized AIDS model and error correction model to conduct the analysis. The results difference between these two models were significant. For example, the own-price elasticity of fresh salmon in AIDS model was -1.73, which meant that demand was elastic. However, with an error correction model, it was -0.59, which meant that demand was inelasticity. Therefore, choosing an appropriate model for analyses of demand is important.

In recent years, the supply of main shrimp producing countries is increasing. The scale of shrimp trade in international market is expanding. The research that is related to demand of shrimp product has emerged. Doll (1972) analyzed shrimp price by using econometrics. Adams (1987) had price determined for the United States shrimp market. Houston et al. (1988) analyzed the factors that impact shrimp price. Keithly et al. (1993) analyzed the influential factors for

shrimps on the United States' market by using econometrics. The analysis all focused on market supply and demand equilibrium in order to discover the major factors that influenced supply, demand and price.

With the increase in imported shrimp, researchers from importing countries start to pay attention to the influence of imported shrimp on domestic shrimp producers and consumers' welfare. The relevant research has been conducted from two aspects. One of them is to analyze the purchasing of shrimp. This is to understand the factors that influence consumers' choice and the perspectives of consumers on import shrimp and domestic shrimp. Cheng & Capp (1988) analyzed demand of fresh aquatic products by using the above method. Hanson et al. (2005) utilized the survey to analyze consumers' behavior and preferences on the United States' market from 2000 to 2001. They provided conclusions to consuming habits and preferences to different type of consumers. The other one is from an econometric analysis angle. It analyses the replacement influence of imported shrimp on domestic shrimp. It also analyses expenditure and price elasticities of shrimps from different places of origin.

Researchers have focused on Japan's importing demand of shrimp as it is the largest shrimp importing country in the world in 1990s. Keithy et al. (1993) examined importing market of shrimp in Japan. They discovered that the importing own-price elasticity of Japanese shrimp was relatively low, while its disposable income elasticity was relatively high. They also found that the price elasticity of supply was relatively low and was significantly relevant to the world's total yields. Taya (1991) believed that the price of imported shrimps in Japan was mainly related to exchange rate, volume of frozen shrimps and tendency of time. The influence of exchange rate volatility on imported shrimp price from 1984 to 1989 was a good example. Moreover, seasonal factors have significant impact. Miyazawa & Hirasawa (1992) and Hirasawa (1995) utilized the

function of consumer demand, per-capital income and importing price to analyze Japanese shrimp. They discovered that Japanese consumer' demands on shrimp from 1981 to 1991 tended to be weak. During this period, the influence of price on shrimp consumption was more significant than income. Saowanee et al. (1999) found that the own-price elasticity of Japan's shrimp supply, demand and income elasticity were relatively small. The inventory at the beginning of a certain period will have certain influence on shrimp supply. The results of seasonal analysis indicated that culture factors were related to Japan's shrimp consumption. Keefe (2002) found that the expenditure elasticity of fresh shrimp was relatively high in Japanese market. On the other hand, canned shrimp's expenditure elasticity was negative. The change of price has significant influence on both expenditure and demand. Poudel (2008) found that price and stock at the beginning period had significant influence on demand of shrimp importing demand in Japan. The elasticity of the shrimp product and stock was -0.2187 and -0.5032 respectively. Income elasticity was not significant. Seasonal change was significant.

The literature that is referred above includes research on shrimp demand in Japan. Yang (2008) calculated market share rate, exporting price and net exporting index of Chinese shrimp in world's market. They believed that Chinese shrimp had a high market share rate and low exporting price. This indicated that Chinese shrimp had a relatively high competitiveness. Ai (2008) analyzed the influence of non-tariff trade barriers on Chinese shrimp export from importing countries. The results demonstrated that trade barriers influenced Chinese shrimp exports and the corresponding policy was provided.

To sum up, all the past research on Japan's shrimp import demand has focused on total world shrimp supply and production volume, importing price, exchange rate and some relevant factors. The researches on Chinese shrimp exports also focused on influence of trading policy

and calculation of trade related data. There is little research on consumers' preferences on different sourced shrimps, findings on China's shrimp and influence of Japanese consumers' shrimp expenditure on demand of Chinese exports.

Therefore, in order to fill this gap, this paper will use source-differentiated demand model to calculate relevant data and analyze the issue. Expenditure elasticity, own-price elasticity and cross-price elasticity of the shrimp in Japanese market will be estimated. Chinese shrimps and other countries' shrimps will be compared and analyzed. This will assist the future study on welfare changes and provide profound information for policy makers and relevant producers.

3.3 Data

This paper will use source-differentiated model to analyse Japanese shrimp import demand. The major import products in Japan include frozen shrimp, shrimp products and fresh shrimp. The main import sources are Indonesia, India, Thailand, Vietnam and China. Therefore, the estimation for Japan's shrimp import demand will be conducted based on these countries. Table 3.1 described the major source countries' average market share from January 2001 to April 2014. The average expenditure of frozen shrimp, shrimp products and fresh shrimp in Japan are 84.01%, 14.82% and 1.17% respectively.

In the frozen shrimp import demand system, there will be functions for Indonesia, India, Thailand, Vietnam and China. Other shrimp supplying countries will be categorised into other countries as they only possess a small share of the market. In the shrimp product importing demand system there will be functions for Thailand, China, Indonesia and Vietnam. Other shrimp supplying countries with small market shares will be categorised as other countries. Fresh shrimp importing market is almost monopolised by Taiwan. Due to the influence of shrimp

diseases in late 1980s, the supply declined. At the same time, China mainland and Vietnam started to participate in the competition in the fresh shrimp market. Overall, fresh shrimp only possesses 1% of total amount of Japan's imported shrimp. Therefore, there are no specifics that distinguish the countries.

Theoretically, Japan's domestic production can be considered as an importing source (Winters, 1984). Cause most of the fresh shrimp in Japan market is domestic production, it is can be used as Japan production in this case. Hence, the fresh shrimp can be seen as domestic production.

This paper uses 160 groups' sample data in total. These data are from January 2001 to May 2014. Japan's shrimp trading volume and trading amount are from Trade Statistics of Japan Ministry of Finance (TSOMOF). Unit of importing volume is kilogram and unit of importing amount is thousands Yen. The price of Japan's imported shrimp is CIF value.

3.4 Methodology

In international commodity trading, there are many source-differentiated import demand models that have been developed by researchers. They are Rotterdam model, Central Bureau of Statistics (CBS) model, Almost Ideal Demand System (AIDS) model, National Bureau of Research (NBR) model and General model. These models have been used in a lot of literature to conduct research. Rotterdam model has been widely used to estimate source-differentiated import agricultural product demand in recent years. Rotterdam model was first developed by Theil (1965) and Barten (1964). Rotterdam model can be presented as followings:

1) $\bar{w}_{ih} d\log q_{ih} = \alpha_{ih}\theta_{ih} d\log Q + \sum_j \sum_k \pi_{ihjk} d\log p_{jk} + \sum_l \gamma_{ihl}\ D_l$

$i, j = 1,2,\ldots,m$; $h = 1,2,\ldots,n$; $k = 1,2,\ldots,s$; $l = 1,\ldots,4$

where *i* and *j* represent product types (in this paper, they represent, frozen shrimp and shrimp meat, fresh shrimp, shrimp meat and shrimp product), *h* and *k* represent source (in this paper they represent the original producing countries). $\overline{w}_{ih} = (w_{ih,t} + w_{ih,t-1})/2$ represents average expenditure of product *i from* country *h*. p_{ih} and q_{ih} represent product price and quantity of *i* from country *h* respectively. $d\log q_{ih} = \log(q_{ih,t}) - \log(q_{ih,t-1})$. $d\log Q = \Sigma_i \Sigma_h w_{ih} d\log q_{ih}$ is Divisia quantitative index. $d\log p_{jk} = \log(p_{jk,t}) - \log(p_{jk,t-1})$. D_l is season dummy. $\alpha_{ih}, \theta_{ih}, \pi_{ihjk}, \gamma_{ihl}$ are estimated parameters in the model. E is total expenditure and expenditure index $\theta_{ih} = p_{ih}(\partial q_{ih}/\partial E)$ is marginal expenditure tendency of product *i* in country *h;*

$\pi_{ihjk} = (p_{ih}p_{jk}/E)s_{ihjk}$ is the compensated price effect.

The theoretical restrictions are:

Adding-up: $\sum_i \sum_h \alpha_{ih} = 0, \sum_i \sum_h \theta_{ih} = 1, \sum_i \sum_h \pi_{ihjk} = 0, \sum_i \sum_h \alpha_{ihl} = 0;$

Homogeneity: $\sum_i \sum_h \pi_{ihjk} = 0;$

Symmetry: $\pi_{ihjk} = \pi_{jkih}.$

However, in Rotterdam model, parameter θ_{ih} is assumed as constant. This implies the marginal budget share in total expenditure is constant. Keller & Van Dreil (1985) and Theil & Clement (1987) posited that the marginal expenditure shares vary with budget share. Therefore, they established CBS model. The marginal expenditure tendency replaces expenditure in Rotterdam model. Thus, θ_{ih} is replaced by $\beta_{ih} + w_{ih}$.

In order to choose the model, estimated the maximum likelihood for each model. At 5% significance, CBS model is accepted. While, Rotterdam model, AIDS model and NBR model are rejected. For General model, δ_1=1.1213 and δ_2=0.0011. Therefore, δ_1 is significantly different from 0. δ_2 is not significantly different from 0. Thus, CBS model suits for systematic model

estimation. From the angle of systematic weighting R^2, General model, Rotterdam model, CBS model, AIDS model and NBR model are 0.8912, 0.9321, 0.9207, 0.5686 and 0.8742, respectively. The goodness of fit for Rotterdam model and CBS model are better than the rest.

CBS used in this paper can be presented as followings:

2) $w_{ih}d\log q_{ih} = \alpha_{ih}(\beta_{ih} + w_{ih})d\log Q + \sum_j \sum_k \pi_{ih\_jk}\, d\log p_{jk} + \sum_l \gamma_{ihl} D_l$

Equation (2) can also be represented as:

3) $w_{ih}(dlogq_{ih}\text{-}dlogQ) = \alpha_{ih}\beta_{ih}dlogQ + \sum_j \sum_k \pi_{ih\_jk} dlogp_{jk} + \sum_l \gamma_{ihl} D_l$

In (2) and (3), *i* and *j* represent product type (in this paper, they represent frozen shrimp, shrimp product and fresh shrimp and shrimp meat), and *h* and *k* represent source (in this paper, they represent the original producing countries of various types of shrimp products).

w_{ih} represents average expenditure of product *i from* country *h*. p_{ih} and q_{ih} represent product price and quantity of *i* from country *h* respectively. $d\log Q$ is Divisia quantitative index. D_l is season dummy. $\alpha_{ih}, \beta_{ih}, \pi_{ih\_jk}, \gamma_{ihl}$ are to be estimated parameters in the model.

The restrictions for demand systemic function (2) are:

Adding-up: $\sum \beta_i = 0 \; and \; \sum_i \pi_{ij} = 0$;

Homogeneity: $\sum_j \pi_{ij} = 0$;

Symmetry: $\pi_{ij} = \pi_{ji}$.

Elasticity value of demand system function in CBS model can be calculated by the following function (Barten, 1993):

Expenditure elasticity:

4) $\eta_{ih} = 1 + \beta_{ih}/w_{ih}$

Compensated own-price elasticity:

5) $\delta_i = \pi_{ihih}/w_{ih}$;

Cross-price elasticity:

6) $\delta_{ih\_jk} = \pi_{ih\_jk}/w_{ih};$

Non-compensated own-price elasticity:

7) $\varepsilon_{ihih} = \delta_{ihih} - \eta_{ih} w_{ih}$

Cross-price elasticity:

8) $\varepsilon_{ih\_jk} = \delta_{ih\_jk} - \eta_{ih} w_{jk}$

3.5 Estimation Procedure and Parameter Estimation

In this paper, there are three shrimp product categories and different source countries involved in Japan's shrimp import demand model. Frozen shrimp has six source places. Shrimp product has five source places. The source place of fresh shrimp is not distinguished in this paper. Therefore, in this CBS system, there are 17 solve-for parameters and 12 functions.

The dependent variable of CBS demand function is $w_{ih} d\log q_{ih}$, and independent variable $d\log Q$ has the endogenous possibility. From the estimation of CBS, the π_{ih_jk} is independent variable, and $Cov\,(\varepsilon i, \varepsilon j)$ is dependent variable. The regression equation is $Cov\,(\varepsilon i, \varepsilon j)$ = 0.0000(0.0210)-0.0023(-6.4392), and the statistics in the brackes are the t-value. Therefore, π_{ih_jk} is significantly different from 0 and $Cov\,(\varepsilon i, \varepsilon j)$ is -0.0023 of it. The model does not have endogenous phenomenon.

Parameter Estimation

Table 3.2 shows the estimation parameters of CBS model of Japan's shrimp differentiated import demand.

The constant terms in the Frozen Shrimp functions are significant in three of the six equations: India (-0.0112), Thailand (0.0049), and Other (0.0092). This means that in the

absence of changes in relative prices and expenditure, the budget share for frozen shrimp from India will decrease by 1.1% per month while the budget shares for frozen shrimp from Thailand and Other countries will increase by 0.49% and 0.92% per month, respectively. For Shrimp Products, the constant terms are significant in three of five equations: China (0.0022), Thailand (0.0029), and Vietnam (0.0027). This means that in the absence of changes in relative prices and expenditure, the budget share for shrimp product from China will increase by 0.22% per month while the budget shares for shrimp product from Thailand and Vietnam will increase by 0.29% and 0.27% per month, respectively.

The β_{ih} parameter is significant in the equations for Frozen Shrimp from India, Indonesia, Thailand, and Vietnam. The β_{ih} parameter is also significant in the equations Shrimp Products form Indonesia and Thailand. It is not significant in ~~n~~either of the demand equations for China. An insignificant beta means the expenditure elasticity is one (see equation (4))

The estimated own-price effects are negative and significant at the 5% level or better for seven of 12 products. The products showing an insignificant own-price effect are Frozen Shrimp from India and Vietnam, Shrimp Products from Indonesia and Vietnam, and Fresh Shrimp. Technically, the (conditional) import demand curve for these products is vertical, i.e., perfectly inelastic. The estimated cross-price effects are mostly insignificant. For example, focusing on the demand equation for shrimp from China, of the 11 cross-effects, only four are significant at the $p < 0.05$ level. This suggests substitution by source origin and by product form both are rather limited. For example, changes in the price of shrimp from Vietnam have no effect on Japan's demand for shrimp from China. China's main competitors for market share in the Japanese market appear to be smaller exporters that are included in the "Other" category. A fuller discussion of cross-effects is provided later when elasticities are presented.

Season dummy variables demonstrate that supply of frozen shrimp is seasonal. Shrimp products are slightly affected by season, while the total supply is stable through different seasons. The symbol of functions of "China" in frozen shrimp demonstrates that the first and fourth quarters for China have significant negative relationship. The second and third quarters are significant and positive. The parameter of "Indonesia" and "India" demonstrates that these two countries have significant positive relations in Japan's imported frozen shrimps.

3.6 Results and Analysis

Table 3.3 and 3.4 shows the calculated expenditure elasticity and price elasticity based on Japan's shrimp import demand model. Table 3.3 demonstrates the expenditure elasticity and compensated price elasticity. The (conditional) uncompensated price elasticities are presented in Table 3.4.

Focusing first on Table 3.3, Japan's demand for Frozen Shrimp from India (1.49) and Thailand (1.19) is expenditure elastic. This means demands for frozen shrimp from these countries will grow at a faster pace than the growth in Japan's import expenditure. Expenditure inelastic demands are found for Frozen Shrimp from China (0.87) and Indonesia (0.81), for Shrimp Products from Indonesia (0.60), Thailand (0.67), and Other countries (0.67), and for Fresh Shrimp (0.54). For these products and sources demand will grow at a slower pace than Japan's import expenditures. Japan's demand for Frozen Shrimp from Vietnam (1.05) and Other countries (0.93) is approximately unitary elastic, as is Shrimp Products from China (1.00) and Vietnam (0.94). For these products and sources, demand will grow at the about the same pace as Japan's import expenditure.

Expenditure elasticity is a reflection of consumer preferences. An expenditure elasticity less than zero indicates an inferior good, an expenditure elasticity between zero and one indicates a normal good, and an expenditure elasticity greater than zero indicates a luxury good. In this study, of the three product forms considered, only one is superior: frozen shrimp from India and Thailand.

The compensated price elasticity is negative to all the countries' commodities. The increase in price will lead to export amount decrease in each country. This implies that shrimps are normal products in Japan's market. The own-price elasticity of frozen shrimp of Indonesia and Thailand is elastic, which are -1.03 and -1.76 respectively. The volatility of price has a relatively huge impact on its export amount. On the other hand, the own-price elasticity of China's frozen shrimp is -0.41. It lacks of elasticity and the export amount will be less influenced by the price volatility. In addition, the own-price elasticity of each country's shrimp product is low in Japan's market. This indicates that price has little influence on shrimp product's import volume.

According to the result of non-compensated price, frozen shrimp's own-price elasticity of India and Vietnam changes significantly. This can be observed when the effect of income is eliminated. This shows that income effect on India and Vietnam's frozen shrimp own-price elasticity is relatively huge. Moreover, the higher expenditure elasticity of these two countries also demonstrates this.

According to table 3.3 and table 3.4, different source countries' shrimp's cross-price elasticity is lower than 1. It lacks elasticity. The cross-price elasticity of China's frozen shrimp and India and Vietnam's is negative. This indicates that they have complementary relationship.

In contrast, the cross-price elasticity of China's frozen shrimp and Indonesia and Thailand's is positive. This indicates that they have substitutionally relation.

From own-price elasticities aspect, own-price elasticity of frozen shrimps from Indonesia almost equal to unit price elasticity (-1.0). This means that Indonesia's frozen shrimps have stable revenue in Japan's shrimp market. They are not influenced by the price in the market. However, the own-price elasticity of Thai frozen shrimps is the highest (-1.8). This means the price has a huge influence on the sales. Therefore, Thailand is most likely to import their products at a low price to Japan. The rest of the countries own-price elasticities do not reach unit price elasticity. The influence of price on sales is little.

Moreover, The Allen elasticities are also calculated in the current paper to explore the relative strength of each source (table 3.5). The relative strength of the substitution relationship among goods can be shown by Allen elasticities. Table 3.5 indicates that, among the significant results, the ranking of the strongest competitions is: Chinese frozen shrimp and ROW shrimp product (61.22), Chinese frozen shrimp and Indonesia shrimp product (16.06), Chinese shrimp product and ROW shrimp product (12.39), Therefore, in Japan's shrimp market, Chinese produced more competitive with Indonesia and ROW.

When comparing China's frozen shrimp cross-price elasticity with other countries, it can be observed that China's price influence on other countries' export amount is lower than other countries' on China. This indicates that China's influence on Japan's frozen shrimp market is relatively weak. The cross-price elasticity of source-differentiated shrimp product shows that China's shrimp products have complementary relationship with Vietnam's. Moreover, it has substitutionally relationship with Indonesia and Thailand's. Furthermore, the magnitude of these two relations is not huge. Thus, China's shrimp product influence is not weak in Japan's market.

3.7 Conclusion

As traditional shrimp consuming country, Japan is still the major shrimp product exporting market in the world. Thus, research on Japan's import demand is necessary. This paper calculates shrimp import demand in Japan's market by using CBS model and analyses the statistics by using price elasticity.

China, as an exporting country to Japan's shrimp market, has increased its market share in recent years. Nevertheless, its competitiveness is not obvious when compared to other countries in Asian area. It is foreseeable that Japan's shrimp import market is facing more severe competition.

According to the estimation of Japan's shrimp import demand, China's frozen shrimp and shrimp products face different situations in Japan's market. Firstly, China's exported frozen shrimp lack elasticity anyway. It means that even if the total import expenditure increases highly in Japan's frozen shrimp, China's export volume will not increase dramatically. Moreover, the elasticity of China's frozen shrimp is low. It is advantageous to China's frozen shrimp exports when price increases, ceteris paribus. In addition, the results show that China's shrimp products have certain competitive advantage in Japan's market. The total import expenditures increase in Japan's shrimp products will benefit China's producer the most.

Based on Japan's recent trade, its frozen shrimp import expenditure is declining. The increase in producers' benefit is difficult when combing with China's situation in Japan's market. On the contrary, Japan's shrimp product market is emerging in recent years. China can benefit from this. Therefore, if Chinese producers could develop shrimp product trade, they may

acquire more profits in Japan's market. Furthermore, Chinese government should set up more strategical policy to encourage Chinese producer exporting shrimp products to Japan.

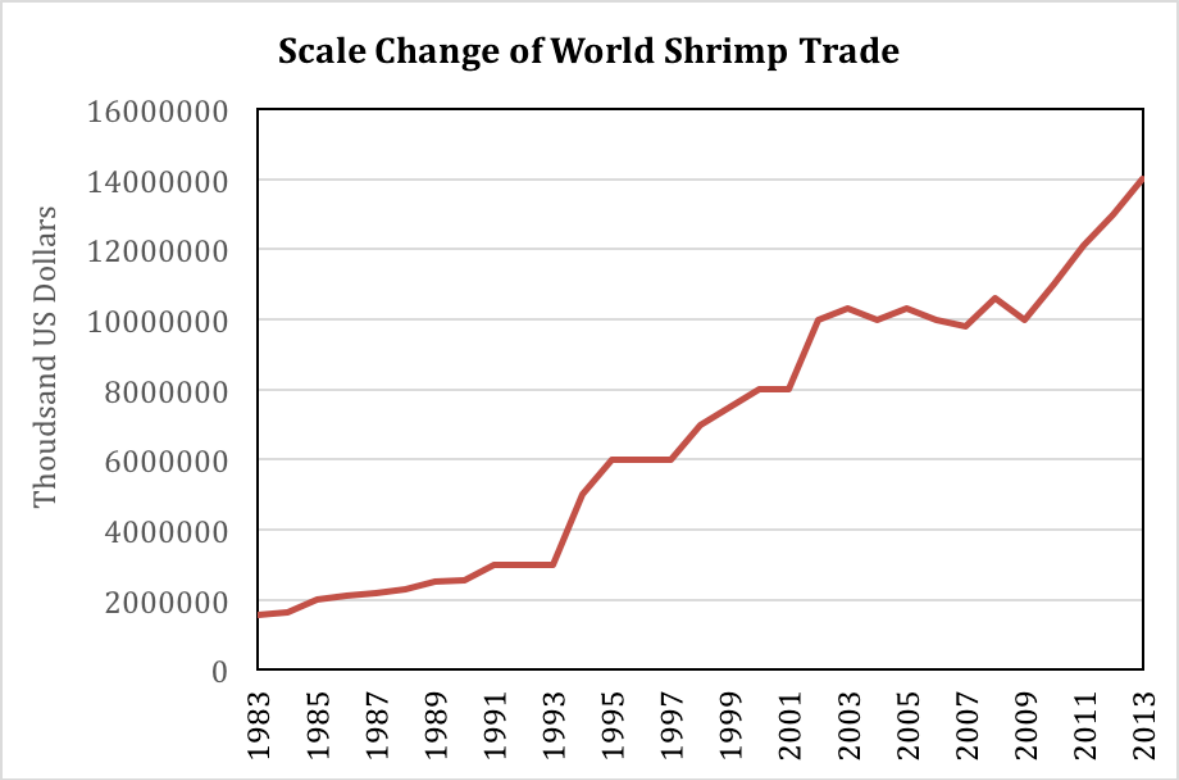

Figure 3. 1 Scale Change of World Shrimp Trade
Data source: FISH PLUS from Food and Agriculture Organization of the United Nations

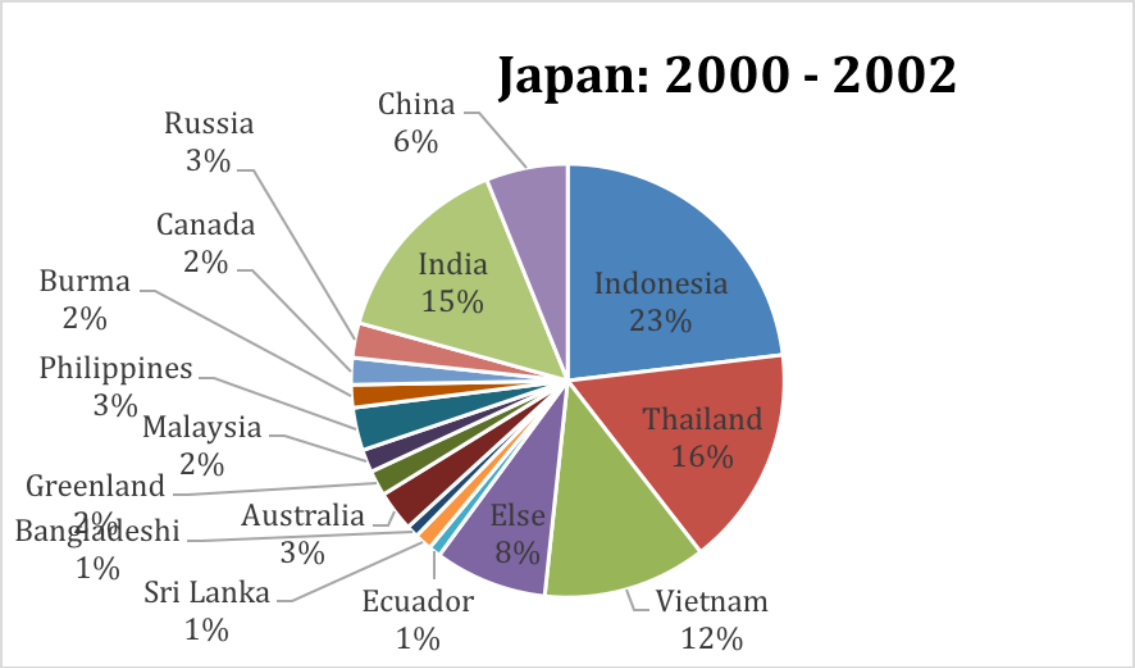

Figure 3. 2 Market Share in Japan Shrimp Market, 2000-2002

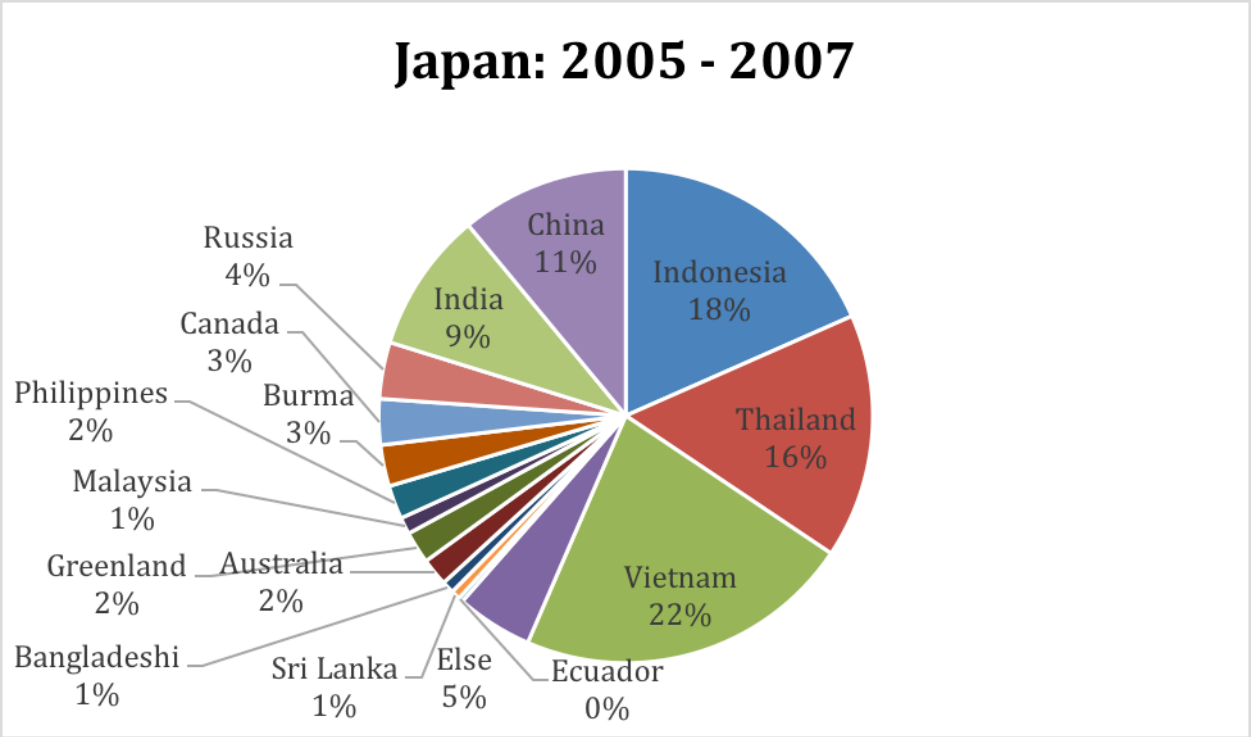

Figure 3. 3 Market Share in Japan Shrimp Market, 2005-2007

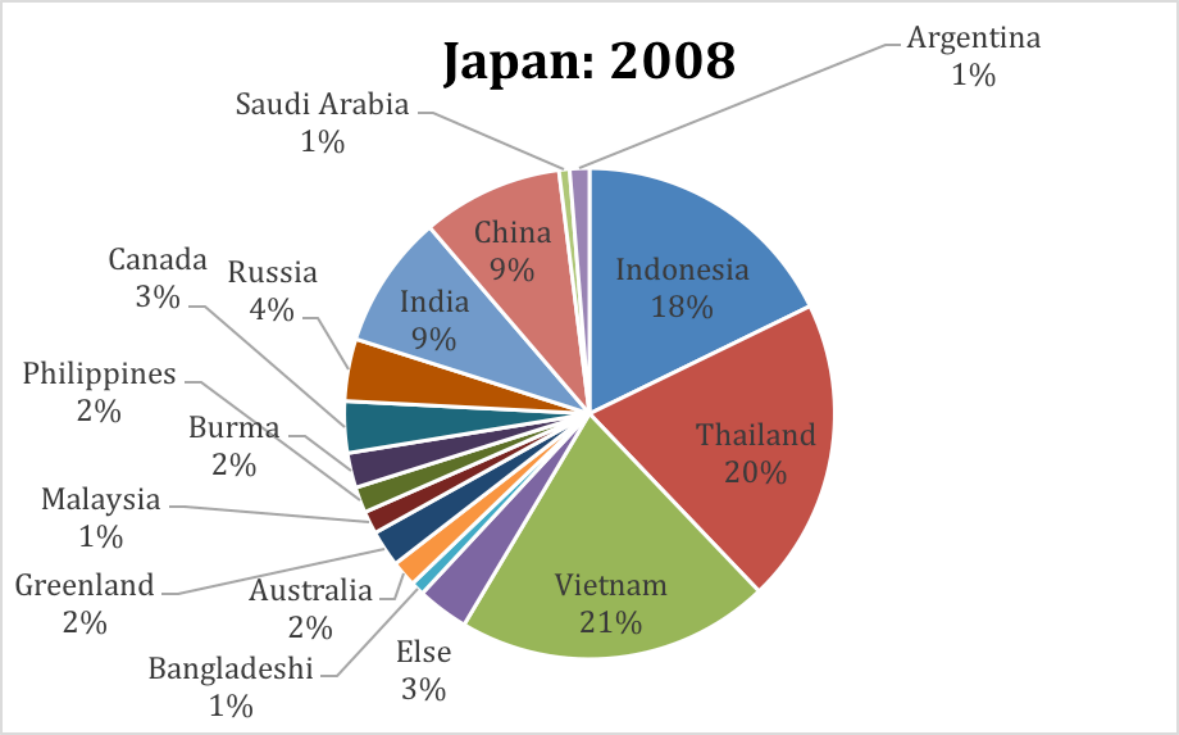

Figure 3. 4 Market Share in Japan Shrimp Market, 2008
Data source: UN Comtrade Database

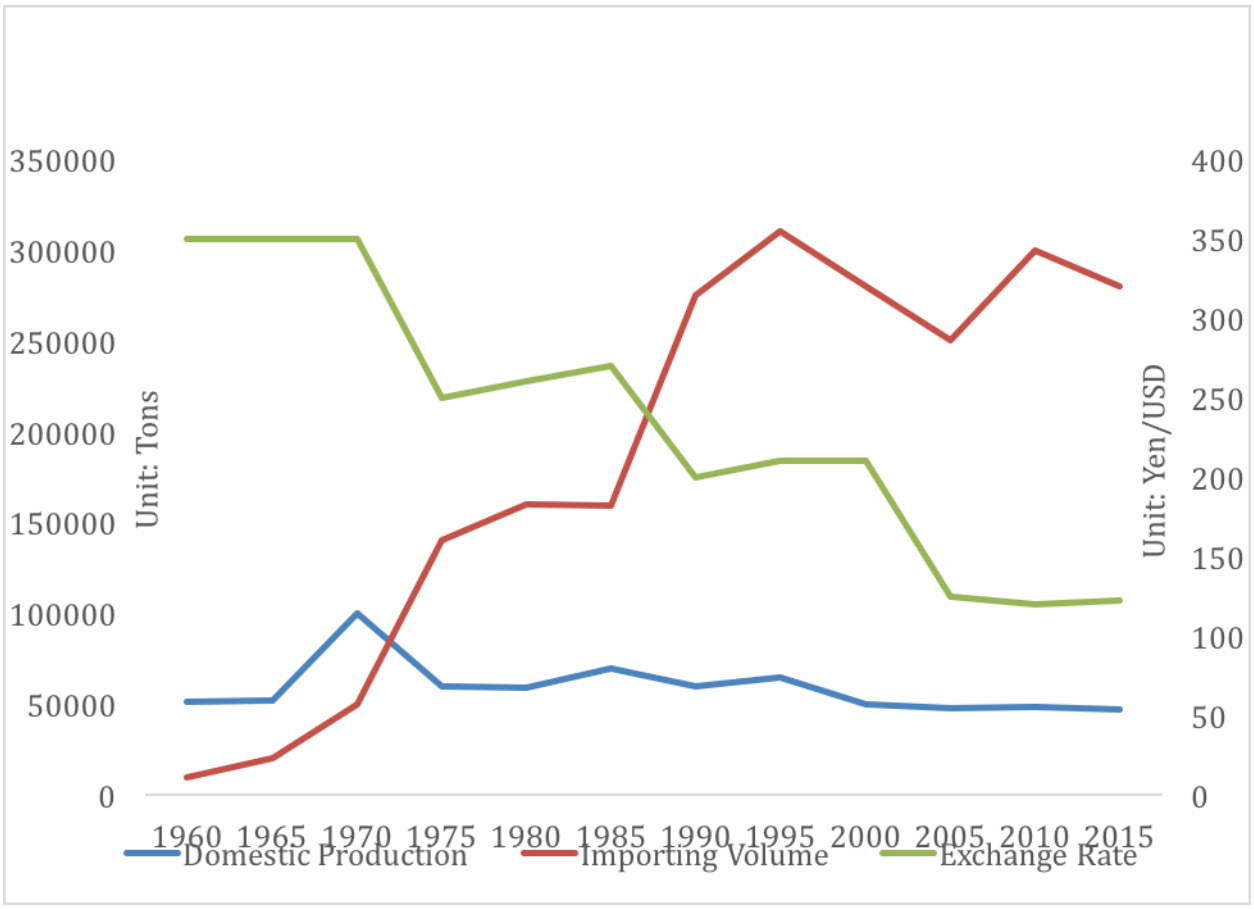

Figure 3. 5 Shrimp Market Change in Japan

Data source: Trade data: UN Comtrade Database
Production data: FAO Database
Exchange rate: IMF Database

Table 3. 1 Budget Share of Major Source Countries (01/2001-04/2014)

Variables	Average	Standard Deviation	Minimum	Maximum
Frozen Shrimp	0.8401	0.0650	0.7140	0.9260
China	0.0452	0.0213	0.0154	0.0971
Indonesia	0.1963	0.0342	0.1085	0.3192
India	0.1245	0.0613	0.0532	0.2767
Thailand	0.0827	0.0231	0.0481	0.1832
Vietnam	0.1246	0.0510	0.0392	0.2413
Other countries	0.2663	0.0353	0.1881	0.3571
Shrimp Products	0.1482	0.0576	0.0672	0.2804
China	0.0219	0.0160	0.0005	0.0534
Indonesia	0.0238	0.0081	0.0080	0.0532
Thailand	0.0812	0.0198	0.0431	0.1587
Vietnam	0.0149	0.0192	0.0008	0.0681
Other countries	0.0064	0.0023	0.0021	0.0145
Fresh Shrimp	0.0117	0.0045	0.0026	0.0259

Data source: Trade Statistics of Japan Ministry of Finance (TSOMOF)

Table 3. 2 Estimated Coefficients of CBS model for Japan Demand for Import Shrimp (01/2001-05/2014)

Variables		Frozen Shrimp						Shrimp Products					Fresh Shrimp
		China	Indonesia	India	Thailand	Vietnam	Other	China	Indonesia	Thailand	Vietnam	Other	
Constant		-0.0011	-0.0057	-0.0112***	0.0049**	-0.0053	0.0092**	0.0022*	0.0009	0.0029*	0.0027***	0.0001	0
		-0.6271	-1.1354	-2.7144	2.3054	-1.0791	2.3743	1.9342	0.9987	1.6923	2.9745	0.3109	-0.0061
Price Coefficient													
Frozen Shrimp	China	-0.091***	0.0152	-0.0203**	0.0179	-0.0087	0.0149*	-0.0051	0.0093***	0.0039	-0.002	0.0021*	-0.0014
		-2.7141	1.2714	-2.3917	1.2131	-0.9701	1.8745	-1.2131	2.7141	0.7014	-0.7141	1.8023	-0.6571
	Indonesia		-0.2021***	0.0513**	0.0508***	0.0032	0.0397	0.0051	-0.0036	0.0017	0.0157**	-0.0019	0.0085*
			-4.9213	2.2989	2.7991	0.5324	1.3215	1.0141	-0.4177	0.7238	2.0094	-0.3077	-1.8233
	India			-0.0351	-0.0031	-0.0288*	0.0151	-0.0119**	-0.0019	-0.0041	0.0051	0.0003	-0.0096*
				-0.7233	-1.307	-1.8798	0.4743	-2.2474	-1.0145	-0.4157	1.1795	0.0388	-1.9523
	Thailand				-0.1439***	0.0440***	0.0181	0.0079	-0.0042	0.0301**	0.0069	0.0009	0.0129***
					-7.1345	4.1324	1.2156	0.8747	-0.7141	2.3141	1.0752	0.8723	4.0533
	Vietnam					-0.0251	-0.0199	0	-0.0024	-0.0066	0.0006	-0.0013	0.0013
						-0.9796	-1.0533	-0.7071	-0.2131	-0.6124	0.1352	-0.7928	0.4333
	Other						-0.0791***	0.0081	0.0049	0.0243**	0.0053	0.0016	0.0035
							-3.4121	1.3142	0.6757	2.0679	0.8845	0.7233	0.1453
Shrimp Products	China							-0.0089***	0.0031	0.003	-0.0004	0.0005	-0.0005
								-3.0141	1.1437	0.7249	-0.1063	0.4352	-0.7728
	Indonesia								-0.0049	-0.0033	0.0009	0.0023*	0.0021
									-0.7124	-0.3041	0.8345	1.8003	1.5233
	Thailand									-0.0487***	0.0007	0.0012	0.0017
										-3.0577	0.0389	0.5062	0.4407
	Vietnam										-0.0005	0.0004	-0.0002
											-0.3328	0.4028	-0.9025
	Other											-0.0040***	0.0013**
												-7.2365	1.9823
Fresh Shrimp													-0.0039
													-0.8754
Expenditure		-0.0057	-0.0366**	0.0614***	0.0149*	0.0320***	-0.0191	0	-0.0099***	-0.0284***	-0.0015	-0.0021	-0.0049*
		-0.8931	-2.2013	3.7142	1.9857	2.8754	-1.0537	-0.0162	-2.8524	-4.038	-0.3045	-1.1752	-1.8738
Season Dummy 1		-0.0055**	0.0167***	0.0198***	-0.0023	-0.0008	-0.0124***	-0.0030**	0.0012	-0.0011	-0.0043***	0.0007	0.0021**
		(-2.6499)	-2.3563	-2.7786	(-1.0649)	(-0.2284)	(-3.3567)	(-2.0467)	-1.4022	(-0.1739)	(-2.0266)	-1.1363	-2.1544
Season Dummy 2		0.0046**	-0.0072	-0.0022	-0.0251***	0.0233***	-0.0005	-0.0001	-0.0015	-0.004	-0.0016	-0.0002	-0.0011
		-2.2386	(-0.3409)	(-0.1879)	(-3.2658)	-3.6669	(-0.1013)	(-0.0798)	(-0.5488)	(-1.0296)	(-1.0890)	(-0.3889)	(-1.1078)
Season Dummy 3		0.0086***	0.0034	0.0143***	-0.0201***	0.0063	-0.0528***	-0.0015	-0.0012	-0.0025*	-0.0053***	0.0001	0.0002
		-3.5377	-0.3687	-5.0026	(-3.2526)	-0.8917	(-4.2515)	(-1.2586)	(-1.1045)	(-1.9046)	(-2.3800)	(-0.2215)	-0.2788
R^2							0.9342						
t-ratios in parentheses *** p<0.001, ** p<0.01, * p<0.05													

Table 3. 3 Expenditure and Compensated Price Elasticity for Shrimp Demand in Japan

		Frozen Shrimp						Shrimp Product					Fresh Shrimp
		China	Indonesia	India	Thailand	Vietnam	Other Countries	China	Indonesia	Thailand	Vietnam	Other Countries	
Expenditure Elasticity		0.8738	0.8147	1.4860	1.1925	1.0526	0.9295	0.9979	0.5955	0.6671	0.9351	0.6731	0.5389
Compensated Price Elasticity													
Frozen Shrimp	China	-0.4094	0.3554	-0.4699	0.2366	-0.2064	0.3425	-0.1027	0.2021	0.0962	-0.0444	0.0552	-0.0336
	Indonesia	0.0852	-1.0330	0.2584	0.2614	0.0155	0.2112	0.0284	-0.0196	0.0077	0.0816	-0.0092	-0.0458
	India	-0.1754	0.4041	-0.2845	-0.0213	-0.2380	0.0871	-0.1039	-0.0164	-0.0333	0.0461	0.0032	-0.0574
	Thailand	0.1324	0.6125	-0.0313	-1.7545	0.5174	0.2286	0.0999	-0.0421	0.3610	0.0842	0.0132	0.1564
	Vietnam	-0.0775	0.0237	-0.2381	0.3458	-0.2197	-0.1643	0.0001	-0.0245	-0.0574	0.0056	-0.0132	0.0132
	Other Countries	0.0628	0.1610	-0.0429	0.0749	-0.0803	-0.3079	0.0285	0.0203	0.0959	0.0222	0.0055	0.0148
Shrimp Product	China	-0.2294	0.2585	-0.6226	0.3993	0.0008	0.3410	-0.4478	0.1517	0.1274	-0.0158	0.0255	-0.0255
	Indonesia	0.3823	-0.1487	-0.0791	-0.1405	-0.1201	0.2020	0.1282	-0.2020	-0.1405	0.0463	0.0873	0.0955
	Thailand	0.0530	0.0772	-0.0483	0.3530	-0.0836	0.2871	0.0318	-0.0412	-0.5753	0.0094	0.0141	0.0212
	Vietnam	-0.0893	0.6928	-0.2479	-0.3052	0.0320	-0.2391	-0.0144	0.0497	0.0364	-0.0232	0.0188	-0.0541
	Other Countries	0.3918	-0.2825	0.0637	-0.1575	-0.2356	0.2200	0.0793	0.3293	0.1731	0.0637	-0.6106	0.1887
Fresh Shrimp		-0.1427	-0.6616	-0.6604	1.2182	0.1427	0.3314	-0.0460	0.2182	0.1616	-0.1120	0.1332	-0.3774

Table 3. 4 Uncompensated Price Elasticity for Shrimp Demand in Japan

		Frozen Shrimp						Shrimp Product					Fresh Shrimp
		China	Indonesia	India	Thailand	Vietnam	Other Countries	China	Indonesia	Thailand	Vietnam	Other Countries	
Uncompensated Price Elasticity													
Frozen Shrimp	China	-0.4498	0.1851	-0.5786	0.1641	-0.3150	0.1185	-0.1207	0.1808	0.0221	-0.0642	0.0496	-0.0428
	Indonesia	0.0476	-1.1918	0.1570	0.1938	-0.0881	0.0013	0.0116	-0.0395	-0.0627	0.0632	-0.0156	-0.0544
	India	-0.2441	0.1143	-0.4695	-0.1447	-0.4228	-0.4681	-0.1345	-0.0527	-0.1595	-0.0798	-0.0073	-0.0731
	Thailand	0.0744	0.3682	-0.1872	-1.8585	0.3616	-0.0949	0.0741	-0.0726	0.2546	-0.1126	-0.0212	0.1432
	Vietnam	-0.1354	-0.2230	-0.3941	0.2418	-0.3755	-0.4854	-0.0268	-0.0550	-0.1638	-0.0240	-0.0213	-0.0012
	Other Countries	0.0198	-0.0226	-0.1586	-0.0035	-0.1959	-0.5461	0.0082	-0.0036	0.0170	0.0433	-0.0005	0.0038
Shrimp Product	China	-0.2755	0.0639	-0.7467	0.3164	-0.1245	0.0853	-0.4683	0.1274	0.0427	-0.0384	0.0191	-0.0360
	Indonesia	0.3548	-0.2647	-0.1531	-0.1899	-0.1940	0.0495	0.1160	-0.2165	-0.1911	0.0328	0.0835	0.0892
	Thailand	0.0221	-0.1135	-0.1312	0.2976	-0.1665	0.1162	0.0181	-0.0574	-0.6319	-0.0057	0.0087	0.0141
	Vietnam	-0.1325	0.5105	-0.3643	-0.3828	-0.0866	-0.4787	-0.0337	0.0269	-0.0453	-0.0372	0.0128	-0.0640
	Other Countries	0.3607	-0.4136	-0.0224	-0.2133	-0.3192	0.0475	0.0655	0.3129	0.1160	0.0484	-0.6149	0.1816
Fresh Shrimp		-0.1676	-0.7665	-0.7286	1.1735	0.0758	0.1934	-0.0540	0.2051	0.1159	-0.2366	0.1110	-0.3843

Table 3. 5 Allen Elasticities

	Frozen Shrimp	Shrimp Product
	China	China
China	-9.06	-2.27
Indonesia	0.43	0.14
India	-1.41	-0.83
Thailand	1.60	1.21
Vietnam	-0.62	0.00
Other Countries	0.24	0.11
China	-10.47	-20.45
Indonesia	16.06	5.39
Thailand	0.65	0.39
Vietnam	-5.99	-0.97
Other Countries	61.22	12.39

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