Effects of Antidumping Duties with Bertrand Competition: Some Evidence for Frozen Catfish Fillets

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Abstract

Antidumping duties are popular in the United States because under the Byrd Amendment domestic industry gets to keep tariff revenues. However, whether antidumping duties are an effective instrument of protection depends crucially on the tariff's ability to increase demand for the home good. Under Bertrand competition, the Byrd Amendment enhances tariff effects on the home price and trade flows in comparison to perfect competition. Assuming Bertrand competition and differentiated products, price-reaction functions of frozen catfish fillets are derived and estimated jointly with a demand equation using monthly data for the period January 1999 - December 2005. An inverse demand equation for farm-level products is also added to explore the efficacy of the tariff on price of farmed catfish. The estimated increase associated with the duty is exhibited tiny in price and sales of domestic fillets but insignificant in farm price. The result suggests antidumping duties are a weak tool for protecting the domestic catfish industry.

Keyword: antidumping tariff, Bertrand competition, Byrd Amendment, catfish, price.

Through various GATT/WTO rounds, tariff barriers have decreased worldwide, but antidumping measure has surged to play a crucial role as the most important non-tariff barrier (Zanardi, 2004). Antidumping duty is recently used more frequently, by more countries, and against more products (Prusa, 2005). As processed and differentiated agricultural products are increasingly traded cross national borders (Reimer and Stiegert, 2006) more of them are facing antidumping measures taken by importing countries (Kinnucan and Myrland, 2005, Bown, 2006).

Since the 1980s, the rise in international competition has led many U.S. firms to seek protection from foreign imports (Hansen and Prusa, 1996). One of the protection tools is the Continued Dumping and Subsidy Offset Act of 2000, commonly referred to as the Byrd Amendment. The Byrd Amendment permits successful petitioners for anti-dumping and countervailing duties to collect tariff revenues. It also increases the incentive for the domestic firm to increase its price because by doing so it increases the sales of the foreign firm, which increases the domestic firm's revenue from the tariff.

As a consequence, the Byrd Amendment has the paradoxical effect of increasing the value and total volume of imports (Evenett, 2006) compared to the equilibrium without the Byrd Amendment and undermines the original intent of the duty. Related research suggests antidumping duties in a competition tend to be ineffective in that an importing country's demand for a product from a particular supply source tends to be highly elastic in relation to supply from that source, which means most of the duty is borne by the foreign supplier rather than the importing-country consumer (Kinnucan, 2003).

The purpose of this research is to test the hypotheses advanced by Kinnucan (2003) and Evenett (2006) by measuring the effects of recent anti-dumping duties imposed by the

United States on frozen catfish fillet imports from Vietnam. Assuming Bertrand competition and differentiated products, price-reaction functions are derived and estimated jointly with a demand equation using monthly data for the period January 1999 - December 2005. A farm-level inverse demand is then added to quantify the effects of the duties on farm price, the industry's main motivation for filing the petition in the first place.

Catfish production is one of the biggest aquaculture industries in the United State and frozen catfish fillets are an important product of the US catfish processing industry (Harvey, 2005). The catfish "trade war" represents a useful case study in that the anti-dumping duties are large (ranging from 45% to 64% of the import price), affected virtually all of the companies in Vietnam that export to the United States, and were implemented in 2003, two years after the Byrd Amendment went into force.

Literature Review

Imperfect Competition in Agricultural International Trade

While there are a few studies examining imperfect competition of international markets for non-agricultural products and services (Reimer and Stiegert, 2006), a large number of the competitive behaviors in specific agricultural products have been documented.

Rice is the most popularly traded agricultural products. With a dynamic New Empirical Industrial Organization approach to examine structure of international rice export market, Karp and Perloff (1989) confirm that the market is oligopolistic with Thailand, Pakistan and China are modeled as oligopolists and all other countries as a competitive fringe. Competitive behaviors between US and Thailand exporter in the market are also imperfect (Yumkella, Unnevehr and Garcia, 1994).

Glauben and Loy (2003) find that there are exercises of market power by German export of beer to North America, in exports of sugar confectionery to the UK and in exports of cocoa powder to Italy. The market powers might be explained by fixed contracts, which are often used in the food and beverage export market. Using a census of some 500 firms for the period 1990–2002, Wilhelmsson (2006) also suggests that firms in the Swedish food and beverage industry do enjoy some varied degrees of market power and increased foreign competition has contributed to reducing market power in sectors that were protected by tariff and non-tariff barriers to trade prior to Swedish EU membership.

The imperfect competitive behaviors are also found in international markets of other commodities. Brazil and Columbia are oligopolistics in coffee export market (Karp and Perloff, 1993). Philippines takes substantial market power in the coconut oil exports market (Buschena and Perloff, 1991) whereas German banana import market follows Cournot-Nash equilibrium (Deodhar and Sheldon, 1996). In international wheat market, there are exist evidence for price discrimination and market power by US wheat exporters (Pick and Park, 1991, Patterson and Abbott, 1994). Empirical study of Carter and MacLaren (1997) indicates that sale data of US and Australian beef exporters fits the Stackerberg model with price leadership by Australians. Statistical evidence also confirms that the global malting barley market operates as a Cournot quantity setting oligopoly (Dong et al., 2006).

Antidumping Measurement – Definition and Investigation Process

Under the GATT/WTO regulations, foreign suppliers named in antidumping suits must met two criteria for duties to be imposed (Knetter and Prusa, 2000). First, there must be evidence that the domestic industry has materially injured (e.g., a loss or decline in profitability) by foreign imports. Second, the foreign suppliers must be found to be selling their products at

"less than fair value" prices. A dumping case occurs when subject products are sold at a price "less than fair value". According to Knetter and Prusa (2000), "less than fair value" is determined: (1) by showing that the price charged in the domestic market by the foreign suppliers is below the price charged for the same product in other markets (i.e., the "price-based" method) or (2) by showing that the price charged in the domestic market is below an estimate of cost plus a normal return (i.e., the "constructed-value" method).

In the United States, the Department of Commerce (DOC) and the International Trade Commission (ITC) administrate the antidumping laws. Each has distinct roles in the antidumping investigation process. For response to petition filed by domestic firms, the DOC calculates whether foreign firms are selling the product to the US at less than "normal" or "fair" value, i.e. whether dumping has occurred. The department then calculates an *ad valorem* dumping margin equal to the percentage difference between the US transaction prices they observe and fair value. The ITC, in its turn, has to determine whether the domestic industry has been materially injured, or is threatened with material injury caused by accused imported products. Both agencies make preliminary and final determinations during the investigation. According to Blonigen and Heynes (2002) if they both give affirmative preliminary determination, the importer must post a cash deposit, a bond or other security equal to the preliminary margin determined by DOC for each entry of the subject product. This requirement stays in effect until either the DOC and ITC makes a negative final determination. If both agencies give an affirmative final determination, an order is issued by DOC to levy an antidumping duty equal to the estimated dumping margin on the subject product. In a timeline, Blonigen and Heynes (2002) summarize the investigation process and

suggest that it would be taking up to 280 days from the petition filed to the ITC final determination.

The Byrd Amendment and Its Impacts

The "Byrd Amendment", named after its sponsor Democratic Senator Robert Byrd and passed by US Congress in 2000, permits plaintiffs to collect revenues from the antidumping and/or countervailing duty. The disbursement is available only to "affected domestic producers for qualifying expenditures." An "affected domestic producer" is defined as a manufacturer, producer, farmer, rancher, or worker representative (including associations of such persons) that (1) was a petitioner or interested party in support of a petition with respect to which an antidumping or countervailing duty order was in effect and (2) remains in operation. Producers that have ceased production of the product covered by the order or that have been acquired by a firm that opposed the petition would not be considered an affected domestic producer (ITC, 2006)

The Byrd Amendment has been found in violation of WTO trade remedy rules (Jung and Lee, 2003) and imposes distortions on the U.S. economy. The Congressional Budget Office (2004) estimates that $3.85 billion in revenues collected will be distributed to firms between 2005 and 2014. Between 2001 and 2004, $1 billion was paid to 770 firms that were allegedly harmed by unfair trade practices (GAO, 2005) but more than one-third going to a single corporation, the Timken Company, and two of its subsidiaries (CITAC, 2006). More than half of the $226 million of Byrd Amendment payouts in 2005 went to five companies, and 80% percent of the payouts went to only 34 companies (CITAC 2006) and two thirds of the disbursement flow to only 3 of the 77 eligible industries (GAO, 2005). Three industries benefited the most from the Byrd payments are ball bearings, candles, and steel (CITAC

2006). The amounts distributed to individual corporations can distort the competitive structure of an industry, leading to a reduction in competition.

The Byrd Amendment not only harms the U.S. economy but also hurts US exporters. Under complaints filed by 11 trading partners including European, Canada and Mexico, the World Trade Organization (WTO) ruled in January 2003 that the Byrd Amendment was in violation of U.S. trade obligations and complaining countries have been awarded the right to impose retaliatory duties on U.S. exports, up to $134 million in 2005 (Odessey 2006). Thus, the longer Byrd payments still offered to US domestic industries, the more US's trade partners can retaliate against U.S. goods, and the more U.S. consumers suffer. Besides various literatures on effects of antidumping measurement, for instance, Blonigen and Prusa (2001), Blonigen and Heynes (2002), Kinnucan (2003), Zanardi (2004), Hansen and Prusa (1996), Prusa (2005), Feenstra (2004), Kinnucan and Myrland (2005), there also exist studies on impacts of the Byrd Amendment.

Jung and Lee (2003) suggest that the Byrd Amendment provides an incentive for domestic industries to file antidumping legislations, distort competition between the firms who are beneficiaries and those who did not have enough resource or information to support the petitions. The amendment disappoints the legitimate expectation from exporting countries and infringe on the rights of the other countries to open and transparent trade. It hurts downstream industries, consumers and global welfare also. Empirical results of Olson (2005) provide strong evidence that more US domestic industries have lobbied for more tariff protection, or filed more antidumping petitions since passage of the Byrd Amendment. Modeling pricing behaviors over bureaucratic discretion and the Byrd Amendment, Evenett (2006) shows that where the Byrd Amendment raises prices in equilibrium, a seemingly

paradoxical result arises as the foreign firm is better off. The foreigner profit rises because of the excess of price over marginal costs increases and the amount of dumping duties paid per unit falls as the foreign firm's price increases. The Byrd Amendment was at last repealed by the US Congress in January 2006 but the repeal will not go into force until October 2007.

Theoretical Framework

Tariff Effects under the Byrd Amendment

The efficacy of antidumping duties depends crucially on tariff absorption. To see this in a differentiated product context with Bertrand competition, let the demand curve for the home product be defined as follows:

(1) $$Q_1 = \alpha_1 - \beta_1 P_1 + \gamma_1 P_2$$

where Q_1 is the quantity sold of the home product, P_1 is the price paid by home consumer for the home firm, P_2 is the price paid by home consumers for the foreign product. Exogenous demand shifters such as consumer income and prices of competing foods are suppressed. The demand curve is downward sloping ($\beta_1 > 0$), an increase in the price of the foreign good increases the demand for the home good ($\gamma_1 > 0$), and demand is more sensitive to own price than to substitute price ($\beta_1 > \gamma_1$). The tariff wedge is defined as:

(2) $$P_2 = P_2^- + t$$

where P_2^- is the f.o.b price received by the foreign seller (ignoring transportation and other transaction costs), and t is the per-unit dumping duty.

Differentiating (1) and (2) with respect to the tariff yields:

(3) $$\frac{\partial Q_1}{\partial t} = (-\beta_1 \frac{\partial P_1}{\partial P_2} + \gamma_1) \frac{\partial P_2}{\partial t}$$

(4) $$\frac{\partial P_2}{\partial t} = \frac{\partial P_2^-}{\partial t} + 1$$

where $-1 \leq \frac{\partial P_2^-}{\partial t} \leq 0$ measures tariff absorption, i.e., the extent to which the antidumping duty is borne by the foreign firm as opposed to the home consumer. If tariff absorption is nil ($\frac{\partial P_2^-}{\partial t} = 0$), i.e., home consumers bear the tariff's full incidence, (3) reduces to

$$\frac{\partial Q_1}{\partial t} = -\beta_1 \frac{\partial P_1}{\partial P_2} + \gamma_1$$

and the demand effect is always positive provided:

(5) $$\frac{\gamma_1}{\beta_1} > \frac{\partial P_1}{\partial P_2}$$

i.e., the vertical shift in the demand curve (the shift in the price direction with quantity held constant) exceeds the price rise associated with the tariff. Conversely, if tariff absorption is complete ($\frac{\partial P_2^-}{\partial t}$ = -1), the price of the foreign good in the home market is unaffected by the duty and the demand effect is nil ($\frac{\partial Q_1}{\partial t} = 0$).

Under Bertrand duopoly tariff absorption is one half. To see this, let Q_{21} be the quantity sold by the foreign firm in the home market and Q_{22} be the quantity sold in alternative export markets where $Q_2 = Q_{21} + Q_{22}$ is the foreign firm's total exports. For simplicity, assume the foreign firm is the sole supply source for non-home markets (a

situation approximated in the present study in that Europe, Vietnam's major alternative export market for frozen catfish fillets, does not produce the product). The demand curves are:

(6a) $$Q_{21} = \alpha_2 - \beta_2 P_2 + \gamma_2 P_1$$

(6b) $$Q_{22} = \alpha_3 - \beta_3 P_3$$

where P_3 is the price charged by the foreign firm in non-home export markets. As before, all parameters are positive, i.e., the demand curves are downward sloping ($\beta_2 > 0, \beta_3 > 0$) and the home good is a substitute for the foreign good ($\gamma_2 > 0$). C_2 and C_3 are the foreign firm's per-unit marginal cost of supplying the two markets, which is assumed be constant. With these assumptions the foreign firm's profit function is:

(7) $$\pi_2 = (P_2 - C_2 - t)Q_{21} + (P_3 - C_3)Q_{22}.$$

Bertrand competition implies the foreign firm takes the home firm's price as given when selecting its price, and vice versa ($\frac{\partial P_i}{\partial P_j} = 0, i \neq j$). Maximizing (7) with respect to P_2 and P_3 under this assumption and solving the resulting equations simultaneously yields the following reaction curve:

(8) $$P_2 = \frac{\alpha_2 - \alpha_3}{2\beta_2} + \frac{\gamma_2}{2\beta_2} P_1 + \frac{\beta_3}{\beta_2} P_3 + \frac{1}{2} C_2 - \frac{\beta_3}{2\beta_2} C_3 + \frac{1}{2} t.$$

Under the stated assumptions, the price the foreign firm sets in the home country is positively related to the home country's price, the price it charges in non-home markets, the cost of supplying the home country, and the tariff; it is negatively related to the cost of supplying non-home markets. Importantly, the coefficient of t is one-half, which means an

increase in the duty is split evenly between a rise in the home country's price of the foreign good and a decrease in the net price received by the foreign firm. This can be seen most clearly by substituting (2) into (8) to yield:

$$(9) \qquad P_2^- = \frac{\alpha_2 - \alpha_3}{2\beta_2} + \frac{\gamma_2}{2\beta_2} P_1 + \frac{\beta_3}{\beta_2} P_3 + \frac{1}{2} C_2 - \frac{\beta_3}{2\beta_2} C_3 - \frac{1}{2} t$$

From (9) $\frac{\partial P_2^-}{\partial t} = -\frac{1}{2}$, which means the foreign firm absorbs half the duty, as claimed. If $\gamma_2 < \beta_2$ (home consumers are less sensitive to the price of the foreign good than the home good), $\frac{\partial P_2}{\partial P_1} < \frac{1}{2}$ and an increase in the duty has a larger effect on the price of the foreign good in the home market than does an increase in the home price itself.

The analysis is completed by bringing into play the home firm's reaction curve. Under the Byrd Amendment the home firm receives a portion of the duty receipts; hence, the profit function is as follows:

$$(10) \qquad \pi_1 = (P_1 - C_1) Q_1 + \varphi t Q_{21}$$

where C_1 is the home firm's constant marginal cost and φ is a parameter, less than one, that indicates the firm's share of the total duties collected. Maximizing (10) with respect to P_1 under the assumption the home firm takes P_2 as given yields:

$$(11) \qquad P_1 = \frac{\alpha_1}{2\beta_1} + \frac{\gamma_1}{2\beta_1} P_2 + \frac{1}{2} C_1 + \frac{\varphi \gamma_2}{2\beta_1} t \,.$$

The interpretation of (11) is similar to (8) in that the home firm's response to the foreign competitor's price depends on the substitutability of the foreign good for the domestic good. If the goods are perfect substitutes such that $\beta_1 = \gamma_1$, a one dollar increase in

the foreign good's price causes the home firm to raise its price by 50 cents; if the goods are imperfect substitutes such that $\gamma_1 < \beta_1$, the home firm's price will rise by less than 50 cents.

Importantly, the Byrd Amendment provides an incentive for the home firm to raise its price above that which would obtain in the absence of the Amendment. This can be seen by noting that the tariff term in (11) disappears when $\varphi = 0$. The intuition for this result, as explained by Evenett (2006, p. 734), is that, by raising its own price, the home firm can increase the demand for imports, which raises the value of duties collected. The added incentive can be seen most clearly by substituting (2) into (11):

$$P_1 = \frac{\alpha_1}{2\beta_1} + \frac{\gamma_1}{2\beta_1} P_2^- + \frac{1}{2} C_1 + \frac{\gamma_1 + \varphi\gamma_2}{2\beta_1} t \tag{12}$$

where the coefficient of t measures the effect of an increase in the duty on the home firm's price holding constant the foreign firm's *net* price. This effect is enlarged by an amount equal to the "Byrd term" $\varphi\gamma_2 > 0$. From (12) the duty's ability to raise home price depends crucially on product differentiation and is nil when the foreign and home goods are independent ($\gamma_1 = \gamma_2 = 0$).

Comparison with Perfect Competition

Given the importance of absorption for the efficacy of dumping duties, it is of some interest to compare the foregoing Bertrand results with the competitive solution. For this purpose, we assume for simplicity that the home market has just two sources of supply: home production and imports from the foreign country in which the duty is imposed. The supply equations for the home and imported goods are:

$$Q_1 = \phi_1 + \varepsilon_1(P_1 + \psi t) - \theta_1 C_1 \tag{13}$$

(14) $$Q_{21} = \phi_2 + \varepsilon_2(P_2 - t) - \theta_2 C_2$$

where the ε_i (> 0) parameters indicate the responsiveness of home production and imports to price, and the θ_i (> 0) parameters indicate the effect of cost factors on supply. The ψ parameter in (13) is defined as $\psi = \frac{\tilde{Q}_{21}}{\tilde{Q}_1} \geq 0$ where $\tilde{Q}_{21} \leq Q_{21}$ is the quantity of imports subject to the duty and $\tilde{Q}_1 \leq Q_1$ is the quantity of domestic production certified to receive duty revenue under the Byrd Amendment. The composite term $\psi\, t$ in essence measures the per-unit subsidy enjoyed by domestic firms as a result of the Byrd Amendment.

Setting supply equal to demand [(13) = (1) and (14) = (6a)] and substituting (2) yields the following price-transmission equations:

(15) $$P_1 = \frac{\alpha_1 + \phi_1}{\varepsilon_1 + \beta_1} + \frac{\gamma_1}{\varepsilon_1 + \beta_1} P_2^- + \frac{\theta_1}{\varepsilon_1 + \beta_1} C_1 + \frac{\gamma_1 - \psi\varepsilon_1}{\varepsilon_1 + \beta_1} t$$

(16) $$P_2^- = \frac{\alpha_2 + \phi_2}{\varepsilon_2 + \beta_2} + \frac{\gamma_2}{\varepsilon_2 + \beta_2} P_1 + \frac{\theta_2}{\varepsilon_2 + \beta_2} C_2 - \frac{\beta_2}{\varepsilon_2 + \beta_2} t\ .$$

Comparing these equations with the previously-derived equations for Bertrand duopoly reproduced below

(12) $$P_1 = \frac{\alpha_1}{2\beta_1} + \frac{\gamma_1}{2\beta_1} P_2^- + \frac{1}{2} C_1 + \frac{\gamma_1 + \varphi\gamma_2}{2\beta_1} t$$

(9) $$P_2^- = \frac{\alpha_2 - \alpha_3}{2\beta_2} + \frac{\gamma_2}{2\beta_2} P_1 + \frac{\beta_3}{\beta_2} P_3 + \frac{1}{2} C_2 - \frac{\beta_3}{2\beta_2} C_3 - \frac{1}{2} t\ ,$$

the most important difference is in the coefficients of t in (15) and (12). Under Bertrand competition the Byrd Amendment enhances the positive effect of the duty on domestic price,

under perfect competition the Byrd Amendment reduces the duty's positive effect on domestic price. Specifically, the sign of the coefficient of *t* switches from positive in (12) to indeterminate in (15). The intuition for this result is that firms in a competitive industry have no ability to influence price and thus respond to the Byrd subsidy simply by enlarging output, which has a depressing effect on home price. Imperfectly competitive firms, on the other hand, use their ability to set price by strategically raising price, which lowers quantity demanded for the home good, but raises imports, which enlarges profits associated with the Byrd payments. If the Byrd Amendment is removed, $\psi = \varphi = 0$ and both models are consistent in showing an unambiguous positive relationship between home price and the tariff under the stated parametric assumptions.

Finally, under Bertrand competition tariff absorption equals one half whereas under perfect competition absorption can range from zero to minus one. For example, in a small-trader situation where $\beta_2 = \infty$, tariff absorption is complete ($\frac{\partial P_2^-}{\partial t} = -1$) and the duty is ineffectual. A full analysis of this case for a homogenous good is in Kinnucan (2003). The upshot is that market structure plays a crucial role in how the Byrd Amendment affects market prices and trade flows, but also on the ability of anti-dumping duties to benefit home producers.

Empirical Model for the Frozen Catfish Fillets

Model Specification

For empirical regression with the frozen catfish fillets case, some following assumptions are made: i) Vietnamese catfish dominates US catfish import when 90% of the catfish imported by US in 2000 came from Vietnam (Cohen and Hiebert, 2001). Therefore, US catfish import

from other foreign suppliers could be ignored in this study; ii) Catfish fillets produced by US and Vietnamese processors are differentiated under "labeling" law and biological species differences; and iii) U.S and Vietnamese firms behave as price setting duopolists.

With the foregoing assumptions the econometric model used to test for duty effects is

$$(17)\quad \Delta \ln P_{1,t} = a_0 + a_1 PRELIM_t + a_2 FINAL_t + \sum_{k=3}^{5} a_k D_{k,t} + a_6 \Delta \ln P^{-}_{2,t} + a_7 \Delta \ln P_{p,t} + a_8 \Delta \ln P_{sal,t} + a_9 \Delta \ln I_t + a_{10} \Delta \ln f_t + a_{11} \Delta \ln W_t + a_{12} \Delta \ln G_t + a_{13} \Delta \ln P_{1,t-1} + e_{1,t}$$

$$(18)\quad \Delta \ln P^{-}_{2,t} = b_0 + b_1 PRELIM_t + b_2 FINAL_t + \sum_{k=3}^{5} b_k D_{k,t} + b_6 \Delta \ln P_{1,t} + b_7 \Delta \ln P_{p,t} + b_8 \Delta \ln P_{sal,t} + b_9 \Delta \ln P_{o,t} + b_{10} \Delta \ln I_{1,t} + b_{11} \Delta \ln f_t + b_{12} \Delta \ln X_t + b_{13} \Delta \ln P^{-}_{2,t-1} + e_{2,t}$$

$$(19)\quad \Delta \ln Q_{1,t} = c_0 + c_1 PRELIM_t + c_2 FINAL_t + \sum_{k=3}^{5} c_k D_{k,t} + c_6 \Delta \ln P_{1,t} + c_7 \Delta \ln P^{-}_{2,t} + c_8 \Delta \ln P_{p,t} + c_9 \Delta \ln P_{sal,t} + c_{10} \Delta \ln I_{1,t} + c_{11} \Delta \ln Q_{1,t-1} + e_{3,t}$$

where $\Delta \ln x_t = \ln x_t - \ln x_{t-1}$ denotes the first-difference operator. Equations (17) and (18) correspond to the price reaction functions (12) and (9) whereas equation (19) corresponds to the domestic demand equation (1). The time subscript t denotes months (t =1, 2, …, 84) for January 1999 through December 2005) and the $e_{i,t}$ (i= 1, 2, 3) denote random disturbance terms. P_p, P_{sal}, P_o and I are exogenous demand shifters. $P_{sal,t}$ and $P_{p,t}$ are the prices of imported salmon and poultry respectively in the US in month t. $P_{o,t}$ is the price of Vietnamese catfish export to non-US markets. I_t is US personal income per capita while W_t represents for US wage rate in manufacture sectors and G_t represents domestic energy price in month t. Variable f_t is a monthly freight index for shipments from the Pacific used to proxy shipping costs from Vietnam to the US. X_t is the real US-Vietnam exchange rate (VND/$) in

month *t*. A more complete description of the data and sources are provided in Table 2. The price of Vietnamese catfish exported to non-US markets is deflated by the world Consumer Price Index (CPI); all other monetary variables in the model are deflated by US Consumer Price Index.

The tariff effects are modeled using two dummies: *PRELIM* for the period of investigation (June 2002 through July 2003) and *FINAL* for the implementation period (August 2003 through December 2005). The *PRELIM* variable is included to test whether foreign firms raise price during the investigation period in order to reduce the dumping margin in the event of a positive ruling, as proposed by Blonigen and Heynes (2002) and by Feenstra (2004). The tariff effect is the sum of the estimated coefficients from the two dummies. Quarterly dummies are included to control for seasonal demand shifts (Kinnucan and Miao 1999). The first difference logarithm specification is used because preliminary analysis showed the variables to be stationary, coefficients of dummy variables can be interpreted as relative change, and coefficients of continuous variables can be interpreted as elasticities. Lagged dependent variables are specified to test for dynamic effects.

To determine the producer impacts of the tariff we augmented the foregoing wholesale-level model with the following inverse demand equation for catfish at the farm level:

$$(20)\qquad \Delta \ln P_{f,t} = d_0 + d_1 PRELIM_t + d_2 FINAL_t + \sum_{k=3}^{5} d_k D_{k,t} + d_6 \Delta \ln P_{1,t} + d_7 \Delta \ln Q_{f,t-5}$$

$$+ d_8 \Delta \ln P_{p,t} + d_9 \Delta \ln P_{sal,t} + d_{10} \Delta \ln P_{f,t-1} + e_{4,t}$$

where $P_{f,t}$ is the price paid by US processors for live catfish purchased from farmers in month t, $Q_{f,t}$ is the quantity of live catfish purchased by US processors in month t, $e_{4,t}$ is a random disturbance term, and the other variables are as previously defined.

Regression results

To account for possible cross-equation correlation in the error terms the equations were estimated as a system using Seemingly Unrelated Regression (SUR). To assess the sensitivity of results to estimation procedure two sets of estimates are provided: a wholesale-level model consisting of equations (17) – (19) and a combined wholesale-to-farm model consisting of equations (17) – (20). Because estimation results are similar our discussion focuses on the wholesale model unless indicated otherwise.

Focusing first on the demand equation the model has an R^2 of 0.54 and most of the estimated coefficients have the correct signs. The estimated coefficient of US price is -2.4 with a t-ratio of -3.3, which suggests the domestic demand for US fillets is price elastic. This implies that if home industry raises price to increase tariff revenues, as predicted by the Bertrand duopoly model, revenues from domestic sales will fall. The estimated coefficient of US income is 1.4 with a t-ratio of 1.4. Although the estimated income coefficient is larger than one, a one-tail test does not permit one to conclude that frozen fillets are a luxury good. Importantly, the estimated coefficient of Vietnam price is 0.13 with a t-ratio of 2.4. This suggests a tariff-induced increase in the price of Vietnam fillets will have little effect on the demand for US fillets. That US fillets are a poor substitute for Vietnam fillets should not be surprising in that the former are substantially more expensive (see table 1). And this is true even allowing for full tariff pass through, i.e., assuming not of the tariff is absorbed by Vietnamese exporters. The estimated coefficient for the lagged dependent variable is -0.53

with a *t*-ratio of -6.2. The negative adjustment elasticity means that long-run elasticiites are smaller than short-run elasticities, which probably reflects inventory behavior. (In the short-run processors can meet a demand increase by drawing down inventory; in the long run production must be increased.) The remaining variables, including the two policy dummies *PRELIM* and *FINAL*, are insignificant at usual probability levels.

Turning to the price reaction functions the US price equation shows better explanatory power (R^2 = 0.48) than the Vietnam price equation (R^2 = 0.26), as might be expected due to the use of proxy variables in the latter. Coefficient estimates are consistent with theory in that the price reaction functions are upward sloping with the estimated coefficient of rival's price in each equation positive. However, the effects are asymmetric with estimated coefficient of US price elastic at 5.0 (*t*-ratio = 3.8) and the estimated coefficient of Vietnam price inelastic at 0.02 (*t*-ratio = 2.6). Thus, whereas the Vietnam price is highly sensitive to changes in the US price, the reverse is not true. In particular, a 10% increase in the Vietnam price would raise the US price by a mere 0.2% *ceteris paribus*. This result reinforces the inference from the demand equation that US fillets are a poor substitute for Vietnam fillets over the observed price range.

The estimated coefficients of the lagged dependent variable in the US and Vietnam price equations are 0.34 and -0.46, respectively, with t-ratios exceeding 3.8 in absolute value. Dividing the foregoing price effects by one minus these estimated coefficients yields long-run elasticities of 3.4 and 0.03. Hence, the conclusion that price reaction is highly asymmetric is not much affected by length of run.

Prices of salmon imports and poultry have no significant effect on both prices of the domestic and Vietnamese catfish fillets. However, freight cost from Pacific gives significant

and expected effects on the prices. A 10% increase in freight cost from Pacific raises price of the domestic product by 1.1% but lowers price of the import from Vietnam by 12.3%.

PRELIM is not significant in either equation. Hence, the hypothesis that firms set price strategically during the investigation period to influence the tariff rate is rejected. *FINAL* is significant in the US price equation but not in the Vietnam price equation. Recalling that the Vietnam price is measured exclusive of the tariff, the lack of significance of *FINAL* in the Vietnam price equation implies US consumers bore the tariff's entire incidence. Despite the tariff's apparent ability to raise the US price of the imported product, it had little effect on the price of the US product. In particular, the estimated coefficient of *FINAL* in the US price equation is 0.005, which means the US price during the duty period increased by a mere 0.5%, *ceteris paribus*. The reason for this modest effect is the low cross-price elasticity of demand as explained in connection with the demand equation.

In the extension model to explore the tariff effect on US farm price (Table 4), the regression results for US home price and Vietnamese price equations are similar to the ones in Table 3, except coefficient of freight cost is not significant any more. The tariff coefficient in demand equation for US frozen catfish fillets becomes significant, although just at 90% level. After the US antidumping is implemented, the demand for US catfish fillets rises by 3.1% associated to a 0.6% improvement in its price. However, the positive effect of the antidumping on US farm price is not significant.

Conclusion

The empirical results suggest domestic and imported catfish compete in a competitive condition rather than in a Bertrand strategy. In a duopoly competition, the results can be explained by the nullification of the duty effect as time allows both firms adjust their prices.

Further studies are necessary to examine long term effects of the antidumping measures. In the meantime, our analysis suggests antidumping duties are a weak tool for protecting the domestic catfish industry. The basic reason is that US fillets are a poor substitute for Vietnam fillets (cross-price elasticity = 0.13). Hence, a tariff that raises the price of the imported product has little effect on the demand for the domestic product. Indeed, our empirical estimates suggest the 45-64% duties imposed on imported frozen catfish fillets raised the domestic price of frozen catfish fillets by less than one percent, and had no measurable effect on the farm price. Still, industry efforts were not futile in that plaintiffs in the antidumping case were able to collect some $9.2 million in tariff revenue over the sample period (equivalent to 3% of wholesale value) thanks to the Byrd Amendment.

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Table 1. Imports, Production and Prices of US Catfish Industry 1999-2005

	1999	2000	2001	2002	2003	2004	2005
Frozen fillets imports from VN (mil. lb.)	1.99	7.04	17.12	9.62	4.25	6.57	17.42
US frozen fillets production (mil.lb.)	102	120	115	131	125	122	124
US Farm Production (mil. lb.)	597	594	597	631	661	630	601
Vietnam export price ($/lb)	2.04	1.52	1.26	1.29	1.21	1.15	0.93
US frozen fillets price ($/lb)	2.76	2.83	2.61	2.39	2.41	2.62	2.67
Farm price (cent/lb.)	73	75	65	57	58	70	72

Table 2. Description of variables and source of data

Variable	Description	Unit	Source of data
P_1	Domestic price of frozen catfish fillets	$/lb	USDA
P_2^-	f.o.b price of Vietnamese frozen catfish fillets	$/lb	NMFS
P_{sal}	Price of salmon import	$/lb	NMFS
P_p	US poultry price	$/lb	IMF
I	US personal income per capita	$/year	US BEA
F	Freight index from Pacific		US BLS
W	US Wage of manufacture sector	$/hr	US BLS
G	Energy index in US market		US BLS
X	Real exchange rate of VND against US$	VDN/$	www.oanda.com

Table 3. SUR Estimates of Price Reaction and Demand Equations for Frozen Catfish Fillets

	US Price		Vietnam Price		US Quantity	
Variable	Coef.	*t*-value	Coef.	*t*-value	Coef.	*t*-value
PRELIM	0.000	0.068	0.015	0.426	0.001	0.054
FINAL	0.005**	2.126	-0.022	-0.783	0.019	1.207
US domestic price			4.972***	3.801	-2.359***	-3.268
Vietnamese price	0.019***	2.613			0.131**	2.407
Non-US market price			0.022	0.395		
Poultry price	0.019	0.253	-0.289	-0.293	-0.593	-1.068
Salmon price	0.016	1.208	-0.026	-0.146	-0.122	-1.211
US per capita income	0.128	1.228	-0.215	-0.149	1.421*	1.821
Manufacture wage	0.207	1.329				
Energy index	0.004	0.151				
Freight index from Pacific	0.114**	2.106	-1.233*	-1.658		
Exchange rate			0.192	0.705		
Lag dependent variable	0.345***	3.879	-0.464***	-4.657	-0.533***	-6.246
First quarter	0.008**	2.374	0.014	0.341	0.202***	8.392
Second quarter	-0.003	-0.914	0.049	1.085	0.039*	1.694
Third quarter	-0.005*	-1.748	0.050	1.242	0.090***	4.034
Constant	-0.003	-1.213	-0.025	-0.741	-0.095***	-4.980
R^2	0.48		0.26		0.54	

, **, * significant at 0.1, 0.05 and 0.01 levels*

Table 4. SUR Estimates of System with Farm Price

	US Wholesale Price		Vietnam Price		US Quantity		US Farm Price	
Variable	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
PRELIM	0.002	0.657	-0.004	-0.106	0.012	0.582	0.004	0.643
FINAL	0.006***	2.531	-0.029	-0.963	0.031*	1.824	0.006	1.167
US domestic price			5.087***	3.656	-2.958***	-3.830	1.148***	4.640
Vietnamese export price	0.017**	2.318			0.126**	2.244		
Non-US market price			0.050	0.919				
Farmed fish demand (5^{th} lag)							-0.084***	-3.139
Poultry price	0.004	0.049	-0.441	-0.382	-0.451	-0.704	-0.113	-0.568
Salmon price	0.016	1.172	-0.024	-0.127	-0.169	-1.614	-0.070**	-2.161
US per capita income	0.135	1.291	-0.935	-0.660	1.454*	1.865		
Manufacture wage	0.232	1.472						
Energy index	0.003	0.133						
Freight index from Pacific	0.073	1.263	-0.952	-1.207				
Exchange rate			-0.531	-1.055				
Lag of dependent variable	0.320***	3.444	-0.460***	-4.463	-0.547***	-6.321	0.208**	2.248

First quarter	0.009**	2.471	0.009	0.223	0.205***	8.350	0.011	1.596
Second quarter	-0.003	-0.831	0.056	1.205	0.029	1.201	-0.003	-0.467
Third quarter	-0.005	-1.562	0.055	1.362	0.088	3.888	0.001	0.189
Constant	-0.005	-1.629	-0.018	-0.504	-0.103***	-5.279	-0.004	-0.748
R^2	0.46		0.23		0.54		0.55	
Durbin *h*	-1.53		-0.11		-1.65		0.90	

, **, * significant at 0.1, 0.05 and 0.01 levels*