# Evaluation of the Possible Threat of NAFTA on U.S. Catfish Industry Using a Traditional Import Demand Function

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The effects of increased exports from NAFTA member countries on the U.S. domestic catfish industry were evaluated. Results showed that the quantity of catfish imported will fall if the domestic price of catfish falls relative to the import price. Past imports have no effect on present imports. The income elasticity was negative indicatting that imported catfish may be an inferior good. Doubling present levels of imports from NAFTA member countries is not a threat to the U.S. catfish industry.

Until recently, aquaculture was viewed as an insignificant contributor to the seafood industry. Today, fresh water aquaculture is a major source of commercial fish and seafood production, especially in the southeastern United States (Hatch and Kinnucan 1993). The industry continues to grow and structurally change at a surprising rate. Total production increased from 130 million pounds to over 400 million pounds between 1975 and 1993 (Jolly and Clonts 1993). Total sales for 1995 are estimated at 470 million pounds (USDA 1995). This shift in production has been driven primarily by changes in supply and lower long run average cost of production (Kinnucan 1995). An increased demand for a varied array of fish products made possible by new technologies and changes in lifestyles, such as a preoccupation with increased nutritional awareness, leading to a switch from red meat to other sources of protein, and increased away from home eating have also affected demand (Wellman 1992).

Catfish production, mostly in the southern states, has lead this recent surge in farm raised fish products. Domestic production has been unable to satisfy domestic demand resulting in a large quantity of catfish being imported. Catfish imports peaked during the 1976 to 1980 period, declined between 1981 to 1984, increased from 1984 to 1986, and then fell (Figure 1). In view of Figures 2 and 3, this variation appears to correlate much more closely with the behavior of domestic production than with that of import prices. In spite of this apparent relationship, very little research has been conducted on the effects of imports on domestic production.

Both domestic catfish farming and catfish importing are relatively new phenomena in the United States, with neither having much of a measurable impact prior to 1969. In that year, a net quantity of 3.8 million pounds of catfish, valued at $1,148,399, was purchased by U.S. buyers from foreign suppliers. Catfish imports peaked in 1978 at slightly over 18 million pounds (valued at $11.3 million), but have subsequently fallen in a cyclical pattern, so that by 1992 they had returned to their approximate 1969 level. Historically, the major portion of catfish imports have come from Brazil, although countries such as Canada, Mexico, Iceland and Denmark also typically contribute a small share (U.S. Department of Commerce, 1969, 1990). Most of the imported catfish are from the wild and caught from rivers. Imported frozen catfish enter the country in processed form and are repackaged and sold to the retailer where they compete directly with the domestically processed catfish (Kinnucan et al. 1988).

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**Figure 1. Quantity of Whole Dressed Catfish (in pounds) Imported into the United States, 1970-91.**

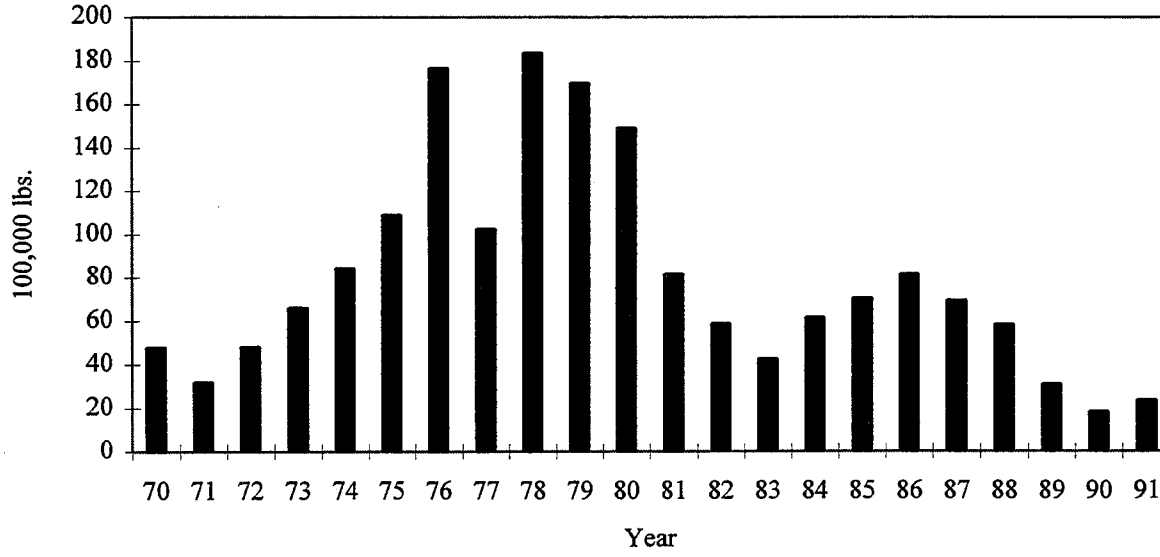



**Figure 2. Quantity of Catfish (in pounds) Delivered to Processing Plants in the United States, 1970-1991.**

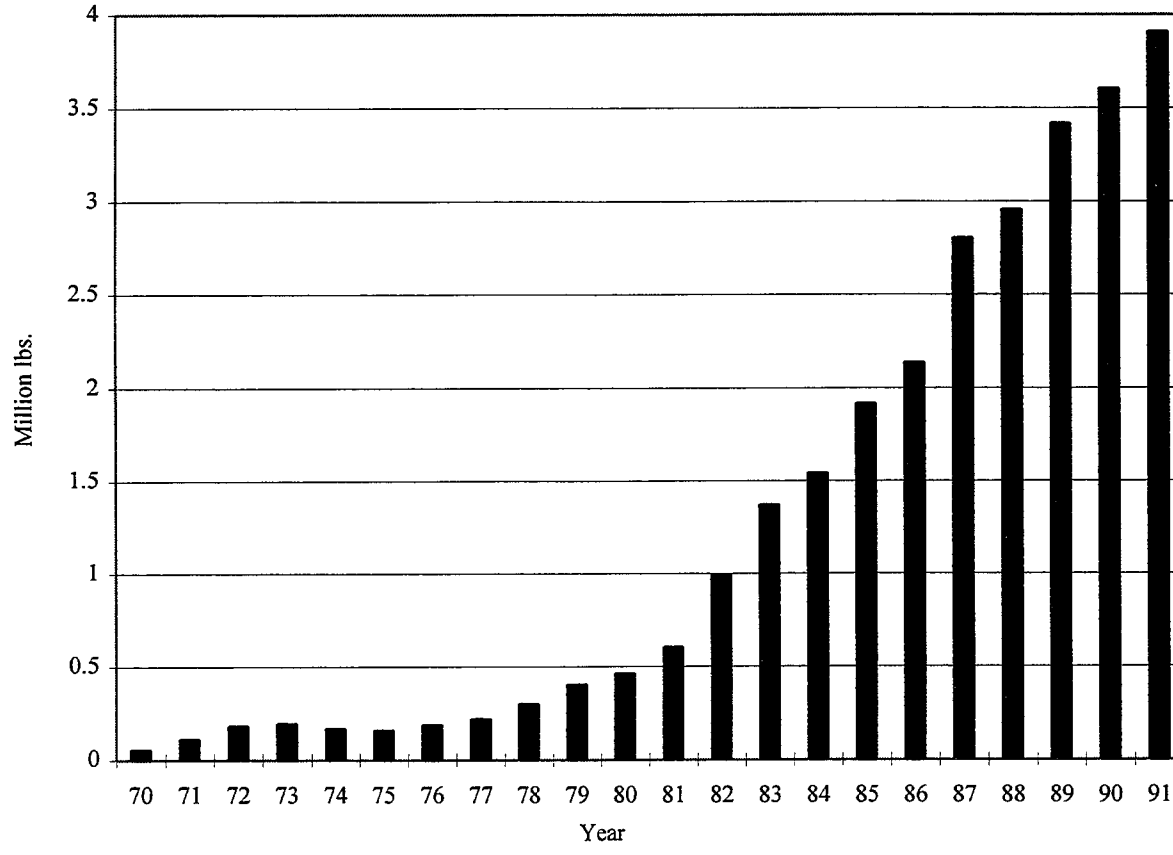
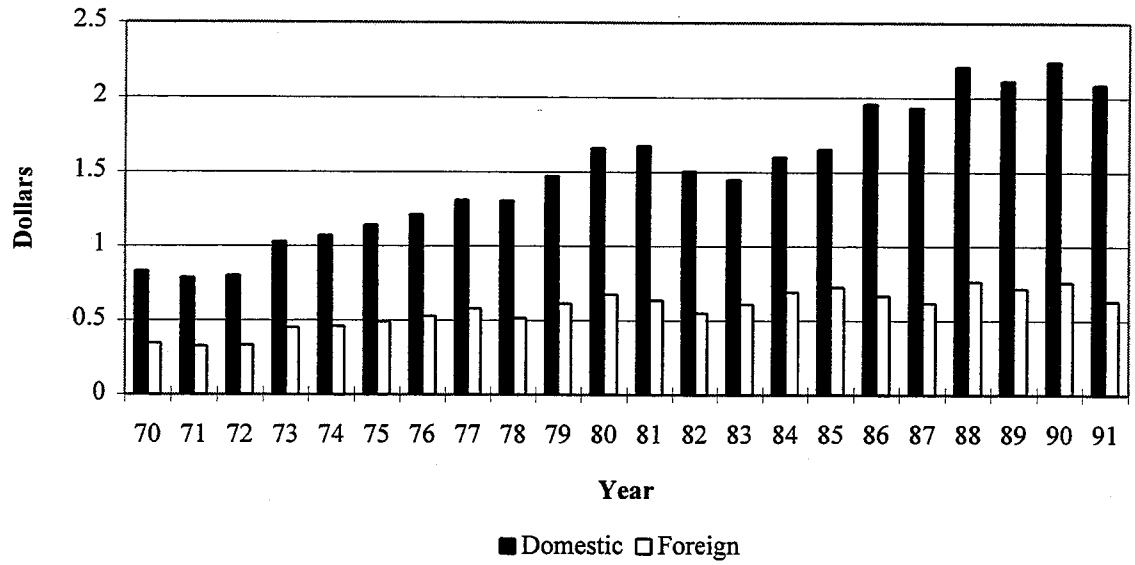


**Figure 3. Domestic and Foreign Price of Catfish in U.S. Dollars Per Pound, 1970-1991.**




These observations raise important questions for domestic U.S. catfish producers. As catfish farming replaces the catch from the wild among foreign exporters, will such production significantly encroach on the domestic market of the U.S. catfish industry? In 1980, imports of catfish represented 32.4 percent of U.S. total output, but with an increase in technology U.S. production increased while imports fell. In 1993, imports fell to less than 5.0 percent of domestic production. Can increased surplus from NAFTA member countries affect U.S. producers? There is currently little quantitative information on this issue since very few analyses of the effects of imports on the domestic catfish market have been conducted. In addition, there is reason to suspect that this issue may become even more pressing with the passage of the North American Free Trade Agreement (NAFTA).

The U.S. is a net importer of fish from NAFTA countries. Even though shellfish and shellfish products dominate total U.S. fish imports, domestic fish producers are understandably apprehensive that, with NAFTA, there will be an increase in fish imports to the United States which might seriously retard U.S. catfish industry production. While experts suggest that the United States has a comparative advantage in the production of catfish, this advantage could change. If the price of fish feed exported from the United States to catfish producing countries were to fall sufficiently low and these resultant cost reductions transmitted to the export price of the foreign countries' catfish, then neighboring countries will be in a comparative cost position to compete with the United States catfish industry (Jolly et al. 1993). Thus, the future effects of NAFTA countries' fish farming activities on the U.S. import demand for catfish is an issue meriting serious study.

The literature reveals few empirical studies of catfish demand. Of those, Hu (1985) and Dellenbarger, et al. (1988) focused on the U.S. market and household demand for domestic farm raised catfish. Raulerson and Trotter (1993) and Engle et al. (1990) estimated grocery store and restaurant demand. The only empirical study of catfish imports to date was done by Kinnucan, et al. (1988). They related catfish imports to external factors such as the price of fuel, biological cycles in fish production, exchange rates, and the U.S. consumer price of fish. However, traditional demand theory suggests that their specification could be improved. The amount of income spent on fish, the (lagged) consumption of fish per capita, and the import price of catfish may also affect

the demand for imported catfish. For these reasons, we propose to apply a traditional import demand specification to the problem of estimating the U.S. demand for imported catfish (Khan and Ross, 1977). A principal goal of the analysis is to obtain estimates of relative (import/export) price elasticities in order to examine the likely effects of production in NAFTA and neighboring countries on domestic sales.

**Model Specification**

A principal problem in estimating import demand functions is the selection of an appropriate functional form. Theoretical import demand functions have been studied in the literature using principally the linear and log linear functional forms (Kreinin and Price 1967, Houthaker and Magee 1969, Maghee 1975, Boylan et al. 1980, and Gafar 1988). The debate on the appropriateness of the functional form continues since the evidence suggests that there is no general superiority of one form over another. Khan and Ross (1977) and Doroodian et al (1994) employed the following general theoretical specification:

$$(1)\quad Q_{im} = f(P_i, P_d, Y)$$

where $Q_{im}$ is the quantity imported, $P_i$ the price of imports, $P_d$ is the domestic price, and Y an income variable. Murray and Ginman (1976) have, however, criticized this model because of multicollinearity problems and large standard errors. To circumvent this problem, other studies have used price (index) ratios:

$$(2)\quad Q_{im} = f(P_i / P_d, Y)$$

This form of the model can also be criticized because differential rates of increase in $P_i$ and $P_d$ during the measured period can result in perfectly legitimate substitution effects between imports and domestic output being ruled out *a-priori* by the proportionality of price effects required by this functional form. This type of specification problem will arise unless the individual price variables' coefficients are equal in magnitude, but opposite in sign. In addition, Khan and Ross suggested the inclusion of a lagged dependent variable in their model to account for time lags and logistic delays inherent in the adjustment of actual imports to their desired levels. The resultant model is:

$$(3)\quad Q_{im} = f(P_i, P_d, Y, Q_{im,t-1})$$

Asseery and Peel (1991) estimated a variant of this import demand function which explicitly models a partial adjustment process. They posited the following aggregate demand specification for the desired level of imports:

$$(4)\quad \ln M^*_t = \beta_1 + \beta_2 \ln Y + \beta_3 \ln \frac{P_i}{P_d} + \varepsilon_t$$

where $M^*_t$ is the desired quantity of imports at time t; Y, $P_i$, and $P_d$ are as defined above, and $\varepsilon_t$ is a stochastic error term. Then they postulated the following partial adjustment model:

$$(5)\quad \ln M_t = \gamma(\ln M^*_t - \ln M_{t-1}),\ 0 \le \gamma \le 1$$

Substituting (5) into (4) gives the full equation for import demand:

$$(6)\quad \ln M_t = \gamma\beta_1 + \gamma\beta_2 \ln Y + \gamma\beta_3 \ln \left(\frac{P_i}{P_d}\right)_t + (1-\gamma)\ln M_{t-1} + \gamma u_t$$

One advantage of this specification is that it allows the derivation of short run and long run price elasticities.

Employing variations on the above themes, we pose the following statistical model.[1] In this paper, we estimate the following form of the U.S. import demand for:

$$(7)\quad \frac{Q_{im,t}}{Q_{prd,t}} = f\left(\frac{P_i}{P_d}, Y_t, \frac{Q_{im,t-1}}{Q_{prd,t-1}}, T\right)$$

where:

[1] Because of the dominance of the catch in the wild, there is always the question of modeling seasonal effects on import supply. Lambregts, et al. (1993) found that seasonal effects in the catfish market were negligible. Regardless, the subsequent analysis employs yearly data, so that any potential seasonal abberations are subsumed in the aggregate figure.

$Q_{im,t}$ = Quantity of catfish imported by the U.S. in year t, in pounds (1970-1991).

$Q_{prd,t}$ = Quantity of domestic (U.S.) catfish produced in year t, in pounds (1970-1991).

$Q_{im,t-1}$ = Quantity of catfish imported by the U.S. in year t-1, in pounds (1970-1991).

$Q_{prd,t-1}$ = Quantity of domestic (U.S.) catfish produced in year t-1, in pounds (1970-1991).

$P_i$ = Import price of catfish in dollars per pound (1970-1991).

$P_d$ = Domestic farm price of catfish in dollars per pound (1970-1991).

$Y_t$ = Real Gross Domestic Production in year t (1982-1984 dollars).

T = Time trend which may represent technological change in market conditions.

The statistical specification used for this study is the double log functional form. Boylan, et al. (1980) and Khan and Ross (1977), using a Box Cox transformation, found that the double log functional specification was superior to the linear version.[2] Making use of this result, we estimate the following model:

$$(8)\quad \ln \frac{Q_{im,t}}{Q_{prd,t}} = \beta_0 + \beta_1 \ln \frac{P_i}{P_d} + \beta_2 \ln Y + \beta_3 \ln \frac{Q_{im,t-1}}{Q_{prd,t-1}} + \beta_4 T + \varepsilon_t$$

The discussion in the previous section provides some insight into the expected relationships. If import prices increase relative to domestic prices, one would expect import quantities to fall relative to domestic quantities so that we expect $\beta_1 < 0$. Casual empiricism suggests that many imports are more income elastic than their domestically produced counterparts. If this is the case, then increases in Y should increase $Q_{im}$ more than $Q_{prd}$ so that $\beta_2 > 0$. But if imports are purchased on long term contracts while domestically produced output is free to respond instantaneously to market changes, the opposite effect would be observed ($\beta_2 < 0$). Indeed, if imports and domestic output have identical income elasticities, $\beta_2 = 0$. We are tempted to argue that $\beta_3$ should be positive so that long run elasticities will exceed short run elasticities, but that expectation simply is not justified. We are dealing with ratios of import to export quantities and prices; the sign of $\beta_3$ will depend on the relative magnitudes of the short run and long run price and income elasticities of catfish imports as compared to domestically produced catfish. *A-priori*, the sign is ambiguous. One interpretation of the trend variable is as a measure of the effects of technological change in market conditions. Thus, the sign of the trend variable will depend on whether advancing technology results in imports growing faster ($\beta_4 > 0$), slower ($\beta_4 < 0$), or at the same rate ($\beta_4 = 0$) as domestic output after all other factors have been taken into account. While Figures 1 and 2 clearly indicate general upward trends in both, not much can be said *a-priori* about their relative magnitudes, *ceteris paribus*.

We estimated this model for the U.S. using data from U.S. Import Statistics for Fishery and Marine Related Commodities 1981-1986, U.S. Imports of Consumption and General Imports, U.S. Food Consumption, Prices, and Expenditures, and various USDA publications, covering the period 1970 through 1991. The import value of catfish for the year 1988 could not be obtained, so that this observation was eliminated from the empirical analysis which follows. The data are given in Table 1.

[2] We concur with this evaluation. A linear version of the model analyzed here produced no statistically significant coefficients, even at the ten percent level of significance.

**Table 1. Annual Import Quantity, Value and Prices of Imported and Domestic Catfish, 1970-1991.**

| YEAR | IMPQUANT lbs. | IMPVALUE $ | PD $ | PI $ | TPS $ | RWP lbs. | FPRICE $ |
|---|---|---|---|---|---|---|---|
| 1970 | 4799245 | 1493497 | 0.833 | 0.31119 | 2789000 | 5741000 | 0.345 |
| 1971 | 3203787 | 1077584 | 0.788 | 0.33635 | 7219000 | 11257000 | 0.326 |
| 1972 | 4826201 | 1654984 | 0.804 | 0.34292 | 11076000 | 18333000 | 0.333 |
| 1973 | 6612861 | 2360371 | 1.032 | 0.35694 | 11944000 | 19729000 | 0.451 |
| 1974 | 8443417 | 3509000 | 1.071 | 0.41559 | 10909000 | 16945000 | 0.46 |
| 1975 | 1.1E+07 | 5804000 | 1.141 | 0.53217 | 10318000 | 16140000 | 0.492 |
| 1976 | 1.8E+07 | 1.1E+07 | 1.211 | 0.64849 | 11738000 | 18977000 | 0.529 |
| 1977 | 1E+07 | 6174000 | 1.311 | 0.60167 | 13248000 | 22126000 | 0.579 |
| 1978 | 1.8E+07 | 1.1E+07 | 1.306 | 0.61501 | 18513000 | 30177000 | 0.546 |
| 1979 | 1.7E+07 | 1.4E+07 | 1.474 | 0.82707 | 24330000 | 40636000 | 0.615 |
| 1980 | 1.5E+07 | 1.2E+07 | 1.661 | 0.82333 | 27757000 | 46464000 | 0.676 |
| 1981 | 8164793 | 6787294 | 1.676 | 0.83129 | 35137000 | 60640000 | 0.637 |
| 1982 | 5893527 | 5565326 | 1.505 | 0.94431 | 57959000 | 99405000 | 0.55 |
| 1983 | 4274537 | 3519252 | 1.45 | 0.82331 | 73463000 | 137250000 | 0.611 |
| 1984 | 6162951 | 5125829 | 1.602 | 0.83172 | 81963000 | 154255000 | 0.693 |
| 1985 | 7060236 | 5572765 | 1.654 | 0.78932 | 99280000 | 191616000 | 0.725 |
| 1986 | 8164793 | 6787294 | 1.957 | 0.83129 | 113894000 | 213756000 | 0.668 |
| 1987 | 6931959 | 5092000 | 1.933 | 0.73457 | 146501000 | 280496000 | 0.618 |
| 1988 | 5845000 | N/A | 2.208 | N/A | 149560000 | 295109000 | 0.764 |
| 1989 | 3103810 | 5647000 | 2.112 | 1.81938 | 176293000 | 341900000 | 0.717 |
| 1990 | 1826352 | 3818000 | 2.24 | 2.09051 | 183146000 | 360435000 | 0.758 |
| 1991 | 2361722 | 5600000 | 2.086 | 2.37115 | 199809000 | 390870000 | 0.631 |

Where: IMPQUANT = import quantitiy, IMPVALUE = import value, PD = domestic price, PI = import price, TPS = total processor sale, RWP = total fish delivered for processing, and FPRICE = farm level price.

## Results and Discussion

The average import quantity of catfish over the period 1970 through 1991 was 8,036,902 pounds with an average value of 5,937,771 dollars. The average domestic round weight for this was 137,762,950 pounds valued at $206,644,425. The average import price and domestic (farm) price over the same period were $0.85 and $1.50, respectively.

Ordinary least squares regression results are presented in Table 2. The estimated coefficients were all statistically significant at $\alpha = 0.05$, except for that of the lagged dependent variable. The model explained 94.6% of the variation in the log of the ratio of imported to domestically produced catfish for the sample period -- 93%, after correcting for degrees of freedom. The model also appeared to be free of heteroscedasticity and autocorrelation problems. The Goldfeld-Quandt test resulted in a computed F-value of 1.43 (compared to a critical value of $F_{.05}(5,5) = 5.05$), and the Durban h-value was -0.54 which is easily insignificant at any of the traditional levels (Gujarati, 1988).

We also conducted Ramsey's RESET test. Many previous authors have estimated linear rather than double-log specifications of the import demand function. If they are correct then the current estimates are biased, inconsistent, and inefficient. RESET can be used to test for the statistical significance of this bias; it also has power to

detect biases due to omitted variables and simultaneity, but it is not constructive (if RESET "fails", we do not know which of the three problems is to blame). We computed the RESET F statistic by first squaring and cubing the estimated dependent variable from our original estimates, adding these two variables to the model, and then estimating the augmented model in order to test for the joint significance of these two "new" variables (Greene, 1995). The null hypothesis of the test is "no specification error".[3] Since the computed F value turned out to be F(2,13)=0.508, the null hypothesis could not be rejected even at the $\alpha = .05$ level. Thus, the model as a whole, appeared to be sound and our estimators reliable.

**Table 2. The Estimated Parameters of a Double log Specification of the U.S. Import Demand Equation for Catfish.**

| Independent variable | Double log[a] |
|---|---|
| Constant | -13.518<br>(-2.122)[b] |
| $\frac{P_i}{P_d}$ | -0.064<br>(-2.811)[b] |
| Y | -0.134<br>(-3.649)[b] |
| $\frac{Q_{im,t-1}}{Q_{prd,t-1}}$ | -0.118<br>(0.574) |
| T | 0.008<br>(2.396)[b] |
| $R^2$ | 0.946 |
| $\overline{R^2}$ | 0.932 |
| h | -0.586 |

[a] t-values are in parentheses.
[b] Significant at the 95 percent level of confidence.

As anticipated, the price ratio coefficient was negative and significant. A rise in import prices of one percent relative to domestic prices causes imports to fall by .064 percent relative to domestic output, *ceteris paribus*. Somewhat surprisingly, the log income coefficient turned out to be negative and significant also. A one percent increase in real U.S. GDP will result in a fall in the ratio of imported to domestic catfish of .134 percent. Imported catfish are viewed as an "inferior" good. This result makes sense only if the income elasticity of imports is less than that of domestically produced catfish. One explanation for this finding, as noted above, is that imports are bought on longer term contracts, so that a change in income may not be reflected immediately in a change in imports, while domestic output is free to instantaneously respond to domestic income changes. Also as noted above, the log of the lagged ratio of imports to domestic production is negative, but statistically insignificant. Finally, our estimate of $\beta_4$ is positive and significant indicating that, *ceteris paribus*, imports are increasing faster than domestic output over time. This result may not be as surprising, on reflection, as it initially appears. It is reasonable to expect that a given technological advance in catfish production would have a larger effect in economies where the industry is in its infancy than in the United States where the industry is relatively mature. At any rate the growth rate differential is quite small, being estimated at .009 percent.

## Effects of Increased Production from NAFTA Member Countries

There are no tariffs levied on the importation of catfish to the United States. Ingredients of catfish feed face an import tariff by Mexico of about 10 percent on the average market price. Trade liberalization and the lifting of the tariff will increase the competitiveness of producers in neighboring countries if the removal of the tariff results in a lower cost of production. However, the elimination of production subsidies is expected to mitigate the trade advantages gained from the lifting of tariffs. Presently, NAFTA countries, especially Mexico, have no real competitive advantage in catfish production, but U.S. producers entertain the fear that changes enforced by trade arrangements may affect the U.S. catfish industry. For this light, it is important to determine whether this fear is justified.

In lieu of data on cost of production from exporting countries, elasticities of import demand will be used to evaluate the effects of imports of

[3] Technically, the null hypothesis is that the theoretical disturbance vector $\underline{\varepsilon}$ has a null mean, i.e. $E[\underline{\varepsilon}]=\underline{0}$.

catfish on the U.S. industry. The elasticities for the price of imports over price of domestic price of catfish in the United States are very small and for a one percent fall in price of foreign catfish, domestic price remaining constant, imports will fall by 0.6 of a percent which is less than 0.001 percent of domestic production. The average price of imports was $0.85 per pound, while the average price of catfish at the retail level was $1.50. Since most of the imported fish come from the wild, it means that average cost of commercial production in the exporting country would have to be less than the average retail price in the U.S. It also means that average cost of farm production would have to be lower than $0.85. The average cost of production in the U.S. (round weight of catfish) is about $0.65 per pound (Crews et al., 1992).

All export data of catfish to the United States are aggregated for some years of the study period; therefore, it was difficult to tell how much was exported from NAFTA member countries. Brazil exports about 85 percent of all catfish to the U.S. and most of these are from the wild. Mexico's contribution has been negligible varying from 5 to 10 percent. The climatic conditions of Mexico may, however, allow it to expand catfish production in regions with sufficient water resources if prices of inputs fall sufficiently. Let us assume that all exports come from a NAFTA member country, and that the cost of transportation of feed to Mexico is transmitted to the export price of catfish, other things remaining constant. Let us further assume that transport cost increases price by 100 percent, then the quantity of catfish imported would fall by 6.4 percent. This relationship translates into a fall in total exports of 488,415 pounds which is 0.11 percent of domestic production. Feed cost forms about 50 percent of the variable cost of production, and given that Mexico is a net importer of feed, it would be difficult for Mexican catfish farmers to compete with U.S. producers. Let us further assume that the break-even price for U.S. producers to cover feed cost is $0.24, as calculated from the Crews et al. budget. Let us also assume the Mexican efficiency in producing catfish is increased and that $0.24 is the imported price of catfish. This is a fall in price of 254 percent. If the price of imported catfish falls by 254 percent, *ceteris paribus,* imports would increase by 16 percent which is 1,285,904 pounds and only 0.28 percent of domestic output. This scenario reflects no threat to the U.S. producers since production from one year to the next may vary by more than 1.0 percent. The fear of production of catfish from NAFTA member countries damaging the domestic industry is, therefore, unwarranted.

## Conclusions

The basic conclusion drawn from this study is that the double log functional form is more appropriate than the linear form for the evaluation of import demand of catfish. The quantity of catfish imported will decline if the domestic price of catfish falls relative to the import price. Past imports have no effect on present imports indicating that domestic consumers have not developed an allegiance to imported catfish. The elasticity related to income is negative which means that imported catfish is an inferior good. Present levels of imports are not a threat to U.S. producers and imports vary inversely with domestic production. The import price elasticities of demand show that increased exports of catfish from NAFTA countries at much lower prices may not be damaging to the domestic catfish industry.

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