APPLICATION OF ECONOMETRIC MODELS FOR PRICE IMPACT ASSESSMENT OF ANTIDUMPING MEASURES AND LABELING LAWS ON GLOBAL MARKETS: A CASE STUDY OF VIETNAMESE STRIPED CATFISH

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Abstract

Since 1998, Vietnamese fishery product exports, especially frozen catfish fillets, to the US increased significantly supported by the bilateral trade agreement (BTA) between the two countries signed in December 2001. With similarities of texture and taste but of lower price, catfish imports from Vietnam were a concern of US catfish producers. To protect its catfish sector, the US Congress passed a labeling law in November 2002 restricting the use of the word "catfish" to only those fish of the Ictaluridae family, which is farmed popularly in US southern states. Antidumping measures, a trade policy permitted by the WTO, were also issued by the US in 2003 leading to tariffs ranging from 44.66% to 63.88% levied on frozen fillet catfish imported from Vietnam.

This paper applies selected econometric models examining the effects of the US laws and policy on prices and trade flows, as a part of a comparative case study of other primary production. With an assumption the products of the US and of Vietnam are similar as stated by the US ITC, econometric models show that the antidumping tariff raised the US domestic price of processed catfish and lowered the Vietnamese export price. The fall in the price of Vietnamese catfish caused by the US tariff raised market demand outside the US and consequently boosted the Vietnamese export volume of catfish. In another analysis with Bertrand competition assumption, the bilateral trade agreement is estimated to benefited the US consumers, the antidumping measures were not favourable to them and to US farmers. The labeling law in reality harmed the US catfish industry.

Keywords: antidumping, labeling, world market, econometric model, catfish, trade

INTRODUCTION

Globalization benefits growth, encourages technology transfer, and alleviates poverty, hunger, and malnutrition. Through various negotiation rounds of the World Trade Organization (WTO) and its predecessor, the General Agreement on Tariffs and Trade (GATT), tariff barriers have decreased worldwide but anti-dumping measures have surged to play a crucial role as one of the most important non-tariff barriers (2004). Antidumping duties have been recently used with increasing frequency, by more countries, and against more products (Prusa, 2005). From 1980 to 2004, the US alone filed 1,092 antidumping tariff cases and 461 of them led to an affirmative determination and antidumping duty imposed on targeted imports.

Antidumping duties are enforced in the country by the Continued Dumping and Subsidy Offset Act of 2000, commonly referred to as the Byrd Amendment (USITC, 2000). The Byrd Amendment permits successful petitioners for anti-dumping duties to collect tariff revenues. Being substitutes of imported products, an increase in price of domestic products would enforce consumers switch to buy more imported goods. If the foreign firms was imposed an antidumping tariff, calculated as a percentage of their revenues, an increase in their sales may result in an increase in tariff revenues. The Byrd Amendment therefore increases an incentive for the domestic firms to increase its price because by doing so it increases the sales of the foreign firms, which increases the domestic firm's revenue from the tariff. This concept will be further developed later in the text with reference to farmed catfish imports to the US. As a consequence, the Byrd Amendment has the paradoxical effect of increasing the value and total volume of imports (Evenett, 2005) compared to the equilibrium without the Byrd Amendment and thereby 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, leading to the duty being borne by the foreign supplier rather than the importing-country consumer (Kinnucan, 2003).

As processed and differentiated agricultural products are increasingly traded across national borders (Reimer and Stiegert, 2006) more of them are facing antidumping measurements conducted by importing countries (Table 1). This presentation examines the case of Vietnamese catfish, of which the US used to be the biggest importer before an antidumping tariff was imposed on the product, as an example from the fish trade, which is becoming increasingly important particularly to developing countries (Kurien, 2005). Catfish represents a useful case study in that it shares characteristics with other agricultural products subjected to antidumping activity, data availability to measure impacts, an *ex ante* research based on a simulation model predicted that the tariff would be ineffectual (Kinnucan, 2003). A 2001 bilateral trade agreement between the US and Vietnam and a 2002 federal labeling law to differentiate the US product from imported catfish also provides a chance for an empirical estimation to test whether such institutions affect price and trade flow of catfish.

Prior to model estimation to explore impacts of the trade policy, the globalization of Vietnamese catfish industry is also summarized alongside with reviewed antidumping process and arguments on the Byrd Amendment. With a simplified world market of US and Vietnamese catfish, first-difference logarithtic and error-correction models are specified under perfect competition conditions, followed with an estimated equation system of price-reaction functions implied by a market-clearing model for imperfect competition to identify the price and demand impacts of the tariff scheme.

First and foremost the impacts of the steps adopted by the US in respect the catfish imports to the US was undertaken to demonstrate its relevance on a fast developing food commodity sector that supports over 150,000 livelihoods and generates nearly 1 billion US$ per annum revenue to a developing country. Secondly, the case of catfish is considered to be one of the most significant instances in which an aquaculture commodity has been dealt with and drew attention of the public at large.

Globalization of Vietnamese catfish and the US market

The catfish farming, based on the tra or striped catfish, *Pangasianodon hypophthalamus*, in Vietnam developed rapidly with the country adopting a "free economy" and the consequent joining global fora to facilitate marketing (Cohen & Hiebert, 2001), with the sector currently employing almost a half of million labours (Narog, 2003). Under a close cooperation between French and Vietnamese fisheries researchers, artificial propagation techniques of catfish were developed and commercialized in 1998 involving 15,000 families (Cohen & Hiebert, 2001) and concurrently relevant management techniques were improved upon in respect of feeds and feeding, health management, etc., and the catfish farming gradually took root in the Mekong Delta in South Vietnam from the latter half of 1990s. Vietnamese farmers also adopted advanced feeding technologies to improve fish meat quality, in order to comply to requirements of US and EU consumers whilst catfish processors in turn invested in state of the art machinery (Cohen and Hiebert, 2001), to enable to comply to quality control protocols of HACCP and Good Aquaculture Practice (GAP) recommended by US FDA and FAO.

Since gaining membership in APEC in 1998, an organization of economic cooperation oriented to reducing tariff and non-tariff barriers among its 21 member economies in the Asia-Pacific region, Vietnamese fisheries export to the US increased significantly, especially in the

catfish sales, from 0.6 million pounds in 1998 to 17 million pounds in 2001 (Sengupta, 2003). Although catfish was exported even before 1995, when the official embargo on Vietnamese exports was lifted by the US, the tremendous spurt in exports to the US occurred in 1999 when raw seafood tariffs were dropped (Figure 1), and with the subsequent bilateral trade agreement between the US and Vietnam in December 2001 the volume reached 18.3 million pound of catfish valued at $55.1 million in 2002 (Sengupta, 2003).

With similarity in texture and taste but lower price, the "most similar product in characteristics and uses" (U.S. International Trade Commission, 2002), Vietnamese catfish was beginning to threaten the US catfish growers and wholesalers when 90% of the catfish imported by US in 2000 was from Vietnam (Cohen and Hiebert, 2001). Catfish production is the biggest aquaculture industry in the United States and frozen catfish fillets is the most important product of the US catfish processing industry (Harvey, 2005). In 2005, 124 million pounds of frozen catfish fillet were sold by domestic processors, increasing 1.5% relative to 2004 (Harvey, 2006). Catfish is raised popularly in southern states of the US are of the Ictaluridae family, and predominantly channel catfish *(Ictalurus punctatus)* and blue catfish (*Ictalurus furcatus*) farmed in closed ponds while Vietnamese catfishes are basa (*Pangasius bocourti*) and tra (*Pangasianodon hypophthalamus*) belong to the family Pangasidae, and cultured popularly in pond and pens along the Mekong River, predominantly the latter.

After a marketing dispute, the US Congress passed a law in November 2002 restricting the use of the word "catfish" for labeling, restricting its use to only those Ictaluridae varieties farmed in US (Narog, 2003), and this was considered the first step of the "catfish war" (Kinnucan, 2003). The next step was lobbying for renegotiation of the 2001 bilateral trade agreement between US and Vietnam to set limits on catfish imports (Cooper, 2001 ; cited by

Kinnucan, 2003). The third was the antidumping suit filed by US producers that led to tariffs ranging from 44.66% to 63.88% levied on frozen fillet catfish imported from Vietnam. Considering Vietnamese economy is 'non-market' for antidumping investigation purpose, US Department of Commerce took India as a proxy country to identify the 'dumping margin' (Intrafish, 2003). The tariff is theoretically a 'dumping margin' which is the difference between price of the subjected goods sold in the home market and in the US market according to antidumping duty calculations suggested by US-DOC and ITC. Therefore, the initial tariff imposed on Vietnamese catfish was actually the gap between price of catfish frozen fillet sold in India and that in the US market, but not between the Vietnamese and US markets.

Antidumping Measurement – Definition and Investigation Process

Under the WTO regulations, foreign suppliers named in antidumping suits must comply to two criteria for duties to be imposed (Knetter & Prusa, 2000). First, there must be evidence that the domestic industry has been materially injured (e.g., a loss or decline in profitability) by the foreign imports, and secondly, the foreign suppliers must be found to be selling their products at "less than a fair value" prices. A dumping case occurs when the products are sold at a price "less than fair value". According to Knetter and Prusa (2000), "less than fair value" is determined by: (1) 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) showing that the price charged in the domestic market is below the estimated 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) administer the antidumping laws. Each has distinct roles in the antidumping investigation process. In response to petitions 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 that they observe as 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 the targeted imported products. Both agencies make preliminary and final determinations during the investigations. According to Blonigen and Heynes (2002) if both arrive at 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/or 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. Blonigen and Heynes (2002) summarized the investigation process and suggested that it would take up to 280 days from the date of filing the petition to the final determination.

The Byrd Amendment and Its Impacts

The "Byrd Amendment", named after its sponsor, the Democratic Senator Robert Byrd and passed by US Congress in 2000, permits plaintiffs to collect revenues from 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 covered by the order or that have been acquired by a firm that opposed the petition would not be considered as an affected domestic producer.

The Byrd Amendment has been found in violation of WTO trade remedy rules (Jung & Lee, 2003) and imposes distortions on the U.S. economy. In this regard the Congressional Budget Office (2004) estimated that US$ 3.85 billion in revenues collected will be distributed to firms between 2005 and 2014. Between 2001 and 2004, US$ 1 billion was paid to 770 firms that were allegedly harmed by unfair trade practices (GAO, 2005) but more than one-third was to a single corporation, the Timken Company, and two of its subsidiaries (CITAC, 2006). More than half of the US$ 226 million of Byrd Amendment payouts in 2005 was 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 were manufacturers of ball bearings, candles and steel (CITAC, 2006). In the catfish case, the Byrd disbursement gave US processors US$ 9.2 million in two fiscal years of 2005-2006, or 3% of their 2005 sales revenue of frozen catfish fillets. The amounts disbursed to individual corporations were accused to 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 Europe, 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 rights 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 are able to retaliate against U.S. goods. The effects of antidumping measurements and the impacts of Byrd

Amendment for example, have also been dealt with previously by Blonigen and Prusa (2001), Blonigen and Heynes (2002), Kinnucan (2003), Zanardi (2004), Hansen and Prusa (1996), Prusa (Prusa, 2005), Feenstra (2004), and Kinnucan and Myrland (2005). Jung and Lee (2003) suggested that the Byrd Amendment provided an incentive for domestic industries to file antidumping legislations, distort competition between the firms who are beneficiaries and those who did not have sufficient resources or information to support petitions. The amendment disappoints the legitimate expectation from exporting countries and infringes 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) provided 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) showed that where the latter raised prices in equilibrium, a seemingly paradoxical result arose as the foreign firm began to be 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. In view of the apparent disadvantages and the imbalances that were brought by the Byrd Amendment it was repealed by the US Congress in January 2006 and came into force in October 2007.

METHODS

For simplification, the product in the world market was assumed identical to a combination of Ictalurus catfish and Pangasius catfish, so called the world catfish market in short. With that assumption, an equilibrium displacement model (EDM) was developed for the world market to explore the theoretical impacts of the antidumping measures on the price and trade flows in the world market. Based on the reduced equations derived from the equilibrium

displacement model, time-series econometrics with first-difference logarithmic and error-correction models were estimated under perfect competition conditions.

The subsidy effect of the Byrd Amendment on prices of the two products, US and Vietnamese catfish, was analyzed alongside with an estimated equation system of price-reaction functions for imperfect competition to identify the price and demand impacts of the tariff, using the Seemingly Unrelated Regression (SUR) method. The analysis also examined the previous suggestion by Evennet (2006) that the Byrd Amendment had the paradoxical effect of increasing the value and total volume of imports and undermined the original intent of the duty because it gave an incentive for the domestic firms to increase their price for an increase in the sales of the foreign firm, which increased the domestic firms' revenue from the tariff.

Monthly data from January 1999 to August 2006 were utilized for regression of empirical models. Description and source of the data is presented in Tables 2 and 3. The data since January 1999 focus on the effort to isolate the possible effects on the Vietnam-US bilateral trade issue related to APEC membership of Vietnam in November 1998. The membership created lots of advantages for Vietnamese producers to export their products to the US as the US custom tariff on Vietnamese products were reduced considerably.

EFFECTIVENESS OF ANTIDUMPING MEASURES ON THE CATFISH MARKETS

Model Specification

As mentioned earlier, frozen fillets of US channel catfish and imported Pangasius catfish are considered perfect substitutes in this study. This consideration is based on the affirmation by the U.S. International Trade Commission (2002) that "most similar product in characteristics and uses". With the stated assumption on the world catfish market, the word "catfish" may be used for a combination of Ictalurus catfish and Pangasius catfish. US export and Vietnam import of

catfish are negligible and were not considered in this review. Free trade is assumed in the model specification. The antidumping tariff is a tool of trade remedy, permitted by the WTO. Transaction costs and insurance are assumed to be constant, and the "rule of one price" also holds.

Demand (Import) Side

The EU imports but does not produce either the Ictalurus catfish or Pangasius, the Rest-of-World (ROW) is treated as a group of importers. Accordingly, the three demand equations for three importers are:

$M_{eu} = M (P_{eu,} Z_{eu})$ EU demand for catfish imports (Equation 1)

$M_{us} = M (P_{us}, Z_{us})$ US demand for catfish imports (Equation 2)

$M_r = M (P_{rd}, Z_r)$ Rest-of-world's demand for catfish imports (Equation 3)

Where, $Z_{eu,}$ Z_{us} and Z_r are demand shifters of catfish imports to US, EU and ROW.

P_i (i= us, eu and rd) is the consumer price of the frozen catfish fillets in the markets of the US, EU and the ROW.

Supply (Export) Side

On the supply side, freight cost is the most important trade cost of catfish exports. A rise in freight cost lowers catfish exports. Assuming Vietnam is the globally biggest exporter of catfish, the supply equation for Vietnamese catfish exports and its competitors from the ROW are described as:

$X_v = X (P_v, C_v)$ Vietnamese export quantity of catfish (Equation 4)

$X_r = X (P_{rs}, C_r)$ ROW export quantity of catfish (Equation 5)

where P_v and C_i (i=v, r) are export prices and costs of Vietnamese and ROW's exporters.

Price Linkage Functions

The price linkage functions among the markets can be written as

$$P_{us} = P_{us}(P_v, T) \quad \text{(Equation 6)}$$

$$P_{eu} = P_{eu}(P_v) \quad \text{(Equation 7)}$$

$$P_{rd} = P_{rd}(P_v) \quad \text{(Equation 8)}$$

$$P_{rs} = P_{rs}(P_v) \quad \text{(Equation 9)}$$

where T = (1+t) with t as the *ad valorem* US tariff rate imposed on the Vietnamese catfish imports

Market Equilibrium

Under the free trade assumption and zero balance of trade with the sum of exports equal to sum of imports, the market equilibrium is defined by ;

$$X_v + X_r = M_{us} + M_{eu} + M_r \quad \text{(Equation 10)}$$

The above ten equations can be rewritten under equilibrium displacement model (EDM) form as:

$$M^*_{eu} = -\mu_{eu}P^*_{eu} + z_{eu}Z^*_{eu} \quad \text{(Equation 11)}$$

$$M^*_{us} = -\mu_{us}P^*_{us} + z_{us}Z^*_{us} \quad \text{(Equation 12)}$$

$$M^*_{r} = -\mu_{r}P^*_{rd} + z_{r}Z^*_{r} \quad \text{(Equation 13)}$$

$$X^*_{v} = \varepsilon_v P^*_v - \varepsilon_{vc}C_v^* \quad \text{(Equation 14)}$$

$$X^*_{r} = \varepsilon_r P^*_{rs} - \varepsilon_{rc}C_r^* \quad \text{(Equation 15)}$$

$$P^*_{us} = P^*_v + T^* \quad \text{(Equation 16)}$$

$$P^*_{eu} = \sigma_{eu} P^*_v \quad \text{(Equation 17)}$$

$$P^*_{rd} = \sigma_{rd} P^*_v \quad \text{(Equation 18)}$$

$$P^*_{rs} = \sigma_{rs} P^*_v \quad \text{(Equation 19)}$$

$$k_v X^*_v + k_{xr} X^*_r = k_{us} M^*_{us} + k_{eu} M^*_{eu} + k_{mr} M^*_r \quad \text{(Equation 20)}$$

where the asterisks represent percentage changes of the variables (for example, $X^* = d\ln X = dX/X$). Endogenous variables include M^*_{us}, M^*_{eu}, M^*_r, X^*_v, X^*_r, P^*_{us}, P^*_{eu}, P^*_{rd}, P^*_{rs} and P^*_v while the exogenous are Z^*_{us}, Z^*_{eu}, Z^*_r, C_v^*, C_a^*, and T^*.

Parameters in the equations 11 to 20 are described in Table 2 and they all are theoretically positive, assuming that the product is normal in all markets. The methods to build EDM based on Kinnucan (2003). Solving the above equations, we have

$$\psi X^*_{vn} = -\varepsilon_{vf}(\psi - \varepsilon_v k_v) C_v^* + \varepsilon_v k_{xr} \varepsilon_{rf} C_r^* + \varepsilon_v k_{us} z_{us} Z^*_{us} + \varepsilon_v k_{eu} z_{eu} Z^*_{eu} + \varepsilon_v k_{mr} z_r Z^*_r + \varepsilon_v k_{us} \mu_{us} T^* \quad \text{(Equation 21)}$$

where $\psi = (k_v \varepsilon_v + k_{xr} \varepsilon_r \sigma_{rs} + k_{us} \mu_{us} + k_{eu} \mu_{eu} \sigma_{eu} + k_{mr} \mu_r \sigma_{rd}) > 0$ (Equation 22)

Therefore, the reduced form equation of VN exports will be

$$X^*_{vn} = [-\varepsilon_{vf}(\psi - \varepsilon_v k_v)/\psi] C_v^* + (\varepsilon_v k_{xr} \varepsilon_{rf}/\psi) C_r^* + (\varepsilon_v k_{us} z_{us}/\psi) Z^*_{us} + (\varepsilon_v k_{eu} z_{eu}/\psi) Z^*_{eu} + (\varepsilon_v k_{mr} z_r/\psi) Z^*_r + (\varepsilon_v k_{us} \mu_{us}/\psi) T^* \quad \text{(Equation 23)}$$

Similarly, the reduced form equations of exported Vietnamese catfish price, US catfish price, and US imports of catfish will be

$$P^*_v = (k_v \varepsilon_{vf}/\psi) C_v^* + (k_{xr} \varepsilon_{rf}/\psi) C_r^* + (k_{us} z_{us}/\psi) Z^*_{us} + (k_{eu} z_{eu}/\psi) Z^*_{eu} + (k_{mr} z_r/\psi) Z^*_r - (k_{us} \mu_{us}/\psi) T^* \quad \text{(Equation 24)}$$

$$P^*_{us} = (k_v \varepsilon_{vc}/\psi) C_v^* + (k_{xr} \varepsilon_{rc}/\psi) C_r^* + (k_{us} z_{us}/\psi) Z^*_{us} + (k_{eu} z_{eu}/\psi) Z^*_{eu} + (k_{mr} z_r/\psi) Z^*_r$$

$$+ [(\psi - k_{us}\mu_{us}) /\psi)]T^* \quad \text{(Equation 25)}$$

$$M^*_{us} = - (\mu_{us}k_v\varepsilon_{vf}/\psi)C_v^* - (\mu_{us}k_{xr}\varepsilon_{rf}/\psi)C_r^* + [z_{us}(\psi - \mu_{us}k_{us})/\psi]Z^*_{us} - (\mu_{us}k_{eu}z_{eu}/\psi)Z^*_{eu} - (\mu_{us}k_{mr}z_r/\psi)Z^*_r - \mu_{us}(\psi - k_{us}\mu_{us}) /\psi\, T^* \quad \text{(Equation 26)}$$

The theoretical effects of antidumping measures on Vietnamese export price and consumer price in the US could be derived as follows

$$P^*_v/ T^* = - k_{us}\mu_{us}/\psi \leq 0 \quad \text{(Equation 27)}$$

$$P^*_{us}/T^* = (\psi - k_{us}\mu_{us})/ \psi < 1 \quad \text{(Equation 28)}$$

The effects can be interpreted in tariff elasticities of the prices. A 1% increase in antidumping tariff raises the US price of catfish by less than 1% and lowers the Vietnamese price by less than 1%.

The elasticities of other endogenous variables with respect to the exogenous variables are summarized in Table 5.

Empirical Estimation of the Reduced Form Equations

US personal income per capita and the price of catfish feed are considered demand shifters of US import demand. For demand shifters in the EU and ROW markets, prices of salmon and poultry are assumed as suitable substitutes for catfish. Accordingly, a reduced form equation of Vietnamese exports of frozen catfish fillets could be regressed as

$$X^*_{vn} = \beta_1 F_v^* + \beta_2 F_a^* + \beta_3 Y^*_{us} + \beta_4 P_f^* + \beta_5 P^*_{salm} + \beta_6 P^*_{poul} + \beta_7 T_v^* + \varepsilon \quad \text{(Equation 29)}$$

Dummy variables Q_1, Q_2 and Q_3 for yearly quarters and an intercept are then included in the above model following a suggestion from Kinnucan and Miao (1999). The descriptions of variables are in given in Table 2.

In efforts to compete with the Vietnamese catfish, the labeling legislation in November 2002 supported US catfish producers as it did not permit *Pangasius* catfish to be called "catfish". With the labeling legislation, the US catfish producers expected a price increase. Dummy variable LABEL, therefore, is added into the empirical reduced equations to explore the effects of the legislation. The LABEL gets unit value from December 2002 when the labeling law was effective and its value is zero before then. The effect of the US antidumping can be explored with the dummy variable TAX. Until January 2003, the time tariff imposed on Vietnamese catfish import to US, dummy variable TAX equals zero. TAX gets value of one after January 2003 until December 2005. An additional dummy variable BTA is included in the model to examine the effect of the bilateral trade agreement (BTA) between the US and Vietnam signed in December 2001. The variable BTA also helps to control effect of the agreement when exploring effects of the antidumping and the labeling law. Equations (24) and (25) for Vietnamese and US prices becomes

$$P^*_v = \alpha_0 + \alpha_1 BTA + \alpha_2 TAX + \alpha_3 LABEL + \alpha_4 Y^*_{us} + \alpha_5 P_f^* + \alpha_6 P^*_{salm} + \alpha_7 P^*_{poul} + \alpha_8 F_v^* + \alpha_9 F_a^* + \alpha_{10} Q_1^* + \alpha_{11} Q_2^* + \alpha_{12} Q_3^* + \varepsilon \quad \text{(Equation 30)}$$

$$P^*_{us} = \beta_0 + \beta_1 BTA + \beta_2 TAX + \beta_3 LABEL + \beta_4 Y^*_{us} + \beta_5 P_f^* + \beta_6 P^*_{salm} + \beta_7 P^*_{poul} + \beta_8 F_v^* + \beta_9 F_a^* + \beta_{10} Q_1^* + \beta_{11} Q_2^* + \beta_{12} Q_3^* + \varepsilon \quad \text{(Equation 31)}$$

The other empirical models for Vietnamese catfish exports and US imports with explanatory variables identical to the above equations (30) and (31) are also estimated to explore the effects of the BTA, antidumping measures and labeling law on catfish trade flow.

Because the data series are stationary at the difference levels with Dickey Fuller tests, the effects of the BTA, the catfish antidumping measures, and labeling law are examined using

logarithmic first difference models and error correction models. Statistical tests show that TAX and LABEL do not create structural breaks in the dataset. Interaction terms between them with other explanatory variables are dropped for model simplification. In basic and simple graphs of supply and demand, the US antidumping tariff and labeling law may shift (back or forward) the US import demand and/or Vietnamese export supply. The lags of dependent variables are added in logarithmic first difference models to capture the dynamic behavior of investigated economic variables.

Logarithmic First Difference Models

The OLS regression results of logarithmic first difference models show that the bilateral trade agreement and the labeling law did not have a significant effect on all investigated variables of the Vietnamese export price, US imports, and Vietnamese exports in Table 6. Effect of the antidumping measures (represented by *TAX* variable) is significant on the US price but insignificant on the three other variables. The antidumping effect on the US price is positive, consistent with the expected sign in the theoretical framework but its incidence is very small. After imposing an antidumping tariff on Vietnamese catfish imports, the US price is estimated to rise by 0.7%. The equation of the US price also gives the expected positive coefficient of catfish feed price. The transmission elasticity between prices of catfish feed and processed products are 0.11, confirming that feed is a major cost in the catfish farming industry.

A question mark remains on the negative effect of catfish feed in US import. This matter can be explained by the fact that the important role of feed as a major factor of the catfish industry. Exported catfish from Vietnam relied increasingly on pellet feed imports and one of the US biggest feed company, Cargill, established its plant in Vietnam to supply feed to the sector (Cohen & Hiebert, 2001; Sengupta, 2003). Along with the globalization, with advantages

from low price and huge available supply of soybean, important ingredients in feed composition, US catfish feed is traded over the world. As catfish feed price decreased, the price of catfish from the exporters (Vietnam and ROW) decreased, made their products more competitive and the US import increased as a consequence. A 1% drop in catfish feed price raised the US catfish imports by 5.57%. With two crops per year, the striped catfish is usually harvested in second and fourth quarters. Therefore, a shortage of catfish supply might occur in first and third quarters of a year, leading to a decrease in export volume and increase in price in the quarters as predicted in the first difference logarithms models.

Error Correction Models

Because the first difference models focus only on short term behaviors, missing adjustments and underlying long term relationships, these may not exhibit the potential effects of the BTA, the US antidumping and labeling law, error correction models were considered as an alternative. Satisfying the different stationary condition with Dickey Fuller tests, data series of continuous variables in four investigating equations are justified co-integrated by the Johansen and Juselius (JJ) co-integration test using trace statistics (Table 7) allowing Ordinary Least Square regression for error correction models. An important advantage of the error correction model is its ability to capture a long term trend in a co-integrated series and study their short term fluctuations from this trend. The error correction models described in Table 8 are estimated following Enders (2004) in which lags of spurious model residuals and lags of difference terms of explanatory variables are employed[1]. Three dummy variables BTA, TAX and LABEL are also added along with three other dummy variables representing the first three quarters of a year to be consistent with the first difference models.

[1] The spurious models are not reported to get this manuscript clearer.

In the short run term, with error correction models (ECM) in Table 8, the BTA has no significant effect on the US domestic price, Vietnamese export price, US imports, and or Vietnamese exports. While the US antidumping creates an expected positive effect on the US domestic price, the labeling law shows its effect reducing US catfish imports. After the labeling law becomes effective, catfish imports declined by 36.7%. However, the rise in US domestic price was insignificant.

The negative coefficients of poultry price in US and import equations represent the complementary attributes of poultry and catfish at the whole sale level. Salmon is shown to be an important substitute for US catfish imports. The catfish import increased by 2.87% with a 1% rise in world price of salmon. Although freight cost from Pacific Oceanshad no effect, freight cost from the Atlantic Ocean exhibited its expected effect on the US catfish imports. A 1% increase in the Atlantic freight cost reduced the import by 5.74%.

Long-Run Models

Significance of error correction terms in the estimated error correction models allow to derive long run models as given in Table 9. Ignoringg insignificant parameters, significant ones in the long-run models are long-run elasticity. US catfish imports apart from decreasing with the labeling law in the short run, also declined after the US antidumping tariffs were announced, controlling for the effect of the BTA. The BTA gave a significantly positive effect on US catfish imports. After the BTA, the US catfish imports increased by 67%. This figure justifies the benefits of globalization when the US consumers get more opportunities to select to choose from products of similar quality at a cheaper price. The cheaper price of Vietnamese catfish introduced them to an alternative for domestic catfish. This extreme increase in catfish imports created pressure on the US domestic catfish processors to reduce price.

The long-run model in Table 9 might be relevant for US price equation when the poultry and salmon prices, and freight cost from Pacific Oceans gave expected signs of their coefficients. All three dummy variables investigated gave significant effects. After the bilateral trade agreement was signed in December 2001, the US domestic catfish price declined by 1.4%, reflecting the competition from cheaper catfish from Vietnam. However, trade policies for domestic production protection such as the antidumping and also the labeling legislation were ineffective in the long run model of the US catfish price. The US domestic price declined, albeit to a small extent, after the labeling law was passed and antidumping tariffs were imposed on catfish imports.

The effect of US income on Vietnamese export was negative, suggesting Vietnamese catfish was an inferior good in the US market. This suggestion is consistent with the finding of Quagraine (2006). In long-run models, poultry is confirmed as a substitute for catfish. The Vietnamese catfish exporters seem to get a "free rider" effect with the US labeling laws. This legislation differentiates Vietnamese catfish from US catfish and motivates Vietnamese exporters to rename their brand as "tra, basa" in the US market and "Pangasius catfish" in others as well as forcing them to diversify their markets. The differentiation also gave Vietnamese exporters a monopolistic advantage to sell catfish not only in the US market but also in other markets. However, the export price of Vietnamese catfish was negatively affected by the legislation. After differentiation by the US labeling laws, export of Vietnamese catfish increased by more than three times but its price decreased 22.1%. US antidumping tariff also depressed the Vietnamese catfish export price by 23.7%. The result confirmed a previous study of Kinnucan (2003) which found that the US catfish antidumping did more to punish Vietnamese exporter than support the domestic catfish industry.

TARIFF EFFECTS UNDER IMPERFECT COMPETITION

Theoretical analysis

The above models are estimated under perfect competition. For a further analysis on the subsidy effect of the Byrd Amendment on prices of the two products, US and Vietnamese catfish, was analyzed alongside with an estimated equation system of price-reaction functions. In the empirical regression, impacts of the antidumping measures were estimated under imperfect competition. The competition strategy assumed was Bertrand (price) strategy in which one competitor would lead the competition by lowering its price, forcing the rival to lower price to retain the market share. In the catfish case, based on Evennet (2006), the US producers could raise their price, forcing Vietnamese exporters to increase their price to narrow the gap, which in its turn lessens a tariff incidence for next years, following the calculation methods of antidumping duties. By that way, the US producers would get more money from Byrd disbursement which is considered in its turn a subsidy to the US domestic industry under perfect competition.

The difference between antidumping tariff effects under the Bertrand competition with the ones under perfect competition is presented in Figures 2 and 3. In Figure 2, with Bertrand competition strategy, when an antidumping tariff imposed on an imported product, its price reaction function R_2 would shift up (to R'_2), leading to a rise in its price P^*_2 increase to $P^{*'}_2$, also the rival's price P^*_1 increase to $P^{*'}_1$. With the motives to get more money disbursement from the Byrd Amendment, the US producers could behave to raise their price, and so their price reaction function R1 would shift up to R'1, and contribute to raise $P^{*'}_2$ to $P^{*''}_2$, $P^{*'}_1$ to $P^{*''}_1$. In perfect competition conditions (Figure 3), when an antidumping tariff was imposed on its competitive imports, substitute effect would shift the demand curve for domestic product D_d up

to D'_d, raising the equilibrium price P* to P'*. With the Byrd Amendment, the domestic industry gets its disbursement as production subsidy and its supply curve S_d would shift down to S'_d. Therefore the Byrd effect can offset the tariff effect on domestic price. However, the fact that whether the final equilibrium price is higher, lower or equal to the initial price P* needs more empirical evidence.

Empirical Models for Price Reaction Functions

Model Specification

For empirical regression with the frozen catfish fillets case, some assumptions were made: i) Vietnamese catfish dominate the US catfish imports when 90 percent of the catfish imported by US in 2000 originated from Vietnam (Cohen & Hiebert, 2001). Therefore, US catfish imports from other foreign suppliers could be ignored; 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:

$$\Delta \ln P_{1,t} = a_0 + a_1 PRELIM_t + a_2 FINAL_t + \sum_{k=3}^{5} a_k D_{k,t} + a_6 \Delta \ln P^{-}_{2,t} + a_7 \Delta \ln P_{p,t} + a_8 \Delta \ln P_{sal,t} + a_9 \Delta \ln I_t + a_{10} \Delta \ln f_t + a_{11} \Delta \ln W_t + a_{12} \Delta \ln G_t + a_{13} \Delta \ln P_{1,t-1} + e_{1,t} \quad \text{(Equation 32)}$$

$$\Delta \ln P^{-}_{2,t} = b_0 + b_1 PRELIM_t + b_2 FINAL_t + \sum_{k=3}^{5} b_k D_{k,t} + b_6 \Delta \ln P_{1,t} + b_7 \Delta \ln P_{p,t} + b_8 \Delta \ln P_{sal,t} + b_9 \Delta \ln P_{o,t} + b_{10} \Delta \ln I_{1,t} + b_{11} \Delta \ln f_t + b_{12} \Delta \ln X_t + b_{13} \Delta \ln P^{-}_{2,t-1} + e_{2,t} \quad \text{(Equation 33)}$$

$$\Delta \ln Q_{1,t} = c_0 + c_1 PRELIM_t + c_2 FINAL_t + \sum_{k=3}^{5} c_k D_{k,t} + c_6 \Delta \ln P_{1,t} + c_7 \Delta \ln P^{-}_{2,t} + c_8 \Delta \ln P_{p,t} + c_9 \Delta \ln P_{sal,t} + c_{10} \Delta \ln I_{1,t} + c_{11} \Delta \ln Q_{1,t-1} + e_{3,t} \quad \text{(Equation 34)}$$

Where, $\Delta \ln x_t = \ln x_t - \ln x_{t-1}$ denotes the first-difference operator. Equations (32) and (33) are the price reaction functions of US and Vietnamese catfish respectively whereas equation (34) is the US catfish demand equation. Description of the variables are summarized in Table 3.

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 prices 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 & 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 a 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 farmed catfish:

$$\Delta \ln P_{f,t} = d_0 + d_1 PRELIM_t + d_2 FINAL_t + \sum_{k=3}^{5} d_k D_{k,t} + d_6 \Delta \ln P_{1,t} + d_7 \Delta \ln Q_{f,t-5} + d_8 \Delta \ln P_{p,t} + d_9 \Delta \ln P_{sal,t} + d_{10} \Delta \ln P_{f,t-1} + e_{4,t} \quad \text{(Equation 35)}$$

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 (32) – (34) and a combined wholesale-to-farm model consisting of equations (32) – (35). Because estimation results are similar the discussion is focused 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 that the domestic demand for US fillets is price elastic. This implies that if the home industry raises the 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 (Table 10). 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 showed 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 percent increase in the Vietnam price would raise the US price by a mere 0.2 percent *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 the length of the 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 gave significant and expected effects on the prices. A 10 percent increase in freight cost from Pacific raised the price of the domestic product by 1.1 percent but lowered the price of the imports from Vietnam by 12.3 percent.

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 was measured exclusive of the tariff, the lack of significance of *FINAL* in the Vietnam price equation implied that the US consumers bore the tariff. 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 was 0.005, which means the US price during the duty period increased by a mere 0.5 percent, *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 11), the regression results for US home price and Vietnamese price equations were similar to the ones in Table 10, except coefficient of freight cost was not significant any more. The tariff coefficient in demand equation for US frozen catfish fillets becomes significant, although just at 90 percent level. After the US antidumping measures was implemented, the demand for US catfish fillets rose by 3.1 percent associated with a 0.6 percent improvement in its price. However, the positive effect of the antidumping on US farm price was not significantt.

CONCLUSION

The US catfish imports increased since a bilateral trade agreement between the US and Vietnam was signed in December 2001. This study provides evidence for the futility of the US labeling law and antidumping tariffs imposed on catfish imports from Vietnam. In contrast to the positive effect on the domestic price in the short term, antidumping lowered the price in the long term but with a very small incidence.

In the error correction model, the punishment affect of US antidumping on rival imports was large when it lowered both US catfish imports and Vietnamese export price. The price effect of the labeling law was not positive as expected by the US catfish processors. In spite of lowering of the price, Vietnamese catfish exports still increased.

With the Byrd Amendment effect included in a SUR estimation and Bertrand imperfect competition, the price and demand of domestic catfish increased after the US ITC imposed an antidumping tariff on Vietnamese catfish imports, but the tariff was estimated to be ineffective. Antidumping duty was confirmed to be a weak tool to protect the US catfish industry. Because the import price was not affected by the duty imposition, the US consumers had to bear the duty as domestic price increased. While the bilateral trade agreement benefited the US consumers as free trade principles were applied, the antidumping tariff was futile and the labeling law caused negative effects on domestic price of catfish.

This, to the author's knowledge, is the first time that a detailed analysis with econometric models has been undertaken on the issues that have been dealt with in respect of an aquaculture commodity. The findings are significant as it also relates to the barriers that new commodities destined for export have to confront with. In the fishery sector, it is accepted that the gap between demand and supply of the fish needs, which is estimated to reach 30 to 40 million tonnes by year 2020, has to be mostly met with from aquaculture (Cressey, 2009 ; FAO, 2009), the production of which is dominated by developing countries, particularly Asia. It is therefore to be expected that new commodities will be destined for export to developed countries and cases comparable to catfish could well arise again and again, that are both economic and political concerns.

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Table 1. Examples of global antidumping cases for agricultural and fisheries products

(modified after Kinnucan and Myrland, 2006 and with data from Brown, 2006).

Product	Year	Filing country	Target countries
Apples	1994	Canada	US
	1998		
	1997	Mexico	US
Beef	1991	Poland	EU
Bovine meat	1993	Mexico	EU
	1994	Mexico	US
	1998	Mexico	US
Canned ham	1990	Australia	Denmark, Ireland and the Neitherlands
Canned Mushrooms	1982	US	China
Chicken	1999	Argentina	Brazil
Crawfish tail meat	1996	US	China
Dried Salted Codfish	1984	US	Canada
Fresh Atlantic Salmon	1990	US	Norway
	1997	US	Chile
	1996	EU	Norway
	1998	Mexico	US
Fresh Atlantic Salmon	2002	Canada	Chile
	2004	EU	Chile, Faroe Islands and Norway
Fishmeal	1994	Mexico	Chile
Frozen Beef	1993	Mexico	EU
Garlic	1994	US	China
	1996	Canada	China
	2000	South Africa	China
	2001	Canada	China and Vietnam
Fresh Round White Potatoes	1983	US	Canada
Fresh-Cut Roses	1983	US	Columbia
	1986	US	Canada, Columbia, Costa Rica, Ecuador, Mexico and Peru
	1994	US	Columbia and Ecuador
Frozen catfish fillets	2002	US	Vietnam
Frozen Orange Juice	1986	US	Brazil
	1991	Australia	Brazil
Honey	1994	US	China

Kiwi fruit	1991	US	New Zealand
Large Rainbow Trout	2003	EU	Norwey, Faeroe Islands
Lettuce	1992	Canada	US
Live catle	1998	US	Canada and Mexico
Live Swine	2004	US	Canada
Non-Frozen Apple Juice Concentrate	1999	US	China
Peaches	1997	Mexico	Greece
Pineapple	1994	US	Thailand
Pork	1993	Australia	Canada
Poultry meat	1999	South Africa	US
Shrimp	2003	US	Brazil, China, Ecuador, India, Thailand and Vietnam
Slaughter hogs	1998	Mexico	US
Sour cherries	1991	Australia	France and Italy
Sour cherries	1998	Canada	US
	1995	Canada	US, Denmark, Germany, Neitherlands and UK
Sugar	1998	Panama	Columbia and Mexico
Tart cherry juice	1991	US	Germany and Yugoslavia
Turkey	1999	Yugoslavia/ Slovenia	Hungary
Vegetable Oil	2001	Peru	Argentina
Whole potato	1985	Canada	US
Yellow Onion	1986	Canada	US

Table 2. Description of variables in the reduced form equations of the world market

	Unit	Source	Mean	Min	Max	Definition
P_{us}	cent/lb.	USDA	223	202	245	US price of processed catfish
P_v	cent/lb.	VN MOF	144	101	284	fob VN price of catfish
M_u	1000 lb.	NMFS	1007	53	4638	US import of catfish
X_v	1000 lb.	VN MOF	7602	4	37708	VN catfish export
Y_{US}	$	BEA	27267	23647	31094	US disposable income per capita
P_{poul}	cent/lb.	IMF	66	57	81	price of US poultry
P_{salm}	cent/lb.	IMF	233	155	306	price of Atlantic salmon
P_f	cent/lb.	USDA	220	186	310	price of catfish feed in US
F_a	-	BLS	107	89	133	freight index from Atlantic
F_v	-	BLS	105	73	130	freight index from Pacific
BTA	Dummy variable, BTA=0 before December 2001, otherwise, BTA=1					
TAX	Dummy variable, TAX=0 before February 2003, otherwise, TAX=1					
LABEL	Dummy variable, LABEL=0 before December 2002, otherwise, BTA=1					
Q_i	Dummy variables for quarters (i=1,2,3), Q_i=1 if data in quarter *i*, otherwise, Q_i=0					

Table 3 Description of variables in equation system of price reaction functions

Variable	Description	Unit	Source
P_1	Domestic price of frozen catfish fillets	$/lb	USDA
P_2^-	Price of Vietnamese frozen catfish fillets	$/lb	NMFS
P_{sal}	Price of salmon import	$/lb	NMFS
P_p	US poultry price	$/lb	IMF
P_o	Non-US market price of VN catfish fillets	$/lb	VN MoF
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/$	oanda.com

Table 4. Description of parameters used in the conceptual model

μ_i	Price elasticity (in absolute value) of import demand for catfish in i^{th} market (i= US, EU and ROW)
z_{us}	elasticity of US import demand for catfish respected to Z_{us}
z_{eu}	elasticity of EU import demand for catfish respected to Z_{eu}
z_r	elasticity of ROW's import demand for catfish respected to Z_r
ε_i	Supply price elasticity of catfish from i^{th} source (i= Vietnam, ROW)
ε_{vc}	Supply elasticity of Vietnamese catfish exports respected to C_v
ε_{rc}	Supply elasticity of ROW's frozen catfish exports respected to C_r
σ_{eu}	Transmission price elasticity between EU market price and Vietnamese catfish price
σ_{rd}	Transmission price elasticity between ROW's purchase price and Vietnam's export price
σ_{rs}	Transmission price elasticity between export prices of ROW and Vietnam
k_{us}, k_{eu}, k_{mr}	Global import shares of US, EU and ROW respectively
k_v, k_{xr}	Global export shares of Vietnam and ROW

Table 5. General elasticities of endogenous variables in respect to exogenous variables

	C_v^*	C_r^*	Z^*_{us}	Z^*_{eu}	Z^*_r	T^*
M^*_{us}	$-(\mu_{us} k_v \varepsilon_{vf}/\psi)$	$-\mu_{us} k_{xr}\varepsilon_{rf}/\psi$	$+ z_{us}(\psi - \mu_{us}k_{us})/\psi$	$-\mu_{us} k_{eu}z_{eu}/\psi$	$-\mu_{us} k_{mr}z_r/\psi$	$-\mu_{us}(\psi - k_{us}\mu_{us})/\psi$
M^*_{eu}	$-\mu_{eu}\sigma_{eu}k_v\varepsilon_{vf}/\psi$	$-\mu_{eu}\sigma_{eu} k_{xr}\varepsilon_{rf}/\psi$	$-\mu_{eu}\sigma_{eu} k_{us}z_{us}/\psi$	$+ z_{eu}(\psi - \mu_{eu}\sigma_{eu} k_{eu})/\psi$	$-\mu_{eu}\sigma_{eu} k_{mr}z_r/\psi$	$+\mu_{eu}\sigma_{eu}k_{us}\mu_{us}/\psi$
M^*_r	$-\mu_r\sigma_{rd}k_v\varepsilon_{vf}/\psi$	$-\mu_r\sigma_{rd}k_{xr}\varepsilon_{rf}/\psi$	$-\mu_r\sigma_{rd}k_{us}z_{us}/\psi$	$-\mu_r\sigma_{rd}k_{eu}z_{eu}/\psi$	$+ z_r(\psi - \mu_r\sigma_{rd}k_{mr})/\psi$	$+\mu_r\sigma_{rd}k_{us}\mu_{us}/\psi$
X^*_v	$-\varepsilon_{vf}(\psi - \varepsilon_v k_v)/\psi$	$+\varepsilon_v k_{xr}\varepsilon_{rf}/\psi$	$+\varepsilon_v k_{us}z_{us}/\psi$	$+\varepsilon_v k_{eu}z_{eu}/\psi$	$+\varepsilon_v k_{mr}z_r/\psi$	$+\varepsilon_v k_{us}\mu_{us}/\psi$
X^*_r	$+\varepsilon_r\sigma_{rs}k_v\varepsilon_{vf}/\psi$	$-\varepsilon_{rf}(\psi - \varepsilon_r\sigma_{rs}k_{xr})/\psi$	$+\varepsilon_r\sigma_{rs}k_{us}z_{us}/\psi$	$+\varepsilon_r\sigma_{rs}k_{eu}z_{eu}/\psi$	$+\varepsilon_r\sigma_{rs}k_{mr}z_r/\psi$	$-\varepsilon_r\sigma_{rs}k_{us}\mu_{us}/\psi$
P^*_{eu}	$+\sigma_{eu}k_v\varepsilon_{vf}/\psi$	$+\sigma_{eu}k_{xr}\varepsilon_{rf}/\psi$	$+\sigma_{eu}k_{us}z_{us}/\psi$	$+\sigma_{eu}k_{eu}z_{eu}/\psi$	$+\sigma_{eu}k_{mr}z_r/\psi$	$-\sigma_{eu}k_{us}\mu_{us}/\psi$
P^*_{rd}	$+\sigma_{rd}k_v\varepsilon_{vf}/\psi$	$+\sigma_{rd}k_{xr}\varepsilon_{rf}/\psi$	$+\sigma_{rd}k_{us}z_{us}/\psi$	$+\sigma_{rd}k_{eu}z_{eu}/\psi$	$+\sigma_{rd}k_{mr}z_r/\psi$	$-\sigma_{rd}k_{us}\mu_{us}/\psi$
P^*_{rs}	$+\sigma_{rs}k_v\varepsilon_{vf}/\psi$	$+\sigma_{rs}k_{xr}\varepsilon_{rf}/\psi$	$+\sigma_{rs}k_{us}z_{us}/\psi$	$+\sigma_{rs}k_{eu}z_{eu}/\psi$	$+\sigma_{rs}k_{mr}z_r/\psi$	$-\sigma_{rs}k_{us}\mu_{us}/\psi$
P^*_{us}	$+k_v\varepsilon_{vf}/\psi$	$+k_{xr}\varepsilon_{rf}/\psi$	$+k_{us}z_{us}/\psi$	$+k_{eu}z_{eu}/\psi$	$+k_{mr}z_r/\psi$	$+(\psi - k_{us}\mu_{us}/\psi)$
P^*_v	$+k_v\varepsilon_{vf}/\psi$	$+k_{xr}\varepsilon_{rf}/\psi$	$+k_{us}z_{us}/\psi$	$+k_{eu}z_{eu}/\psi$	$+k_{mr}z_r/\psi$	$-k_{us}\mu_{us}/\psi$

Note: Signs represent for direction of the effects; $\psi = (k_v\varepsilon_v + k_{us}\mu_{us} + k_{xr}\varepsilon_r\sigma_{rs} + k_{eu}\mu_{eu}\sigma_{eu} + k_{mr}\mu_r\sigma_{rd}) > 0$

Table 6. First difference models of some empirical reduced form equations

	US Price		VN Price		US Import		VN Export	
	Coef.	*t-ratio*	Coef.	*t-ratio*	Coef.	*t-ratio*	Coef.	*t-ratio*
BTA	-0.004	*-0.849*	-0.003	*-0.055*	-0.009	*-0.044*	0.041	*0.106*
TAX	0.007*	*1.727*	-0.023	*-0.553*	0.032	*0.195*	-0.074	*-0.238*
LABEL	0.001	*0.184*	0.017	*0.325*	-0.091	*-0.434*	0.118	*0.295*
US Income	0.171	*0.990*	0.479	*0.232*	0.834	*0.134*	-10.767	*-0.901*
Poultry price	-0.131	*-1.141*	1.385	*1.041*	-6.683	*-1.454*	-2.819	*-0.324*
Salmon price	0.001	*0.060*	-0.230	*-0.747*	-0.994	*-1.180*	1.245	*0.770*
Atlantic freight	-0.041	*-0.514*	0.115	*0.122*	1.932	*0.603*	-1.194	*-0.197*
Pacific freight	0.115	*1.617*	-0.005	*-0.006*	3.317	*1.127*	-2.034	*-0.366*
Catfish feed price	0.106**	*2.043*	-0.167	*-0.262*	-5.573***	*-2.931*	2.122	*0.595*
Lag of dependents	0.121	*1.026*	-0.233**	*-2.183*	-0.204*	*-1.730*	-0.308***	*-2.785*
First quarter	0.014***	*3.174*	0.088*	*1.770*	-0.069	*-0.387*	-0.642*	*-1.892*
Second quarter	-0.004	*-0.698*	0.061	*1.084*	0.355*	*1.686*	-0.396	*-0.988*
Third quarter	0.000	*-0.067*	0.090*	*1.827*	0.009	*0.053*	-0.728**	*-2.158*
Constant	-0.005	*-1.379*	-0.069*	*-1.680*	0.015	*0.092*	0.446	*1.481*
R^2	0.29		0.36		0.27		0.20	
D.W.	2.16		2.19		2.16		2.13	

All continuous variables in the first difference of logarithms;, **, ***: significant at 90%, 95% and 99 levels; autocorrelations are corrected by Prais and Winsten method.*

Table 7. Cointegration rank test using trace (H_1: Rank>r)

	H0: Rank=r	Eigenvalue	Trace	5% Critical Value	Drift in ECM	Drift in Process
US Price	0	0.4685	113.0524	109.93	NOINT	Constant
Equation	1	0.2758	61.2188	82.61		
	2	0.1878	34.7557	59.24		
VN Price	0	0.509	114.3784	109.93	NOINT	Constant
Equation	1	0.2505	56.0547	82.61		
	2	0.153	32.4133	59.24		
US Import	0	0.4124	109.8641	109.93	NOINT	Constant
Equation	1	0.2626	66.2579	82.61		
	2	0.239	41.2811	59.24		
VN Export	0	0.4449	113.2996	109.93	NOINT	Constant
Equation	1	0.2662	65.0359	82.61		
	2	0.2013	39.6527	59.24		
	H0: Rank=r	Eigenvalue	Trace	5% Critical Value	Drift in ECM	Drift in Process
US Price	0	0.523	160.553	132.00	Constant	Constant
Equation	1	0.412	99.940	101.84		
	2	0.260	56.365	75.74		
VN Price	0	0.521	143.901	132.00	Constant	Constant
Equation	1	0.350	83.586	101.84		
	2	0.220	48.207	75.74		
US Import	0	0.505	154.299	132.00	Constant	Constant
Equation	1	0.356	96.631	101.84		
	2	0.261	60.535	75.74		
VN Export	0	0.447	139.888	132.00	Constant	Constant
Equation	1	0.343	91.340	101.84		
	2	0.235	56.886	75.74		

Table 8. Regression results of error correction models (ECMs)

	US Price		VN Price		US Import		VN Export	
	Coef.	*t-ratio*	Coef.	*t-ratio*	Coef.	*t-ratio*	Coef.	*t-ratio*
BTA	-0.006	-1.122	-0.001	-0.019	0.315	1.633	0.044	0.140
TAX	0.008*	1.677	0.003	0.063	0.115	0.759	-0.109	-0.427
LABEL	0.002	0.291	-0.020	-0.309	-0.367*	-1.861	0.165	0.507
US Income (1)	-0.014	-0.083	1.430	0.761	8.121	1.403	-10.309	-1.111
Poultry price (1)	-0.279**	-2.221	-1.677	-1.200	-9.648**	-2.365	-2.782	-0.396
Salmon price (1)	-0.008	-0.356	-0.074	-0.291	2.149***	2.873	-0.620	-0.493
Atlantic freight (1)	0.033	0.379	0.485	0.499	-5.743*	-1.972	-0.657	-0.137
Pacific freight (1)	0.031	0.417	0.750	0.886	-0.733	-0.298	1.196	0.288
Catfish feed price (1)	0.045	0.848	-0.173	-0.282	-0.584	-0.334	2.497	0.827
Error correction term	-0.196**	-2.152	-0.914***	-7.072	-0.468***	-4.133	-0.920***	-6.845
First quarter	0.015***	3.358	0.092*	1.768	0.007	0.044	-0.276	-1.077
Second quarter	0.004	0.734	0.076	1.404	0.348**	2.210	-0.157	-0.581
Third quarter	0.004	0.716	0.090	1.602	0.056	0.345	-0.135	-0.469
Constant	-0.008*	-1.781	-0.061	-1.229	-0.106	-0.735	0.093	0.382
R^2	0.15		0.49		0.38		0.47	
D.W.	2.06		2.20		2.11		2.25	

All continuous variables in the first difference of logarithms; (1) represents for the first lag of the variables
, **, *: significant at 90%, 95% and 99% levels.*

Table 9. Long run model derived from ECMs

	US Price	VN Price	US Import	VN Export
BTA	-0.014		0.674	
TAX	-0.004	-0.237	-0.460	
LABEL	-0.014	-0.221	-0.367	3.100
US Income				-22.104
Poultry price	0.058		1.668	7.395
Salmon price	0.017			
Atlantic freight		-1.047	1.773	
Pacific freight	0.022		1.827	
Catfish feed price		0.691	-3.776	
First quarter	0.024	0.092	-0.151	-0.500
Second quarter	0.009		0.348	
Third quarter		0.095		-0.477
Constant	-0.008			193.395
lag of dependent variable	0.803	0.086	0.532	0.080

All continuous variables in logarithms;

Table 10. Regression for reaction price equations and demand of US catfish

	US home price	Vietnamese price	Demand for US fillets
PRELIM	0.000	0.015	0.001
	(0.068)	(0.426)	(0.054)
FINAL	0.005	-0.022	0.019
	(2.126)	(-0.783)	(1.207)
US price		4.972	-2.359
		(3.801)	(-3.268)
VN price	0.019		0.13
	(2.613)		(2.407)
Non-US price		0.022	
		(0.395)	
Salmon price	0.016	-0.026	-0.122
	(1.208)	(-0.146)	(-1.211)
Poultry price	0.019	-0.289	-0.593
	(0.253)	(-0.293)	(-1.068)
US income	0.128	-0.215	1.421
	(1.228)	(-0.149)	(1.821)
Wage rate	0.207		
	(1.329)		
Energy index	0.004		
	(0.151)		
Freight index	0.114	-1.233	
	(2.106)	(-1.658)	
Exchange rate		0.192	

		(0.705)	
Lag of dep.var.	0.345	-0.464	-0.533
	(3.879)	(-4.657)	(-6.246)
First quarter	0.008	0.014	0.202
	(2.374)	(0.341)	(8.392)
Second quarter	-0.003	0.049	0.039
	(-0.914)	(1.085)	(1.694)
Third quarter	-0.005	0.050	0.090
	(-1.748)	(1.242)	(4.034)
Constant	-0.003	-0.025	-0.095
	(-1.213)	(-0.741)	(-4.980)
R^2	0.48	0.26	0.54
D.W-h	1.31	0	1.1

Note: Numbers in parentheses are asymptotic *t*-ratios

Table 11. SUR regression for the equation system with US farm price equation

	US price	VN price	US Demand	US farm price
PRELIM	0.002	-0.004	0.012	0.004
	(0.657)	(-0.106)	(0.582)	(0.643)
FINAL	0.006	-0.029	0.031	0.006
	(2.531)	(-0.963)	(1.824)	(1.167)
US price		5.087	-2.958	1.148
		(3.656)	(-3.83)	(4.64)
VN price	0.017		0.126	
	(2.318)		(2.244)	
Non-US price		0.05		
		(0.919)		
Salmon price	0.016	-0.024	-0.169	-0.07
	(1.172)	(-0.127)	(-1.614)	(-2.161)
Poultry price	0.004	-0.441	-0.451	-0.113
	(0.049)	(-0.382)	(-0.704)	(-0.568)
US income	0.135	-0.935	1.454	
	(1.291)	(-0.66)	(1.865)	
Wage	0.232			
	(1.472)			
Energy index	0.003			
	(0.133)			
Freight rate	0.073	-0.952		
	(1.263)	(-1.207)		
Exchange rate		-0.531		
		(-1.055)		
US demand (lag 5)				-0.084

				(-3.139)
Lag of dep. Var.	0.32	-0.46	-0.547	0.208
	(3.444)	(-4.463)	(-6.321)	(2.248)
First quarter	0.009	0.009	0.205	0.011
	(2.471)	(0.223)	(8.35)	(1.596)
Second quarter	-0.003	0.056	0.029	-0.003
	(-0.831)	(1.205)	(1.201)	(-0.467)
Third quarter	-0.005	0.055	0.088	0.001
	(-1.562)	(1.362)	(3.888)	(0.189)
Constant	-0.005	-0.018	-0.103	-0.004
	(-1.629)	(-0.504)	(-5.279)	(-0.748)
R^2	0.46	0.23	0.54	0.55
DW-h	-1.53	-0.11	-1.65	0.9

Note: Numbers in parentheses are asymptotic *t*-ratios

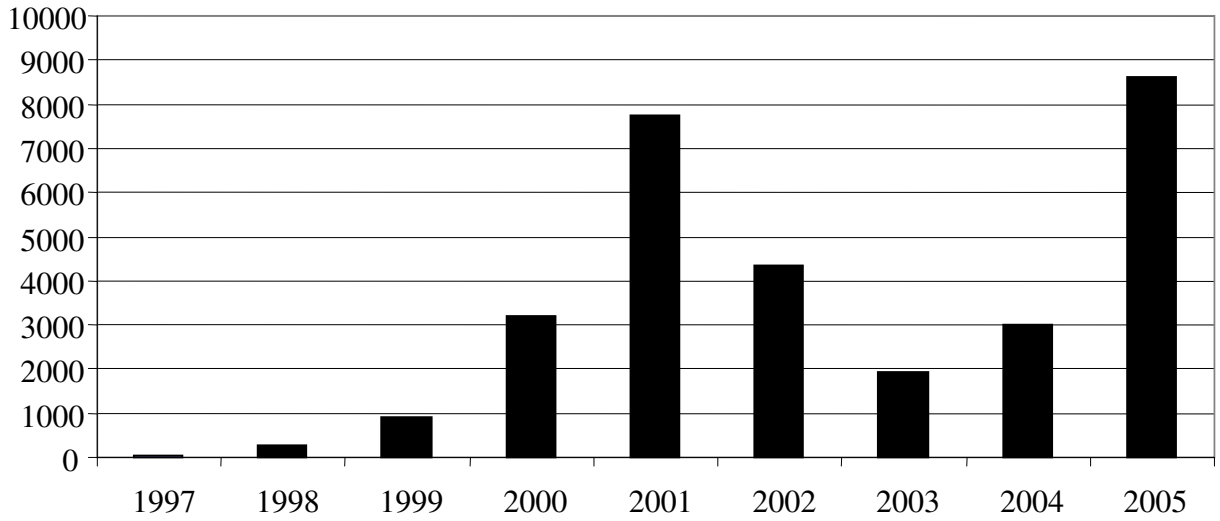

Figure 1. Vietnamese catfish exports to the US 1997 - 2005

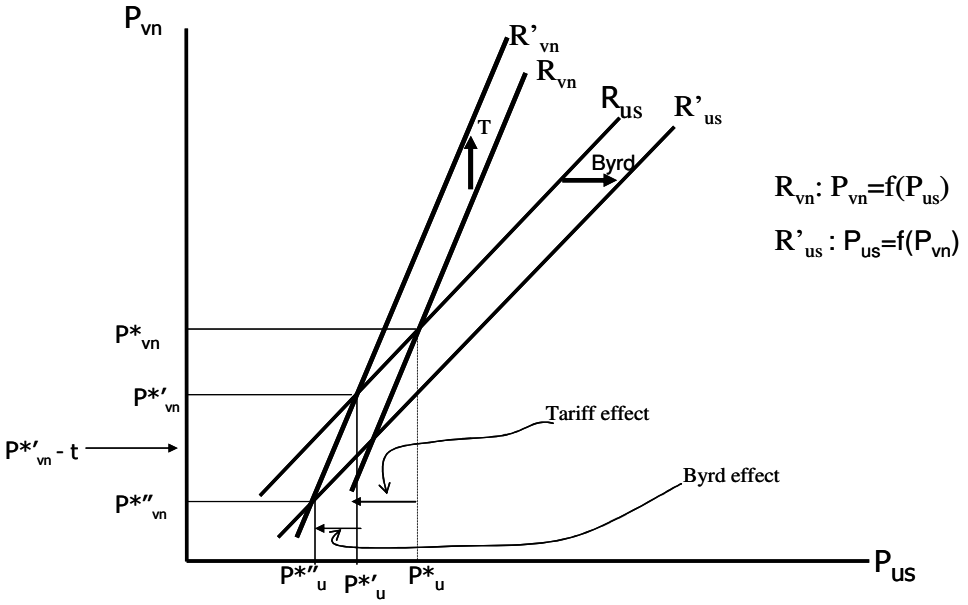

Figure 2. Effects of antidumping tariff on US catfish market with Byrd Amendment under Bertrand competition

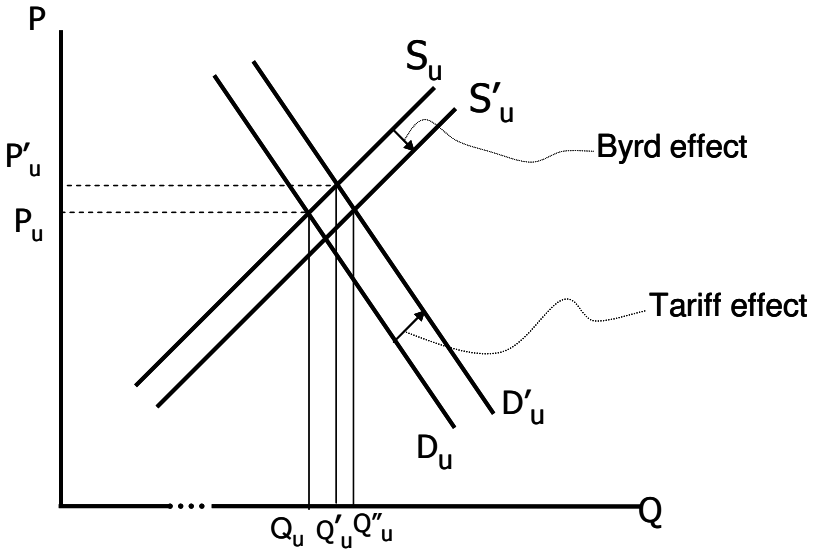

Figure 3. Effects of antidumping tariff on US catfish with Byrd Amendment under perfect competition