THE CATFISH ANTIDUMPING IN PERFECT AND IMPERFECT COMPETITION AND THE ROLE OF AQUACULTURE IN FARMERS' HAPPINESS

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THE CATFISH ANTIDUMPING IN PERFECT AND IMPERFECT COMPETITION AND THE ROLE OF AQUACULTURE IN FARMERS' HAPPINESS

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THE CATFISH ANTIDUMPING IN PERFECT AND IMPERFECT COMPETITION

AND THE ROLE OF AQUACULTURE IN FARMERS' HAPPINESS

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Nguyen Minh Duc, the son of Nguyen Van Dinh and Ngo Thi Huong, was born on October 24, 1972, in Saigon City, Vietnam. After graduating from Le Hong Phong High School for the Gifted (Hochiminh City, Vietnam) in 1990, he enrolled to the University of Agriculture and Forestry (UAF, Vietnam), a member university of the Vietnam National University – Hochiminh City. He started his academic career as a lecturer and a socio-economic researcher in April 1995 at the university immediately upon completion of his Bachelor of Science degree in Fisheries Science with a thesis on diseases treatments and precautions for farmed catfish. After his graduate study starting from January 2000 at the Asian Institute of Technology (AIT, Thailand) with a thesis on impacts of aquaculture development on fish farmers' livelihoods, he was awarded a Master of Science degree in Aquaculture and Aquatic Resource Management in August 2001. Coming back the University of Agriculture and Forestry (recently named Nong Lam University, Thuduc, Hochiminh City) for his teaching job, he was also taking in charge of the Field Director position of AIT – UAF Aqua Outreach Program as a part of faculty duties before working for a degree of Doctor of Philosophy in Applied Economics at Auburn University from January 2004.

DISSERTATION ABSTRACT

THE CATFISH ANTIDUMPING IN PERFECT AND IMPERFECT COMPETITION

AND THE ROLE OF AQUACULTURE IN FARMERS' HAPPINESS

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This dissertation consists of three chapters. Two focus on trade policy issues and provide empirical evidence for effectiveness of U.S. antidumping measures under Byrd Amendment. The Byrd Amendment permits US firms that petition successfully for antidumping duties to collect tariff revenues. Whether these payments strengthen the duty's ability to raise price depends crucially on market structure. The first chapter explores the price effects of antidumping duties under the Byrd Amendment in a competitive market situation. In a competitive market where domestic and imported goods are imperfect substitutes, the payments are akin to a production subsidy and thus undermine the duty's ability to raise price. Applying the theory to the "catfish war," antidumping measures taken by the US against Vietnam are shown to have had a modest yet positive effect on the US price. Although the weak price effect is consistent with supply enlargement induced by the payments, our econometric results suggest substitution effects coupled with incidence shifting are stronger causal factors. In the second chapter, the Byrd Amendment is justified to enhance tariff effects on the home price and trade flows under the Bertrand competition. The estimated increase associated with the duty is very small in price and sales of domestic fillets and insignificant on farm price. The result confirms antidumping duties are a weak tool for protecting the domestic catfish industry.

Using cumulative logit models, the third chapter identifies determinants of job satisfaction and subjective well being of small scale fish farmers in Vietnam, and examines the role of earnings from fish production in generating their happiness. Relative income, not absolute income, from aquaculture raises their job satisfaction. Higher satisfaction is also associated with involvement in extension services, a larger relative pond surface and a higher expectation level on earnings from aquaculture. The role of income per capita in job satisfaction or happiness is not confirmed. Happiness of the farmers increases with cash earnings from fish farming and income from wild fish relative to total household income.

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CHAPTER 1. EFFECTS OF U.S ANTIDUMPING UNDER PERFECT COMPETITION: THE CASE OF CATFISH

I. INTRODUCTION

Import competing firms in the United States are increasingly turning to antidumping duties as an "easy" means to gain protection (Irwin, 2005). Although the reasons for this are varied (Zanardi 2004; Prusa 2005), a contributing factor is the Continued Dumping and Subsidy Offset Act passed by the US Congress in October 2000. This act, commonly known as the "Byrd Amendment" (BA), permits producers and processors who petition successfully for antidumping duties to collect tariff receipts. The ability to collect tariff receipts provides an added incentive to seek protection, and to participate in the petition process (Reynolds 2006).

Schmitz and Seale (2004) report that between 2001 and 2003 payments under the BA totaled $749 million with $299 million going to two bearing manufacturers that merged in 2003. By way of comparison, the average payout per claimant over the three year period was $209 thousand. Most studies of BA focus on how the "offset payments" to domestic firms affect producer and consumer welfare using imperfect competition models (Collie and Vandenbussche 2005; Evenett 2006; Chang and Gayle 2006; Falvey and Wittayarungruangsri 2006). Although such models are appropriate for industrial goods such as steel that are the major beneficiaries of BA (Schmitz and Seale, 2004), they have less relevance for agricultural products where product differentiation is weak and firms are more numerous. Indeed, in their study of the effects of BA on tariff levels lobbied for by U.S. agricultural groups, Schmitz and Seale (2004) assume a homogenous product and perfect competition. Reimer and Stiegert (2006, p. 18) note that "tests of market structure and behavior in international food and agricultural markets…universally find that price-cost markups are small or nonexistent in most markets." Although zero markups do not preclude oligopoly behavior, Occam's razor argues for a simple market-clearing model. A test presented later affirms this choice in the context of the present study.

The market structure issue is important because BA is properly viewed as a production subsidy since offset payments are based on firm output. A production subsidy under perfect competition implies an outward shift in the domestic industry's supply curve. The enlarged supply undermines the ability of the duty to raise price. This is in contrast to imperfect competition models where BA is shown to magnify the duty's effect on price. To wit, results based on a Bertrand competition model are summarized by Evenett (2006, p. 734) as follows:

> The next step in my analysis is to introduce a Byrd amendment-like provision, whereby the domestic firm is given all of the dumping duties that are paid by the foreign firm. This provision has the effect of creating an additional incentive for the domestic firm to raise its price as doing so increases the sales of foreign firm, thereby increasing the total value of the dumping duties paid. I show that the Byrd amendment provision effectively introduces a price floor into the domestic firm's best response function, although this finding is due to the symmetric nature of the own price-responsiveness of the linear demand functions assumed for the domestic and foreign firms. I also show that where the Byrd amendment raises prices in equilibrium (compared to the case where there is no Byrd amendment provision), a seemingly paradoxical result arises; namely, that the foreign firm is better off. This latter finding occurs in part because the foreign firm's profit margin rises for two reasons: 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 a perfectly competitive market the apparent paradox vanishes because the increase in domestic supply induced by BA erodes the price and demand for the foreign good, making foreign producers worse off. Non-petitioning producers who are not eligible for offset payments are also made worse off if the subsidy effect dominates the tariff effect leading to a decline in domestic price.

According to Schmitz and Seale (2004), the eleven food products that received BA payments between 2001 and 2003 are as follows: apple juice, crawfish, cut flowers, garlic, honey, mushrooms, orange juice, pasta, pistachios, salmon, and sugar. The payments totaled $62.4 million; the largest single recipient was crawfish at $17.2 million. Kinnucan and Myrland (2006) provide a more complete listing of food products subject to anti-dumping activity, including an analysis of duties levied by the United States against salmon imports from Norway and Chile.

The purpose of this research is to determine the price effects of antidumping duties under the Byrd Amendment in a competitive market situation. The analysis differs from Schmitz and Seale (2004) in that the domestic and imported goods are treated as differentiated (as opposed to homogenous) products, and the supply shift induced by BA is explicitly taken into account. In addition, empirical evidence is provided using catfish as a case study. Catfish represents a useful case study in that it shares characteristics with other agricultural products subject to antidumping activity, data exist to measure impacts, and a federal labeling law passed in 2001 to differentiate domestic from imported catfish affords the opportunity to test whether such laws are a useful adjunct to antidumping policy.

The "catfish war" generated national media attention with articles appearing in *The New York Times*, *Wall Street Journal*, *Christian Science Monitor*, and *The Economist* discussing the policy and ethical dilemmas posed by the dispute (Coleman, 2005). The dispute was precipitated by a surge in imports of frozen catfish fillets from Vietnam that coincided with a period of low farm prices in the domestic market (Table 1.1).

Although Vietnam's share of the US frozen fillet market at peak imports was less than 13 percent, and frozen fillets account for only a fraction of the total demand for US farm output, the domestic industry saw the low and declining price of the Vietnamese product as a threat. It responded by launching a media campaign to differentiate domestic catfish from and the imported product, by securing federal legislation requiring catfish imports from Vietnam be labeled "basa" or "tra," and by filing antidumping petitions. The petitions resulted in an average tariff of $0.64 per pound in 2003 on a base (fob) import price of $1.21. Two years after full implementation of the tariff the fob import price had declined by $0.28 to $0.93 per pound and the US price had risen by 26 cents to $2.67 per pound. An *ex ante* analysis based on a simulation model suggested a catfish tariff would have little effect on domestic price owing to the highly elastic nature of US demand for imported fish (Kinnucan 2003). This study tests that prediction by determining the extent to which the foregoing price movements can be ascribed to the antidumping measures.

Prior to model specification we present a graphical analysis of the problem. The price equations implied by a market-clearing model are then estimated along with a demand equation to identify the price and demand impacts of the tariff/subsidy scheme.

II. ANALYTICAL FRAMEWORK

A critical factor governing the efficacy of the tariff *cum* subsidy scheme is incidence. This is shown in Figure 1.1 where in Panel A we isolate the subsidy effect by treating the price of the imported good as temporarily exogenous. With the domestic price of the imported good fixed the tariff's full burden is borne by foreign producers and the tariff has no effect on the demand for the domestic good. Redistributing the tariff revenue to domestic producers causes the domestic supply curve to shift down by the amount of the per-unit subsidy, which places a wedge between the producer and consumer price of the domestic good. The producers' share of the subsidy wedge depends on the price elasticities of supply and demand for the domestic good and will decrease as demand becomes less elastic in relation to supply. Thus, for example, if labeling causes the demand for the domestic good to become less price elastic, as shown in Panel A, it will redistribute the benefits of the subsidy in favor of consumers.

The role of tariff incidence is shown in Panel B. The ability of the tariff to increase the demand for the domestic good depends on the substitutability of the domestic good for the foreign good, but also on the domestic consumers' share of the tariff wedge. If import demand is less elastic than import supply, as depicted in Panel B, most of the tariff will appear as a rise in the domestic price of the foreign good as opposed to a decline in the foreign sellers' price. In this instance, and assuming the two goods are substitutes, the induced increase in demand for the domestic good will be relatively large. The added demand increases the equilibrium supply and demand prices for the domestic good, augmenting the benefit domestic producers receive from the subsidy, but at the expense of domestic consumers.

Comparing Panels A and B the equilibrium demand price of the domestic good may rise or fall depending on whether the tariff effect outweighs the subsidy effect. In Panel B domestic consumers of the foreign good are unambiguously harmed by the tariff/subsidy scheme as they pay more for the imported good. Domestic consumers of the domestic good may be better or worse off depending on the relative strengths of the subsidy and tariff effects. If incidence shifting of the tariff is complete, as in Panel A, the subsidy is financed entirely by foreign producers and the tariff/subsidy scheme has no effect on domestic consumer welfare. If tariff incidence shifting is incomplete, as in Panel B, the cost of the subsidy is shared with domestic consumers of the foreign product and their welfare declines along with the welfare for foreign producers. The upshot is that the incidence of the subsidy and tariff wedges is crucial in assessing policy impact.

To measure the impacts indicated in Figure 1.1 we use an equilibrium displacement model. The model and methods are similar to those used by Alston (1986) to examine the effects of agricultural policy on poultry trade, by Metcalf (1992) to examine the effects of environmental regulations on pork trade, and by Kinnucan and Myland (2005, 2006) to examine the effects of tariffs on salmon trade. The endogenous variables in the model are proportionate changes in the prices and quantities of frozen catfish fillets in the US market, the product subjected to the antidumping duty. (Hereafter we drop the adjective "frozen.") The production subsidy associated with BA is treated as endogenous, dependent on the exogenous tariff rate, and level of imports in the post-tariff equilibrium.

The domestic demand for US fillets is a function of the price for US fillets, the price of Vietnam fillets, the price of other goods, and consumer income; the domestic demand for Vietnam fillets is a function of the same variables. Therefore, the demand side of the model is represented as:

(1) $$EQ_1 = -\eta_{11} EP_1^D + \eta_{12} EP_2^D + \eta_{13} EP_3 + \iota_1 EY$$

(2) $$EQ_2 = \eta_{21} EP_1^D - \eta_{22} EP_2^D + \eta_{23} EP_3 + \iota_2 EY$$

where the operator $EX = dX / X = d \ln X$ denotes proportionate change. Subscripts for the quantity (*Q*) and price (*P*) variables denote source/product (1 = US, 2 = Vietnam, 3 = other); the superscript "*D*" on the US and Vietnam price variables denotes demand prices. The price of other goods and consumer income (*Y*) are treated as exogenous. The parameters η_{ij} and ι_i are price and income elasticities of demand, respectively, with the own-price elasticities η_{ii} expressed as absolute values. Under the maintained hypothesis that the goods are normal and substitute for one another, all parameters in (1) and (2) are positive. Labeling may shift or rotate these curves, an issue addressed in the empirical model presented later.

The domestic supply of US fillets is a function of the price of US fillets *inclusive of the subsidy*, herein labeled P_1^S. The domestic supply curve is shifted by C_1, a variable to represent factors that alter domestic processors' marginal cost of producing fillets. Similarly, the domestic supply of catfish fillets from Vietnam is a function of the price of Vietnam fillets *exclusive of the tariff*, herein labeled P_2^S. The supply curve for Vietnam fillets is shifted by C_2, a variable to represent factors that alter the marginal cost of producing and shipping Vietnam fillets to the United States. Therefore, in proportionate change the supply side of the model is represented as:

(3) $$EQ_1 = \varepsilon_1 EP_1^S + \delta_1 EC_1$$

(4) $$EQ_2 = \varepsilon_2 EP_2^S + \delta_2 EC_2$$

where the parameters ε_i and δ_i are supply elasticities with respect to price and the shift variables, respectively. In this study, the supply curves are assumed to be upward sloping ($\varepsilon_i > 0$).

The antidumping duty on Vietnam fillets places a wedge between the supply and demand prices for Vietnam fillets as follows:

$$P_2^D = P_2^S \cdot T$$

where $T = 1 + \tau$ and τ is the *ad valorem* tariff rate. Since the tariff in initial equilibrium is zero, in proportionate change the tariff wedge is modeled as:

(5) $$EP_2^D = EP_2^S + \tau.$$

It should be noted by definition $ET = \frac{d\tau}{1+\tau}$. Letting τ^o be the tariff rate in the initial equilibrium in discrete change $ET = \frac{\tau - \tau^o}{1+\tau^o}$, which reduces to $ET = \tau$ when $\tau^o = 0$. From (5) if the demand price is unaffected by the tariff $EP_2^S = -\tau$ and the supply price falls by the full amount of the tariff. This is the situation depicted in Figure 1, Panel A. In general, however, the tariff is split between and rise in the demand price and a fall in the supply price such that $EP_2^D - EP_2^S = \tau$.

The subsidy introduced by the Byrd Amendment places a wedge between the demand and supply price of US fillets as follows:

$$P_1^S = P_1^D \cdot S$$

where $S = 1 + \varsigma$ and ς is the *ad valorem* subsidy defined as the ratio of the per-unit subsidy to the supply price. Since the subsidy in initial equilibrium is zero, in proportionate change the subsidy wedge is modeled as:

(6) $$EP_1^S = EP_1^D + \varsigma.$$

From (6) the *ad valorem* subsidy is split between a rise in the supply price of US fillets and a fall in the demand price such that $EP_1^S - EP_1^D = \varsigma$.

The subsidy is endogenized by setting the subsidy rate proportional to the tariff rate:

(7) $$\varsigma = \varphi \cdot \tau$$

where $0 < \varphi < 1$. (The implicit assumption here is that the tariff would not generate sufficient revenue to provide a proportionate subsidy larger than the proportionate tariff itself.)

Equations (1) – (7) contain seven endogenous variables (EP_2^S, EQ_1 , EQ_2, EP_1^D, EP_1^S, EP_2^D, and ς) and four exogenous variables (EP_3, EY, EC_1, EC_2 and τ). Since only the demand price of US fillets and the supply price of Vietnam fillets are observable, we solve for equilibrium in the two markets by setting (1) = (3) and (2) = (4) making use of (5) and (6) to eliminate EP_1^S and EP_2^D. Substituting (7) into the resulting equations yields the following price relations:

(8) $$EP_1^D = \frac{\eta_{12}}{\varepsilon_1 + \eta_{11}} EP_2^S + \frac{(\eta_{12} - \varphi\varepsilon_1)}{\varepsilon_1 + \eta_{11}} \tau + \frac{\eta_{13}}{\varepsilon_1 + \eta_{11}} EP_3 + \frac{\iota_1}{\varepsilon_1 + \eta_{11}} EY - \frac{\delta_1}{\varepsilon_1 + \eta_{11}} EC_1$$

(9) $$EP_2^S = \frac{\eta_{21}}{\varepsilon_2 + \eta_{22}} EP_1^D - \frac{\eta_{22}}{\varepsilon_2 + \eta_{22}} \tau + \frac{\eta_{23}}{\varepsilon_2 + \eta_{22}} EP_3 + \frac{\iota_2}{\varepsilon_2 + \eta_{22}} EY - \frac{\delta_2}{\varepsilon_2 + \eta_{22}} EC_2 .$$

The coefficients of τ in (8) and (9) indicate the effect of the tariff on observed prices when the price of the competing product is held constant. With this caveat in mind and focusing first on (9) competitive market clearing implies the supply price of Vietnam fillets will fall, but by less than the amount of the tariff. Incidence depends on the relative magnitudes of the supply and demand elasticities for Vietnam fillets, and will bear more heavily on US consumers as demand becomes less elastic in relation to supply.

The more interesting result is from (8) where the tariff *cum* subsidy under competitive market clearing is shown to have an ambiguous effect on the price of the protected good. The positive effect predicted by imperfect competition models occurs only if the outward shift in the demand curve for US fillets induced by the tariff exceeds the outward shift in the supply curve for US fillets induced by the subsidy, i.e., $\eta_{12} > \varphi\varepsilon_1$. If the subsidy effect exceeds the tariff effect such that $\eta_{12} < \varphi\varepsilon_1$ a tariff under BA has a perverse effect in the sense that the price of the protected good falls.

Permitting prices to adjust simultaneously complicates the tariff effect, but does not alter the basic conclusions derived from (8) and (9). The tariff's net price effects are obtained by setting $EP_3 = EY = EC_i = 0$ and solving (8) and (9) simultaneously to yield:

$$EP_1^D = \frac{\varepsilon_2\eta_{12} - \varphi\varepsilon_1(\varepsilon_2 + \eta_{22})}{D}\tau \tag{10}$$

$$EP_2^S = \frac{-[(\eta_{11}\eta_{22} - \eta_{12}\eta_{21}) + \varepsilon_1(\eta_{22} + \varphi\eta_{21})]}{D}\tau \tag{11}$$

where $D = (\varepsilon_1 + \eta_{11})(\varepsilon_2 + \eta_{22}) - \eta_{12}\eta_{21}$. Under the maintained hypothesis consumers are more sensitive to changes in own price than to changes in substitute price the composite term $(\eta_{11}\eta_{22} - \eta_{12}\eta_{21})$ in (11) is positive, which implies with upward-sloping supply $D > 0$. Hence, in competitive equilibrium a tariff under BA unambiguously depresses the supply price of the foreign good and has an indeterminate effect on the demand price of the protected good.

As expected, "turning off" BA be setting $\varphi = 0$ removes the indeterminancy and attenuates the negative effect of the tariff on the foreign supply price. The attenuation occurs because the subsidy depresses the protected good's price, which erodes the demand for the foreign good through second-round or market feedback effects. This backshift in demand is eliminated with subsidy removal. The upshot is that in a competitive market the Byrd Amendment exacerbates the negative effect of the antidumping duty on foreign sellers. This is in contradistinction to Evenett's (2006) result based on a duopoly model that BA makes the foreign firm better off relative to the equilibrium without BA.

III. EMPIRICAL MODEL

To test whether the catfish market exhibits the behavior predicted by the foregoing theory we estimated the following three-equation system:

(12) $$\Delta \ln Q_{1,t} = a_0 + a_1 TARIFF_t + a_2 LABEL_t + \sum_{k=3}^{5} a_k D_{k,t} + a_6 \Delta \ln P_{1,t}^{D} + a_7 \Delta \ln P_{2,t}^{S}$$

$$+ a_8 \Delta \ln P_{salmon,t} + a_9 \Delta \ln Y_t + a_{10} \Delta \ln Q_{1,t-1} + e_{1,t}$$

(13) $$\Delta \ln P_{1,t}^{D} = b_0 + b_1 TARIFF_t + b_2 LABEL_t + \sum_{k=3}^{5} b_k D_{k,t} + b_6 \Delta \ln P_{2,t}^{S} + b_7 \Delta \ln P_{salmon,t}$$

$$+ b_8 \Delta \ln Y_t + b_9 \Delta WAGE_t + b_{10} \Delta \ln P_{livefish,t} + b_{11} \Delta \ln P_{1,t-1}^{D} + e_{2,t}$$

(14) $$\Delta \ln P_{2,t}^{S} = c_0 + c_1 TARIFF_t + c_2 LABEL_t + c_3 PRELIM_t + \sum_{k=4}^{6} c_k D_{k,t} + c_7 \Delta \ln P_{1,t\,t}^{D}$$

$$+ c_8 \Delta \ln P_{salmon,t} + c_9 \Delta \ln Y + c_{10} \Delta \ln ENERGY_t + c_{11} \Delta \ln FREIGHT_t + c_{12} \Delta \ln P_{2,t-1}^{S} + e_{3,t}$$

where $\Delta \ln x_t = \ln x_t - \ln x_{t-1}$ denotes the first-difference operator. Equation (12) corresponds to the domestic demand relation (1); equations (13) and (14) correspond to the price relations (8) and (9). Equations (13) and (14) contain all the information in the structural model (1)-(7) and in this sense equation (12) is superfluous. However, the cross-price elasticity $a_7 = \eta_{12}$ indicates the extent to which tariff-induced increase in the Vietnam price will shift the demand curve for the US product, which is useful in interpreting the estimated coefficients of (13). The time subscript *t* denotes months (*t* =1, 2, …, 92 for January 1999 through August 2006) and the $e_{i,t}$ (*i*= 1, 2, 3) denote random disturbance terms.

Previous research indicates the demand for catfish is seasonal, peaking in the Lenten period, and that it takes between three and twelve months for demand and prices to respond to supply/demand shocks (Zidack, Kinnucan and Hatch 1992; Kinnucan and Miao 1999; Quagraine and Engle 2002). Accordingly, lagged dependent variables are included in (12) - (14) to account for dynamics and quarterly dummy variables are included to account for seasonal demand shifts. Specifically, D_k , where k=1,2,3, are dummy variables that represent the first three calendar quarters of the year. Salmon fillets are hypothesized to be the major substitute for catfish frozen fillets. Hence, the wholesale price of salmon fillets, $P_{salmon,t}$, along with US disposable per capita consumer income, Y_t , are included in (12) - (14) as demand shifters.

The $P_{1,t}^D$ and $P_{2.t}^S$ variables in these equations are the prices of frozen catfish fillets received by US processors and Vietnamese exporters to the US, respectively, in month *t*. The latter price is f.o.b., i.e., it is the price received by exporters *before* the US duty is paid. These prices as well as all other monetary variables in the model are deflated by the US CPI.

The remaining variables are defined as follows: $Q_{1,t}$ is the per-capita quantity of frozen catfish fillets sold by US processors in month *t*; $TARIFF_t$ is a dummy variable that assumes the value of one during the tariff period (August 2003 through August 2006) and zero otherwise; $LABEL_t$ is a dummy variable that assumes the value of one during the labeling law period (December 2001 through August 2006) and zero otherwise. Major cost factors for US processors are the price of live fish and labor. Hence, supply shifters in (13) are defined as $WAGE_t$, the average wage rate for US manufacturing workers in month *t*, and $P_{livefish,t}$, the average price received by US catfish farmers in month *t*. Major cost factors for Vietnamese processors and exporters are energy and shipping to the

United States. Hence, supply shifters in (14) are defined as $ENERGY_t$, the world energy price index in month *t*, and $FREIGHT_t$, the Pacific freight rate index in month *t*.

Feenstra (2004) argues that under duopoly the antidumping duty must be treated as endogenous. The reason is that during the investigation stage, which can last a year or longer, the foreign firm has an incentive to raise price so as to lower the duty should the investigation find in favor of the domestic firm. That is, strategic behavior causes the price of the foreign good to increase *before* the duty is imposed. Because this strategic behavior is ruled out if firms are price takers, to provide an indirect test of the perfect competition model we include a dummy variable $PRELIM_t$ that assumes the value of one during the preliminary investigation period (June 2002 through July 2003) and zero otherwise.

IV. ESTIMATION RESULTS

The system contains four endogenous variables: US quantity, US and Vietnam price, and US farm price. Accordingly (12) - (14) was estimated as a system using Generalized Method of Moments (GMM) that corrects both for simultaneous-equation bias and cross-equation correlation in the error terms. However, Seemingly Unrelated Regression (SUR) estimates are also presented to assess the sensitivity of results to simultaneous-equation bias. Results from testing for unit-roots using Dickey-Fuller tests affirmed all series are stationary in logarithmic first differences. First differencing coupled with the presence of lagged dependent variables resulted in the loss of the first two observations; hence, estimates are based on 90 observations (March 1999 through August 2006).

Focusing first on the SUR estimates, results in general are satisfactory in that most of the estimated coefficients have the expected sign and Durbin-*h* statistics indicate a lack of serial correlation (Table 1.2). The R^2s are higher for US quantity and price (0.56 and 0.58) than for Vietnam price (0.24), as might be expected owing to the use of proxy variables in the latter equation. Overall, the model does a better job of explaining movements in US price and quantity than movements in Vietnam price. Similar conclusions follow from the GMM estimates, which will serve as the basis for the remaining discussion unless indicated otherwise.

4.1 Quantity Equation

Results suggest US fillets are a superior good in that demand is sensitive both to price and income. The estimated own-price elasticity is -3.01 (*t*-ratio = -6.3) and the estimated income elasticity is 1.60 (*t*-ratio = 9.9). These elasticities are short run in that they indicate the percent change in quantity in the current month to isolated one percent changes in own-price and income in the current month. The associated long-run elasticities are obtained by dividing the short-run elasticities by one minus the estimated coefficient of the lagged dependent variable (Nerlove 1958). This estimated "adjustment coefficient" is -0.48 (*t*-ratio = -30.5) yielding long-run elasticities of -2.03 and 1.08, respectively, for own-price and income. Thus, the demand for US catfish fillets at the wholesale level is less responsive to price and income in the long run than in the short run, perhaps reflecting inventory behavior. Over the sample period processor inventories of frozen fillets averaged 70 percent of sales on monthly basis, providing some scope for meeting short-run increases in market demand by drawing down inventories rather than increasing production.

Importantly, US fillets are a poor substitute for Vietnam fillets; the estimated short-run cross-price elasticity is 0.10 (t-ratio = 6.8) implying an estimated long-run cross-price elasticity of 0.07. This suggests tariff-induced increases in the price of Vietnam fillets will have little impact on the demand for US fillets. One reason US fillets may be a poor substitute for Vietnam fillets is the former's higher cost: over the sample period the US price on average was twice the Vietnam f.o.b. price, \$2.63/lb. versus \$1.34/lb. Even with a 60 percent tariff the average tariff-inclusive Vietnam price at \$2.14/lb. is well below the average US price. Hence, unless buyers see a significant quality difference between the US and Vietnam products, there would be little inducement to switch to the US product given the observed price ranges. The upshot is the tariff is not apt to be effective at raising the US price, as is clear from equation (8) when $\eta_{12} = 0.07$.

US catfish and salmon fillets are weak complements as evidenced by an estimated short-run cross-price elasticity of -0.09 (t-ratio = -3.6). Recalling that this is a wholesale level relationship, the complementary relationship may reflect menu offerings of institutional buyers (especially restaurants) as opposed to actual substitution effects by final consumers at retail. In any event, salmon prices appear not to be an important determinant of catfish demand, at least for frozen fillets.

The estimated coefficients of the quarterly dummy variables are significant and show the expected pattern, namely a heightening in demand during the Lenton period. Specifically, the estimated coefficient of D_1 is 0.202 (t-ratio = 33.1), which suggests demand in the first calendar quarter is 20 percent higher than in the fourth quarter, *ceteris* *paribus*. Demand increases again during the third quarter, albeit by a lesser amount 8.5 percent.

The estimated intercept is negative and significant, indicating trend decreases in demand over the sample period. That is, in the absence of changes in relative prices and income the demand for US frozen fillets is expected to decline over time, which suggests a weakening in consumer preferences.

Turning to the policy variables, the estimated coefficient of *TARIFF* is 0.025 and significant (*t*-ratio = 3.96) while the estimated coefficient of *LABEL* is insignificant. Hence, the labeling law had no effect on the demand for US fillets. The tariff effect, though statistically significant, is not economically large. That is, despite the tariff's size (40 - 65 percent depending on the dumping margin assigned to the foreign firm) it shifted the demand curve for the US product to the right, i.e., in the quantity direction, by a mere 2.5 percent. This modest shift is consistent with the tiny long-run cross-price elasticity ($\eta_{12} = 0.07$) estimated in the same equation.

4.2 US Price Equation

Consistent with the demand equation the estimated coefficient of *TARIFF* is positive (0.005) and significant (*t*-ratio = 8.4) while the estimated coefficient of *LABEL* is insignificant. Hence, the labeling law was futile in that it affected neither the price nor quantity of US fillets. Although the tariff was effective in that it increased US price as well as demand, the price effect was modest, less than one percent. Recalling the BA renders the sign of the tariff coefficient ambiguous (in equation (8)), the positive coefficient suggests the tariff effect dominates the subsidy effect, albeit modestly.

Estimates of the remaining coefficients are less than 0.5 in absolute value, indicating US price is insensitive both to supply and demand shocks and to changes in the Vietnam fillet price. The most important variable to affect the US price is labor costs with an estimated coefficient for $\Delta WAGE_t$ equal to 0.37 (*t*-ratio = 9.6) followed by consumer income with an estimated coefficient for ΔY_t equal to 0.11 (*t*-ratio = 5.1). These are short-run elasticities. The estimated coefficient of the lagged dependent variable is 0.44 (*t*-ratio = 11.9) implying long-run elasticities for labor cost and income equal to 0.66 and 0.20, respectively. Increases in farm price and salmon price have positive effects on US price, but the effects are modest, with long-run elasticities equal to 0.14 and 0.04, respectively. Quagrainie and Engle's (2002) estimate of the farm-US fillet price transmission elasticity from a VAR model is somewhat larger at 0.322.

The estimated coefficient for Vietnam price switches from positive in the SUR estimate to negative in the GMM estimate, but the estimated coefficients in both cases are tiny, 0.013 and -0.013. Quagrainie and Engle (2002) estimate the same elasticity at 0.004 and insignificant. Combining these estimates, it appears the Vietnam fillet price has had little, if any, effect on the US fillet price.

4.3 Vietnam Price Equation

The estimated coefficient of *PRELIM* is significant and negative, indicating the Vietnam price fell during the investigation period. Because the duopoly model discussed by Feenstra predicts foreign price should rise during the investigation period, this constitutes evidence in favor of the perfect competition model used here. That is, there is little evidence either in the raw data (see Table 1.1) or in our econometric estimates to suggest

Vietnam exporters had sufficient market power to raise price during the investigation period to reduce the antidumping duty.

The estimated coefficient of *TARIFF* is -0.098 and significant (*t*-ratio = -9.1). Thus, the tariff reduced the fob price received by Vietnam exporters, as the perfect-competition model predicts. The estimated reduction in Vietnam price of 9.8 percent is much larger than the estimated increase in US price of 0.5 percent, which suggests the tariff did more to punish Vietnam producers than to reward US producers, a finding consistent with Kinnucan's (2003) analysis. The estimated coefficient of -0.098 suggests 81 percent of the tariff appears as a rise in the US consumer price for Vietnam fillets. (From equation (9) the *ceteris paribus* relationship between the fob Vietnam price and the tariff is $EP_2^S = -[\eta_{22}/(\varepsilon_2 + \eta_{22})]\ \tau$. Setting EP_2^S =-0.098 and $\tau = 0.52$, the average *ad valorem* duty over the sample period, yields $-[\eta_{22}/(\varepsilon_2 + \eta_{22})] = -0.19$. Hence, Vietnam producer incidence of the tariff was 19 percent, which implies US consumer incidence is 81 percent.) This implies import demand is less elastic than import supply, which means most of the tariff is borne by US consumers rather than Vietnam producers. Despite the high US incidence, the tariff *per se* (ignoring the subsidy) is not a potent policy instrument because US demand for US fillets is insensitive to the price of Vietnam fillets. In other words, the tariff *sans* subsidy harms US consumers and Vietnam producers with little in the way of benefits for US producers.

The labeling law appears to have had the unintended consequence of benefiting Vietnam producers. Specifically, the estimated coefficient of *LABEL* is 0.057 (*t*-ratio = 7.1), which suggests the labeling law increased the Vietnam price 5.7 percent, *ceteris* *paribus*. The positive effect suggests US buyers value the ability to identify source origin. In this sense the law was not devoid of public benefits.

The Vietnam price is highly sensitive to the US price with an estimated coefficient of 7.33 (*t*-ratio = 11.2). The corresponding long-run elasticity, obtained by dividing the short-run elasticity by one minus the estimated coefficient of the lagged dependent variable, is 5.01. Quagraine and Engle's (2002) estimate of the same elasticity is 3.56. The asymmetric price response is intuitive given the price advantage enjoyed by the Vietnam product. Thus, while Vietnam price has little effect on US price, the Vietnam price is highly sensitive to the US price, especially in the short run when imports are relatively fixed in supply. For example, assuming a US tariff incidence of 81 percent, the tariff-inclusive price of Vietnam fillets in 2004 was $1.64 versus $2.62 for US fillets. If buyers view the products as similar in quality, as the positive coefficient for *LABEL* suggests, an increase in the US price would provide a powerful incentive for buyers to switch to the relatively cheaper imported product.

Increases in the price of energy raise the price of Vietnam fillets, although the effect is modest with a short-run elasticity of 0.15 (*t*-ratio = 3.7). Vietnam price is negatively related to changes in income, shipping costs, and salmon price. The negative coefficient for salmon price suggests imported catfish and salmon and catfish are complements, which may reflect the fact that fish buyers at wholesale handle both products and imports constitute a significant share of US salmon consumption (Kinnucan and Myrland 2005). The quarterly dummy variables suggest a seasonal pricing pattern opposite the US pattern with a strengthening in the Vietnam price during the third quarter when the US price is weakening and vice-versa during the first calendar quarter. This suggest imports are responsive to seasonal shifts in domestic supply and demand, which may explain the lack of seasonal price variation for frozen fillets found in Quagraine and Engle's study.

V. CONCLUDING COMMENTS

A basic theme of this research is the Byrd amendment renders the domestic price effect of an antidumping duty indeterminate owing to the implicit production subsidy. Thus, there is little reason to expect the price of the protected good to rise following imposition of the duty as the upward pressure on price associated with the tariff is offset by the downward pressure on price associated with the subsidy. Indeed, in the case of catfish we found the antidumping duties of between 40 and 60 percent imposed by the United States between 2003 and 2006 on frozen catfish fillets imported from Vietnam raised the US price of frozen fillets by less than one percent.

Although it is tempting to attribute the modest price effect to enlarged supply induced by the Byrd payments, our econometric estimates suggest weak demand-side effects coupled with incidence shifting may be at play. Specifically, the cross-price elasticity of demand of US fillets with respect to Vietnam price is estimated at less than 0.10, and 19 percent of the tariff is estimated to have been absorbed by Vietnam producers in the form of a lower export price. This tariff "leakage" coupled with the minute cross-price elasticity implies the shift in the demand curve for US fillets associated with tariff was modest. Indeed, the demand equation estimated in this study placed the demand shift at less than three percent.

It appears, therefore, that in the absence of the Byrd Amendment, which permitted the domestic industry to collect some $9.2 million in tariff revenues over the sample period, equivalent to 3 percent of 2005's wholesale value, the antidumping duty yielded little in the way of benefits for domestic producers. And what benefits that were generated came at the expense of domestic consumers and foreign producers. This conclusion is consistent with a growing body of evidence that suggests antidumping and countervailing duties are impotent instruments of protection for farm products (Asche 2001; Brester, Marsh, and Smith 2002; Kinnucan 2003; Kinnucan and Myrland 2005).

Table 1.1 Catfish Price and Quantity Data, United States, 1999-2005

Item	Unit	1999	2000	2001	2002	2003	2004	2005
Vietnam fillet price	$/lb.	2.04	1.52	1.26	1.29	1.21	1.15	0.93
US fillet price	$/lb.	2.76	2.83	2.61	2.39	2.41	2.62	2.67
US tariff	$/lb.	--	--	--	--	0.64	0.61	0.49
US farm price	$/lb.	74	75	65	57	58	70	72
Imports from Vietnam	mil. lbs.	2	7	17	10	4	7	17
US fillet production	mil. lbs.	120	120	115	131	125	122	124
US farm production	mil. lbs.	597	594	597	631	661	630	601

Note: fillets and imports are frozen; farm production is live-weight.

Source: Harvey (2006); authors' computation.

Table 1.2 Estimated Demand and Price Relations for Frozen Catfish Fillets, US Market, January 1999-August 2006 Data

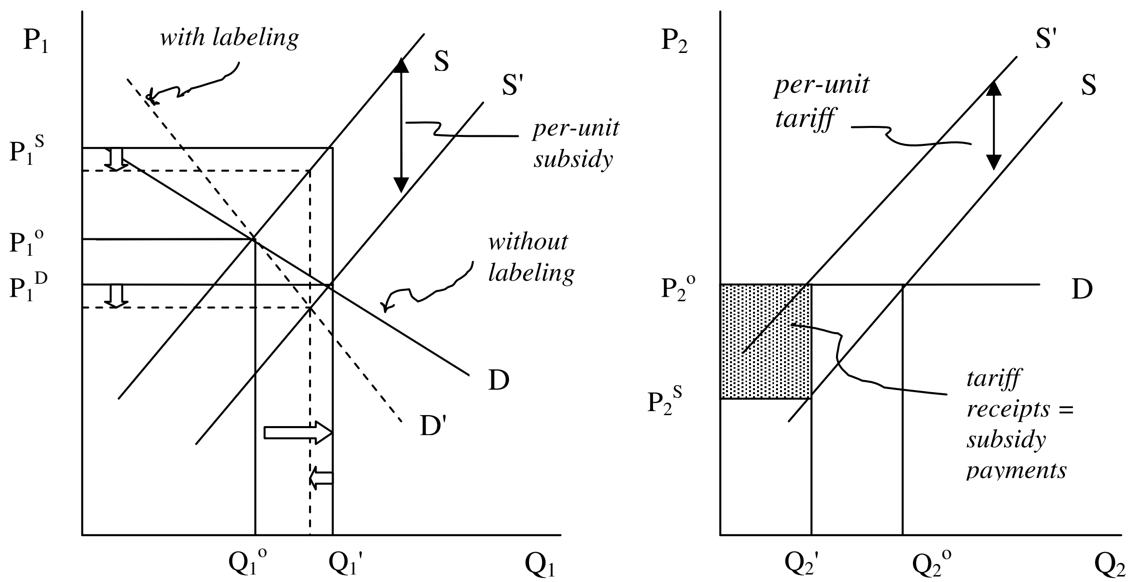
Variable/ Statistic	SUR Estimates			GMM Estimates		
	US Quantity	US Price	Vietnam Price	US Quantity	US Price	Vietnam Price
Intercept	-0.087	-0.003	-0.030	-0.091	-0.004	-0.006
	(-5.12)	(-1.39)	(-0.94)	(-12.1)	(-9.51)	(-0.54)
TARIFF	0.020	0.004	-0.048	0.025	0.005	-0.098
	(1.15)	(2.01)	(-0.89)	(3.96)	(8.41)	(-9.13)
LABEL	-0.0002	-0.001	0.036	-0.001	-0.0002	0.057
	(-0.01)	(-0.45)	(0.69)	(-0.23)	(-0.31)	(7.05)
PRELIM	--	--	-0.0064	--	--	-0.037
			(-0.11)			(-4.73)
US Price	-2.40	--	4.08	-3.01	--	7.33
	(-3.75)		(3.38)	(-6.30)		(11.2)
Vietnam Price	0.11	0.013	--	0.10	-0.013	--
	(2.20)	(1.95)		(6.83)	(-4.54)	
Salmon Price	-0.11	0.028	-0.12	-0.09	0.022	-0.15
	(-1.07)	(2.25)	(-0.65)	(-3.62)	(10.3)	(-2.61)
Income	1.49	0.16	-0.91	1.60	0.11	-1.33
	(1.92)	(1.61)	(-0.62)	(9.92)	(5.11)	(-3.90)
Farm Price	--	0.16	--	--	0.08	--
		(4.34)			(2.12)	
Wage Rate	--	0.25	--	--	0.37	--
		(1.61)			(9.58)	
Energy Price	--	--	0.18	--	--	0.15

			(1.02)			(3.74)
Shipping Price	--	--	-1.21	--	--	-1.57
			(-1.72)			(-10.2)
Lagged US Quantity	-0.49	--	--	-0.48	--	--
	(-6.32)			(-30.5)		
Lagged US Price	--	0.30	--	--	0.44	--
		(3.55)			(11.9)	
Lagged VN Price	--	--	-0.400	--	--	-0.444
			(-4.22)			(-16.3)
Quarter 1	0.194	0.006	0.016	0.202	0.008	-0.016
	(8.93)	(2.06)	(0.40)	(33.1)	(10.6)	(1.54)
Quarter 2	0.023	0.002	0.041	0.028	0.003	0.030
	(1.24)	(0.94)	(1.07)	(7.21)	(4.79)	(2.59)
Quarter 3	0.085	-0.001	0.032	0.085	-0.001	0.041
	(4.38)	(-0.42)	(0.88)	(20.6)	(-2.01)	(3.22)
R^2	0.559	0.578	0.237	0.547	0.521	0.135
Adjusted R^2	0.503	0.518	0.119	0.490	0.453	0.001
Durbin-*h*	-1.19	-0.08	-0.11	-0.67	0.00	0.44
s.e. of regression	0.0648	0.0083	0.1222	0.0656	0.0089	0.1301

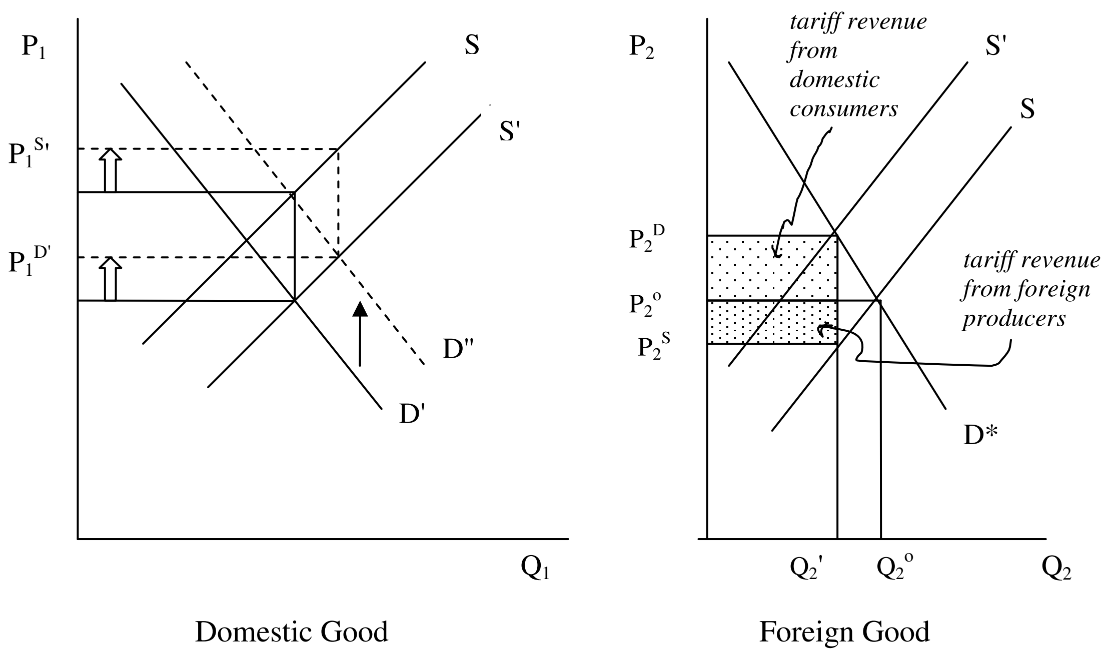
Note: Numbers in parentheses are asymptotic *t*-ratios; see text for details.

Figure 1.1 Effects of Antidumping Duty under the Byrd Amendment

Panel A. Exogenous Foreign Price



Panel B. Endogenous Foreign Price



CHAPTER 2. EFFECTS OF ANTIDUMPING DUTIES UNDER BERTRAND COMPETITION: SOME EVIDENCE FOR CATFISH

I. INTRODUCTION

Through various GATT/WTO rounds, tariff barriers have decreased worldwide, but anti-dumping measurement 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 measurements conducted by importing countries (Table 2.1)

Since 1980's decade, the rise in international competition has led many U.S. firms to seek protection from foreign imports (Hansen and Prusa, 1996). One of protection tools, antidumping duty is enforced by the Continued Dumping and Subsidy Offset Act of 2000, commonly referred to as the Byrd Amendment. A large theoretical literature exists on the effects of the duty and of the Byrd Amendment. The Byrd Amendment permits successful petitioners for anti-dumping and countervailing duties to collect tariff revenues. The Byrd Amendment 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 percent to 64 percent 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.

II. LITERATURE REVIEW

2.1 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 one of 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 Colombia 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). The 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, Marsh, and Stiergert, 2006).

2.2 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.

2.3 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 as 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 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 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 literature on effects of antidumping measurements, 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.

III. THEORETICAL FRAMEWORK

3.1 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:

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

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

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

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

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):

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

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 ($\gamma_1 = \gamma_2 = 0$).

3.2 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:

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

(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.

IV. EMPIRICAL MODEL FOR THE FROZEN CATFISH FILLETS

4.1 Model Specification

For empirical regression with the frozen catfish fillets case, some following assumptions are made: i) Vietnamese catfish dominate US catfish import when 90 percent 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 farmed catfish:

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

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.

4.2 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 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 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 percent increase in freight cost from Pacific raises price of the domestic product by 1.1 percent but lowers price of the import 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 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 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 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 percent level. After the US antidumping is 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 is not significant.

V. 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 percent 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 percent of 2005's wholesale value) thanks to the Byrd Amendment.

Table 2.1 Global Antidumping Activity for Agricultural and Fisheries Products

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

Product	Year	Filing country	Target countries
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

Product	Year	Filing country	Target countries
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

Product	Year	Filing country	Target countries
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

Source: Modification from Kinnucan and Myrland (2006) with data from Bown (2006)

Table 2.2 Description of Variables and Source of Data

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 2.3 SUR Regression for Reaction Price Equations and Demand of US Catfish Fillets

	US home price	Vietnamese price	Demand for US products
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 2.4 SUR Regression for the Equation System with Farm Price Equation for US Catfish Fillets

	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

CHAPTER 3. AQUACULTURE AND HAPPINESS IN VIETNAM

– A MICROECONOMETRIC ANALYSIS

I. INTRODUCTION

Aquaculture is a farming activity almost as old as humanity. However, there is now, more than ever, a growing awareness of the importance of food fish production on human nutrition, employment, poverty (Bailey and Skladany, 1991; Edwards, 2000, Edwards, Little and Demaine, 2002) and even recreation in more developed societies (Jolly and Clonts, 1993). In Vietnam, aquaculture has also been considered an important economic sector due to its rapid growth and its 30-40 percent contribution to total national fisheries production (FAO and NACA, 1997). In addition, seafood is the third most important export product of Vietnam after crude oil and textile-garments. Alongside capture fisheries, aquaculture revenue constituted four percent of Vietnamese GDP in 2003 and $2.35 billion in exports in 2004 (FAO, 2005), or 10 percent of the country's total export revenue. The total area used for aquaculture in Vietnam is 902,229 hectares of two million hectare potential water surface areas (FICEN, 2005) covering three percent of the total land area.

The contribution of aquaculture development to the Vietnamese national economy and to farmers' incomes has been the focus of various government reports as well as working papers produced by development projects. However, the role of aquaculture in the job satisfaction of poor farmers has not been considered rigorously. In particular, it is very difficult to find any literature relating aquaculture adoption to happiness or life satisfaction of the adopters although since the 1990s, a number of studies of the determinants of "happiness" have been conducted by economists following a long history of happiness analysis by psychologists (Frey and Stutzer, 2002). Furthermore, the relationship between income and happiness is confounded by economists and social researchers because the terms of happiness, subjective well-being, satisfaction, utility or even welfare are usually used interchangeably (Easterline, 2001).

Di Tella, MacCulloch and Oswald (2003) state that happiness equations are monotonically increasing in income, and have a similar structure in different countries. Higher income persons are likely happier because they have more opportunities to get what they desire (Frey and Stutzer, 2002). The important role of higher income in lasting human happiness is also supported by Andrews (1986), Argyle (1999), Diener (1984), Diener and Lucas (1999), Lykken and Tellegen (1996), Schwars and Strack (1999). Although it does not provide lasting happiness, more money allows for life style improvements, whether those improvements arise from more money or other desirable objects (Lee, 2006).

Despite of evidence that increased income raises happiness, according to Frank (2004), the absolute income increases of recent decades have failed to translate into corresponding increases in measured well-being. The evidence thus suggests that if income affects happiness, it is relative, not absolute, income that matters. Frey and

Stutzer (2002) argue that higher income aspirations reduce individuals' satisfaction with life.

Due to the controversial role of income in creating happiness and the increased contribution of fish production in the livelihoods of small scale farmers (Edwards, 2000, Edwards, Little and Demaine, 2002), there exists a question of whether income increases from adoption of the enterprise would raise happiness of fish farmers. This study uses cumulative logistic models to explore the level of fish farmers' happiness as well as examine impacts of aquaculture on beneficiaries' life style improvements and thus, complements previous studies on contributions of aquaculture to farmers' lives. Furthermore, secondary micro data measuring happiness, especially related to job satisfaction, is unavailable in a developing country like Vietnam. Thus, this study uses primary data from a survey conducted of fish farmers in Vietnam.

To examine the contribution of aquaculture in improving farmers' happiness, this study contains three parts. The first part is reserved for description of the methodology. The second part investigates the determinants of happiness associated with fish culture and the third part examines the role of earnings from fish culture in improvement of farmers' quality of life.

II. RESEARCH METHODS

2.1 The Cumulative Logistic Model

Since subjective well-being is a broader concept than decision utility, including experienced utility as well as procedural utility, Frey and Stutzer (2002) suggest a microeconometric function to measure happiness, $W = \alpha + \boldsymbol{\beta}\mathbf{x} + \varepsilon$ where W is level of happiness and **x** is a vector of explanatory variables of demographics and socioeconomics characteristics. Therefore, cumulative logit models are used to explore the relationship of fish culture to pleasure to the enterprise as well as to improvement of life quality.

Given that utility levels are represented by ordinal variables, a farmer's utility (represented by satisfaction or happiness from aquaculture) takes the following function

$$U_i = \alpha^* + \boldsymbol{\beta}^* \mathbf{x}_i + \sigma\varepsilon_i , \tag{1}$$

where U is utility level, **x** is vector of explanatory variables and *i* represents individual respondent. However, U_i can not be observed directly. Instead, according to Allison (1999) and Greene (2003), there exists a set of cut off points or thresholds, $\pi_{1, \ldots,}$ π_{J-1}, that are used to transform U_i into the observed variable Y as following

$$Y_i = 1 \text{ if } \pi_1 \leqq U_i \tag{2}$$

$$Y_i = 2 \text{ if } \pi_2 < U_i \leqq \pi_1$$

$$Y_i = 3 \text{ if } \pi_3 < U_i \leqq \pi_2$$

•

•

$$Y_i = J \text{ if } U_i \leqq \pi_{J-1}$$

Assuming ε_i has a standard logistic distribution, it follows that the dependence of Y on **x** is given by the cumulative logit model.

$$\text{Log } [F_{ij}/(1-F_{ij})] = \alpha^* + \boldsymbol{\beta}^* \mathbf{x}_i \qquad j = 1, \ldots, J - 1; \tag{3}$$

where $F_{ij} = \sum_{m=1}^{j} p_{im}$ represents cumulative probabilities (4)

Agresti (2002) defines the cumulative probabilities in simpler form

$$P(Y \leq j|\mathbf{x}) = p_1(\mathbf{x}) + \cdots + p_j(\mathbf{x}) \qquad (j = 1, \ldots, J) \tag{5}$$

and the cumulative logits are

$$\text{logit}[P(Y \leq j \mid x)] = \frac{\log P[(Y \leq j \mid x)]}{1 - \log p[(Y \leq j \mid x)]} \qquad (j = 1, \ldots, J - 1) \tag{6}$$

A model that simultaneously uses all cumulative logits is given by

$$\text{logit}[P(Y_i \leq j \mid x)] = \alpha_{ij} + X_{ij}'\beta \tag{7}$$

where Y_i is response level, i= respondents and j = 1, …, J − 1 and J represents number of categories of responses; in our study, J = 5; X is the vector of explanatory variables.

Each cumulative logit has its own intercept α_j increasing in j, but the same coefficient β for each explanatory variable, representing the effect of explanatory variable x on the response Y. The response curves for j = 1, …J-1 have the same shape determined by β. They share exactly the same rate of increase or decrease but are horizontally displaced from each other. According to Agresti (2002), for fixed j, the response curve is a logistic regression curve for a binary response with outcomes Y≤j and Y>j.

Allison (1999) states that the coefficients in equation 7 are related to equation (1) by

$$\alpha_j = \frac{\alpha^* - \pi_j}{\sigma} \tag{8}$$

and $\beta = \beta^*/\sigma$. (9)

Allison (1999) emphasizes that coefficients β are not affected by the placement of the thresholds. Some of π's may be close together while others far apart, but the effects of the explanatory variables stay the same. The effect of π is on the intercepts.

The levels of pleasure from fish culture are proxy for job satisfaction, the respondents were asked by the question of "*Do you feel to be completely satisfied or pleased by integrating fish culture into farming?*" To measure the farmers' life satisfaction, a proxy for their subjective well-being or 'utility' (Frey and Stutzer, 2002), the respondents were asked "*Do you recognize generally a considerable improvement in quality of life in your household since adoption of fish culture*?" Farmers' responses to the above questions are based from Leikert scale ranging from one ("strongly agree") to five ("strongly disagree"). Frequencies of the responses are summarized in Table 3.1.

The scales of j=1,2 indicate that the farmer is pleased with his/her fish farming experiences (for the question on job satisfaction) or that he/she is happy with their life (for the question on life satisfaction). At fixed threshold j=2, the response curve is a logistic regression curve for a binary response with outcomes $Y \leq 2$ and $Y > 2$. From this, we can obtain the estimated cumulative probability p of farmers' satisfaction or happiness from which we can calculate marginal effects which are then used to calculated elasticities of continuous explanatory variables for each observation. For dummy variables (say, D), the marginal effects are differences between $P(Y \leq 2 \mid D=1, x)$ and $P(Y \leq 2 \mid D=0, x)$.

The SAS logistic regression procedure with backward selection is used, setting a maximum P-value of 10 percent. From the logistic procedure the best fit model is selected. Elasticities are also calculated to measure the magnitude of effects of explanatory variables. Since elasticities are nonlinear functions of the observed data the logit function is not guaranteed to pass through the mean point (Train, 1986). Further elasticity is calculated at the means tend to overestimate the probability response to a change in an explanatory variable (Hensher and Johnson, 1981). The elasticity measured at means is thus not used to measure effects of continuous variables. Instead, based on Hensher and Johnson's (1981) formulation, the weighted average elasticities are calculated from the marginal effects.

2.2 Data Description

The data for this study are obtained from a 2001 field survey involving 120 fish farmers in three provinces of Binh Phuoc, Tay Ninh and Long An in Southern Vietnam. Because of poor resources due to dry soil and water scarcity as well as remote distances to urban regions, aquaculture was underdeveloped in the provinces before 1994. Limited resource farmers in these provinces live mainly on subsistence agriculture and are irregularly employed in off-farm labor. Aquaculture has been adopted as a solution for rural development and improvement of farmers' livelihoods.

The investigated region is also the target area of an aquaculture development program, UAF-Aqua Outreach Program (UAF-AOP), which was implemented starting in 1994 under cooperation of the provincial extension agencies and Fisheries Faculty of the University of Agriculture and Forestry (currently renamed Nong Lam University, Thuduc, Hochiminh City, Vietnam). Between 1994 and 2000, the program had transferred appropriate and low cost technologies, utilizing local resources, to small scale farmers involved in on-farm trials. Since the beginning of the program, aquaculture has been continuously growing in both water surface and production intensity, mostly within extensive and semi-extensive aquaculture systems in the area (Duc, 2001).

This study is limited to small-scale fish farmers, examining the relationship between their adoption of aquaculture technology and the improvement of their quality of life. According to Edwards et al. (1996) small-scale farms have relatively little land area, often as small as 0.5-1.0 ha, are typically nutrient-poor; rain-fed with seasonal or unreliable rainfall; dominated by crops, with a few animals fed from agricultural by-products on or near the farm. Nevertheless, irrespective of the economic or other benefits of large-scale aquaculture operations, greater emphasis is placed on small-scale farming in developing countries. According to Pillay (1990), this is largely because of the opportunities small scale operations offer for part- and full-time employment, helping to sustain peasants and fishermen in rural areas, and reducing the drift of populations to urban centers. Edwards and Demaine (1997) also discuss small-scale farmers in the definition of "rural aquaculture". They define this type of aquaculture as "the farming of aquatic organisms by small-scale farming households using mainly extensive and semi-intensive husbandry for household consumption and/or income".

Headed mostly by men, the surveyed households had an average size of five members, ranging from one to sixteen and median number of men is two, while the age of the respondents (also household heads) ranged from 26 to 80, with a mean of 47, mostly concentrated in the 35 - 60 year old range. The respondents had quite high education levels, with more than 75 percent of them having completed secondary or higher levels. The rather high educational level of the farmers should make them more willing to adopt new farming technologies, thereby improving their livelihoods.

Prior to the development project, aquaculture was underdeveloped in the survey area. However, overall pond area has considerably increased since 1995, the beginning of the UAF-Aqua Outreach Program. This study focuses on small-scale fish farmers, whose pond area is generally small or very small, ranging from 40 to 9,000 m^2, and the ratio of pond to land ranges from 0.25 – 80.00 percent. The land area owned by households in this survey ranges from 500 m^2 to 12 ha.

Employing Enterprise Budgeting methods (Jolly and Clont, 1993), household income includes farming income, off-farm income and non-farm income and also income from wild-caught fish which plays an important role in the livelihoods of the target farmers. Total household income is divided by household size to get per capita income. Farming income includes incomes from farming enterprises such as rice cultivation, livestock, fish culture, non-rice crop farming and fruit trees, all of which contribute to farmers' annual incomes. Any enterprises practiced solely for consumption and which do not contribute to a farmer's income are ignored in this study because farmers do not consider them as sources of income and their role in farmers' livelihoods is not empirically relevant.

Because a few farmers suffer economic losses during the study year, the household income, farming income, non-farming income and income from fish culture (fish income) are added with 1,000 to make their profits positive and enable positive ratios of fish income to household income and farming income as relative values of income received from the enterprise.

In this study, “fish income” is defined as total income from fish production, including cash income received from fish harvest sales and ‘forgone’ income from the amount of fish given away and eaten while “wild fish catch income” is cash income received from selling wild fish caught off-farm. Cash income from fish culture is more appreciated by the farmers because they can use cash to buy necessities and to improve their livelihood. To explore their effects on farmers’ satisfaction or happiness, incomes either in their absolute or in relative values are assumed exogenous in regressed models.

Michalos (1991) and Inglehart (1990), cited by Easterline (2002), state that “individual well-being is determined by the gap between aspiration and achievement”, thus this study includes farmer’s expectation to earnings from fish culture (called ‘fish expectation’ in brief) which is defined as the difference between the farmer’s estimated value of fish income relative to his total household income and the real value we calculated from collected economic data of his actual operations. Descriptive statistics are summarized in Table 3.2.

III. SATISFACTION FROM FISH CULTURE

The pleasure of farmers receive by engaging in fish culture may be considered a proxy for ‘job satisfaction’, where ‘job’ is the fish culture enterprise in which all respondents of this study are involved.

Using a cumulative logit model to estimate farmers’ satisfaction to fish culture, the first explanatory variable included is fish yield which is fish production divided by pond area. When fish yields increase, the satisfaction derived from fish culture is expected to increase. Demographic characteristics, such as age and education level of the respondents, are also included in the model, as suggested as Frey and Stutzer (2002).

Per capita income is included to control the effect of income on a respondent's satisfaction from fish culture. In the target area, fish culture represents an increasing contribution to household income of small scale farmers (Duc, 2001) although it is not the most important source. Due to capital constraints involved with fish culture (Duc, 2002), higher income farmers are expected to be more likely to gain satisfaction from fish culture. The absolute level of income from fish culture in addition to income as a proportion of total household income and farming income are major variables of interest and are considered exogenous to the farmers' satisfaction. The variables are used to explore the utility effects of earnings from fish culture. The number of men in a household represents the role of male labor in the household in household livelihoods.

Land area is also considered because of its important role in the small scale farmers' livelihoods (Quan, 1998); higher land area is expected to increase satisfaction derived from fish culture, assuming that farmers would expand operations in order to increase profits and hence utility. On the other hand, for small scale farmers, whose land is the only material resource invested in production, the relative area of pond to total land area defines the scale of fish culture on their farms and represents a farmer's investment in fish farming. The other explanatory variables are farmers' involvement in on-farm trials with support from AOP, their 'fish expectation' which is measured by the gap of their estimates of contribution of fish farming to household income in percentage and the real values calculated from production data.

The cumulative logit model for the satisfaction farmers receive from fish culture is specified as follows

Logit[P(pls_fish≤j)] = f(yield, income, fish-farminc, fishincome, age, edulevel, men, land, pond-land, involve, expectation) Model (1)

where:

- *pls_fish*: categorical variable for satisfaction derived from fish culture where j indicates the value of the Leikert scale, representing five levels of job satisfaction from "strongly satisfied" to "strongly dissatisfied", j = 1…5

- *yield*: farmer's productivity of fish culture, total fish production divided by pond area

- *income*: capita household income in US dollar

- *fish_income:* total income from fish production

- *fish_farmincome:* the ratio of *fish_income* to farming income

- *age:* age of respondent; *age* = 1 if the respondent is older than 40, *age* = 0 otherwise.

- *edulevel:* education level of respondent; *edulevel* = 1 if the respondent has completed secondary school, *edulevel* = 0 otherwise

- *men*: number of men in household

- *land:* farmer's total occupied land

- *pond-land*: the ratio of pond area to total area of land (*land*)

- *involve*: involvement with extension services; *involve* = 1 if the farmer is involved with extension services (UAF-AOP's on-farm trials); *involve* = 0 otherwise.

- *expectation:* farmer's expectation to the role of fish farming in household income, defined by the gap of the value estimated by the farmer about the ratio between *fish_income* and their household income and the actual ratio calculated by the Enterprise Budgeting method

The interaction between respondent's age, expectation in earnings from fish culture, and involvement in extension and other variables are also added in the model.

From the logistic procedure, the best fit model for farmer's satisfaction derived from their fish culture enterprise is selected and the regression results are reported in Table 3.3. The intercepts in the regressed models indicate that probability of each level of satisfaction ($pls\_fish \leq j$), given explanatory variables x, increases in j and the logit is an increasing function of this probability.

The cumulative logit of satisfaction from fish culture is

$$\text{logit}\,[\text{P}\,(\text{Pls\_fish} \leq 2)] = \log \frac{\text{P(Pls\_fish} \leq 2)}{\text{P(Pls\_fish} > 2)} = \log \frac{\text{P(Pls\_fish} \leq 2)}{1 - \text{P(Pls\_fish} \leq 2)}$$

The estimated probability of the farmer's satisfaction from fish culture is

$$\text{P (Pls\_fish} \leq 2) = \exp\{\text{Logit[P(Pls\_fish} \leq 2)]\}$$

$$\text{P(satisfaction)} = \text{P (Pls\_fish} \leq 2) = \frac{\exp\{\text{logit[P(Pls\_fish} \leq 2)]\}}{1 + \exp\{\text{logit[P(Pls\_fish} \leq 2)]\}}$$

At j = 2, the response curve is a logistic regression curve for a binary response with outcomes P($pls\_fish \leq 2$) and P($pls\_fish > 2$), we can get the estimated cumulative probability p of farmers' satisfaction to calculate marginal effects of continuous explanatory variables. Estimated coefficients, marginal effects and elasticities of explanatory variables are reported in Table 3.3.

Among farmers who were not involved with extension services, better educated farmers are more satisfied from their fish culture relative to the less educated. The negative effect of the interaction between education level and involvement in extension service suggests that the better educated farmers who were involved with extension services obtain less satisfaction from their fish culture. In other word, less educated farmers involved in more extension services would get more satisfaction to their fish farming activities.

Unexpectedly, neither per capita income nor absolute fish income significantly affects the pleasure farmers derived from their fish culture. However, the regression results show that higher income from fish culture relative to farming income the higher cumulative probability of farmer's satisfaction, especially for farmers not involved in the UAF - Aqua Outreach Program (UAF-AOP).

The positive effect of relative income from fish culture (*fishincome/farmincome*) decreases for farmers involved in extension activities, although involvement in AOP activities generally have a positive effect on the probability that farmers will be satisfied. A double (100 percent) growth in income from fish culture relative to farming income increases the satisfaction probability of AOP-non-involved farmers by 20 percent but just increase the satisfaction of AOP-involved farmers by (2.009 – 1.958) = 0.051 percent. This shows that among farmers involving AOP activities, those who obtain higher relative income from fish culture seem not satisfied in their achievement from the enterprise despite the fact that farmers involved in extension activities are more satisfied to their fish production in general.

The income from aquaculture in this study is not only cash income from the enterprise but also includes 'hidden' indirect benefits from fish consumed and given away, but those benefits are not quantifiable by the farmers. Their higher satisfaction from fish farming may be a positive consequence derived from more indirect benefits they get from this enterprise. Although income from fish culture has no explicit effect on farmers' satisfaction, fish production benefits the farmers as an available source of fresh and high valued food locally. This benefit is very important in rural areas with limited resources due to dry soil and water deficiency.

The effect of age is significant in the model; older farmers have a higher probability of satisfaction from fish culture. The marginal satisfaction of *age* is 0.15. For older farmers, a larger relative area of pond to total land area tends to increase probability of farmer's satisfaction from fish culture. A 100 percent increase in the ratio between pond surface and land area would raise satisfaction for younger farmers by only seven percent, but would increase satisfaction for older farmers by 13 percent.

The regression results also show that younger farmers with higher expectations from fish culture are more satisfied with fish culture, although the effect is fairly small. A 100 percent increase in expectation on fish culture results in a 10 percent rise in the probability of satisfaction level of younger farmers (less than 40 years old) from their fish enterprise relative to the older.

In general, farmers' expectation on earnings from fish culture raises their satisfaction from the enterprise. This scenario seems not to support the discussion of Frey and Stutzer (2002) who argue that 'wants are insatiable', the more one gets, the more one wants and higher expectation leads to less satisfaction. Their argument is possibly appropriate to the farmers who are older than 40 years old in this study or have limited pond surface in the target area. Nevertheless, with higher expectation on earnings from fish culture as a solution to poverty alleviation, small scale farmers can maximize their use of limited resources to pursue fish farming, resulting in more production and higher income from the enterprise.

In brief, absolute income, aquaculture productivity and the number of men in household do not directly increase farmers' satisfaction levels. Higher satisfaction is associated with involvement in extension activities, larger pond ratio, higher expectations and higher relative income from aquaculture. Higher age and education levels are also raise the probability of farmers' satisfaction from the enterprise.

IV. FISH CULTURE AND LIFE QUALITY IMPROVEMENT

To explore the role of aquaculture in improving farmers' quality of life, a cumulative logit function is also employed for categorical responses of farmers' happiness. The Leikert scale, from one to five, is used again to represent five responses from "strongly agree" to "strongly disagree". Five levels representing improvement of farmers' life quality are also created in response to the question of "*Do you recognize in generally a considerable improvement in life quality of your household since adoption of fish* *culture*?" It should be noted that responses from farmers are subjective; therefore the "happiness" term in this study is considered subjective well-being.

Easterline (2001) states that the terms of happiness and subjective well-being are usually used interchangeable, the level of happiness term in this study is thus assumed identical to farmers' responses on life quality improvement, a proxy for subjective well-being. This section of the paper concentrates on examination of the role of earnings from fish culture in improving farmers' quality of life; and also verifies the role of fish culture in contributing farmers' long run happiness.

Because absolute income may be not a determinant for quality of life (Frank, 2004) relative incomes calculated as the ratios of absolute income from fish culture ("fish income" in brief) and from captured wild fish ("wild fish income" in brief) to total household income are included in the model to examine their effects on life quality improvement in addition to the variable of *income* variable, per capita income. Cash income from fish culture is more appreciated by farmers because cash can be used to buy necessities and improve their livelihood. Therefore, cash income from fish culture relative to total household income is also included in the model. Higher cash income is expected to lead to higher levels of happiness. The income from non-farm activities relative to total household income is used to control for the effect of non-farm income.

According to Cantril (1965), a good job and personal characteristics are also associated with happiness. Satisfaction from aquaculture, a proxy for job satisfaction, is thus expected to raise fish farmers' happiness levels. Education level of respondents as well as number of men and land area of a farm are used as controlling variables in the model. In previous research, younger respondents report the lower life satisfaction than the older respondents (Frey and Stutzer, 2002). The age variable plays an important role. The number of men in a household controls for the possible role of male labor in creating income and improving household livelihood in poor and remote communities where women's role in the labor market are limited. The importance of farm size in a farmer's livelihood merits inclusion of a land area variable in the model; more land area is likely to result in higher levels of quality of life. The logit model is specified as follows

$$Logit[P(\ happy \leq j)] = f(pls\_fish,\ income,\ fcash\_total,\ nonfarm\_total,\ catch\_total,\ fish\_total,\ age,\ edulevel,\ men,\ land) \qquad \text{Model (2)}$$

where:

- *happy*: categorical variable of improvement in farmer's life quality
- *pls_fish*: categorical level of farmer's satisfaction from fish culture, ranging from 1 – 5 for five levels from "strongly satisfied" to "strongly dissatisfied"
- *income*: per capita income
- *fcash_total*: cash income from fish culture relative to total household income
- *nonfarm_total*: non-farm income relative to total household income
- *catch_total*: income from wild fish capture relative to total household income
- *fish_total*: income from fish culture relative to total household income
- *age*: age of respondent; *age* = 1 if the respondent is older than 40, *age* =0 otherwise

- *edulevel*: education level of respondents; *edulevel* = 1 if the respondent has completed secondary school, *edulevel* = 0 otherwise.
- *men*: number of men in a respondent's household
- *land*: total area of land occupied by a respondent's household

In another version of this model, a variable of improvement of community life was also added, but the variable is highly correlated with the dependent variable and explicitly dominates other variables. It was thus dropped out of the model.

To investigate possible interaction effects of age, education level and job satisfaction levels of fish farmers with other variables, the interaction variables are also added into the model (2).

Similarly to the model (1) for job satisfaction, the cumulative logit of farmers' happiness is

$$\text{logit}\,[\text{P}\,(\text{Happy} \leq 2)] = \log\frac{\text{P}(\text{Happy} \leq 2)}{\text{P}(\text{Happy} > 2)} = \log\frac{\text{P}(\text{Happy} \leq 2)}{1 - \text{P}(\text{Happy} \leq 2)}$$

The estimated probability of the farmer's well- being is

$$\text{P}\,(\text{Happy} \leq 2) = \exp\{\text{Logit}[\text{P}(\text{Happy} \leq 2)]\}$$

$$\text{P(happiness)} = \text{P}\,(\text{Happy} \leq 2) = \frac{\exp\{\text{logit}[\text{P}(\text{Happy} \leq 2)]\}}{1 + \exp\{\text{logit}[\text{P}(\text{Happy} \leq 2)]\}}$$

Model (2) has two versions, distinguished by two different types of variable *pls_fish* representing farmer's satisfaction from fish culture: the first (model 2a) uses variable *plsfish* with its scaled data collected directly from interviews while the second (model 2b) uses the alternative *pls* with data from the predicted probability that a farmer is satisfied with his aquaculture operation, P(*pls_fish* $\leq$ 2), estimated from model (1). That means the variable of *pls* is continuous while the *plsfish* is categorical.

The predicted value *pls* in model (2b) is also considered an instrument to correct for potential endogeneity of *pls_fish* in the model (2a). The intercepts in the regressed logistic models indicate probability of each level of happiness (*pls_fish* $\leq$ j), given explanatory variables *x*, increases in *j* and the logit is an increasing function of this probability.

The logit regression coefficients, marginal effects and elasticities for explanatory variables in both models are respectively reported in Table 3.4 and Table 3.5. The results show that the cumulative probability of life quality improvement increases with higher levels of farmer's satisfaction to fish culture. It should be noted here that the negative sign of *plsfish* in model (2a) indicates a positive effect on farmers' satisfaction. That is, *plsfish* values are lower for higher levels of satisfaction. The elasticity of happiness with respect to *plsfish* is -0.6364 and respect with to cumulative probability of farmer's satisfaction, *pls*, is 0.91. This means the farmers' satisfaction from fish production is positively related to their happiness. When a fish farmer's satisfaction from fish culture increases by 10 percent, his (her) probability of happiness increases by 9.1 percent.

Age has a positive effect on the probability of improvement in life quality of farmers in both versions of model 2. In model (2a), better educated farmers who are more satisfied with their fish culture would be happier relative to those with lower education and satisfaction levels.

Effects of income on farmer's happiness are interesting in this study. Income per capita has a positive effect on the cumulative probability of happiness in model (2a). A double (100 percent) increase in income per capita raises the probability of happiness by 31 percent. Happiness is income inelastic; so fish farmers would have to get more income to increase their happiness levels. However, income effect is insignificant in model (2b). Non-farm income lowers the happiness levels. A 10 percent rise in non-farm income relative to total household income lowers the probability of happiness by 12 percent. All of the interviewed fish farmers are household heads, and most of their non-farm income comes from younger family members working for local manufacturing and service sectors, as well as from remittances from their relatives living in urban regions. The interviewed farmers are committed to the farming operations for most time of their life. The more non-farm money the farmers receive from other people, the less happiness they get because they feel they are more dependent on others. The negative effect of non-farm income thus indicates farmers receive utility from their working on the farm.

The regression results of both models (2a) and (2b) show that for older farmers, higher relative income from fish farming seems to lower their happiness levels. For farmers older than 40 years old, when relative income from fish culture doubles their happiness probability decreases by 32 percent (in model 2a) or 26 percent (in model 2b). The negative influence of relative income from fish production to farming income may be related to the negative effect of relative income from fish culture to total household income for older farmers. As fish income relative to total income doubles, the happiness probability of older farmers decreases by 32 percent. This result shows that income from fish culture is unlikely to increase happiness of the older. However, the result suggests that the younger farmers are happier with the higher income from aquaculture, a new farming operation introduced to their community. That implies a potential to introduce the new technology and/or operations to the young fish farmers community.

The important role of income in small scale farmers' livelihoods can be represented via cash income as they can use cash to improve their life, leading to a happiness increase. Cash earned from fish culture has a similar positive effect in the two models. A 100 percent increase in cash returns from fish culture relative to household income raises a farmer's happiness probability by 10.6 percent in model (2a) and by 9.3 percent in model (2b).

Earnings from wild fish capture also significantly contribute to well-being of the fish farmers, as the higher it is relative to total income, the higher the positive effects in both models. When income from wild fish sales doubles, the probability of farmers' happiness increases by more than two times, from 111 percent (Model 2b) to 139 percent (model 2a).

In short, the contribution of fish culture to improvement of farmers' livelihoods and well-being can be represented by their pleasure and cash earnings from the enterprise. Although negatively affected by higher relative non-farm income, the probability of their happiness increases with higher age. The regression that includes a categorical variable for farmers' pleasure, *pls_fish,* (model 2a) affirms that per capita income is still an important determinant of life quality improvement, a proxy for subjective well-being or happiness, which supports to findings from previous studies (Andrews, 1986, Argyle, 1999, Diener, 1984, Diener and Lucas, 1999, Lykken and Tellegen, 1996, Schwars and Strack, 1999, and Di Tella, MacCulloch and Oswald, 2003).

Furtherly, the significance of predicted probability of farmers' satisfaction (via *pls* variable) on their happiness probability enables us to use the model (1) as the first stage and its predicted value as an instrument in a two-stage estimation of happiness determinants. Substituting *pls* in model (2b) by its determinants found in model (1), we can get marginal effects and elasticities of happiness respected to the determinants which are reported in Table 3.6.

In accordance with Frey and Stutzer (2002), the marginal utility of age dummy variable is 0.0946. Younger respondents appear to be more pessimistic than older respondents. Involvement with extension services also positively influences farmers' happiness as indicated by its marginal effect of 0.0125. Farmers who are better educated and are more satisfied with fish culture would be happier than those in other categories.

Pond surface relative to land area also increases happiness of the farmers, especially as respondent's age increases. A 100 percent increase in relative pond area raises happiness probability of younger farmers by 6.6 percent but increases that of older farmers by 11.5 percent. This suggests that farmers who have larger scale fish culture operations get more satisfaction and happiness.

Farmers' expectation on fish culture also increases their happiness. Farmers who are younger and have higher expectation level on fish culture are likely to be happier than the olders. A 10 percent increase in farmer's expectation level on fish culture contributes a 1.55 percent increase in happiness probability of the younger farmers. This contribution is less for older farmers by 0.86 percent but in total effect, they still experience higher happiness levels with higher expectation levels. For farmers who have larger relative pond areas, the happiness effect of their expectation level on fish production is also less but by a small amount.

Per capita income has no effect on farmers' happiness. However, opposite to the negative effect of non-farm income, income from fish culture relative to farming income or income from wild fish capture relative to total household income raises farmers' happiness while the ratio of fish income to total household income lowers their utility. The negative effect of non-farm income indicates fish farmers are happier with their farming work. In other words, non-farm work leads to dissatisfaction with life while farm work has the positive effect. Nevertheless, an 11.8 percent decrease in farmers' happiness, caused by a 10 percent increase in relative non-farm income, may be offset by a 10 percent increase in relative cash income obtained from wild fish catch.

Aquaculture contributes to happiness both through relative pond size and by earnings from the enterprise. Although the positive effect is lower for farmers who involved with AOP's extension services, relative income from fish culture raises the farmers' happiness. A 100 percent growth in relative income from fish culture contributes to an 18 percent increase in happiness probability of the farmers who were not involved with AOP's on-farm trials activities. For those who were involved with the AOP's trial activities, the farmers who have lower relative income from fish culture appear to be happier because they are expected to get more income from their fish production with more continuous support from AOP's aquaculture extension services.

The contribution of earnings from aquaculture to fish farmers' happiness is reflected by the cash income the farmers receive from the enterprise. Affirming its important role in fish farmers' well-being, a double increase in cash income relative to household income raises their happiness by 9 percent.

V. CONCLUSION

Neither income per capita nor absolute income from fish culture has a significant effect on the pleasure farmers receive from fish culture. However, the regression results show that relative income from fish culture raises the cumulative probability of a farmer's satisfaction from fish culture, demonstrating that relative income, not absolute income, is associated with job satisfaction. The higher satisfaction is also expressed by the farmers who were involved with AOP's aquaculture extension services, who have higher expectation level on income earning from fish culture and who have larger pond surface relative to total land area. Older farmers are more satisfied with fish culture and are generally happier than the younger.

The negative effect of non-farm relative to total household income indicates farmers are happy with working on their farms. The probability that small scale fish farmers are happier is raised by higher relative income from wild fish caught, by higher ages of respondents and by involvement in extension activities. The cumulative logit regression also justifies that satisfaction from fish culture has positively contributed to increase probability of small scale farmers' happiness. This significant effect allows one to conclude that aquaculture contributes to happiness both through relative pond size and by earnings from the enterprise.

This study is a case study for research on the contribution of aquaculture to the well-being of fish farmers in Vietnam, a developing country where aquaculture is an important national economic sector. A possible area of future research is the potential endogeneity of income as functions of happiness and job satisfaction. In this study, the number of observation is small, consisting of interviews from only 120 farmers. Future research on this topic should be conducted at a larger scale, with more observations, in order to confirm the findings of this study.

Table 3.1 Frequencies of Dependent Response Variables

	Level	Frequency	Percent
Satisfied with	1 – *strongly satisfied*	25	20.83
fish culture?	2 – *satisfied*	74	61.67
(*pls_fish*)	3 – *undecided*	19	15.83
	4 – *dissatisfied*	2	1.67
	5 – *strongly dissatisfied*	0	0
Improved	1 – *strongly agreed*	4	3.33
quality of life?	2 – *agreed*	71	59.17
(*happy*)	3 – *undecided*	41	34.17
	4 – *disagreed*	3	2.5
	5 – *strongly disagreed*	1	0.83

Table 3.2 Summary of Data Descriptive Statistics

	Mean	S.E	Minimum	Maximum
Age	47.5167	0.97086	26	80
age (dummy)	0.7417	0.4396	0.0000	1.0000
edulevel	2.00833	0.7503	0	4
Hhsize	5.01667	0.1661	1	16
Men	2.39167	0.0934	0	5
land (m^2)	14660.42	1734.047	500	120000
pond/land	12.9407	1.4581	0.2439	80
hhincome ($)	1215.298	85.6945	-637.931	5043.103
farmincome ($)	686.9075	70.2029	-1051.72	5043.103
fish/household income	27.7569	2.3284	1.4030	100
fish/farm income	46.9511	6.3367	-579.688	215.3846
fish_income ($)	304.55	44.5622	14.4828	4172.414
fishcash ($)	176.5397	20.5130	0.0000	1103.448
Capita income ($)	260.6084	20.2045	-159.483	1425.69
nonfarm_income ($)	494.1379	691.3666	0.0000	4137.9300
Catch_income ($)	10.8184	38.8199	0.0000	344.8276
involve	0.2500	0.4348	0.0000	1.0000
fish expectation	15.7174	18.5256	-8.0033	75.8571
Pls	0.8289	0.1586	0.3432	0.9989
yield (kg/m^2)	0.5826	0.5706	0.015	3.3333

Table 3.3 Estimates and Marginal Effects for Farmers' Satisfaction from Fish Culture

	Regression Estimates		Marginal effect	Elasticity
Parameter	Coef.	Error	Weight average	Weight average
Intercept1	-6.2185***	1.2781		
Intercept2	-2.2659**	1.098		
Intercept3	0.5158	1.2447		
fish_farminc	1.8626*	0.9848	0.2176	0.2009
Age	1.2231*	0.6944	0.1500	
Edulevel	0.4164	0.5091	0.0267	
pond_land	0.0616**	0.0272	0.0072	0.0725
Involve	2.3381**	0.9999	0.0203	
Expectation	0.1387***	0.0335	0.0162	0.1713
age.pond_land	0.0642**	0.0301	0.0073	0.0539
age.expectation	-0.0795***	0.0297	-0.0090	-0.0953
pond_land.expectatio	-0.003***	0.00087	-0.0004	-0.0036
fish_farminc.involve	-1.865*	0.9881	-0.2108	-0.1958
edulevel.involve	-2.1587*	1.2277	-0.1951	

** significant at 90% level, ** significant at 95% level, *** significant at 99% level*

Table 3.4 Estimates and Marginal Effects for Happiness from Model 2a

	Regression Estimates		Marginal effect	Elasticity
Parameter	Coef.	Error	Weight average	Weight average
Intercept1	-4.6981***	1.4666		
Intercept2	0.061	1.2983		
Intercept3	3.4474**	1.4154		
Intercept4	4.9001***	1.6641		
plsfish	-0.7632**	0.365	-0.1425	-0.6364
income	0.00179*	0.00102	0.0003	0.3145
Fcash_total	0.0256**	0.0129	0.0048	0.1057
nonfarm_total	-0.042***	0.0131	-0.0078	-1.1966
Catch_total	0.0704***	0.0256	0.0131	1.3871
fish_total	-0.1553	1.878		
age	4.0651***	1.487	0.0503823	
edulevel	2.6866	1.6944		
fish_total.age	-5.8222***	2.1138	-0.9486	-0.2663
plsfish.edulevel	-1.5786*	0.812	-0.2615	-0.2306

** significant at 90% level, ** significant at 95% level, *** significant at 99% level*

Table 3.5 Estimates and Marginal Effects from Model 2b

	Estimate		Marginal effect	Elasticity
Parameter	Estimate	Error	Weight average	Weight average
Intercept	-7.1014***	1.368		
Intercept	-2.6582**	1.1576		
Intercept	0.4729	1.1957		
Intercept	1.8806	1.4714		
pls	3.1232**	1.4613	0.6172	0.9059
Fcash_total	0.0226*	0.013	0.0045	0.0926
nonfarm_total	-0.0415***	0.013	-0.0082	-1.1800
Catch_total	0.057**	0.0225	0.0113	1.1093
fish_total	0.4852	1.746		
age	3.7583***	1.4564	0.0020	
fish_total.age	-6.0363***	2.0856	-1.1659	-0.3208

** significant at 90% level, ** significant at 95% level, *** significant at 99% level*

Table 3.6 Marginal Effects and Elasticities of Variables on Happiness (Two-Stage Estimation)

Parameter	Logit parameter	Marginal Effect	Elasticity
Fcash_total	0.0226	0.0045	0.0926
nonfarm_total	-0.0415	-0.0082	-1.1799
Catch_total	0.0570	0.0113	1.1093
Age	7.5783	0.0946	
fish_total.age	-6.0363	-1.1659	-0.3208
fish_farminc	5.8173	0.1343	0.1820
pond_land	0.1924	0.0044	0.0657
involve	7.3024	0.0125	
expectation	0.4332	0.0100	0.1552
age.pond_land	0.2005	0.0045	0.0488
age.expectation	-0.2483	-0.0056	-0.0864
pond_land.expectatio	-0.0095	-0.0002	-0.0032
fish_farminc.involve	-5.8248	-0.1301	-0.1774
edulevel.involve	-6.7421	-0.1204	

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