HOW DOES HACCP CHANGE U.S. SEAFOOD EXPORTS?-ANALYSIS WITH FISHES, MOLLUSCA, AND SHELLFISH OTHER THAN MOLLUSCA

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ABSTRACT

Although the effect of HACCP on international trade is an issue with many concerns recently, only a few empirical studies focus on the impact of HACCP on U.S seafood export industry. Using the approach of Gravity Model with adjustment of unobserved country characteristics, this paper contributes to analyze the differential effects of HACCP implementation on three kinds of seafood: fishes, mollusca, and shellfish other than mollusca. The results indicate that HACCP application has negative but insignificant effect on seafood exports in the short run. In the long run, HACCP only negatively and significantly affect seafood exports of mollusca and shellfish. Moreover, the higher risk of food born disease seafood has, the easier is seafood trading affected by the enforcement of stricter food safety standards.

Keywords: HACCP; Mollusca; Fishes; Shellfish Other Than Mollusca; Trade Flow

Introduction

World fish production has increased steadily in recent years. While capture production has stayed around 90 million tons since 2001, aquaculture production has continued to increase steadily at an average annual growth rate of 6.2% and reached to approximately USD 98.4 billion in 2008. The global total production (aquaculture and catches) of fish and fishery products has reached 142 million tons in 2008. About 81 percent of total fishery production (115.1 million tons in 2008) was used for direct human consumption. The international trade of fishery commodities reached an export value of about US $102 billion and an import value of around $107 billion in 2008. China with sharp increase in seafood export performance is now the first country while U.S. ranks as the sixth among all exporting countries (FAO 2010). The USA, Japan and Europe still dominant the importing markets and accounted for more than 80% of total import value recently (Ferri 2005).

With large increase in fish consumption, the number of reported cases of food-borne associated with fishery products also dramatically increases. In the United States, it is estimated there are 76 million of cases of food-borne diseases, 325.000 hospitalizations and 5,000 deaths each year (Maurizio 2005). 10-19% of food-borne illness reported involved seafood as a vehicle, 5.1% was caused by directly consumption of fish and 1.7% was caused by consumption of shellfish during the period from 1993 to 1997. Based on Outbreak Alert (CSPI 2001), from 1990 to 1998, molluscan shellfish was responsible for 64% of cases, which double the number of cases caused by fish and fish caused 78% of the outbreaks related to seafood.

As the seafood consumption and reported outbreaks and cases of food-borne diseases have substantially grown during last few decades, food safety is a major concern facing the seafood industry today. Many surveys show that consumer awareness of the food safety is increasing. Traditional food quality control system was based on effectively established and generally accepted Codes of Good Hygiene Practices (GHP) and of Good Manufacturing Practices (GMP). The new wildly implemented seafood safety regulatory- Hazard Analysis Critical Control Point (HACCP) seeks to identify the different inherent hazards of different kinds of seafood at the very beginning of food production. Compared with traditional quality control system, the advantage of HACCP is its prevention functions in addition to react and inspect the inherent seafood hazards.

Nowadays, many countries have enforced new standards or regulations to adopt HACCP system to control seafood safety. However, there is no internationally agreed upon procedures to assess risk. HACCP is only recommended by Codex as a preferred set of standards to control food safety hazards (Unnevehr and Jensen, 1999, 631). Countries implemented HACCP in multiple different ways. In general, developed countries implement food safety regulatory in stricter status than developing countries. In this case, the difference of food safety standards created non-tariff barriers and trade disputes. Thus research on the impact of emerging new standards on international trade flows of fish and fishery products should be taken in concern of global view. Moreover, considering the diversity food-borne hazards inherent in different kinds of seafood, the criteria are not identical and then the impact of HACCP implementation should also be dissimilar for each kind of seafood.

U.S. began to adopt HACCP after 1997. Food and Drug Administration (FDA)(2011) published guidelines to help processors identify and analyze potential species-related hazards (vertebrate and invertebrate) based on different categories of fishery products as well as develop the whole HACCP plan to control food safety. Considering the different hazards inherent in different ki ' of seafood, the majority of food- borne hazards control analysis (pathogens, parasites, and natural toxin) is based on categories of “molluscan shellfish” and “fishes other than molluscan shellfish” to identify significant food inherent hazards and further setup critical points for seafood quality control.

This research focuses on the seafood exporting market and seeks to quantify how HACCP implementation influence U.S. seafood exports at the level of aggregate market and individual seafood market. After taking account of different requirement of US HACCP on different kinds of seafood, this paper categorizes US exports fishery products into three categories: fishes, molluscan shellfish and shellfish other than molluscan shellfish. The purpose of this research is to help managers of seafood export firms to investigate how HACCP implementation could affect U.S. seafood exports in the long run and short run and how HACCP implementation could change different kinds of seafood exports. Individual export firms could use the results of this study to adjust their market policy and increase their benefits in seafood trading markets.

Literature Review

This part provides the overview of current academic research on seafood safety. The first part generalizes seafood borne diseases and kinds of seafood causes seafood exports refusal because of unqualified quality with standards of importing countries. The second part generalizes the impact of HACCP implementation on seafood trading flow based on the level of aggregate market and individual product.

Seafood Borne Diseases and Import Refusal

Pathogens, parasites and toxin are response for seafood borne diseases. In general, pathogens, including both bacteria and viruses, and parasites are common in both shellfish and fishes (F

2011). At least ten genera of bacterial pathogens have been implicated in seafood-borne diseases. Feldhusen (2000) categorises pathogenic bacteria associated with seafood into three general groups: indigenous bacteria (bacteria which are normal components of the marine or estuarine environment, including Vibrio spp, Listeria monocytogenes, Clostridium botulinum and Aeromonas hydrophila), nonindigenous bacteria (enteric bacteria which are present due to faecal contamination, such as Salmonella spp.), and bacterial contamination during processing. Illness associated with consumption of mullscan shellfish are mainly attributed to either nonindigenous bacterial and viral agents that are associated with human-animal reservoir or indigenous bacterial pathogens (Rippey 1994). However, FAO (2004) points out that the later bacteria did not cause several cases, but organisms from former ones were the dominant causes. Major cause includes viral gastroenteritis, Salmonella, Shigella and Hepatitis A (FAO 2004; Ferri 2005; Lees 2000). Viruses- Norwalk viruses- were also present in outbreaks of mullscan shellfish consumption in USA and Sweden (Frankhauser et al. 2002). All above bacteria and virus were identified in cases of diseases originated to consumption with shellfish other than molluscan shellfish (FAO 2004). Nonindigenous bacteria (Salmonella spp.) (FAO 2004; Ferri 2005) and bacterial contamination during processing (S. aureus) (Ferri 2005) were responsible for large number of cases associated with fish consumption. Moreover, A. hydrophila was found to be about 28% in ready to eat finfish (Abeyta et al. 1986). The natural toxin-Paralytic shellfish poisoning (PSP) occurs from consumption of molluscan shellfish, lobster and crab (shellfish other than molluscan shellfish), and puffer fish (FDA 2011). In addition, the majority of cases were caused by scombroid or ciguatera fish poisoning (CFP).

As HACCP standards discrimination existing among countries, various control analysis of end products are carries out, particularly of imported foods at port of entry, which in further cause various import refusals. In USA, the most common reasons for import refusal are filthy of products and detection of salmonella. For EU countries, the main products and the main reasons for refusals included: chilled and frozen fish (or fish products) for the presence of pathogenic bacteria (e.g. Vibrio spp., Salmonella, etc.); shrimp, cray-fish tails and crab-tails also for the reason of pathogenic bacteria; tuna-fish products with too high content of histamine, mercury or presence of Salmonella or detection of biotoxins, viruses or indicator bacteria and molluscan shellfish with presence of pathogenic bacteria. Exporting countries from Asia accounted for 69.8% of the refusals, followed by Africa (17.8%), the Americas (8.8%), Europe (non-EU) (2.7%) and Oceania (0.9%) (FAO 2004).

HACCP and Seafood Trading Flow

Numbers of empirical studies have attempted to quantify the effects of HACCP food safety standards on trade flows. In general, most of these studies are applied at industry or country level, while some attempts are made at plant level.

For the whole food industry, conforming and harmonization of HACCP with original sanitation or food safety standards is a big issue for both exporting and importing parties. A fairly extensive literature on the general effects of food safety standards provides evidence that HACCP standards have negative and statistically significant effects on bilateral trade flows (Otsuki, Wilson and Sewadeh, 2001; Wilson and Otuki, 2003; Nguyen and Wilson, 2009). Buzby, Unnevehr, and Roberts (2008), Baylis, Nogueira and Pace (2010), as well as Baylis, Martens, and Nogueira (2009) suggest that the higher standard causes import refusal. Unnevehr and Roberts (2008) argue that seafood industry is of particular interest in that it is a fast growing area and holds great potential for developing countries, so seafood exports from developing countries attract most focus. Their results suggest that developing countries receives most import refusal in the U.S. and EU. Baylis, Nogueira and Pace (2010) also show the negative effect of HACCP by studying the import refusals of EU. Jaffee and Henson (2004) conclude that simply judging whether HACCP obstructs or benefits trading from developing countries is more complex in reality, which deserves close analysis based on particular countries, markets and products.

For particular countries, Caswell and Anders (2009) found that although as a group developing countries suffered significant trade reduction under HACCP, based on country-specific picture, larger or more established seafood exporters increased their trade flows while smaller exports suffered reduction. In addition, for countries import seafood from U.S., those which implement HACCP at the same status with USA (Li 2011) or define HACCP at the way of performance standards actually benefit from high standards requirements in seafood trading market.

When concentrated in particular seafood products, Nguyen and Wilson (2009) investigated that seafood safety regulations have different effects on different seafood products. In industrialized markets, shrimp is most sensitive, which suffered a dramatic reduction, while fish is the least sensitive to changing food safety policies. Their findings imply than the impact of changing standards on seafood products should not be identical based on the fact that risks with coherent seafood-borne disease is different across different seafood products. Products with high risk should be more sensitive than those with lower risk.

Model

The framework work of our empirical method follows the econometric approach, the gravity model. Analogous to Newton's law of universal gravitation, gravity model infers that trade flow between two countries is proportional to the product of each country's 'economic mass' (generally be GDP), divided by the trade costs (generally be the distance) and adjusted by other factors (Yunus 2009; Anderson and Wincoop 2003). One major advantage of this approach is the ability to examine the most relevant variables of seafood trade including standards variables and determinants of bilateral trade flows. Moreover, the direction of effect of standards-whether negative or positive need not to be predetermined. Therefore, this method can be used to for hypothesis testing and estimating elasticity of trade flows with respect to standards (Wilson and Otsuki 2003; Anders and Caswell 2009).

Typical gravity equation is applied in cross-section way to study trade effects of regulatory standards. Since U.S. is the exporter this paper concerned about, I only take consideration of the bilateral trade flows between U.S. and importer courtiers and do not count in the bilateral trade flows among importer countries. The typical econometric equation of gravity model can be specified as following form:

$$\ln EXP_{ijt}^{k} = \alpha_0 + \alpha_1 lnGDPC_{it} + \alpha_2 lnGDPC_{jt} + \alpha_3 lnDIST_{ij} + \alpha_4 Exrate_{ijt} + \alpha_5 lnIMPORT_{jt}^{k} + \alpha_6 HACCP_t + \alpha_7 FTA_{ijt} + \varepsilon_{jt}$$

Since I only concentrate on U.S. seafood export market, the typical model could be specified as:

(1)

$$\ln EXP_{jt}^{k} = \alpha_0 + \alpha_1 lnGDPC_{us,t} + \alpha_2 lnGDPC_{jt} + \alpha_3 lnDIST_j + \alpha_4 Exrate_{jt} + \alpha_5 lnIMPORT_{jt}^{k} + \alpha_6 HACCP_t + \alpha_7 FTA_{jt} + \varepsilon_{jt}$$

where the dependent variable EXP_{ijt}^{k} is the value of seafood k exported from country U.S. to country j at time t. $GDPC_{jt}$ ($GDPC_{us,t}$) which normally represents income of each country, is gross domestic product per capital of country j (U.S.) at time t in current constant 2000 US dollar. $DIST_j$, the proxy of transaction cost, donates to the geography distance between U.S. and country j. The amount of importer currency purchase one unit of U.S. dollar is given by Exra

The variable $lnIMPORT_{jt}^{k}$ is the total value of seafood k imports by country j in year t. Dummy variable HACCP reflects the implementation and enforcement of HACCP requirements by the FDA effective by 1998. It equals one since 1998 and zero in previous years. Dummy variable FTA_{jt} equals 1 if country j belongs to the same Free Trade Agreements with U.S. at time t, and zero otherwise. The disturbance term, ε_{jt}, is assumed to be normally distributed with zero mean and constant variance for all time periods.

Model 1 is the benchmark specification of the gravity model. It controls for the overall impact of HACCP requirements on the U.S. exports of the three categories of seafood investigated in this paper. Empirical results showed that HACCP actually acts as a non-tariff barrier for poor countries' exports to rich countries. U.S. implements HACCP at the strict level, which give it comparative advantage in seafood trading market. In this case, HACCP should benefit U.S. seafood exports in the long run, regardless of seafood categories. Our former works support that HACCP indeed has significant positive impact on the aggregate level of U.S. seafood exports (Li and Saghaian 2011). This paper would then explore HACCP impact at the level of individual plant. Considering that processors spend large amount of time and expense to comply with HACCP requirements, seafood exports may fall over in a short period after HACCP applied in U.S. seafood industry. However, since HACCP is world wildly enforced in the long time run, the negative effects of HACCP could be a short time shock on U.S. seafood exports, which maybe insignificant. This assumption will also be tested in this paper. The estimation results of the benchmark model will be compared with the improved model to test the first two hypotheses. Both of the two models would be run three times based on the type of seafood to compare the results.

Hypothesis 1: HACCP has insignificant negative impact on U.S. seafood exports of fishes, molluscan shellfish and shellfish other than molluscan shellfish in the short run.

Hypothesis 2: HACCP has significant positive impact on U.S. seafood exports of fishes, molluscan shellfish and shellfish other than molluscan shellfish in the long run.

However, the typical gravity model suffers from two problems. The first one involves endogeneity problem, which comes from unobserved heterogeneity between countries (Baier and Bergstrand 2007; Cheng and Wall 2005; Wilson and Otsuki 2004; Anders and Julie 2009). From the view of econometric, this special effect can be treated as either random variables (error component approach) or fixed effect (Mátyás 1997, 364). However, the majority of existing empirical studies used fix-effect approach (Baier and Bergstrand 2007; Cheng and Wall 2005; Wilson and Otsuki 2004; Baylis, Nogueira and Pace 2010). Because fixed-effects models allow for unobserved or misspecified factors that simultaneously explain trade volume between two countries (Cheng and Wall 2005, 50) and they are best adjusted for by using country specific fixed-effects. Researchers suggest that in addition to time-invariant fixed effect, fixed effects for bilateral country pairs and time varying fixed effects for importer and exporter countries should also be included in order to deal with endogeneity problem.

The other problem is zero observations when a double log model is used. Burger, Oort and Linders (2009) point out that omitting zero value observations could lead to biased results, particularly when these zero valued trade flows are not randomly distributed. And heteroskedasticity can lead to biases if samples are truncated by excluding zero values. Many researchers propose Poisson pseudo-maximum likelihood (PPML) method and find that it performs better than other estimators in the presence of heteroskedasticity. Furthermore, Santos

Silva and Tenreyro (2009) posit that the PPML estimator is generally well behaved even when the dependent variable has a large proportion of zeros.

In this paper, the PPML method adjusted with fixed effects is used to deal with unobserved country characteristics and bias caused by zero observations. Since only U.S. export market is focused in this study, bilateral fixed effect is not used and the time varying fixed effect of U.S. is included in the constant. And distance is also omitted because time-invariant fixed effect is involved in the model. In this case, the typical gravity model can be improved as:

$$(2) EXP_{jt}^{k} = EXP\ (\alpha_0 + \alpha_j + \alpha_t + \alpha_1 lnGDPC_{us,t} + \alpha_2 lnGDPC_{jt} + \alpha_3 Exrate_{jt} + \alpha_4 lnIMPORT_{jt}^{k} + \alpha_5 HACCP_t + \alpha_6 FTA_{ijt} + \varepsilon_{jt}),$$

Where α_j accounts for unobserved country effects of import country. Considering the differential risk identification by seafood categories, the sensitivity of different categories of seafood to HACCP implementation could be dissimilar. Model two will be used to test the third hypothesis:

Hypothesis 3: The sensitivities to HACCP implementation in U.S. are dissimilar based on categories of fishes, molluscan shellfish and shellfish other than molluscan shellfish.

Data

The panel data used in the analysis includes the value amount of U.S. exported seafood from year 1989 and 2008, which can be obtained from the Foreign Agricultural Service's Global Agricultural Trade System (GATS). Countries with incomplete data are dropped from analysis. Since U.S. unevenly exports seafood among these three categories, countries used in analysis are not the same for models of fishes, molluscas, and shellfishes other than mollusca (SOM).

Considering trade flow, 57 countries are used for fish's analysis, 34 countries are used for analysis and 56 import countries are used for analysis with shellfish other than mollusca shellfish. For EU countries, Belgium and Luxembourg were separated after 2000. For the purpose of data completeness, we still combine these two countries together after 2000 in analysis.

The data of the dollar value of total seafood imports by importing countries is achieved from Fishery Commodities Global Production and Trade (online query). For all countries used for analysis, Data of GDP per capital are obtained from the database of World Development Indicators and Global Development Finance. Information on distance, contiguity and common language are from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). Data of exchange rate is obtained from Penn Trade Table.

Information on Free Trade Agreements is justified from WTO Regional Trade Agreement Lists. Before assigning values for FTA dummy variable, the effective time of each country's membership is carefully verified, because countries within each RTA group did not join the RTA group simultaneous. FTAs considered in this paper include NAFTA (North American Free Trade Agreement), US – Australia, US – Chile, US – Israel and US – Singapore. We also verified the time when FTAs were actually in force to avoid mistakenly value the RTA dummy variables with panel data. Take agreements between U.S. and Peru for example, this FTA was actually in force on February 1st, 2009, which beyond the period in this research. Thus this FTA is not considered in research.

Results and Discussions

The estimation results for all three categories of seafood with model 1 and model 2 are presented into two groups – short run and long run, listed by table 1 and table 2 respectively. The long run expands to all time period, from 1989 to 2008 and the time period used for short run is from 1990 to 1999. All import and export countries are included in the regression of short run and long run.

Table 1: Gravity Model Estimates of HACCP Impacts on U.S. Seafood Exports of Molluscas, Fishes and Shellfishes Other than Mollusca in the Short Run, from 1989 to 1999

ln EXPORT	Fishes		Mollusca		Shellfish other than mollusca	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
ln GDPCus	0.97	0.86	2.11**	1.80	0.014	2.67**
	(0.96)	(1.15)	(1.06)	(2.25)	(0.26)	(1.17)
ln GDPCj	0.56*	1.47*	-0.00024	0.00013***	-0.048	-0.000061
	(0.15)	(0.48)	(0.25)	(0.000074)	(0.20)	(0.000044)
ln Distance	-0.30	-	-0.30	-	-0.14	-
	(0.27)		(0.47)		(0.40)	
ln EXRATE	0.18*	0.22*	0.076**	-0.062	0.014	0.13***
	(0.041)	(0.048)	(0.046)	(0.10)	(0.049)	(0.074)
ln Import	0.64*	0.39*	0.33*	0.27**	0.33*	0.26*
	(0.064)	(0.085)	(0.068)	(0.11)	(0.066)	(0.062)
HACCP	-0.12	-0.12	-0.085	-0.0029	-0.027	-0.31**
	(0.15)	(0.15)	(0.15)	(0.25)	(0.095)	(0.15)
FTA	0.19	0.025	-0.37	0.21	0.42*	0.099
	(0.36)	(0.37)	(0.33)	(0.45)	(0.13)	(0.45)
Constant	-13.04	-19.91**	-16.77	-17.88	4.77	-22.75***
	(10.10)	(9.95)	(11.33)	(22.20)	(4.69)	(11.63)

Notes : *, **and *** donate to statistically significant at 1 %, 5%, and 10% level respectively.

This paper hypothesizes that all else equal, mandatory HACCP has an overall insignificant and negative impact on U.S seafood exports in the short run. The results presented in table 1 are consistent with this hypothesis except for SOM. For all three categories of seafood, Model 1 and model 2 show consistent picture of HACCP influence. The negative sign of HACCP infers that HACCP implementation had negative effect on seafood exports in short period. For fish and mollusca, the insignificance of HACCP infers that HACCP enforcement acts as a short run shock for U.S. seafood exports. But for SOM, Considering the P-value for SOM in model 2, -0.31, HACCP application indeed has significant effects. Based on the magnitude shown in table 3, compared to seafood export before the standard enactment, the enforcement of HACCP system in U.S. is associated with an average of 0.27% decrease in annual exports value of SOM, amounting with about $2845 thousand. Comparing the coefficients, exports of SOM are most sensitive to HACCP application over the short period and sequentially are mollusca and fishes. Since shellfishes are normally regarded to be with high level of food borne risk, the results are consistent with hypothesis in general.

The results infer the importance of GDP per capital of both importing country and U.S. as factors in explaining changes of trade flow. Both of the two models indicate positive effect of U.S. GDP per capital on exports of all three types of seafood. And increasing U.S. GDP per capital could significantly benefit exports of SOM, while GDP per capital of importing countries has insignificant effects on fish and mollusca exports based on estimators in model 2. However, income of import country has negative effect on SOM exports from U.S. although the effect is insignificant, which is wired.

The panel regressions also highlight the significance of TIMPORT in the short run, which measures the total value of the particular kind of seafood imported by importing country, as another major factor in explaining trade flows. The same sign of all estimators implies that the more dollar value of total seafood the country annually imports from global market, the m value of seafood it imports from U.S. Table 4 provides the magnitude of total seafood imports effect on US seafood exports based on the estimated results of model 2. A one percent increase in a country's value of global fishes (mollusca, SOM) imports is associated with an increase of fish (mollusca, SOM) exports from U.S. of around 0.39 (0.27, 0.26) percent in annual value in the short run, valuing at about $96 ($2.31, $30.96) thousand.

Another important factor explaining trade flow appeared in my research was exchange rate, which represents the amount of importer currency exchange for one unit of exporter currency. Increased exchange rate implies undervalue of currency in exporter country, and then in turn results more export. Thus the sign of the coefficient is supposed to be positive. For exports of fish and SOM, estimates present consistent results. But for exports of mollusca, the effect of exchange rate is insignificantly negative.

For distance and free trade agreement, the former variable, which represents transaction costs, is supposed to have negative effect while the latter is supposed to have positive effect based on the majority of empirical results. The analysis of distance is only based on results of model 1. The results in table 1 are consistent with the hypothesis. However, it is also indicated that in the short run, distance and FTA does not present significant effects on U.S. seafood export markets.

In general, the results of regression in the long run show a similar picture with that in the short run for the majority of estimators. The coefficients of HACCP indicate that HACCP still has negative impact on U.S seafood exports but only with significant effect on exports of SOM and mollusca in the long time period. For exports of fishes and mollusca, model 1 and model 2 induce similar results. But for SOM, as shown in table 2, the estimator of HACCP in model 2 imply that HACCP implementation significantly hamper SOM exports, while based on model 1, HACCP could enhance U.S. SOM exports although the effect is insignificant. These results are inconsistent with the hypothesis 2. If we consider the situation of U.S. seafood exports- U.S. is one of the leading exporters of canned salmon (fish), exports lots of crabs and lobster (SOM) and only exports a little amount of molluscas, then it is not surprised to see such distinct effect of HACCP enforcement on these three kinds of seafood. The steady international demand of fish determines that HACCP application could not significantly influence U.S. fish exports.

Table 2: Gravity Model Estimates of HACCP Impacts on U.S. Seafood Exports of Molluscas, Fishes and Shellfishes Other than Mollusca in the Long Run, from 1989 to 2008

ln EXPORT	Fishes		Mollusca		Shellfish other than mollusca	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
ln GDPCus	1.18***	0.26	4.77*	10.18*	0.14	2.66*
	(0.68)	(0.80)	(0.81)	(1.32)	(0.17)	(0.72)
ln GDPCj	0.68*	2.11*	-0.046	0.000031	0.16	0.0000085
	(0.14)	(0.30)	(0.22)	(0.000028)	(0.17)	(0.000017)
ln Distance	-0.17	-	-0.26	-	-0.13	-
	(0.25)		(0.45)		(0.33)	
ln EXRATE	0.20*	0.25*	-0.017	-0.29*	0.020	0.19*
	(0.036)	(0.040)	(0.046)	(0.099)	(0.034)	(0.058)
ln Import	0.61*	0.40*	0.54*	0.36*	0.33**	0.28*
	(0.052)	(0.062)	(0.058)	(0.078)	(0.035)	(0.040)
HACCP	-0.21	-0.20	-0.45*	-0.76*	0.031	-0.45*
	(0.14)	(0.14)	(0.16)	(0.23)	(0.070)	(0.14)
FTA	0.064	-0.037	-0.61*	0.96*	-0.097	0.096
	(0.23)	(0.23)	(0.20)	(0.31)	(0.0.18)	(0.26)
Constant	-17.15**	-19.25*	-46.22*	-102.97*	1.50	-23.54*
	(7.28)	(6.96)	(8.80)	(13.06)	(3.83)	(7.26)

Notes : *, **and *** donate to statistically significant at 5 %, 10%, and 15% level respectively.

Moreover, the magnitude of coefficient shows difference in the long run. Mollusca present much more elasticity in the long run than in the short run while fish exports are remotely affected in the long run. Compare with estimations of short time period, during which SOM exports tend to be the most sensitive one, mollusca exports are the most sensitive to HACCP enforcement and follow by SOM and fish sequentially in the long time period. Based on calculations in table 3, the average annual decrease rate is 53 percentages for dollar value of mollusca exports in the long term period, 36 percentages for SOM exports, and 18 percentages on average for fish exports. It implies that exports of fishes follow a smoother long time trend than exports of the other two kinds of seafood and exports of mollusca tract a volatile way. This result verify the third hypothesis that exports of seafood that has higher risk of food borne disease are more sensitive to enforcement of stricter standards.

Table 3 Magnitudes of HACCP Effects on U.S. Seafood Exports of Fishes, Molluscas and Shellfish Other than Mollusca

Seafood Type	Period	Average Annual Export Pre-HACCP in 1997 (thousand)	HACCP Impact (thousand)	Change (%)
Fishes	Short run	19779	-2236.60	-11
	Long Run	19779	-3585.32	-18
Mollusca	Short run	120	-0.35	-0.29
	Long Run	120	-63.88	-53
Shellfish other than mollusca	Short run	10675	-2845.45	-27
	Long Run	10675	-3868.32	-36

The estimator of IMPORT shows consistent implication as it does in the models of short run. The total value of global seafood imports could significantly and positively impact U.S. seafood exports to that import country. The enhancing effect of IMPORT lies in that if a country adds its imports of one kind of seafood from the global market, there is greater chance for that country to increase its imports of that particular seafood from U.S. too. My results support this assumption with positive sign of estimator. Moreover, U.S. is a large exporter of fishes, such as canned salmon, but do not export so much seafood of mollusca in the global market, thus exports of mollusca appear least sensitivity to the changes of IMPORT while exports of fishes are most sensitive to changes of this variable. Based on calculation provided in table 4, a one percent increase in a country's value of total fishes (mollusca, SOM) imports in the long run is associated with an increase of fish (mollusca, SOM) exports from U.S. by around 0.40% (0.36%, 0.28%), amounting at about $110 ($8.16, $32.21) thousand in annual value.

Table 4 Magnitude of Total Import by Importing Countries Effect on U.S. Seafood Export of Fishes, Molluscas and Shellfish Other than Mollusca

Seafood Type	Period	Average Annual US Exports (thousands)	Amount (thousands)	Percentage
Fishes	Short run	24658	96.17	0.39
	Long Run	27620	110.48	0.40
Mollusca	Short run	857	2.31	0.27
	Long Run	2268	8.16	0.36
Shellfish other than mollusca	Short run	11908	30.96	0.26
	Long Run	11505	32.21	0.28

GDP per capital of U.S. has positive and significant effect on U.S. seafood exports of SOM and mollusca, and the GDP per capital of importer country only has positive and significant effect on U.S. exports of fish. Moreover, the magnitudes of estimation present great differences. In my opinion, these results are consistent with current situation of U.S. seafood exports. Since U.S. has more influence on fish exports market, it is normal for countries with higher income to import fishes from U.S. While for exports of SOM and mollusca, which have much less share in seafood trading market, importers may not increase their demand amount from U.S. since U.S. is not their first choice.

In the long time period, the exchange rate presents similar effect as it does in models of short run period except for models with mollusca exports. The variable EXRATE has significant effect on mollusca exports in the long run instead of insignificant effects in the short run. Since mollusca exports concentrates to several major importer countries, such as Canada, Japan and France, the importance of exchange rate may gradually exhibit its significance for explaining changes of trade flows.

Conclusions

Although the effect of HACCP on international trade is an issue with many concerns recently, only a few empirical studies focus on the impact of HACCP on U.S seafood export industry. Using the approach of Gravity Model with adjustment of unobserved country characteristics, this paper contributes to analyze the differential effects of HACCP implementation on three kinds of seafood: fishes, mollusca, and shellfish other than mollusca.

The results indicate that HACCP application negatively effects on U.S seafood exports in both long run and short run. The lucky part is that for exports of fish, the most important part of all U.S. seafood exports, the effect of HACCP enforcement is remote. While for shellfish and mollusca, the influence could be significant in the long run. However, Mollusca exports only constitute a small proportion of the total seafood exports from U.S. and shell fish exports do not play leading role in U.S. seafood export market. Nowadays, more and more countries tend to adopt stricter food safety regulatory, including HACCP, and U.S. is one of these countries that enforce food safety in stringent standards. Thus it is too simple to make the conclusion that the stricter status of seafood safety requirement in U.S. actually harms U.S. seafood exports and the government should not enforce it anymore. In other words, although we cannot conclude that stringent standards requirement could provide U.S. comparative advantage in the global seafood market, HACCP still could not be discarded. In addition, mollusca exports present the highest sensitivity to HACCP enforcement. The higher risk of food born disease seafood has, the easier is seafood trading affected by the enforcement of stricter food safety standards.

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