Estimation of Import Demand for Fishery Products in the U.S. Using the Source-Differentiated AIDS Model

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Abstract

Fishery product imports by the U.S. have been gradually increasing in recent years. The leading exporting countries include Canada, Chile, China, Ecuador, Indonesia, Thailand, and Vietnam. A source-differentiated Almost Ideal Demand System (AIDS) model and its Error Correction Model (ECM) version are employed to investigate the static and dynamic U.S. import demand for fishery products from the top seven countries using monthly data from January 1999 to September 2012. Long-run and short-run own-price, cross-price and expenditure elasticities are calculated.

Key words: fishery products, import demand, Almost Ideal Demand System Model, Error Correction Model.

JEL Codes: Q11; Q17; Q22.

The United States is one of the world's largest importers of seafood products. Aquaculture imports by the U.S. have been gradually increasing over the period from 1999 to 2011. According to National Marine Fishery Service reports, the value of U.S. imports of edible fishery products in 2011 reached $16.6 billion; $ 1.8 billion more than in 2010. U.S. fishery imports over time are presented in figure 1. The largest categories of imported aquaculture products are shrimp, salmon, and tilapia. The imported value of shrimp alone in 2011 was $5.2 billion, which accounted for 31 percent of the value of total edible imports; making it the most imported fishery product.

U.S. annual per capita consumption of commercial fish and shellfish has been steady in the last decade at around 16.0 pounds (the ERS Food Availability (Per Capita) Data System, 2012). Majority of the seafood consumed in the U.S. is imported in recent years. The import share of fish and shellfish has grown substantially over the past two decades, from 56.3% in 1990 to 85.2% in 2009. By value, about 91 percent of seafood consumed in the U.S. was imported in 2011, up five percent from 2010, according to the report Fisheries of the United States 2011(NOAA, 2011). By volume, fish and shellfish have the highest import share in the U.S. among all animal products, and are second only to tropical products among food items. The report also reveals that the U.S. aquaculture industry currently meets less than five percent of U.S. seafood demand, producing primarily oysters, clams, mussels, and some finfish, including salmon. There is an increasing dependence on the international market for fishery products. Thus, the imports' responses to the price fluctuations and income changes, as well as the pattern of imports from different exporting countries are very important for the fishery market in the U.S.

Despite these developments, few studies have examined demand for U.S. fisheries imports. Herrmann, Mittelhammer and Lin (1993) estimate U.S., Japan and European Community (EC) demands for Atlantic and Pacific salmon, and find the two products to be substitutes in destination markets. Ligeon, Jolly and Jackson (1996) use the traditional import demand function to evaluate the effect of increased exports from NAFTA member countries on the U.S. domestic catfish industry. Asche, et al. (2005) study the swordfish import demand of the U.S. and find that demand is inelastic for all products, indicating a limited degree of substitution possibilities. Ligeon, et al (2007) use a source differentiated AIDS model to examine the import demand for tilapia and tilapia products in the U.S. Muhammad and Jones (2011) examine the U.S. demand for salmon imports differentiated by country of origin, product cut, and form.

This study of the U.S. fishery demand is motivated by the above statistics. It estimates both static and dynamic versions of the Almost Ideal Demand System (AIDS) model for U.S. imports of fishery products, which are differentiated by source. The overall objective of this article is to provide reliable estimates of U.S. fishery import demand elasticities. Long-run and short-run own-price, cross-price and expenditure elasticities are calculated to evaluate the pattern of imports among fishery products from different exporting countries.

The remainder of the article is organized as follows. In the next section, the source differentiated AIDS model and its Error Correction Model (ECM/AIDS) version are specified for this study. Data and summary statistics are presented in the third section. Estimation procedures are explained in the fourth section, followed by a presentation and interpretation of empirical results. Conclusions are presented in the final section.

Empirical Methods

The methodology used in this article is the Almost Ideal Demand System (AIDS) model, which has been widely used in analyzing demand elasticilities and substitution effects since its introduction. The popularity of the AIDS model is mainly attributed to its various nice properties. Specifically, it is consistent with consumer demand theory in that it satisfies three types of theoretical restrictions: adding-up (Engel aggregation), homogeneity and symmetry requirements (Deaton and Muellbauer, 1980; Ramirez, and Wolf, 2008; Wan, Sun and Grebner, 2010; Nzaku, Houston and Fonsah, 2012).

Source differentiation is important in demand analysis. Product aggregation, under which the demand system does not differentiate products by source, seems too strong in international agricultural trade. Yang and Koo (1994) use a source differentiated Almost Ideal Demand System Model (AIDS) to estimate Japanese meat import demand. Product aggregation are tested and rejected at conventional levels of significance. Ramirez and Wolf (2008) estimate the demand for dairy products imported into Mexico and examine the competition among exporting firms and countries, using a restricted source-differentiated AIDS model. Muhammad and Jones (2011) use the Rotterdam model to examine the U.S. demand for salmon imports, perform source aggregation tests and find that import preferences were not homogeneous across exporting countries, illustrating that there is significant information loss when source differentiation is not considered. Given the results from previous studies, a source-differentiated AIDS model is employed in this article.

Static Almost Ideal Demand System Model

A conventional source-differentiated Almost Ideal Demand System (static AIDS model hereby) model for fishery imports of the U.S. can be expressed as follows:

(1) $$w_{it} = \alpha_i + \beta_i \, ln\left(\frac{m_t}{P_t^*}\right) + \sum_{j=1}^{N} \gamma_{ij} \, lnp_{jt} + u_{it}$$

(2) $$lnP^* = \alpha_0 + \sum_j \alpha_j \, lnp_j + \frac{1}{2}\sum_j \sum_k \gamma_{jk} \, lnp_j lnp_k$$

where w is the import share of fishery products by the origin of country ($w_{it} = {p_{it}q_{it}}/{m_t}$) ; m is the total expenditure on all imports ($m_t = \sum_{i=1}^{N} p_{it}q_{it}$, where $q_{it}$is the import quantity; since the price index lnP^* in Equation (2) is nonlinear and provides difficulties in estimation. The Paasche index, i.e. ln $P^* = \sum_{j=1}^{N} w_{j,t-1} \, ln \, (\frac{p_{j,t}}{p_{j,0}})$, is used as a linear approximation. p is the import price for each exporting country; α is the constant term, β and γ are the coefficients to be estimated; and u is the disturbance term. For subscripts, i indices country in the import share for each equation (i =1, 2…N); j represents country in the price variables (j= 1, 2 . . . N), t indicates time (t = 1, 2…T). The Paasche index uses lagged expenditure shares to avoid endogeneity with the dependent variable w (where $p_{j,0}$ is the initial value of p_j in the data set.) (Moschini, 1995; Chern, et al., 2003).

The AIDS model satisfies the following properties:

Adding-up restrictions: $\sum_{i=1}^{N} \alpha_i = 1$; $\sum_{i=1}^{N} \beta_i = 0$; $\sum_{i=1}^{N} \gamma_{ij} = 0 \ \forall \ j = 1 \dots N$;

Homogeneity: $\sum_{j=1}^{N} \gamma_{ij} = 0$

Symmetry: $\gamma_{ij} = \gamma_{ji}$

Based on the estimated parameters from the AIDS models and the average import shares, expenditure elasticity, uncompensated (Marshallian) price elasticities, and compensated (Hicksian) price elasticities are calculated as follows:

(3) $$\eta_i = 1 + (\beta_i / \overline{w}_i)$$

(4) $$\varepsilon_{ij}^{m} = -\delta_{ij} + \left(\gamma_{ij} / \overline{w}_i\right) - (\beta_i \overline{w}_j / \overline{w}_i)$$

(5) $$\varepsilon_{ij}^{h} = -\delta_{ij} + \left(\gamma_{ij} / \overline{w}_i\right) + \overline{w}_j$$

Where η, ε^m and ε^h are the expenditure elasticity, uncompensated price elasticity, and compensated price elasticity, respectively; δ_{ij} is the Kronecker delta, which is equal to 1 if $i = j$ (i.e., own-price elasticity) and 0 if if $i \neq j$ (i.e., cross-price elasticity), and $\overline{w}$ is the sample mean of import share. The uncompensated price elasticity combines two effects: the substitution effect and the expenditure effect. In order to isolate the substitution effect, only expenditure elasticities and compensated price elasticities are calculated in this article.

Dynamic Almost Ideal Demand System Model

The static AIDS model, also known as long-run AIDS model, assumes that consumption is always in equilibrium, which is not always true, especially with time series data. In reality, consumers' behavior can be affected by various factors such as habit persistence, adjustment costs, imperfect information, incorrect expectations and policy intervention. These factors might interfere with instant expenditure adjustment to prices and income changes (Wan, Sun, and Grebner, 2010; Nzaku, Houston, and Fonsah, 2012). Unit root and cointegration tests are recommended when analyzing time series data. If two or more non-stationary time series are found cointegrated, an Error Correction Model (ECM) version of the AIDS model is suggested to estimate the short-run dynamics in which a dependent variable deviates and returns to long run equilibrium after a change in an independent variable. Meanwhile, if the residuals calculated from the static AIDS are found to be stationary, it suggests that there is a long-run equilibrium and cointegraion relationship for the variables in Equation (1). Thus the elasticities computed from the static AIDS model can still reveal the long-run demand responsiveness to income and price changes (Karagiannis, Katranidis, and Velentzas, 2000).

An ECM/AIDS (or called the dynamic AIDS) model can be expressed in the following equation:

$$(6) \qquad \Delta w_{it} = \psi_i \Delta w_{i,t-1} + \lambda_i \left(w_{it-1} - \alpha_i - \beta_i \, ln\left(\frac{m_{t-1}}{P^*_{t-1}}\right) - \sum_{j=1}^{N} \gamma_{ij} \, lnp_{jt-1}\right) + \beta_i^d \Delta Ln\left(\frac{m_t}{P_t^*}\right) + \sum_{j=1}^{N} \gamma_{ij}^d \Delta lnp_{jt} + \upsilon_{it}$$

Where Δ is the first-difference operator; the expression in the parenthesis (i.e. $w_{it-1} - \alpha_i - \beta_i \, ln\left(\frac{m_{t-1}}{P_{t-1}^*}\right) - \sum_{j=1}^{N} \gamma_{ij} \, lnp_{jt-1}$) is the error correction term, embedding the cointegrating relationship; υ is the disturbance term and all other variables are as previously defined in the static AIDS model. ψ, λ, β and γ are the parameters to be estimated. The superscript *d* on parameters β and γ indicates a dynamic AIDS model.

Compared to the static AIDS model, the ECM/AIDS model has two more independent variables: the error correction term $w_{it-1} - \alpha_i - \beta_i \, ln\left(\frac{m_{t-1}}{P_{t-1}^*}\right) - \sum_{j=1}^{N} \gamma_{ij} \, lnp_{jt-1}$ and lagged first difference of import share Δw_{t-1}. The error correction term is actually the error in the previous period, i.e. the lagged residuals $\hat{u}_{i,t-1}$. Its coefficient, λ_i, measures the speed of short-run adjustment towards the long-run equilibrium and is theoretically expected to be negative. For example, if $|\lambda_i|$ =1, the adjustment is instantaneous. The larger or closer to one in absolute value is λ_i, the faster the adjustment goes back to long-run equilibrium, and vice versa. Coefficient ψ of the lagged first difference of the buget share variable is to account for the effect of consumption habit, which is usually important in demand specification (Eakins and Gallagher, 2003; Susanto, Rosson, and Henneberry, 2008).

Akin to the static AIDS model, the dynamic AIDS model is also constructed to meet the three properties: adding-up, homogeneity, and symmetry. Likelihood ratio tests can be used to test whether the model satisfy these properties. If not, constraints can be imposed accordingly.

Additional independent variables incorporated in every equation of the ECM/AIDS model can bring more adding-up restrictions to the model apart from the ones specified in the static AIDs model: $\sum_{i=1}^{N} \psi_i = 0$; $\sum_{i=1}^{N} \lambda_i = 0$; $\sum_{i=1}^{N} \upsilon_{it} = 1$.

The elasticities for the dynamic AIDS model can be computed in a manner similar to the static AIDS model (Equations 3-5). The ECM/AIDS regression equation reveals explicitly the short-run dynamics in the form of differenced terms. Thus the elasticities calculated from the coefficients in the ECM/AIDS could be interpreted as the short-tun elasticities.

Data and Summary Statistics

All the data in this study are retrieved from the Foreign Agricultural Service's Global Agricultural Trade System (GATS), USDA (http://www.fas.usda.gov/gats). According to the categorization of Foreign Agricultural Service (FAS, USDA), fishery products include catfish, salmon, trout, tuna, shrimps and prawns, all other crustaceans, molluscs, invertebrate, and all other fish products.

In this study, there are 8 countries or regions considered (N=8), including the seven countries Canada, Chile, China, Ecuador, Indonesia, Thailand, Vietnam, and rest of the world (ROW), which is an aggregation of the exporting countries not specified. The monthly data span from January 1999 to September 2012 (T =165). The top suppliers are selected according to the statistical data from GATS, USDA. The total imports value of the leading seven suppliers accounted for 65.78 % of the total imports during the 1999–2011 period.

Due to the unavailability of data, unit values (US $/MT) for the aggregate fishery products, which are the ratio of cost-insurance-freight (CIF) import value (US $) to quantity (Metric Tons), serve as proxies for import prices.

Table 1 shows the descriptive statistics for fishery products from Jan. 1999 to Sept. 2012. Monthly average U.S. imports of fishery products are US $752.047 million over the study period. Thailand has the highest monthly average import share (13.9%), with Canada in second place (13.3%), and China in third (11.7%). Imports from Vietnam are the most expensive with a monthly average CIF price of $ 5679 per MT, while those from China have the lowest price at $ 2778 per MT. Import shares from Chile and China tripled, while the import share from Canada declined by almost 90% over the studied period. The rapid growth and development of Chile and China's aquaculture, or farmed seafood industry resulted in competitive prices of fishery products that appealed to U.S. consumers.

Empirical Results

Stationarity and Cointegration Tests

Time series of import share and price variables as specified in Equation (1) are firstly plotted for visual inspection. All of the importing share series appear to be fluctuating around a linear trend. The modified Augmented Dickey-Fuller (ADF) *t* test (the DF-GLS test) is used to determine whether the variables under consideration are stationary or non-stationary, since the DF-GLS test with a trend included by default has significantly greater power than the previous versions of the augmented Dickey–Fuller test (Stock and Watson, 2007). The choice of lag length is based on the modified Akaike Information Criteria (MAIC) and the minimum Schwarz Information Criterion (SIC). If the lag lengths suggested by the two criteria are the same, the corresponding lag length is chosen. If not, the longer lag length is chosen.

The *tau* values from the DF-GLS test for the import shares and prices are all larger than their corresponding 1% critical values for *tau*. Therefore, we do not reject the null hypothesis that the series are non-stationary. Then we do the same tests for first differences of import share and price variables. Test results can't reject the null hypothesis of unit root at the 5% significance level for all the first differences, indicating that all the import share and price variables are integrated of order one.

Then the Engle-Granger two-step test is employed to examine the cointegration relationships among the variables. The first step is to run an OLS regression for each share in Equation (1). The second step is to conduct ADF tests for stationarity of the residuals. The null hypotheses of unit roots are rejected at the 5% significance level for all of the residuals. Thus, cointegration is found among the variables for each share equation, indicating that the budget share and prices share a common stochastic drift for each exporting country. These diagnostic tests justify the use of the ECM model for estimation. The static AIDS is still estimated for this article, so the results can be compared with the ECM/AIDS model.

Estimated Coefficients

Static and dynamic AIDS models are estimated using the constrained seemingly unrelated regression (SUREG) procedure in Stata. Since importing budget shares sum to one in the system, one equation is dropped to deal with the singularity problem of the disturbance covariance matrix (Greene, 2005). In practice, the share equation for the ROW is eliminated.

Tables 2 and 3 show estimated parameters for both the static and dynamic AIDS models. Most of the estimated coefficients for both the real expenditure and price terms are statistically significant at the 1% level in both models. The property of symmetry was apparently satisfied ($\gamma_{ij} = \gamma_{ji}$) by the estimated coefficients shown in the above two tables. For instance, in the static AIDS model, the coefficient for the price of imported fishery products from Thailand in China's share equation γ_{13} is equal to the coefficient for the price of imported fishery products from China in the Thailand share equation γ_{31}. They are both -0.042. Significance levels for the same coefficients are roughly consistent between both models. And the R squares of the static model are slightly higher than those of the dynamic model.

As mentioned before, the dynamic AIDS model has two additional critical coefficients worth interpretation. Coefficients for the lagged first difference of import share reveal the consumption habit formation, indicating that last period's consumption pattern affects current decisions. They are significant for only two countries, i.e., Canada (0.130), and Ecuador (0.221), all significant at the 1% level. Evidence of consumer habit in import demand for the other four countries was not present.

All the estimated coefficients λ_i of the error correction terms are negative as expected, and significant at the 1% level for all seven countries. The speed of adjustment varies across countries. China has the highest speed of adjustment with the coefficient -0.618, implying that 61.8% of the deviation from the long-run equilibrium could be corrected or adjusted within one period (month). In other words, it takes approximately 1.6 months ($1/0.618 \approx 1.6$) to get back to the equilibrium for China. Similarly, the equilibrium adjustment time is around 1.8 months for Canada; 2.0 months for Thailand; 2.4 months for Ecuador; 4.0 months for Chile; 4.5 months for Indonesia; and the longest for Vietnam, 7.0 months. Despite the discrepancies in speed, imports from these countries are still stable, with long-run equilibriums being restored after short-term deviations.

Calculated Elasticities

Table 4 displays the estimates of the expenditure elasticities (η_{i}) and compensated own-price elasticities (ε_{ij}^{h}) for both models. All the own-price elasticities are less than 1 in absolute value in both models, meaning that fishery imports from all these countries are inelastic. Imports of fishery products are not very responsive to price changes. In the static model, own-price elasticities of China, Indonesia, and Vietnam are negative, as theory predicts. The others were positive, which are against the law of demand, thus classifying the products from those countries as inferior goods. As for the dynamic AIDS model, short-run (monthly) own-price Hicksian elasticities are negative as expected (except for Chile) and significant at the 1% level for all countries, confirming that imported fishery products are considered normal goods from those countries.

The results of the dynamic AIDS model make more sense than its static counterpart. Indonesia has the largest own-price elasticities in short run and long run cases, i.e., 0.532 and 0.488, respectively. Compared to other countries, changes in price have a relatively large effect on the quantity of fishery products imported form Indonesia. Given a 10% increase in the price, the import share for Indonesia would decrease by around 5.32% and 4.88% in the short and long run. Canada has the smallest own-price elasticities in the short run, 0.118, making the import share least sensitive to the price change among all the seven countries.

Expenditure elasticities for all the seven countries have positive signs as expected, indicating that the more consumers spend on imports of fishery products, the more they would import from the these top seven countries. The magnitude of expenditure elasticities varies across countries, with the majority greater than 1. China and Vietnam have the highest long-run expenditure elasticities, 2.401 and 2.339 (both are significant at the 1% level). Ecuador has the lowest ones, 0.241 and 0.129 (significant at the 1% level) in both models. Overall, results show that the more the total expenditure on the imported fishery products, the more likely the majority of the increase would be imported from China, Vietnam, and Thailand in the long run. The large expenditure elasticities for China were consistent with the fact that China has emerged as a major fishery products exporter in recent years.

In order to know better about the competitive pattern between different exporters, compensated cross-price elasticities (reported in tables 5 and 6) are computed. The cross-price elasticity of demand measure the responsiveness of the demand for fishery product imports from one country to a change in the price of another country. A positive cross-price elasticity between imported fishery products from two countries implies substitutes and a negative cross-price elasticity denotes complements. There are totally 21 pairs of cross-price elasticities among the seven countries. Each pair has the same sign and significance level, but may have different magnitudes. For instance, in the long run, when the price of fishery products from Canada increases by 10%, the imports from Indonesia increase by 2.81%; when the price of fishery products from Indonesia increase by 10%, the imports from Canada increase by 0.04%.

The magnitudes of the cross-price elasticities are quite small in both models; all of the elasticities are below one in absolute value, indicating that the fishery imports from one country is not very sensitive to the price change of another country. In both models, around half of the cross-price elasticities (significant at the 1% and 5% levels) are positive, implying that products from different sources are substitutes. Most of cross-price elasticities for China and Vietnam with other countries are not significant. This reflects the fact products from these two countries do not substitute for products from other countries, mainly because of quality differences.

The other halves of the significant cross-price elasticities are all negative, indicating complementary relations, contrary to our expectations. Several restrictions imposed on the model (e.g., homogeneity and symmetry) may contribute to the apparent complementary relationships. Comovements in exchange rates may also account for these results, given that the unit values are used as a proxy for price.

The signs and magnitudes of cross-price elasticities vary cross country. Thailand's cross-price elasticities are negative and significant at the 1% level for almost all countries in both models, suggesting that fishery products from Thailand were complements for those imported from other countries, contrary to our expectations. For instance, in the short run, in response to a 10% increase in the price of fishery products imported from Ecuador, the demand of imported fishery products from Thailand would decrease by 0.90%. This result could be explained by the difference in product species imported from Thailand and other countries. Distance might play a vital role in the homogeneity of the fishery products from different countries. For instance, in the static model, the imported fishery products from Thailand and its neighbor Vietnam were substitutes. Due to the geographical proximity, products from those two countries have high possibility of homogeneity. Analysis of data at a more disaggregate level is needed for further explanation.

Conclusions

In recent years, the majority of the seafood consumed in the U.S. is imported. Aquaculture imports have been steadily increasing in the past decade. As the dependence on the international market increases, investigation of the import demand for fishery products in the U.S. from different exporting countries is very necessary. Both static and dynamic AIDS models are specified to estimate the long-run and short-run U.S. import demand for fishery products, which are differentiated by source, using monthly data from January 1999 to September 2012. Specifically, they are from the top seven countries: Canada, Chile, China, Ecuador, Indonesia, Thailand, and Vietnam.

Empirical results show that overall imports of fishery products are insensitive to price changes in both models. Compared to other countries, changes in price had a relatively large effect on the quantity of fishery products imported from Indonesia in both long and short terms. All the fishery products expenditure shares were significant and responded positively to expenditures, suggesting that all the imported fishery products are normal goods. The more the total expenditure on the imported fishery products, the more likely the majority of the increase would be imported from China, Vietnam, and Thailand. Fishery imports from all countries were inelastic to their own prices. A country is regarded as having strong export potential in an import market if demand for the product is insensitive to price changes but increases with import expenditure. In the long run, only Vietnam is in this position, while Canada, Thailand and Ecuador have strong export potential in the short run. Most of the cross-price elasticities were quite small in value, showing no fierce competition among these countries. More than half of these elasticities were negative, indicating complementary relationships between those products from different sources. Model restrictions and comovements in exchange rates might account for such results.

In addition, results from the dynamic AIDS model indicate that only Canada and Ecuador exhibit consumer habit, i.e. last period's consumption pattern affects current decisions. There is no evidence of consumer habit in import demand for the other five countries. All seven countries adjust their short run deviation to the long run equilibrium, albeit the speed of adjustment varies across countries. China is the fastest country to get back to the equilibrium, taking approximately 1.6 months, indicating constant and steady trade, while Vietnam takes the long time for adjustment, around 7 months.

Given the results above, it would be worthwhile to develop and estimate the models using more disaggregated data, which could be based on the HTS classification. Furthermore, seasonality might play an important role in the seafood supply and should also be considered for incorporation into the estimation system.

References:

Asche, F, Guttormsen, A. G., Kristofersson, D, and Roheim, C. A. 2005. Import Demand Estimation and the Generalized Composite Commodity Theorem. American Agricultural Economics Association. Annual meeting, July 24-27, Providence, RI.

Barnett, W. A., & Seck, O. 2008. "Rotterdam model versus almost ideal demand system: will the best specification please stand up?." *Journal of Applied Econometrics*, 23(6), 795-824.

Chern, W. S., Ishibashi, K., Taniguchi, K., Tokoyama, Y., & Pingali, P. 2003. "*Analysis of the food consumption of Japanese households*." Food and Agriculture Organization of the United Nations.

Costa, R, Susanto, D, and Rosson, P. 2010. "The Structure of U.S. Red Meat and Fish Imports." Presented article at the 20th Annual World Food and Agribusiness Forum and Symposium, Boston, MA, June 19-22.

Deaton, A., and J. Muellbauer. 1980. ''An Almost Ideal Demand System.'' *The American Economic Review.* 70:312–26.

Eakins, J. M., & Gallagher, L. A. 2003. "Dynamic almost ideal demand systems: an empirical analysis of alcohol expenditure in Ireland." *Applied Economics*, *35*(9), 1025-1036.

Greene, William H. 2002. Econometric Analysis. Fifth edition. Pearson Education. New Jersey.

Herrmann, M. L., Mittelhammer, R. C., & Lin, B. H. 1993. Import demands for Norwegian farmed Atlantic salmon and wild Pacific salmon in North America, Japan and the EC. *Canadian Journal of Agricultural Economics*, *41*(1), 111-125.

Hill, R. C., Griffiths, W. E., & Lim, G. C. 2008. *Principles of econometrics* (Vol. 5). Hoboken, NJ: Wiley.

Ligeon, C., Bayard, B., Clark, J., Jolly, C., 2007. U.S. Import Demand For Tilapia From Selected FTAA Countries. *Farm & Business: The Journal of the Caribbean Agro-Economic Society* (CAES) .7 (1) 139-156.

Ligeon, C., Jolly, C. M., & Jackson, J. D. 1996. Evaluation of the possible threat of NAFTA on US catfish industry using a traditional import demand function. *Journal of Food Distribution Research*, *27*, 33-41.

Karagiannis, G., Katranidis, S., & Velentzas, K. 2000. "An error correction almost ideal demand system for meat in Greece." *Agricultural Economics*, *22*(1), 29-35.

Moschini, G. 1995. "Units Of Measurement And The Stone Index In Demand System Estimation." *American Journal of Agricultural Economics.* 77(1), 63-68.

Muhammad, A., and Jones, K. G., 2011. "Source-Based Preferences and U.S. Salmon Imports." *Marine Resource Economics*: September 2011, Vol. 26, No. 3, pp. 191-209.

National Marine Fisheries Service. 2011. http://www.st.nmfs.noaa.gov/st1/trade/documents/TRADE2011.pdf.

Nzaku, K. Houston, J.E. and Fonsah, E.G. 2012. "A Dynamic Application of the AIDS Model to Import Demand for Tropical Fresh Fruits in the USA." Selected Article prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August.

Ramirez, M. A. and Wolf, C. A., 2008. "Source Differentiated Mexican Dairy Import Demand." *International Food and Agribusiness Management Review*, vol. 11, issue 1.

Stock, J. H., and M. W. Watson. 2007. *Introduction to Econometrics*. 2nd ed. Boston: Addison–Wesley.

Susanto, D., Rosson III, C. P., & Henneberry, S. R. 2008. "Changes in Import Demand Elasticity for Red Meat and Livestock: Measuring the Impacts of Animal Disease and Trade Policy." In *2008 Annual Meeting, July 27-29, 2008, Orlando, Florida* (No. 6337). American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association).

Wan, Y, Sun, C and Grebner, D. L. 2010. "Analysis of Import Demand for Wooden Beds in the U.S." *Journal of Agricultural and Applied Economics*, 42,4: 643–658.

Yang, S. R., & Koo, W. W. 1994. Japanese meat import demand estimation with the source differentiated AIDS model. *Journal of Agricultural and Resource Economics*, 396-408.

Yeboah, G., & Maynard, L. J. 2004. "The impact of BSE, FMD, and US export promotion expenditures on Japanese meat demand." In *annual meeting of AAEA, Denver CO* (pp. 1-4).

Table 1. Descriptive Statistics for Fishery Products, Jan. 1999-Sept. 2012

Variable	Mean	Standard Deviation	Min	Max
w_1	0.117	0.043	0.039	0.211
w_2	0.133	0.081	0.014	0.302
w_3	0.139	0.03	0.066	0.228
w_4	0.051	0.014	0.027	0.094
w_5	0.051	0.017	0.009	0.083
w_6	0.074	0.025	0.04	0.172
w_7	0.047	0.014	0.021	0.113
w_8	0.388	0.056	0.235	0.521
p_1	2778.389	1619.155	195.8904	4991.743
p_2	4334.28	2755.404	45.4776	9396.386
p_3	4229.862	2585.814	229.2573	9152.241
p_4	5208.829	3072.087	281.8166	9074.05
p_5	5678.741	3383.338	225.088	10540.26
p_6	4741.142	2743.22	547.9932	8994.479
p_7	3926.74	2299.339	277.9868	7404.633
p_8	4548.215	2546.728	468.275	7758.638
m	752.047	453.587	55.004	1449.934

Note: The subscripts in the import shares: 1 –China; 2 – Canada; 3 – Thailand; 4 – Indonesia; 5 – Vietnam; 6 – Chile; 7 – Ecuador; and 8 –ROW.

Table 2. Estimated Parameters from the Static Almost Ideal Demand System Model for Imported Fishery Products

Parameter	China (i=1)	Canada (i=2)	Thailand (i=3)	Indonesia (i=4)	Vietnam (i=5)	Chile (i=6)	Ecuador (i=7)
α_i	-3.262***	1.502***	-0.942***	-0.124	-1.358***	0.669***	0.876***
β_i	0.164***	-0.032*	0.052***	0.008	0.068***	-0.029**	-0.041***
γ_{i1}	0.023	-0.009*	-0.042***	-0.006	0.003	0.033***	-0.008
γ_{i2}	-0.009*	0.159***	-0.010**	0.008***	-0.012***	0.001	-0.006***
γ_{i3}	-0.042***	-0.010**	0.134***	-0.044***	-0.003	-0.037***	-0.031***
γ_{i4}	-0.006	0.008***	-0.044***	0.024***	-0.006	0.018***	0.016***
γ_{i5}	0.003	-0.012***	-0.018***	-0.006	0.027***	-0.012**	0.004
γ_{i6}	0.033***	0.001	-0.037***	0.018***	-0.012**	0.071***	-0.004
γ_{i7}	-0.008	-0.006***	-0.031***	0.016***	0.004	-0.004	0.054***
R^2	0.7033	0.8572	0.5027	0.518	0.4284	0.4953	0.5693

Note: ***, **, * denote the significant levels of 1%, 5%, and 10% respectively.

Table 3. Estimated Parameters from the Dynamic Almost Ideal Demand System Model for Imported Fishery Products

Parameter	China (i=1)	Canada (i=2)	Thailand (i=3)	Indonesia (i=4)	Vietnam (i=5)	Chile (i=6)	Ecuador (i=7)
ψ_i	0.063	0.130***	0.082	-0.057	-0.048	-0.078	0.221***
λ_i	-0.618***	-0.569***	-0.489***	-0.221***	-0.147***	-0.258***	-0.410***
β_i	0.016	0.059***	0.029**	0.0001	0.010	-0.026***	-0.035***
γ_{i1}	0.056***	-0.019***	-0.007	0.004	-0.002	-0.016*	0.004
γ_{i2}	-0.019***	0.100***	-0.016***	-0.005**	-0.006**	-0.024***	-0.002
γ_{i3}	-0.007	-0.016***	0.095***	-0.010**	-0.006	-0.025***	-0.019***
γ_{i4}	0.004	-0.005**	-0.010**	0.021***	0.001	-0.004	0.010***
γ_{i5}	-0.002	-0.006**	-0.006	0.001	0.039***	-0.008**	-0.007**
γ_{i6}	-0.016*	-0.024***	-0.025***	-0.004	-0.008**	0.074***	0.014***
γ_{i7}	0.004	-0.002	-0.019***	0.010***	-0.007**	0.014***	0.027***
R^2	0.422	0.578	0.447	0.225	0.373	0.588	0.433

Note: ***, **, * denote the significant levels of 1%, 5%, and 10% respectively.

Table 4. Estimates of the Expenditure Elasticity (η_i) and Compensated Own-Price Elasticity (ε_{ij}^h)

Country	Long-run		Short-run	
	ε_{ij}^h	η_i	ε_{ij}^h	η_i
China	-0.684	2.401***	-0.408***	1.135
Canada	0.328***	0.762*	-0.118***	1.439***
Thailand	0.106***	1.378***	-0.175***	1.208**
Indonesia	-0.488***	1.161	-0.532***	0.998
Vietnam	-0.410***	2.339***	-0.192***	1.194
Chile	0.033***	0.609**	0.071***	0.645***
Ecuador	0.204***	0.129***	-0.368***	0.241***

Note: ***, **, * denote significance at the 1%, 5%, and 10% level respectively.

Table 5. Compensated Cross-Price Elasticity for the Static AIDS model

Quantity of a country	Price of a country						
	China	Canada	Thailand	Indonesia	Vietnam	Chile	Ecuador
China		0.057*	-0.219***	0.000	0.072	0.353***	-0.019
Canada	0.051*		0.064**	0.004***	-0.036***	0.081	-0.001***
Thailand	-0.182***	0.062**		-0.266***	0.027***	-0.191***	-0.179***
Indonesia	-0.006	0.281***	-0.720***		-0.057	0.427***	0.366***
Vietnam	0.167	-0.095***	-0.218	-0.057		-0.154**	0.125
Chile	0.561***	0.147	-0.359***	0.297***	-0.106**		-0.006
Ecuador	-0.048	-0.004***	-0.535***	0.403***	0.137	-0.010	

Note: ***, **, * denote significance at the 1%, 5%, and 10% level respectively.

Table 6. Compensated Cross-Price Elasticity for the Dynamic AIDS model

Quantity of a country	Price of a country						
	China	Canada	Thailand	Indonesia	Vietnam	Chile	Ecuador
China		-0.031***	0.082	0.087	0.035	-0.059*	0.076
Canada	-0.027***		0.016***	0.010**	0.003**	-0.103***	0.032
Thailand	0.070	0.016***		-0.022**	0.010	-0.109***	-0.090***
Indonesia	0.199	0.026**	-0.059**		0.072	-0.004	0.245***
Vietnam	0.104	0.007**	0.027	0.073		-0.091**	-0.084**
Chile	-0.093*	-0.186***	-0.205***	-0.003	-0.063**		0.237***
Ecuador	0.193	0.092	-0.267***	0.269***	-0.092**	0.376***	

Note: ***, **, * denote significance at the 1%, 5%, and 10% level respectively.

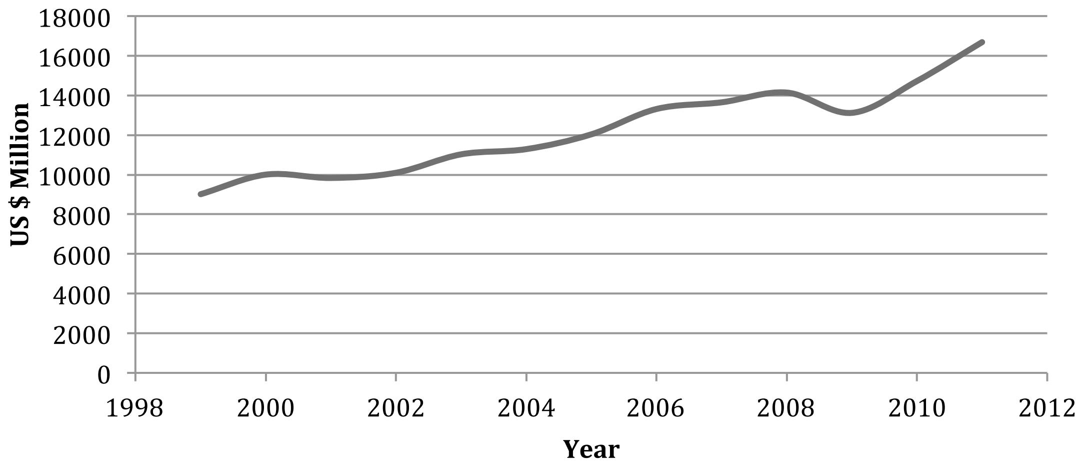

Figure 1. Annual total import value of fishery products by U.S. (US $ Million)

Data source: Foreign Agricultural Service's Global Agricultural Trade System (GATS), USDA (http://www.fas.usda.gov/gats).