

Effects of Food Safety Standards on Seafood Exports to US, EU and Japan

Anh Van Thi Nguyen
Graduate Research Assistant
Department of Agricultural Economics and Rural Sociology
Auburn University
202 Comer Hall
Auburn University, AL, 36849-5406
334-844-5616
Email: atn0002@auburn.edu

and

Norbert L. W. Wilson, Ph.D.*
Associate Professor
Department of Agricultural Economics and Rural Sociology
Auburn University
100 C Comer Hall
Auburn University, AL, 36849-5406
334-844-5616
Email: wilsonl@auburn.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Atlanta, Georgia, January 31-February 3, 2009

Copyright 2009 by Anh Van Thi Nguyen and Norbert L. W. Wilson. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

*Corresponding author

Abstract

Estimating the panel gravity model with bilateral pair and country-by-time fixed-effects separately for each seafood product, we found that food safety regulations have differential effects across seafood products. In all three industrialized markets, shrimp is most sensitive, while fish is the least sensitive to changing food safety policies. The enforcement of the US HACCP, the EU Minimum Required Performance Level and the Japanese Food Safety Basic Law caused a loss of 90.45%, 99.47%, and 99.97% to shrimp trade in these markets, and a reduction associated with fish trade was 66.71%, 82.83%, and 89.32%.

Key Words: food safety, seafood, international trade, gravity model, HACCP

JEL Codes: C33, F13, Q17, Q18

Effects of Food Safety Standards on Seafood Exports to US, EU and Japan

Introduction

The Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures of World Trade Organization (WTO) provides member countries guidelines for regulations to protect human health, plants and animal life in importing countries. However, researchers are concerned that countries are increasingly using SPS measures as non-tariff barriers to trade, especially when tariffs and quantitative restrictions are reduced due to progressive trade liberalization (Henson and Loader, 2001).

In global seafood trade, emerging food safety regulations have been imposed in industrialized markets, including the Hazard Analysis Critical Control Points (HACCP) in the US (1997), minimum required performance limits (MRPLs) in the EU (2002), and the Food Safety Basic Law in Japan (2003). This paper explores imports into these three major markets. In particular, we try to understand how changes in food safety regulations in these markets affected seafood imports. We hypothesize that the imposition of the new regulations causes a loss of markets for exporting countries. We also hypothesize that the regulations have differential effects on differentiated products.

International Trade in Seafood and Policy Context

World export of seafood increased during the period 1984-2004, and achieved a record value of US\$ 71.5 billion in 2004 (FAO, 2007). On the one hand, the global expansion of trade in seafood highlights an important role of developing countries as major seafood exporters. FAO (2007) reveals that 48 % of the value of fish and fishery products traded worldwide in 2004 came from developing countries. On the other hand, the top importers of seafood are developed countries in which the European Union (EU), Japan and the United States (US) are the largest

import markets. During the period 2002-2004, the developed markets comprising of the EU, Japan and the United States accounted for 77% of the fishery exports from developing countries (FAO, 2007). In 2005, for example, Japan was the top seafood importing nation with \$14.4 billion of seafood value, followed by the US with an estimated imported value of \$12.1 million (Johnson et al., 2007).

In 2002, the EU implemented Commission Decision 2003/181/EC to set out Minimum Required Performance Limits (MRPLs) for residues of certain substances in foods of animal origin. These substances are those with no established Maximum Residue Limit (MRLs) and/or Acceptable Daily Intake (ADIs). MRPLs are specified minimum concentration levels of a detectable residue. The EU set the MRPL for poultry and aquaculture products for chloramphenicol at 0.3 μ g/kg and for nitrofurans metabolites at 1 μ g/kg (EC, 2003). In 2002, the Commission introduced regulations on the analytical technologies to detect residues (EC, 2002). As a result, the EU has been able to detect very low levels of residues in food, with sensitivity increasing ten-fold compared with the early 1990s (FAO/WHO, 2004).

In Japan, a series of incidents relating to food occurred in the period 2000-2002, raising the consciousness of consumers over food safety. To respond to the increasing concerns of consumers, the Japanese government amended the Food Sanitation Law and passed the new Food Safety Basic Law, taking effect from summer 2003 (Japanese Government, the Cabinet Office, 2003). The Food Safety Basic Law is based on a risk analysis, which aims to protect consumer health and safety. Under this law, the Food Safety Commission, an advisory committee constituted of scientific experts, was newly established. This Commission is required to evaluate toxicological residues in food stuff as a part of its risk assessment. In addition, the revised Food Sanitation Law restricts substances without MRLs to zero tolerance and does not

allow products with these substances to enter the Japanese market. This regulation is more stringent than what was required in the previous Food Sanitation Law, as the unrevised law did not prohibit residues of substances with no available MRLs (Miyagawa, 2004).

In the US seafood industry, Hazard Analysis Critical Control Point (HACCP) became mandatory application from 18 December 1997 (Anders and Caswell, 2007). HACCP is a preventative system to control hazards in food products, with particular emphasis on the reduction of food-borne pathogens. It was a new approach to food safety, since it focuses on controlling production process instead of testing final products (Cato, 1998). According to the FDA, the purpose of HACCP adoption is to identify hazardous risks and reduce contaminations at the early stages of the production process. Under HACCP, seafood processing firms need to conduct a hazard analysis. Once firms establish critical control points for each hazard, firms are required to develop and implement a HACCP plan to prevent, or eliminate contaminations (GAO, 2001).

Literature review

Food Safety Standards and International Trade

A number of empirical studies have attempted to quantify the trade effects of emerging food safety standards. Otsuki, Wilson and Sewadeh (2001), Wilson and Otsuki (2003 and 2004) employed the gravity model to look at the effects of EU standards on agricultural exports. Their findings provide evidence that higher standards have negative and statistically significant effects on bilateral trade flows.

In the case of seafood, fewer studies have measured trade effects of food safety regulations quantitatively. Cato and dos Santos (1998) examined the economic loss to Bangladesh shrimp industry when the European Commission banned seafood exports from

Bangladesh in 1997 due to safety problems. Using secondary data analysis and a survey, the authors estimated that Bangladesh frozen shrimp processors experienced a loss in total revenue of \$14.6 million (in 1997 dollars) as consequence of the ban. Debaere (2005) suggested that differences in technical barriers among countries can generate considerable diversion effects on shrimp trade. He provided evidence that the declaration of zero tolerance for antibiotics by the EU diverted shrimp exports of Thailand from the EU to the US. The author argues that this shift caused the shrimp price to fall in the US market. Thus, strengthened food safety regulations in the EU market not only affect trade between the EU and Thailand, but also trade relationship between Thailand and the US.

Recently, Anders and Caswell (2007) investigated the impact of the mandatory application of HACCP in the US on seafood exports from the top 33 countries. Estimating the gravity model with random effects, they found that HACCP adoption by the US reduced its import value of seafood from 0.13% to 0.35%.

Our paper makes another effort to quantify the impacts of stricter technical barriers in the industrialized markets on the global seafood trade. However, our study differs from the others in the following ways: First, while previous studies examining trade effects of standards in a particular market, we investigate simultaneously three major markets, the EU, US and Japan. Second, unlike Anders and Caswell (2007) estimating effects of standards on aggregate seafood, our paper analyzes disaggregated data to assess the impacts on different types of seafood. This approach is motivated by our hypothesis that the stringency of food safety regulation may have differential effects on products. Finally, following Anderson and van Wincoop (AvW) (2003) and Baier and Berstrand (B&B) (2007), which are described below, this paper employs the theoretically consistent gravity model, using panel data and country-by-time fixed-effects. This

theory-motivated model was not estimated in Otsuki, Wilson and Sewadeh. (2001), Wilson and Otsuki (2003 and 2004); and Anders and Caswell (2007).

The Gravity Equation

Applying the typical cross-section gravity equation to study trade effects of regulatory standards, we can specify the model as follows:

$$(1) \quad \ln X_{ijt} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} \\ + \alpha_3 \ln DIST_{ij} + \alpha_4 CONTIG_{ij} + \alpha_5 COLONY_{ij} + \alpha_6 LANG_{ij} \\ + \alpha_7 NAFTA_{ijt} + \alpha_8 EU_{ijt} + \sum_{n=9}^{11} \alpha_n FOODSTND_{nijt} + \varepsilon_{ijt}$$

where X_{ij} is seafood exports deflated in 2000 dollars from country i to country j . GDP_{it} and GDP_{jt} are real GDP of country i and country j in year t . $DIST_{ij}$ is the distance between exporter i and importer j . $CONTIG_{ij}$ is a dummy variable for shared borders, taking the value of 1 if country i and j share a common border and 0 otherwise. $COLONY_{ij}$ is a dummy variable, taking the value of 1 if two countries have a common colonial history and 0 otherwise. $LANG_{ij}$ is a dummy variable for language, taking the value of 1 if country i and j speak a common language. $NAFTA_{ijt}$ (EU_{ijt}) are dummy variables denoting memberships of country i and j in year t to the regional trade agreements, taking the value of 1 if both exporter i and importer j are members of the NAFTA (EU), and 0 otherwise. $FOODSTND_{nijt}$ are dummy variables indicating food safety policies ($n=US$ HACCP, EU MRPL, and Japan Law) imposed by country i on country j in year t .

Despite a workhorse in empirical research, the gravity model specified in equation 1 is not formally motivated by an economic theory (Anderson, 1979; Bergstrand, 1985; AvW, 2003, B&B (2007). Anderson (1979) is the first researcher who provided a theoretical economic basis to the equation. He showed that trade between two countries depends on their bilateral barriers

relative to the average trade barriers they face in trading with the rest of the world. However, traditional gravity models did not pay any attention to these relative barriers. Following Anderson (1979), Bergstrand (1985) pointed out that the traditional gravity equation is misspecified since it excluded price terms. Recently, AvW (2003) used the price indices to account for average trade barriers, and estimated the model by nonlinear least square method. AvW (2003) also suggested another alternative method for cross-sectional data set. That is to replace the multilateral price terms with country-specific dummy variables, i.e. using fixed-effects by exporter i and importer j , restrict the *GDP* coefficients to unity, and estimate by ordinary least square method.

Recently, B&B (2007) pointed out that the theoretically consistent model suggested by AvW (2003) still suffers from an endogeneity problem. This endogeneity comes from unobserved time-invariant heterogeneity between countries. Therefore, the authors expanded the previously developed framework to a panel setting to control for endogeneity. In addition, they argued that since in panel setting, the multilateral price terms, as noted in Bergstrand (1985), are time-varying, they are best adjusted for by using country-by-time fixed-effects. Finally, B&B (2007) scaled the dependent variable by the product of GDPs as suggested by the theory.

In empirical studies, Grant and Lambert (2008) adapted B&B (2007) method to estimate treatment effects of membership in regional trade agreements. However, the method suggested by B&B (2007) has not been used in analyzing the relationship between trade and regulatory standards. For example, Otsuki, Wilson and Sewadeh (2001) and Wilson and Otsuki (2003 and 2004) used fixed-effects model with importing countries. On the other hand, Anders and Caswell (2007) adapted random effect method. In this paper, we adopt the theory-motivated model developed by AvW (2003) and B&B (2007), with panel data and country-by-time fixed-effects

for two reasons: i) to control for endogeneity of policy variables and ii) to account for time-varying multiple price terms.

Estimating Equations and Data

In this paper, we will test two hypothesis: i) more stringent food safety regulations in the EU, Japan and US markets have negative effects on world exports of seafood; and ii) emerging standards have differential effects on different categories of seafood. To test the first hypothesis, we estimate the following gravity equations:

Model 1: Typical gravity equation with no time and country pair fixed-effects

$$(2.1) \quad \ln X_{ijt} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} \\ + \alpha_3 \ln DIST_{ij} + \alpha_4 CONTIG_{ij} + \alpha_5 COLONY_{ij} + \alpha_6 LANG_{ij} \\ + \alpha_7 NAFTA_{ijt} + \alpha_8 EU_{ijt} + \alpha_9 EUMRPL_{ijt} + \alpha_{10} JPLAW_{ijt} \\ + \alpha_{11} USHACCP_{ijt} + \varepsilon_{ijt}$$

Model 2: Time fixed-effects

$$(2.2) \quad \ln X_{ijt} = \alpha_0 + \alpha_t \\ + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} \\ + \alpha_3 \ln DIST_{ij} + \alpha_4 CONTIG_{ij} + \alpha_5 COLONY_{ij} + \alpha_6 LANG_{ij} \\ + \alpha_7 NAFTA_{ijt} + \alpha_8 EU_{ijt} + \alpha_9 EUMRPL_{ijt} + \alpha_{10} JPLAW_{ijt} \\ + \alpha_{11} USHACCP_{ijt} + \varepsilon_{ijt}$$

Model 3: Time and bilateral pair fixed-effects

$$(2.3) \quad \ln X_{ijt} = \alpha_0 + \alpha_t + \alpha_{ij} \\ + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} \\ + \alpha_3 \ln DIST_{ij} + \alpha_4 CONTIG_{ij} + \alpha_5 COLONY_{ij} + \alpha_6 LANG_{ij} \\ + \alpha_7 NAFTA_{ijt} + \alpha_8 EU_{ijt} + \alpha_9 EUMRPL_{ijt} + \alpha_{10} JPLAW_{ijt} \\ + \alpha_{11} USHACCP_{ijt} + \varepsilon_{ijt}$$

Model 4: Theory-consistent model with bilateral pair and country-by-time fixed-effects

$$(2.4) \quad \ln \frac{X_{ijt}}{GDP_{it} * GDP_{jt}} = \alpha_0 + \alpha_{ij} + \alpha_{it} + \alpha_{jt} + \alpha_1 NAFTA_{ijt} + \alpha_2 EU_{ijt} \\ + \alpha_3 EUMRPL_{ijt} + \alpha_4 JPLAW_{ijt} + \alpha_5 USHACCP_{ijt} + \varepsilon_{ijt}$$

where $USHACCP_{ijt}$, which is a dummy variable representing the US imposition of HACCP on seafood, equals 1 for trade beginning 1997 and 0, otherwise. $EUMRPL_{ijt}$, which is a dummy variable representing the EU implementation of MPRPs, equals 1 for trade beginning 2002 and 0 otherwise. $JPLAW_{ijt}$, which is a dummy variable representing the amendment and new laws for food safety in Japan, equals 1 for trade beginning 2004 and 0 otherwise. All other variables are previously defined in equation (1). To test the second hypothesis, we regress separately equation (2.4) on data for shrimp, fish, and mollusk.

Trade data are from UNCOMTRADE data base for three products, shrimp (code 03611) fish (code 034 and 035) and mollusks (code 0363) in the period 1990-2005. The data include 123 exporting countries and 17 importing countries (Japan, US and EU 15). The 15 European countries covered in the study are those that were EU members in 2000, including Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Greece, Portugal, Spain, Sweden, and United Kingdom. GDP data are from the *World*

Development Indicators (World Bank, 2006). Information on distance, contiguity and common language are from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). After excluding the zero trade values and missing records, the total number of observations used for the study is 33,791.

Bilateral real export value (the 2000 price) of each seafood commodity (shrimp, fish, and mollusks) is on average \$10.45 million per year when all three seafood products are pooled together (See Table 1). Standard deviation is about 4.6 times larger than the mean of real seafood trade value. By commodity, the means of shrimp and fish trade values are close to each other about \$12.42 million for shrimp and \$11.58 million for fish. The mean value of mollusks trade is about \$5.69 million.

Results

Table 2 presents the estimated results for four model specifications with pool panel data. Model 1 with no time or country fixed-effects and Model 2 with time fixed-effects produce similar results. Typical gravity variables such as GDPs, distance, continuity, and colonial ties, are statistically significant. The signs and magnitudes of these variables are similar to those in the traditional gravity literature. Also, two variables presenting regional trade agreements, *NAFTA* and *EU*, are statistically significant and have positive effects on bilateral trade flow of seafood. However, while the distance variable has an expected sign, its magnitude is much smaller (10-20 times) than that commonly found in the gravity model. The dummy variable standing for common language is also statistically significant but has a negative sign.

Considering three key variables indicating average effects of seafood safety policies in the Model 1 and 2, *USHACCP* and *EUMRPL* are statistically significant and have hypothesized sign. The dummy variable capturing the Japanese law, *JPLAW*, has an unexpected sign, but

statistically insignificant. These two models have lower predictive power than that frequently found in the literature—the R^2 is only 0.138 and 0.139.

Consistent with theoretical and empirical findings of other papers e. g., B&B (2007) and Grant and Lambert (2008), the similar results in Model 1 and Model 2 suggest that the time fixed-effects model does not correct the endogeneity problems of the first model. This outcome is understandable, given that the panel data set only covers a short time period (1990-2005), relative to the large involvement of bilateral country pairs (124 exporting and 17 importing countries). Therefore, the heterogeneity between country pairs has not been fixed. Estimates of coefficients in Model 1 and Model 2 are, therefore, not reliable.

For comparison, we estimated the model with time and country pairs fixed-effects (Model 3). The results indicate instability of regression coefficients compared with the Model 1 and Model 2. For example, *NAFTA* and *EUMPRL* variables are no longer statistically significant. The sign of both *EUMPRL* and *JPLAW* have changed compared with the first two models. The magnitude of *USHACCP* variables is 4-5 times smaller in the absolute term, relative to Model 1 and 2. Although the R^2 has improved from 0.138 and 0.139 in Model 1 and 2 to 0.49 in Model 3, Model 3 with time and bilateral pair fixed-effects is still not an appropriate one. The reason is that, like Model 1 and 2, Model 3 is not consistent with the theory because it still has an endogeneity problem due to the omitted multiple price terms.

Accounting for this problem, AvW (2003) B&B (2007) suggested a theoretically consistent model with country-by-time fixed-effects, imposing a unity restriction of GDP coefficients. We estimated this model and present the results in Column 4 of Table 2. These results differ substantially from the three previously estimated models in a number of important ways.

First, the *EU* dummy variable is still significant, whereas the *NAFTA* variable is no longer significant, a result not uncommon in the literature. Second, all the seafood safety dummy variables included in Model 4 are statistically significant. This supports our hypothesis that more stringent food safety regulations in the EU, Japan, and US markets have negative effects on international trade of seafood products. Following Halvorsen and Palmquist (1980), we can calculate the partial elasticities of stricter technical barriers in percentage and level value at the mean. For example, results in Model 4 show that the imposition of HACCP by the US generated a $[(e^{-1.220} - 1) * 100 =]$ 70.48% average annual reduction, or \$7.4 million, of potential export value of seafood products over the period of HACCP imposition. Seafood exporters to EU experienced a loss of 88.6% (\$9.2 million) of export value, while seafood exporters to Japan faced a decrease of 97% (or \$10.2 million) of potential export value (see Column 1 of Table 4). From this analysis, the amendment of Food Sanitation Law and enactment of Food Safety Basic Law in Japan (2003) had a stronger effect on imports, suggesting a greater cost associated with these regulations. The US HACCP regulations while, it lowered imports, may have improved efficiency for some exports.

Effects of Higher Standards on Different Products

Differences in technical standards imposed on various commodities suggest that food safety regulations may have different effects across traded seafood products. This idea is supported by our results of the Chow test for separated regressions of the shrimp, fish and mollusks. Therefore, we estimate the country pair and country-by-time fixed-effects model (Model 4) separately for each product. The results in Table 3 show that shrimp imports to industrialized markets (the EU, US and Japan) are the most sensitive to tighter levels of food safety control. This finding is consistently observed in the three investigated markets (Column 1

of Table 3). Fish is less sensitive than shrimp (indicated by smaller magnitude of food safety regulation coefficients in Table 3). Mollusks is also sensitive to emerging standards in the EU and Japan markets, but its imports into the US is not statistically impacted by the US HACCP mandatory application over the study period.

Partial elasticities of food safety regulations and RTA variables based on estimates presented in Table 3 are derived and presented in Table 4. On average, mandatory application of the US HACCP over the study period resulted in 90% (\$11.2 million) and 66.7% (\$7.7 million) reduction in potential shrimp and fish export value annually. The introduction of MRPL in the EU over the study period led to a decline of 99.5% (\$12.3 million), 82.8% (\$9.6 million), and 92.1% (\$5.2 million) for shrimp, fish, and mollusks. The enforcement of the Japanese laws caused a loss of 98.61% (\$12.4 million) and 99.97% (\$5.7 million) of potential import value of shrimp and mollusks; and about 89% (\$10.3 million) of loss in potential fish import value.

Conclusion

This paper examines the impacts of increased food safety standards in the EU, US, and Japan on world's seafood export performance to these markets. Effects of seafood safety policies such as the US implementation of HACCP in 1997, the EU introduction of MRPL in 2002, and enactment of the Food Safety Basic Law in Japan in 2003 are captured by the dummy variables. The paper uses panel data in a gravity model with bilateral pair and country-by-time fixed-effects developed by AvW (2003) and B&B (2007) to control for endogeneity and time-varying multiple price terms. For comparison purposes, the paper also estimates other gravity model specifications for a panel data (the model with no time and country pair fixed-effects, the model with time fixed-effects, and the model with time and country pair fixed-effects).

Estimating the panel gravity model with bilateral pair and country-by-time fixed-effects separately for each seafood product, we found that food safety regulations have differential effects across seafood products. In all three industrialized markets, shrimp is most sensitive, while fish is the least sensitive to changing food safety policies. The enforcement of the US HACCP, the EU MRPL and the Japanese Food Safety Basic Law caused a respective loss of 90.45%, 99.47%, and 99.97% to shrimp trade in these markets, and a reduction associated with fish trade was 66.71%, 82.83%, and 89.32%.

Our findings are consistent with those of previous studies in that addressing endogeneity of trade policy variables is important to obtain their unbiased estimates. As the results suggest, failing to address the endogeneity of policy variables will lead to underestimating the impacts of policy variables on trade.

From a cursory review of the data, more products come from the least developed countries for shrimp relative to mollusks. In further research, we will analyze the differential effects of these policies on less developed countries. In addition, our findings suggest that future studies should investigate the adjustment of countries overtime to overcome higher food safety regulations. For example, US HACCP had the smallest effect on exports relative to the other policies. Is this because HACCP created greater efficiencies in production processes, as asserted earlier, or has the greater age of the policy allowed more producers to adjust? Future research will address these questions.

Table 1: Descriptive Statistics

Variable	N	Mean	Standard Deviation	Minimum	Maximum
<i>X</i> (\$)	33,791	10,448,023	48,104,235	1	1,808,005,245
<i>X_{shrimp}</i> (\$)	7,010	12,417,404	50,696,974	1	793,980,929
<i>X_{fish}</i> (\$)	19,291	11,580,441	53,913,035	1	1,808,005,245
<i>X_{mollusks}</i> (\$)	7,490	5,688,234	48,104,235	1	332,616,256
<i>GDP_{importer}</i> (\$1000)	33,791	1,847,160,979	2,701,506,025	18,700,012	11,000,039,724
<i>GDP_{exporter}</i> (\$1000)	33,791	542,426,518	1,426,094,899	30,436	11,000,039,724
<i>Distance</i> (km)	33,791	5,725	4,534	60	19,586
<i>NAFTA</i>	33,791	0.00	0.06	0	1
<i>EU</i>	33,791	0.24	0.43	0	1
<i>CONTIG</i>	33,791	0.07	0.25	0	1
<i>LANG</i>	33,791	0.12	0.33	0	1
<i>COLONY</i>	33,791	0.09	0.28	0	1
<i>EUMRPL</i>	33,791	0.26	0.44	0	1
<i>JPlaw</i>	33,791	0.01	0.11	0	1
<i>USHACCP</i>	33,791	0.06	0.23	0	1

Note: All price data are in deflated with 2000 as base year. *X* represents the export value.

Table 2: Gravity Model Specifications of Seafood Trade

Variables	Model 1	Model 2	Model 3	Model 4
<i>Constant</i>	-12.740*** (-28.86)	-12.604*** (-26.76)	13.933*** (-3.03)	9.508*** (46.27)
$\ln GDP_{it}$	0.655*** (51.49)	0.658*** (51.3)	0.727*** (4.49)	1.00 ⁺
$\ln GDP_{jt}$	0.310*** (36.62)	0.309*** (36.43)	0.220*** (6.06)	1.00 ⁺
$\ln DIST_{ij}$	-0.046** (-2.11)	-0.047)** (-2.17)		
<i>CONTIG_{ij}</i>	0.954*** (12.96)	0.951*** (12.92)		
<i>COLONY_{ij}</i>	0.770*** (11.19)	0.769*** (11.2)		
<i>LANG_{ij}</i>	-0.401*** (-6.54)	-0.396*** (-6.47)		
<i>NAFTA_{ijt}</i>	2.831*** (14.07)	2.848*** (14.18)	0.163 (0.28)	-0.944 (-1.24)
<i>EU_{ijt}</i>	0.775*** (14.82)	0.770*** (14.71)	1.023*** (10.16)	1.653*** (10.07)
<i>EUMRPL_{ijt}</i>	-0.259*** (-6.89)	-0.300** (-2.52)	0.115 (1.18)	-2.168*** (-3.26)
<i>JPLAW_{ijt}</i>	0.019 (0.11)	0.063 (0.29)	-0.379** (-2.23)	-3.617*** (-5.11)
<i>USHACCP_{ijt}</i>	-0.941*** (-10.97)	-1.004*** (-9.9)	-0.229** (-2.17)	-1.220*** (-2.94)
R ²	0.138	0.139	0.489	0.733
F statistics	562.5	239.58	-	-
N	33,791	33,791	33,791	33,791

Notes: The numbers in parentheses are t-statistics. We used White's heteroskedastic correction method to produce the standard errors. The symbols ***, **, * indicate significance at 1%, 5%, and 10% level.

⁺Indicates values imposed by model construction (B&B)

Table 3: Estimation with Bilateral Pairs and Country-by-Time Fixed-effects by Seafood

Commodity

Variable	Shrimp	Fish	Mollusks
<i>Constant</i>	9.012*** (12.71)	9.721*** (31.64)	9.107*** (30.27)
<i>NAFTA_{ijt}</i>	1.004 (0.87)	-0.671 (-0.63)	-2.409*** (-3.94)
<i>EU_{ijt}</i>	1.732*** (5.01)	1.988*** (9.36)	1.662*** (6.04)
<i>EUMRPL_{ijt}</i>	-5.237*** (-3.3)	-1.762*** (-2.25)	-2.541** (-2.16)
<i>JPlaw_{ijt}</i>	-8.221*** (-8.57)	-2.237*** (-2.69)	-4.277*** (-3.54)
<i>USHACCP_{ijt}</i>	-2.349** (-2.53)	-1.100** (-2.09)	-0.879 (-1.21)
R^2	0.920	0.810	0.935
N	7,010	19,291	7,490

Notes: The numbers in parentheses are t-statistics. We used White's heteroskedastic correction method to produce the standard errors. The symbols ***, **, * indicate significance at 1%, 5%, and 10% level.

Table 4: Elasticities of Food Safety Standards and RTAs on Real Export Values by Commodity

Variable	Seafood Commodities			
	Pooled	Shrimp	Fish	Mollusks
<i>NAFTA</i>	-	-	-	-91.01** (-5.18)
<i>EU</i>	422.26*** (44.13)	465.19*** (57.78)	630.09*** (72.96)	426.98*** (24.30)
<i>EUMRPL</i>	-88.56*** (-9.25)	-99.47*** (-12.35)	-82.83*** (-9.59)	-92.12*** (-5.24)
<i>JPLAW</i>	-97.31*** (-10.17)	-99.97*** (-12.42)	-89.32*** (-10.34)	-98.61*** (-5.69)
<i>USHACCP</i>	-70.48*** (-7.37)	-90.45** (-11.23)	-66.71** (-7.73)	-

Notes: The numbers in parentheses reflect the change in real export value (\$million) after the imposition of the food safety regulation. The symbols ***, **, * indicate significance at 1%, 5%, and 10% level.

References

- Anders, S.M and J. A. Caswell. "Standards-as-Barriers versus Standards-as-Catalysts: Assessing the Impact of HACCP Implementation on U.S Seafood Imports." Working Paper, Dept. of Resource Economics, University of Massachusetts, Amherst, 2007.
- Anderson, J.E. "A Theoretical Foundation for the Gravity Equation." *American Economic Review* 69 (March 1979):106–16.
- Anderson, J.E., and E. van Wincoop. "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review* 93(March 2003):170–92.
- Baier, S.L., and J.H. Bergstrand. "Do Free Trade Agreements Actually Increase Members' International Trade?" *Journal of International Economics* 71(March 2007):72–95.
- Bergstrand, J.H. "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence." *Review of Economics and Statistics* 67(August 1985):474–81.
- Cato, J. C., and C. A. Lima dos Santos. "European Union 1997 Seafood-Safety Ban: The Economic Impact on Bangladesh Shrimp Processing." *Marine Resource Economics* 13(Fall 1998): 215-227.
- Cato, J.C. "Economic values associated with seafood safety and implementation of seafood Hazard Analysis Critical Control Point (HACCP) programmes". FAO Fisheries Technical Paper. No. 381. Rome, FAO, 1998: 70p. Internet site: <ftp://ftp.fao.org/docrep/fao/005/X0465e/X0465e00.pdf> (Retrieve September 17, 2008).
- Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) (<http://www.cepii.fr/anglaisgraph/bdd/distances.htm>). Retrieved July 22, 2008.

Debaere, P. "Small Fish-Big Issue: The Effect of Trade Policy on the Global Shrimp Market." Discussion Paper No. 5254, Center for Economic Policy Research, London, UK, 2005.

European Commission (EC). "Commission Decision 2002/657/EC of 14 August 2002 implementing Council Directive 96/23/EC concerning the performance of analytical methods and the interpretation of results." *Official Journal of the European Union* L221 (August 2002): 8

---. "Commission Decision 2003/181/EC of 13 March 2003 amending Decision 2002/657/EC as regards the setting of minimum required performance limits (MRPLs) for certain residues in food of animal origin." *Official Journal of the European Union* L71(March 2003): 17.

Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO). "Joint FAO/WHO Technical Workshop on Residues of Veterinary Drugs without ADI/MRL.". Technical Workshop Report, FAO, Bangkok, 2004. Internet site: <ftp://ftp.fao.org/docrep/fao/008/y5723e/y5723e00.pdf> (Retrieved September 16, 2008).

FAO. *The State of world fisheries and aquaculture 2006*. Rome, Italy: FAO, 2007.

Grant, J.H., and D.M. Lambert. "Do Regional Trade Agreements Increase Member's Agricultural Trade?" *American Journal of Agricultural Economics* 3 (August 2008): 765-782

Halvorsen, R. and R. Palmquist. "The Interpretation of Dummy Variables in Semilogarithmic Equations". *American Economic Review* 70 (1980): 474-475.

Henson, S. and R. B. Loader. "Barriers to Agricultural Exports from Developing Countries: The Role of Sanitary and Phytosanitary Requirements." *World Development* 29 (January 2001): 85-102.

H. M. Johnson and Associates. *Annual Report on the United State Seafood Industry*. Urner Barry Publications, Jacksonville: OR, 2007.

Miyagawa, S. "Japanese Regulation Framework for the Control of Residues of Veterinary Drugs." *Joint FAO/WHO Technical Workshop on Residues of Veterinary Drugs without ADI/MRL*. FAO, Rome, 2004.

Otsuki, T., J. Wilson, and M. Sewadeh. "Saving Two in a Billion: Quantifying the Trade Effects of European Food Safety Standards on African Exports." *Food Policy* 26(October 2001):495–514.

The Cabinet Office of Japanese Government. The Food Safety Commission. Internet site: <http://www.fsc.go.jp/> (Retrieved September 18, 2008)

The World Bank. *World Development Indicators 2006*. Internet site: <http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=6> (Retrieved July 19, 2008).

U.S. General Accounting Office (GAO). 2001. *Federal Oversight of Seafood Does not Sufficiently Protect Consumers*. Report to the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate. Internet site: <http://www.gao.gov/new.items/d01204.pdf> (Retrieved September 10, 2008).

Wilson, J. S., and T. Otsuki. "Food Safety and Trade: Winners and Losers in a Non-Harmonized World." *Journal of Economic Integration* 18 (June 2003): 266-387.

---, "To Spray or Not to Spray: Pesticides, Banana Exports, and Food Safety." *Food Policy* 29(April 2004): 131-146.