# U.S. IMPORT DEMAND FOR TILAPIA FROM SELECTED FTAA COUNTRIES

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## ABSTRACT

Seafood consumption in the U.S. has increased over the period 1990 to 2003. A large percentage of the seafood consumed in the U.S. is imported. The most important seafood products imported to the U.S. are shrimp, Atlantic salmon, tilapia, catfish, crayfish, mussels and a mixture of mollusks. In 2003, the U.S. imported 199 million pounds of tilapia and tilapia products, at a value of $241.2 million, a 38% increase from the previous year. The seafood market has been considered an important foreign exchange earner for the Caribbean Common Market (CARICOM), and Free Trade Area of the Americas (FTAA) member countries. Jamaica is the only CARICOM country that exports tilapia products from aquaculture sources to the U.S. In 2003, Jamaica exported 39,950 pounds of frozen tilapia fillet to the U.S. at a value of $77,952 (Aquaculture Outlook, 2004). Given that tilapia culture may be a promising enterprise for CARICOM and FTAA member countries, it is important to evaluate changes in U.S. market demand for tilapia from CARICOM countries. A Source Differentiated Almost Ideal Demand System (SDAIDS) model was used to conduct an import demand study for tilapia and tilapia products in the U.S. The own price elasticity of Jamaica frozen fillet was found to be -0.23, and significant which means that it is price inelastic and which means that increases in exports, other factors remaining constant, may lead to a fall in total revenue. The Jamaican frozen fillet is complementary to that of the rest of the world (ROW) and fresh fillet from Ecuador, but competitive (substitute) to fresh-frozen fillet from Thailand. Fresh fillet from Ecuador, with a cross price elasticity of 0.29, is a substitute for the fresh fillet from Costa Rica. The fresh fillet from Costa Rica is complementary to the fresh-frozen from Thailand. The fresh fillet from Honduras with a cross price elasticity of 1.13 is a substitute for the fresh fillet from Ecuador. However, the fresh fillet from Honduras is a complement to the frozen fillet from Thailand.

The FTAA member states, other than Ecuador, are not major players in the frozen whole tilapia market. Large non-member countries, such as Thailand, Taiwan, and China, may be serious threats to CARICOM and FTAA member country tilapia products in the U.S. market. The FTAA member countries have concentrated on the fresh-frozen fillet and may have a comparative advantage for this product line because of proximity to the market.

**Keywords:** Tilapia, sea-food, Almost-Ideal-Demand-System, import; FTAA countries.

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## INTRODUCTION

Per capita seafood consumption in the U.S. increased from 14.6 to 15.6 pounds from 1990 to 2003 (Aquaculture Outlook 2004). This increase in seafood consumption is relatively small and was generated from a few species. A larger portion of these species are being imported from a number of countries in Asia, Latin America, and the Caribbean. In 1992, the U.S. imported 332.6 million pounds (lbs) of seafood, at a value of $1,031 million but in 2003 seafood imports to the U.S amounted to 816.4 million lbs, at a value of $2,189 million (Aquaculture Outlook 2004). This was a 145 percent increase in the quantity of seafood imported, but only a 112 percent increase in the value of imported seafood.

The most important seafood imported by the U.S. are shrimp, Atlantic salmon, tilapia, catfish from Vietnam, crayfish and mollusk products from China, and mussels from Canada and New Zealand. The importation of tilapia and tilapia products has been increasing at a rapid rate. In 2003, the US imported 98.9 million lbs of tilapia and tilapia products, at a value of $120.3 million (Aquaculture Outlook 2004). This was a 42 percent increase compared to previous year. Figures 1 and 2 illustrate the changes in export values and quantities of tilapia products in the U.S.

The importation of tilapia can be classified into three major groups: fresh fillet, frozen fillet, and frozen whole tilapia. Ninety-eight percent of the frozen whole tilapia imported to the U.S. in 2003 came from China, Indonesia, and Taiwan (Aquaculture Outlook 2004). The major exporters in 2003 for fresh tilapia fillet were Honduras, Costa Rica, and Ecuador exported 94 per cent of the fresh tilapia fillet (Aquaculture Outlook 2004) in the U.S. in 2003. The major exporters for frozen tilapia fillet in 2003 were China, Indonesia, Taiwan, and Thailand (Aquaculture Outlook 2004). They exported about 98 percent of the frozen tilapia (see tables 1 and 2).

The seafood market has been viewed as an important foreign exchange earner for many seafood-exporting countries in Asia, the Caribbean Common Market (CARICOM), and Free Trade Area of America (FTAA) member countries. Given that tilapia culture may be a promising enterprise for CARICOM and FTAA countries, it is important to evaluate changes in the U.S. market demand for tilapia and tilapia products. The objective of this paper is to estimate the own, cross price, and income elasticities for these products and to use this information to examine the competitiveness of the different tilapia-exporting countries in the various geographical regions.

## Empirical Model and Estimation Method

The Almost Ideal Demand System (AIDS), developed by Deaton and Muellbauer (1980), has been used in many applied demand analyses. James *et al*. (2003) estimated the U.S. import demand and the domestic demand for red wine. Keefe (2002) analyzed the U.S. demand for shrimp and shrimp products. Andrikopoulos and Loizides (2000) examined the demand for home-produced and imported alcoholic beverages in Cyprus. The AIDS model was also used by Vidyashankara *et al* (1999) to estimate the import demand for malt in different countries. The demand for salmon in the European Union was estimated by Ashe *et al*. (1998) model while Wessells and Wilen (1994) estimated the seasonal patterns and regional preferences in Japanese household demand for seafood. Syriopoulos and Sinclair (1993) estimated the demand for tourism in the Mediterranean countries and Mergos and Donatos (1989) examined the consumer behavior in Greece using the AIDS model.

An Almost Ideal Demand System is used in this study because it provides an arbitrary first-order approximation to any demand system, satisfies the axioms of choice and aggregation; is consistent with household budget data; avoids the necessity for non-linear estimation; is simple to estimate and can be easily used to test homogeneity and symmetry restriction (Deaton and Muellbauer, 1980). The AIDS model is further extended to the Source Differentiated Almost Ideal Demand System (SDAIDS), which is used when a product has different forms and is imported from different countries. In this case fresh and frozen tilapia fillets and frozen whole tilapia are imported by the U.S. from different countries.

Yang and Koo (1994) used the SDAIDS model to conduct an import demand study for meat imports to Japan. Yang and Koo looked at beef, pork, and poultry imported from different countries. SDAIDS aggregation minimizes bias which results in more reliable estimates.

## Import Demand Estimation

The AIDS model can be represented by the following equations:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + {}_i \ln \left( X \Big/ P^* \right) \quad ij = 1,......,n \tag{1}$$

where
$w_i$ = budget share
$p_j$ = the import price of tilapia from country $i$
$X$ = total expenditure of the U.S. on tilapia and tilapia products
$?_{ij}$ and ß$_i$ are estimated parameters.

The total expenditures are deflated by a non-linear index, which is seen in

equation 2:

$$\ln P^* = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j$$

**(2)**

This specification leads to a non-linear functional form of equation 1. To obtain a linear functional form for equation 1, equation 2 is replaced by the Stone price index which is given in equation 3:

$$\ln P = \sum_i w_i \ln p_i$$

When imported tilapia are disaggregated, the AIDS model is extended to the Source Differentiated Almost Ideal Demand System following the method of Yang and Koo (1994). In this case we have one product that is disaggregated in three forms (fresh fillet tilapia, frozen fillet tilapia and frozen whole tilapia) and that is imported from different countries. The SDAIDS model is given by:

$$w_{ih} = \alpha_{i_h} + \sum_j \sum_k \gamma_{i_h j_k} \ln p_{j_k} + \beta_{i_h} \ln\left(\frac{X}{P^*}\right) \qquad i = 1,2,3$$

**(4)**

In equation (4) the budget share is a function of the import price of the different tilapia forms from the various sources, price of other goods, and the real disposable personal income per capita, and where $P^*$ is used as the price index to deflate the total expenditure.

$$\ln P^* = \alpha_0 + \sum_i^n \sum_h^m \alpha_{i_h} \ln p_{i_h} + \frac{1}{2}\sum_i^n \sum_j^n \sum_h^m \sum_k^m \gamma_{i_h j_k} \ln p_{i_h} \ln p_{j_k}$$

**(5)**

Since equation (5) leads to a non-linear functional form in equation (4), which makes it harder to estimate, equation (5) is replaced by the Stone price index for the SDAIDS model, which is given in equation (6).

$$\ln P = \sum_i \sum_h w_{i_h} \ln p_{i_h}$$

**(6)**

Where $\forall_0$, $\forall_{ih}$, $wi_h$, $\gamma_{ihjk}$ are parameters. The subscripts *i* and *j* denote the different tilapia forms and *h* and *k* denote tilapia exporting countries. The Stone's price index causes simultaneity problems because the expenditure share in the index is also the dependent variable. To circumvent the simultaneity problems, the expenditure share has been replaced by the average of the expenditure share and the lagged expenditure share (Eales and Unnevehr 1988) and (Haden 1990). Based on economic theory, the following restrictions are applied to the SDAIDS model:

adding up :

$$\sum_i \sum_h \alpha_{i_h} = 1; \quad \sum_h \gamma_{i_h j_k} = 0; \quad \sum_i \sum_h \gamma_{ihj} = 0; \quad \sum_i \sum_h \beta_{i_h} = 0$$

**(7)**

homogeneity :

$$\sum_j \sum_k \gamma_{i_h j_k} = 0$$

**(8)**

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symmetry:

$$\gamma_{i_h j_k} = \gamma_{j_k i_h} \qquad \textbf{(9)}$$

The Marshallian elasticities are given in equations (10) through (12). The expenditure elasticity is given in equation (10):

$$\eta_{i_h} = 1 + \frac{i_h}{w_{i_h}} \qquad \textbf{(10)}$$

The own and cross price elasticities are given in equation (11) and (12) respectively:

$$\varepsilon_{i_h i_h} = -1 + \frac{\gamma_{i_{hh}}}{w_{i_h}} - \quad i_h$$

where $i = j$ and $h = k$ $\qquad$ **(11)**

$$\varepsilon_{i_h i_k} = \frac{\gamma_{i_{hk}}}{w_{i_h}} - \quad i_h \frac{w_{i_k}}{w_{i_h}}$$

where i ? j and h ? k $\qquad$ **(12)**

## Data and Procedures

We collected data on monthly import prices, quantities imported and total expenditure on frozen tilapia fillet in the U.S. over the period 1995 to 2003 from the National Marine Fisheries Service. The sources of fresh tilapia fillets to the U.S. in this study were Jamaica, Costa Rica, Ecuador, Honduras, and Rest of the world (ROW). Countries that exported on average less than 8000 Kg fresh tilapia fillet or other products were grouped together in a category, named 'Rest of the World' (ROW). The six major exporters of frozen tilapia fillet to the U.S. were Jamaica, Thailand, China, Taiwan, Indonesia and the ROW. The major exporters of frozen whole tilapia were China, Taiwan and the ROW. The consumer price index for the U.S., with a base year 2000, was used as a proxy for the price of other goods. The Consumer Price Index, (base year 2000), and Real Personal Disposable Income (base year 2000) were collected from the website of the Economic Research site of the Federal Reserve Bank of St Louis.

## Estimation Procedure

The SDAIDS model developed for the U.S. import demand for tilapia and tilapia products consisted of 14 demand equations. Five equations were used to estimate the U.S. demand for fresh tilapia fillet imported from Jamaica, Costa Rica, Ecuador, Honduras and the ROW. Six equations were used to estimate the U.S. demand for frozen tilapia fillets from Jamaica, Thailand, China, Taiwan, Indonesia and the ROW. Three equations were used to estimate the US demand for frozen whole tilapia imported from China, Taiwan and the ROW. The equation for other products

was omitted from this demand system to prevent singularity. The least square estimation technique applied to a conditional AIDS model leads to inconsistent and inefficient estimates because group expenditure is not exogenous (LaFrance 1991). Therefore, Edgerton (1993) suggested using the predicted values from the following auxiliary equation for the log of expenditure: $\log(X) = f(p,q,y)$, where $p$ is the Stone price index, $q$ is the consumer price index, and $y$ is per capita private consumption. Using this method and the Iterative Seemingly Unrelated Regression (ISUR), the SDAIDS model with homogeneity and symmetry condition imposed is estimated.

## Results

The estimated coefficients for the SDAIDS model for the U.S. import demand for tilapia and tilapia products are given in appendix tables 1a and b. The system $R^2$ was 0.96. The own and cross price elasticities and the expenditure elasticity are given in tables 3a and b. The price elasticities for the products sourced from the FTAA countries Jamaica, Ecuador, Costa Rica, and Honduras will be the focus of our discussion. The own price elasticity of Jamaica fillet frozen is -0.23, and significant which means that it is price inelastic, and that increases in exports, other factors remaining constant, may lead to a fall in total revenue. The

Jamaican frozen is complementary to that of ROW, but competitive (substitute) to fresh-frozen from Thailand. It must be remembered that Thailand is a fairly large exporter of frozen-fillet tilapia. Fresh fillet from Ecuador with a cross price elasticity of 0.29 is a substitute for the fresh fillet from Ecuador. Ecuador is the largest exporter of fresh fillet to the U.S. The fresh fillet from Costa Rica is complementary to the fresh-frozen from Thailand. The fresh fillet from Honduras, with a cross price elasticity of 1.13 is a substitute for the fresh fillet from Ecuador. However, the fresh fillet from Honduras is a complement to the frozen fillet from Thailand.

Most of the whole tilapia exported to the U.S. are sourced from China, Taiwan, Ecuador and Costa Rica. However, the whole tilapia from the principal FTAA exporting countries are complementary to the whole tilapia from Taiwan. The income elasticities represented by the expenditure elasticities are all greater than 1 and are positive. This indicates that fresh tilapia fillet, frozen tilapia fillet, and whole tilapia are all normal goods. That is as income in the U.S. increases consumers are likely to allocate more of their resources to the purchase of tilapia.

## Summary and Conclusion

Tilapia exports to the US have been growing at a rapid rate. The Asian

countries, such as China, Thailand, Taiwan, and Indonesia, and the Latina American countries Honduras, Ecuador, Costa Rica, and Ecuador are the dominant exporters. All exporters seem to find their niche in the market and each seems to export more of one of the primary products. The cross price elasticities indicate that competition among FTAA countries is minimal. In most cases exports of one country complement the other instead of substituting for the member countries product. In most cases the income elasticities are positive and greater than one indicating that exports and income are likely to vary positively. The products from FTAA countries are more likely to compete with the products from Thailand and Taiwan rather than from FTAA member countries. The exports from the FTAA countries are likely to expand with few of the countries exports substituting for the other. Though one may surmise that there is room for market growth of tilapia products, the own price elasticities are less than one in absolute terms and that may indicate that an increase in exports from the FTAA countries may result in a fall in total revenue, all things remaining constant. These results should be taken cautiously since there seems to be an imbalance in the quantities exported from the FTAA countries. Only three FTAA countries-Ecuador, Costa Rica and Honduras export significant quantities of fresh fillet tilapia, while only Ecuador exports large amount of whole tilapia.

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**Table 1. Value of U.S. import of tilapia products in 2003 from different countries**

| Country | Fillet Fresh (in $) | Fillet Frozen (in $) | Whole Frozen (in $) | Total (in $) |
|---|---|---|---|---|
| Honduras | 16,911,059 | 0 | 0 | 16,911,059 |
| Nicaragua | 17,333 | 29,062 | 0 | 46,395 |
| Costa Rica | 22,608,592 | 13,921 | 8,310 | 22,630,823 |
| Jamaica | 0 | 77,952 | 0 | 77,952 |
| Columbia | 0 | 0 | 5,940 | 5,940 |
| Ecuador | 55,937,569 | 877,003 | 277,286 | 57,091,858 |
| Thailand | 38,876 | 3,759,683 | 177,645 | 3,976,204 |
| Indonesia | 0 | 17,698,924 | 0 | 17,698,924 |
| China | 2,509,576 | 51,501,163 | 30,496,667 | 84,507,406 |
| Taiwan | 1,148,778 | 9,623,082 | 23,748,663 | 34,520,523 |
| Other | 2,818,694 | 470,263 | 449,569 | 3,738,526 |
| Total | 101,990,477 | 84,051,053 | 55,164,080 | 241,205,610 |

**Table 2. U.S. import quantity of tilapia products for 2003 in Kilogram (kg)**

| Country | Fillet Fresh (in kg) | Fillet Frozen (in kg) | Whole Frozen (in kg) | Total (in kg) |
|---|---|---|---|---|
| Honduras | 2,862,544 | 0 | 0 | 2,862,544 |
| Nicaragua | 2,895 | 8,435 | 0 | 11,330 |
| Costa Rica | 4,004,478 | 2,455 | 1,600 | 4,008,532 |
| Jamaica | 0 | 18,159 | 0 | 18,159 |
| Columbia | 0 | 0 | 3,006 | 3,006 |
| Ecuador | 9,416,565 | 186,838 | 143,553 | 9,746,955 |
| Thailand | 6,590 | 941,723 | 121,568 | 1,069,880 |
| Indonesia | 0 | 3,590,210 | 5,436 | 3,595,646 |
| China | 858,423 | 15,890,144 | 28,823,130 | 45,571,697 |
| Taiwan | 282,058 | 2,474,829 | 19,704,714 | 22,461,600 |
| Other | 555,517 | 185,207 | 344,913 | 1,085,637 |
| Total | 17,989,069 | 23,298,000 | 49,147,919 | 90,434,988 |

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Table 3a. Own and cross price elasticities matrix for fresh and frozen tilapia files imported from the different countries

| | ROW FRE | JAMAICA FRE | COSTA RICA FRE | ECUADOR FRE | HONDURAS FRE | ROW FRO | JAMAICA FRO | THAILAND FRO | CHINA FRO | TAIWAN FRO | INDONESIA FRO |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ROW FRE | -0.63 | 0.89 | 0.87 | 1.90*** | 0.64 | -0.34 | -0.52 | -0.36 | -0.47 | 0.20 | 0.47 |
| JAMAICA FRE | -0.19* | -0.83 | -0.10 | 0.25 | -0.67*** | 0.09 | -0.06 | 0.49** | 0.42*** | -0.50*** | 0.03 |
| COSTARIC A FRE | -0.03 | 0.47* | -1.12 | 0.29** | 0.05 | 0.04 | -0.11 | -0.21* | 0.03 | 0.07 | 0.02 |
| ECUADOR FRE | 0.06 | 0.63 | -0.42 | 1.83*** | 0.39 | 0.07 | -0.36 | -0.52 | -0.09 | 0.17 | 0.16 |
| HONDURAS FRE | -0.05 | -0.38 | 0.68 | 1.13*** | -0.68 | 0.16 | 0.22 | -0.75** | 0.09 | 0.29 | 0.10 |
| ROW FRO | 0.22 | -0.05 | 1.24 | 0.97 | -0.57 | -0.75 | -0.20 | 1.06** | 0.22 | 0.07 | -1.14** |
| JAMAICA FRO | 0.13 | 0.17 | -1.67 | -1.08*** | -0.02 | -0.37*** | -0.23** | 0.46** | -0.09 | -0.17 | 0.08 |
| THAILAND FRO | 0.19 | -0.70 | 0.85 | 0.30 | -0.05 | -0.05 | -0.21 | 0.14*** | -0.13 | -0.02 | -0.02 |
| CHINA FRO | 0.07 | 1.74 | -1.28 | 2.43*** | 0.50 | -0.34 | -0.40 | -0.50 | -0.96 | 0.06 | -0.24 |
| TAIWAN FRO | -0.06 | -0.67 | -4.50*** | 0.11 | -0.19 | 0.16 | 0.73 | -0.43 | -0.28 | -0.01*** | 0.25 |
| INDONESIA FRO | -0.02 | 0.09 | -0.32 | 0.75*** | 0.001 | 0.01 | -0.11 | -0.01 | 0.11 | -0.16 | -0.18*** |
| ROW WHO | 0.31 | 1.52 | 0.08 | -0.93 | 0.54 | -0.46 | 0.55 | 0.11 | -0.16 | -0.50 | 0.11 |
| CHINA WHO | 0.02 | 1.04 | -1.10 | 0.54 | 0.18 | 0.41* | -0.78 | -1.03** | -0.12 | -0.27 | -0.06 |
| TAIWAN WHO | -0.08 | -0.53** | -0.62 | -0.11 | -0.11 | -0.02 | -0.13 | 0.18 | 0.07 | -0.16 | 0.22 |
| OTHER GOODS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

ROWFRE= Rest of the world fresh fillet, JAMAICAFRE= Jamaica fresh fillet, COSTA RICA FRE=Costa Rica fresh fillet, ECUADOR FRE= Ecuador fresh fillet HONDURAS FRE= Honduras fresh fillet, ROWFRO= Rest of the World frozen fillet, JAMAICA FRO= Jamaica frozen fillet, THAILAND FRO= Thailand frozen fillet, CHINA FRO=China frozen fillet, TAIWAN FRO= Taiwan frozen fillet, INDONESIA FRO= Indonesia frozen fillet, ROW WHO= Rest of the world whole frozen fish, CHINA WHO= China whole frozen fish, TAIWAN WHO= Taiwan whole frozen fish, Other Goods, ***=significant at 0.01, **=significant at 0.05, *=significant at 0.10

Table 3b. Own and cross price elasticities matrix for the whole frozen tilapia imported from the different countries

| | ROW WHO | CHINA WHO | TAIWAN WHO | OTHER GOODS | Expenditure |
|---|---|---|---|---|---|
| ROW FRE | -0.05 | 0.98 | -2.40** | -0.18 | 2.35* |
| JAMAICA FRE | -0.19** | 0.89** | 0.60 | 1.49* | 0.97 |
| COSTARICA FRE | 0.04 | -0.31 | -0.90*** | -0.95 | 1.34* |
| ECUADOR FRE | -0.03 | -0.71 | -3.08*** | -2.00 | 1.44 |
| HONDURAS FRE | 0.18 | -1.08* | -1.75*** | -1.41 | 1.28 |
| ROW FRO | -0.15 | -0.46 | -1.08 | -0.60 | 1.63 |
| JAMAICA FRO | -0.003 | 1.23*** | 0.88** | 0.63 | 1.40 |
| THAILAND FRO | -0.08 | 0.16 | -0.54 | 0.31 | 1.38 |
| CHINA FRO | -0.08 | -0.74 | -4.45*** | -5.83 | 3.22** |
| TAIWAN FRO | 0.24* | -1.70*** | -0.22 | -4.35*** | 1.29 |
| INDONESIA FRO | -0.03 | -0.07 | -1.10*** | 0.19 | 0.63 |
| ROW WHO | -1.13 | -1.44 | 1.90** | 1.66 | 0.52 |
| CHINA WHO | 0.17 | -0.69 | -1.99*** | -3.43 | 2.24** |
| TAIWAN WHO | 0.03 | -0.21 | -0.31*** | -0.30 | 1.11 |
| OTHER GOODS | 0.00 | 0.00 | 0.00 | -1.00 | 1.00 |

ROWFRE= Rest of the World fresh fillet, JAMAICAFRE= Jamaica fresh fillet, COSTA RICA FRE=Costa Rica fresh fillet,
ECUADOR FRE= Ecuador fresh fillet HONDURAS FRE= Honduras fresh fillet, ROWFRO= Rest of the World frozen fillet,
JAMAICA FRO= Jamaica frozen fillet, THAILAND FRO= Thailand frozen fillet, CHINA FRO=China frozen fillet, TAIWAN FRO= Taiwan frozen fillet, INDONESIA FRO= Indonesia frozen fillet, ROW WHO= Rest of the World whole frozen fish, CHINA WHO= China whole frozen fish, TAIWAN WHO= Taiwan whole frozen fish, Other Goods, ***=significant at 0.01, **=significant at 0.05, *=significant at 0.10
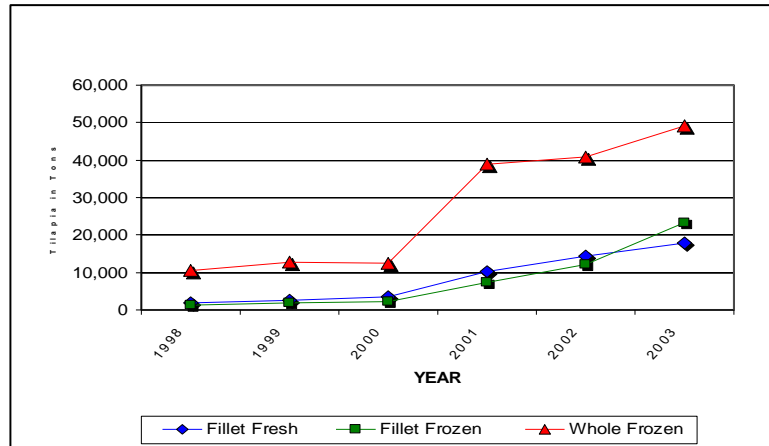
**Figure 1.   U.S. import quantity of tilapia products in tons for 1998 - 2003**
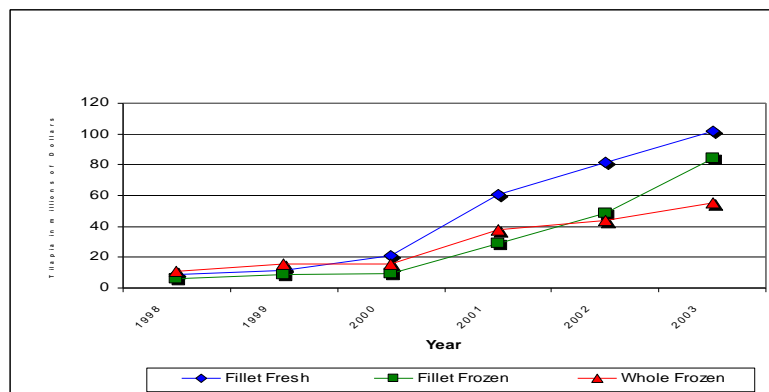


**Figure 2.   U.S. import value of tilapia products  for 1998 - 2003**

# Appendix

Table 1a.  Estimated coefficients and standard errors for the SDAIDS model for fresh and frozen tilapia file

|  | ROW FRE | JAMAICA FRE | COSTA RICA FRE | ECUADOR FRE | HONDURAS FRE | ROW FRO | JAMAICA FRO | THAILAND FRO | CHINA FRO | TAIWAN FRO | INDONESIA FRO |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ROW FRE | 5.95E-09 | 1.44E-08 | 1.4E-08 | 3.06E-08 | 1.03E-08 | -5.4E-09 | -8.4E-09 | -5.8E-09 | -7.5E-09 | 3.26E-09 | 7.64E-09 |
|  | (4.02E-09) | (1.78E-08) | (3.92E-08) | (1.01E-08) | (6.86E-09) | (5.45E-09) | (1.58E-08) | (8.55E-09) | (5.77E-09) | (6.61E-09) | (9.42E-09) |
| JAMAICA FRE | -3E-09 | 2.62E-09 | -1.5E-09 | 3.88E-09 | -1.1E-08 | 1.45E-09 | -9.4E-10 | 7.67E-09 | 6.62E-09 | -7.9E-09 | 5.02E-10 |
|  | (1.63E-09) | (7.21E-09) | (1.59E-08) | (4.09E-09) | (2.78E-09) | (2.21E-09) | (6.39E-09) | (3.46E-09) | (2.34E-09) | (2.68E-09) | (3.82E-09) |
| COSTARICA FRE | -3.4E-09 | 5.92E-08 | -1.4E-08 | 3.6E-08 | 6.53E-09 | 4.68E-09 | -1.4E-08 | -2.6E-08 | 3.59E-09 | 8.68E-09 | 2.66E-09 |
|  | (7.15E-09) | (3.17E-08) | (6.98E-08) | (1.8E-08) | (1.22E-08) | (9.69E-09) | (2.81E-08) | (1.52E-08) | (1.03E-08) | (1.18E-08) | (1.68E-08) |
| ECUADOR FRE | 6.85E-09 | 7.73E-08 | -5.1E-08 | 3.45E-07 | 4.81E-08 | 8.53E-09 | -4.4E-08 | -6.4E-08 | -1.1E-08 | 2.05E-08 | 2.02E-08 |
|  | (2.33E-08) | (1.03E-07) | (2.27E-07) | (5.85E-08) | (3.97E-08) | (3.16E-08) | (9.14E-08) | (4.95E-08) | (3.34E-08) | (3.83E-08) | (5.46E-08) |
| HONDURAS FRE | -2.1E-09 | -1.4E-08 | 2.57E-08 | 4.28E-08 | 1.2E-08 | 6.03E-09 | 8.4E-09 | -2.9E-08 | 3.51E-09 | 1.09E-08 | 3.92E-09 |
|  | (5.34E-09) | (2.36E-08) | (5.21E-08) | (1.34E-08) | (9.1E-09) | (7.23E-09) | (2.09E-08) | (1.14E-08) | (7.67E-09) | (8.78E-09) | (1.25E-08) |
| ROW FRO | 2.69E-09 | -6.4E-10 | 1.5E-08 | 1.16E-08 | -6.8E-09 | 3E-09 | -2.4E-09 | 1.28E-08 | 2.6E-09 | 8.83E-10 | -1.4E-08 |
|  | (2.94E-09) | (1.3E-08) | (2.87E-08) | (7.39E-09) | (5.01E-09) | (3.98E-09) | (1.15E-08) | (6.25E-09) | (4.22E-09) | (4.84E-09) | (6.89E-09) |
| JAMAICA FRO | 4.35E-10 | 5.8E-10 | -5.8E-09 | -3.7E-09 | -7.4E-11 | -1.3E-09 | 2.67E-09 | 1.59E-09 | -3.1E-10 | -5.8E-10 | 2.85E-10 |
|  | (3.44E-10) | (1.52E-09) | (3.35E-09) | (8.64E-10) | (5.86E-10) | (4.66E-10) | (1.35E-09) | (7.31E-10) | (4.94E-10) | (5.66E-10) | (8.06E-10) |
| THAILAND FRO | 3.15E-09 | -1.2E-08 | 1.43E-08 | 5.06E-09 | -8E-10 | -7.7E-10 | -3.5E-09 | 1.92E-08 | -2.3E-09 | -2.9E-10 | -3E-10 |
|  | (3E-09) | (1.33E-08) | (2.93E-08) | (7.55E-09) | (5.12E-09) | (4.07E-09) | (1.18E-08) | (6.38E-09) | (4.31E-09) | (4.94E-09) | (7.04E-09) |
| CHINA FRO | 7.68E-09 | 1.96E-07 | -1.4E-07 | 2.73E-07 | 5.61E-08 | -3.9E-08 | -4.5E-08 | -5.6E-08 | 4.45E-09 | 6.49E-09 | -2.7E-08 |
|  | (3.05E-08) | (1.35E-07) | (2.97E-07) | (7.66E-08) | (5.2E-08) | (4.13E-08) | (1.2E-07) | (6.48E-08) | (4.38E-08) | (5.02E-08) | (7.14E-08) |
| TAIWAN FRO | -4.7E-09 | -5.1E-08 | -3.4E-07 | 8.25E-09 | -1.4E-08 | 1.23E-08 | 5.49E-08 | -3.2E-08 | -2.1E-08 | 7.45E-08 | 1.9E-08 |
|  | (1.09E-08) | (4.8E-08) | (1.06E-07) | (2.73E-08) | (1.85E-08) | (1.47E-08) | (4.26E-08) | (2.31E-08) | (1.56E-08) | (1.79E-08) | (2.54E-08) |

*Continued*

*US Import Demand for Tilapia from selected FTAA countries*

Table 1a. continued

| | ROW FRE | JAMAICA FRE | COSTA RICA FRE | ECUADOR FRE | HONDURAS FRE | ROW FRO | JAMAICA FRO | THAILAND FRO | CHINA FRO | TAIWAN FRO | INDONESIA FRO |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INDONESIA FRO | -1.6E-09 | 6.32E-09 | -2.2E-08 | 4.99E-08 | 8.49E-11 | 4.31E-10 | -7.4E-09 | -5E-10 | 7.02E-09 | -1.1E-08 | 5.44E-08 |
| | (7.03E-09) | (3.11E-08) | (6.86E-08) | (1.77E-08) | (1.2E-08) | (9.53E-09) | (2.76E-08) | (1.5E-08) | (1.01E-08) | (1.16E-08) | (1.65E-08) |
| ROW WHO | 2.64E-09 | 1.3E-08 | 7.16E-10 | -8E-09 | 4.58E-09 | -3.9E-09 | 4.71E-09 | 9.54E-10 | -1.4E-09 | -4.3E-09 | 9.37E-10 |
| | (1.95E-09) | (8.62E-09) | (1.9E-08) | (4.9E-09) | (3.32E-09) | (2.64E-09) | (7.64E-09) | (4.14E-09) | (2.8E-09) | (3.2E-09) | (4.56E-09) |
| CHINA WHO | 2.69E-09 | 1.48E-07 | -1.6E-07 | 7.73E-08 | 2.61E-08 | 5.9E-08 | -1.1E-07 | -1.5E-07 | -1.7E-08 | -3.9E-08 | -9.1E-09 |
| | (2.58E-08) | (1.14E-07) | (2.52E-07) | (6.49E-08) | (4.4E-08) | (3.5E-08) | (1.01E-07) | (5.49E-08) | (3.71E-08) | (4.25E-08) | (6.05E-08) |
| TAIWAN WHO | -2.3E-08 | -1.5E-07 | -1.8E-07 | -3.3E-08 | -3.1E-08 | -5.9E-09 | -3.8E-08 | 5.17E-08 | 1.89E-08 | -4.7E-08 | 6.32E-08 |
| | (1.81E-08) | (7.99E-08) | (1.76E-07) | (4.54E-08) | (3.08E-08) | (2.45E-08) | (7.09E-08) | (3.84E-08) | (2.59E-08) | (2.97E-08) | (4.23E-08) |

Values in brackets are standard errors:
ROWFRE= Rest of the world fresh fillet, JAMAICAFRE= Jamaica fresh fillet, COSTA RICA FRE=Costa Rica fresh fillet, ECUADOR FRE= Ecuador fresh fillet
HONDURAS FRE= Honduras fresh fillet, ROWFRO= Rest of the world frozen fillet, JAMAICA FRO= Jamaica frozen fillet, THAILAND FRO= Thailand frozen fillet, CHINA FRO=China frozen fillet,
TAIWAN FRO= Taiwan frozen fillet, INDONESIA FRO= Indonesia frozen fillet, ROW WHO= Rest of the world whole frozen fish, CHINA WHO= China whole frozen fish, TAIWAN WHO= Taiwan whole
frozen fish, Other Goods,  ***=significant at 0.01, **=significant at 0.05, *=significant at 0.10

Table 1b.  Estimated coefficients and standard errors for the SDAIDS model for
whole frozen tilapia

|  | ROW WHO | CHINA WHO | TAIWAN WHO | OTHER GOODS | Expenditure |
|---|---|---|---|---|---|
| ROW FRE | -8.3E-10 | 1.58E-08 | -3.9E-08 | 1.88E-08 | 2.17E-08 |
|  | (3.59E-09) | (1.68E-08) | (1.57E-08) | (3.41E-08) | (1.31E-08) |
|  |  |  |  |  |  |
| JAMAICA FRE | -3E-09 | 1.4E-08 | 9.51E-09 | 2.3E-08 | -5.3E-10 |
|  | (1.46E-09) | (6.8E-09) | (6.34E-09) | (1.38E-08) | (5.29E-09) |
|  |  |  |  |  |  |
| COSTARICA FRE | 5.47E-09 | -3.8E-08 | -1.1E-07 | -7.6E-08 | 4.26E-08 |
|  | (6.4E-09) | (2.99E-08) | (2.79E-08) | (6.07E-08) | (2.33E-08) |
|  |  |  |  |  |  |
| ECUADOR FRE | -3.8E-09 | -8.7E-08 | -3.8E-07 | -1.9E-07 | 5.35E-08 |
|  | (2.08E-08) | (9.73E-08) | (9.07E-08) | (1.98E-07) | (7.57E-08) |
|  |  |  |  |  |  |
| HONDURAS FRE | 6.65E-09 | -4.1E-08 | -6.7E-08 | -4.3E-08 | 1.08E-08 |
|  | (4.77E-09) | (2.23E-08) | (2.08E-08) | (4.53E-08) | (1.74E-08) |
|  |  |  |  |  |  |
| ROW FRO | -1.8E-09 | -5.5E-09 | -1.3E-08 | 3.82E-10 | 7.61E-09 |
|  | (2.63E-09) | (1.23E-08) | (1.15E-08) | (2.5E-08) | (9.56E-09) |
|  |  |  |  |  |  |
| JAMAICA FRO | -9E-12 | 4.25E-09 | 3.05E-09 | 3.56E-09 | 1.38E-09 |
|  | (3.07E-10) | (1.44E-09) | (1.34E-09) | (2.92E-09) | (1.12E-09) |
|  |  |  |  |  |  |
| THAILAND FRO | -1.3E-09 | 2.65E-09 | -9.1E-09 | 1.17E-08 | 6.45E-09 |
|  | (2.68E-09) | (1.25E-08) | (1.17E-08) | (2.55E-08) | (9.76E-09) |
|  |  |  |  |  |  |
| CHINA FRO | -9.2E-09 | -8.3E-08 | -5E-07 | -4.1E-07 | 2.49E-07 |
|  | (2.73E-08) | (1.27E-07) | (1.19E-07) | (2.59E-07) | (9.91E-08) |
|  |  |  |  |  |  |
| TAIWAN FRO | 1.78E-08 | -1.3E-07 | -1.7E-08 | -3.1E-07 | 2.17E-08 |
|  | (9.7E-09) | (4.53E-08) | (4.23E-08) | (9.21E-08) | (3.53E-08) |
|  |  |  |  |  |  |

Continued

*US Import Demand for Tilapia from selected FTAA countries*

Table 1b. continued

|  | ROW WHO | CHINA WHO | TAIWAN WHO | OTHER GOODS | Expenditure |
|---|---|---|---|---|---|
| INDONESIA FRO | -2.1E-09 | -4.5E-09 | -7.4E-08 | -1.2E-08 | -2.5E-08 |
|  | (6.29E-09) | (2.94E-08) | (2.74E-08) | (5.97E-08) | (2.29E-08) |
|  |  |  |  |  |  |
| ROW WHO | -1.1E-09 | -1.2E-08 | 1.62E-08 | 1.01E-08 | -4.1E-09 |
|  | (1.74E-09) | (8.14E-09) | (7.59E-09) | (1.65E-08) | (6.33E-09) |
|  |  |  |  |  |  |
| CHINA WHO | 2.36E-08 | 4.38E-08 | -2.8E-07 | -3.1E-07 | 1.77E-07 |
|  | (2.31E-08) | (1.08E-07) | (1.01E-07) | (2.19E-07) | (8.4E-08) |
|  |  |  |  |  |  |
| TAIWAN WHO | 7.41E-09 | -6E-08 | 2E-07 | -5.5E-08 | 3.21E-08 |
|  | (1.61E-08) | (7.54E-08) | (7.03E-08) | (1.53E-07) | (5.87E-08) |

Values in brackets are standard errors;
ROWFRE= Rest of the world fresh fillet, JAMAICAFRE= Jamaica fresh fillet, COSTA RICA FRE=Costa Rica fresh fillet, ECUADOR FRE= Ecuador fresh fillet, HONDURAS FRE= Honduras fresh fillet, ROWFRO= Rest of the World frozen fillet, JAMAICA FRO= Jamaica frozen fillet, THAILAND FRO= Thailand frozen fillet, CHINA FRO=China frozen fillet, TAIWAN FRO= Taiwan frozen fillet, INDONESIA FRO= Indonesia frozen fillet, ROW WHO= Rest of the World whole frozen fish, CHINA WHO= China whole frozen fish, TAIWAN WHO= Taiwan whole frozen fish, Other Goods,
 ***=significant at 0.01, **=significant at 0.05, *=significant at 0.10