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Chinese Producer Behavior: Aquaculture Farmers in Southern China

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Abstract

The increasing share of imported food in developed countries, such as the US and European Union countries, poses new challenges for food safety and quality regulators. China as the world's biggest food producer has the fastest growing share of fish and shellfish exports to these countries. While there have been an increasing number of studies conducted on consumer demand for various food product attributes, little research has been focused on producer behavior, and studies on Chinese food producers are especially absent in the literature. The objective of this study is to assess Chinese aquaculture producers' willingness-to-change (WTC) and adopt certain production practices related to food safety. Producer preferences for enhanced food safety measures, and sustainable/eco-friendly production practices are assessed using a choice experiment. Primary data was collected in the leading aquaculture producing provinces of southern China. The average net income per farmer of our sample was 81,286 RMB/year of which approximately 72% originated from their aquaculture operation. Derived WTC estimates from a random parameters logit model suggest that the representative Chinese producer would require a 2.49 % premium per *jin* of fish to adopt enhanced food safety practices such as those required for China GAP, and No Public Harm voluntary certifications and they would accept a 3.22% discount before being indifferent between having an antibiotic-free facility and using antibiotics. WTC estimates of sustainable eco-friendly practices and verification by various entities were also assessed. A latent class model (LCM) is used to segregate producers into group with similar underlying characteristics to develop policies to improve producer practices and ultimately product safety and quality.

1. Introduction

The share of imported foods in developed countries, such as the U.S. and European Union countries, has shown steady growth over the past decade. Foods, such as fish, shellfish, coffee, cocoa, and spices, have contributed to the increase of overall import shares due to their relatively low domestic production volumes. The globalized food industry offers Western consumers a more affordable spread of food products year round and it also increases market access for developing countries (Jerardo, 2008). However, the increasing share of imported food in developed countries poses new challenges for food safety and quality regulators. In recent years, China has emerged as an important supplier of food imports in the U.S., ranking third in value after North American neighbors Canada and Mexico. U.S. imports of Chinese food products increased roughly fivefold in value from \$1 billion in 1998 to \$5.2 billion in 2008 (Becker, 2008). Similarly, The Chinese share in Australia's food imports increased to 7.3% in 2010-2011 from 3.1% in 2000-2001 (Rushdi, 2012).

Highly publicized incidents of food contamination and adulteration in both the Chinese domestic and export market have focused world-wide public concerns on the safety of food from China (Gale and Buzby, 2009). China's food safety problems stem in large part from loose regulations and China's highly fragmented food production. As a result of these issues, the U.S. government has taken swift action in addressing the safety of U.S. imports. In 2007, the Interagency Working Group on Import Safety issued a comprehensive Strategic Framework followed by a detailed Action Plan for Import Safety which explicitly addressed the safety of U.S. imports from China.

Chinese food exports to the U.S. include a large variety of items; however three-fourths can be grouped into the following categories: aquaculture (mostly fish and shellfish), juices, fruits, vegetables and nut products. Of these broad groups, fish and shellfish account for the largest and fastest growing category of imported foods from China (Gale and Buzby, 2009). The majority of the Chinese aquaculture products exported to developed countries originate in factories in China's coastal provinces. Cultivation of fish and shellfish in this area is mainly done by small-scale farmers in ponds, lakes or reservoirs. Moreover, because of significantly lower processing costs, some North American and European fish and shellfish are currently being processed in

China and re-exported to the U.S. and other high demand markets. Currently, the U.S., Japan and the European Union (most notably France, Greece, Italy, Portugal and Spain) account for approximately three-fourths of all aquaculture imports world-wide; the majority originating from China (Paquotte and Lem, 2008).

Food safety issues often arise from problems of asymmetric information between producers and consumers of food with regards to product-specific attributes or characteristics. Credence attributes, which are characteristics that consumers cannot discern before, during or even after consuming the product, are often used to signal information to consumers regarding intangible product characteristics (Caswell and Mojduszka, 1996). Product quality and safety certification, traceability networks, and third-party certification are examples of systems used to help bridge the information gap between market players and reduce inefficiencies that arise from asymmetric information. Because Western consumers do not have complete information about these credence attributes from Chinese food products, the Chinese food import market in the developed world is characterized by asymmetric information. Furthermore, the Chinese food processing sector does not have perfect information regarding product quality characteristics and thus quality regulation mechanisms are ineffective when firms are unable to reveal or guarantee information that they do not possess (Ubilava and Foster, 2009). Information on Chinese production processes that affect food safety and quality must be conveyed to consumers by the importer through a channel which consumers trust. Olynk et al., (2010) explains that producers will seek to maximize profit through their selection of product-specific attributes to provide to the market and that producers will decide not to provide such attributes unless they are either required to do so or find it profitable to supply.

It is crucial for food policy makers to understand both consumer and producer behavior as they propose and implement food safety regulation. Consumer preferences and demand for safety, quality and sustainable attributes have been investigated to a degree in previous research such as Shogren et al. (1999); Grunert (2005); Jaffry et al. (2004). While there have been an increasing number of studies conducted on consumer behavior and willingness-to-pay for food safety and quality attributes, little research has been focused on producer behavior and studies focusing on Chinese producers are currently absent in the literature. The objective of this study is to assess

Chinese aquaculture producers' willingness-to-change and adopt certain production practices. Their preferences for enhanced food safety measures, use of antibiotics and sustainable production practices are assessed.

2. Methods

Given that Chinese producer data are not widely available, field work to gather primary data was necessary. A producer survey was developed to obtain information from Chinese aquaculture producers regarding socio-demographic characteristics, production practices, perceptions of select product attributes and preferences for various verification systems. A choice experiment (CE) was utilized to simulate realistic production decision scenarios in which producers choose between production practices and verification entities.

The producer survey was conducted in the summer of 2011 in the leading aquaculture provinces of China: Fujian, Guangdong and Guangxi. Expert advice was sought from applied economists as well as local county officials to obtain a sample of farmers from the region. The surveys were reviewed by agricultural economists from China and the U.S. and ten enumerators were trained to conduct the producer interview and administer the questionnaire and choice experiment. A total of 150 questionnaires were administered, of which 138 were complete and included in the data set used throughout this analysis.

The location of the provinces where the study was conducted and summary statistics of survey respondents and their aquaculture operations are presented in Figure 1 and Table 1. In our sample, farmers from Fujian province were more export oriented than those in the provinces of Guangdong and Guangxi. As such, the scale of those operations was on average larger than in the other provinces (421*mu* in Fujian, 67*mu* in Guangdong, and 35*mu* in Guangxi). Overall, our sample of aquaculture farmers was predominately male, possessed 8.5 years of formal education and had been farming fish for an average of 10.9 years. The average net income per farmer was 81,286 RMB/year of which approximately 72% was originated from their aquaculture operation. A small proportion of them operated under contracts or were members of a farm cooperative (12.3% and 6.5%, respectively). The majority of farmers (60.1%) reported operating an antibiotic-free operation.

The survey contained a choice experiment in which producers made decisions between various types of production methods to employ in their operations with varying levels of premiums or discounts per *jin* of product. These production methods included enhanced food safety measures, antibiotic use and environmentally sustainable practices. In addition, their preferences for a verification entity were assessed. Each respondent completed a CE designed to best resemble current and potential production-related decision within the aquaculture industry while avoiding being overly complex for respondents (Norwood et al., 2006 and Schulz and Tonsor, 2010). The main objective of the CE is to determine producers willingness-to-change (WTC), accept a premium or discount, and adopt selected production practices in their operation.

Choice experiments allow for the evaluation of multiple attributes and enable the estimation of trade-offs between different alternatives (Lusk et al., 2003). An orthogonal, fractional factorial, D-optimal, balanced blocked design that allows for the estimation of all necessary effects was used. This allowed the CE to be of reasonable size for survey participants and helped reduce the occurrence of response fatigue. Each aquaculture producer was presented with nine different scenarios, each involving a selection between two alternative types of white fin fish each under a specific operation with various types of requirements regarding food safety, antibiotic use and sustainable eco-friendly practices. Following Olynk, Wolf and Tonsor (2012), a no-choice option was included in the design, in which the producer could opt to not produce the product.

The attributes included in the CE design were: (i) a premium or discount (as a percentage of the average market price) per *jin* of white fin fish sold¹; (ii) the presence of high food safety standards referring to the implementation of standards above and beyond what is currently required by law; (iii) antibiotic-free production; (iv) the employment of an eco-friendly, sustainable production method and (v) verification entity referring to the administrative body overseeing and verifying the aforementioned product characteristics: the Chinese government, importing country government (i.e. U.S., E.U., Australia) or third party organization. Though the CEs were hypothetical in nature, a cheap talk script was presented to each farmer as these typically reduce hypothetical bias in stated preference research (Lusk, 2003). A sample choice situation is presented in Figure 2.

¹ Price levels in the CE were: average market price, 15% premium and 15% discount.

3. Econometric Methods and Estimation

McFadden's (1981) random utility model (RUM) is used to analyze producer preferences. RUM assumes that utility maximization is the underlying incentive behind an agent's decision to choose among available alternatives. Although conventional production theory assumes producers maximize their profit instead of utility, we can justify our model involving food safety and environmental factors in that farmers care about the economic externalities by internalizing these values into their own utility criteria. A price premium or discount is included as an argument of the utility function to represent the conventional profitability criterion.

Choice experiments are based on the assumption that individual n obtains utility U_{nit} from selecting alternative i from a finite set of J alternatives contained in choice set C in situation t . In the RUM, utility is composed of a deterministic component V_{nit} which depends on the attributes of an alternative, and a stochastic component ε_{nit} , as

$$U_{nit} = V_{nit} + \varepsilon_{nit} \quad (1)$$

Therefore producer n will choose alternative i if $U_{nit} > U_{njt} \square j \neq i$. Consequently, the probability of producer n choosing alternative i is given by

$$P_{nit} = \text{Prob}(V_{nit} + \varepsilon_{nit} > V_{njt} + \varepsilon_{njt}; \forall j \in C, \forall j \neq i) \quad (2)$$

Given the underlying distribution of the error term, the closed form of the logit choice probability can be expressed as:

$$P_{nit} = \frac{\exp(V_{nit})}{\sum_j \exp(V_{njt})} \quad (3)$$

Because producer preferences are assumed to be heterogeneous, this study examines a random effects specification by implementing a random parameters logit (RPL) model. The RPL relaxes the limitations of the traditional logit by allowing random preference variation within a sample according to a specified distribution (McFadden and Train 2000). Under RPL the deterministic component of Utility V_{nit} in the random utility model takes the form of

$$V_{nit} = \beta'x_{nit} \quad (4)$$

where β is a vector of random parameters, which has its own mean and variance, representing individual preferences, and x_{nit} is the vector of attributes including the profitability factor found in the i th alternative. Following Train (2003), the probability that individual n chooses alternative i from the choice set C in situation t is given by

$$P_{nit} = \int \frac{\exp(V_{nit})}{\sum_j \exp(V_{njt})} f(\beta) d\beta \quad (4)$$

where we can specify the distribution of the random parameter $f(\cdot)$. If the parameters are fixed at β_c (non-random), the distribution collapses, i.e. $f(\beta_c) \rightarrow \infty$ and $f(\beta) = 0$ otherwise (Ortega et al., 2012).

In order to segregate producers into groups with similar underlying characteristics, a latent class model specification is employed. In the LCM, $f(\beta)$ is discrete, taking S distinct values (Train, 2003). The probability that producer n selects option i in a given choice situation t unconditional on the class is represented by

$$P_{nit} = \sum_{s=1}^S \frac{\exp(\beta_s' x_{nit})}{\sum_j \exp(\beta_s' x_{njt})} R_{ns} \quad (5)$$

where β_s is the specific parameter vector for class s , and R_{ns} is the probability that producer n falls into class s .

With the aforementioned CE specification and theoretical framework, the deterministic component of utility can be defined as:

$$V_i = \beta_1 \text{PremDisc}_i + \beta_2 \text{FS}_i + \beta_3 \text{ANT}_i + \beta_4 \text{ENV}_i + \beta_5 \text{IMPC}_i + \beta_6 \text{PRIV}_i + \beta_7 \text{OptOut}_i \quad (6)$$

where PremDisc captures a profit measure per *jin* of fish, FS a binary variable indicating the presence of enhanced food safety practices, ANT no-antibiotic use, and ENV the use of

environmentally sustainable eco-friendly production practices. The coefficients on verification entity are IMPC for importing country government and PRIV for non-governmental third party verification; the default or base for these two variables is Chinese government verification. The OptOut variable is an indicator for the choice of not producing fish.

Both model specifications were estimated using NLOGIT version 5.0. In the RPL, we hypothesize that the product-specific parameters are random and follow normal distributions; for modeling purposes we treat price and the OptOut terms as fixed (Ubilava and Foster 2009).

Willingness-to-change

RUM coefficients (Table 2) have limited economic interpretation due to the non-cardinal nature of utility. Therefore, attribute trade-offs are estimated to provide meaningful insight into producer behavior. We follow Nahuelhual et al (2004), Rigby and Burton (2005) and Schulz and Tonsor (2010) to assess how Chinese aquaculture producers are willing-to-change their production practices. Accordingly, producers' WTC is calculated as:

$$WTC = \frac{MU}{MUI} \quad (7)$$

Where MU is the marginal utility of the various product attributes driven by the adoption of corresponding production practices and MUI is the marginal utility of profit, which we proxy with the premium/discount coefficient. The use of a premium/discount coefficient enables the WTC calculation to capture both willingness-to-pay (WTP) and willingness-to-accept (WTA) (Schulz and Tonsor, 2010). In this context, a negative WTC reflects a premium which producers would have to receive to provide a certain product attribute and a positive WTC a discount they are willing to accept when providing the attribute.

Since WTC is a function of two random variables, a parametric bootstrapping method suggested by Krisnky and Robb (1986) is employed to obtain confidence intervals on the WTC estimates and assign statistical significance. The Krisnky Robb bootstrapping procedure simulates WTC estimates by drawing from a multivariate normal distribution parameterized with mean coefficient and variance-covariance matrix of the logit models. This technique produced

analogous results to estimating standard errors using the delta method, however, it relaxes the assumption that WTP is symmetrically distributed (Hole, 2007). Mean WTC estimates and derived 95% confidence intervals for both models are presented in Table 3.

4. Results

The significant standard deviation coefficients (Table 2) in the RPL assert our hypothesis that farmers have heterogeneous preference with respect to their production practices. The derived WTC estimates (Table 3) imply that the representative Chinese producer would require a 2.49 % premium per *jin* of fish to adopt enhanced food safety practices such those required for China Good Agricultural Practice (GAP), and No Public Harm voluntary certifications. With respect to antibiotic use, they would accept a 3.22% discount before being indifferent between having an antibiotic-free facility and using antibiotics. Aquaculture farmers were found to be already willing to change and adopt sustainable eco-friendly practices. When assessing producers' preference for verification entity, we find that they would require a 3.38% premium to be indifferent between importing country government verification and Chinese government verification and over a 3.99% premium before adopting third party verification.

Two latent classes were found optimal using both the Bayesian and Akaike Information Criterion in the LCM (Table 2). The derived WTC profiles (Table 3) of both groups point to striking differences between both classes of producers. The probability that a randomly chosen farmer belongs to a given class is 59% and 41%, respectively. WTC results for the first latent class shows a group of producers that behaves similar to what is described in the RPL results. These farmers would require reasonable premiums to adopt enhanced food safety practices (2.81% per *jin*) and undergo verification by both the importing country government and a third party (1.37% and 1.75%, respectively). Similarly, they would accept a 2.38% discount before being indifferent between using antibiotics or not in their operation. Given their preference profile, we label this group of individuals as 'Rational Producers.'

The second group of producers exhibits more interesting behavior. They do not have a significant WTC with regards to enhanced food safety practices and antibiotic use and as such, would require significant premiums to undergo inspection and verification by either the U.S.

government or a third party (23.57% and 10.68%, respectively). Consistent to showing an affinity for environmental stewardship, this group of producers is found to be already willing to change their current practices with regards to safety and quality but would require substantial compensation before undergoing verification by an entity other than the Chinese government. As such we refer to this group as ‘Verification Averse Producers.’ Results from the LCM point to two distinct groups of producers. Food policy and regulations will need to be tailored specifically to target the latter group of producers and provide incentives for them to enhance their food safety and quality practices in their operations.

5. Policy Discussion and Conclusion

Preventive policies are often preferred to reactionary measures in food safety policy. Producer and on-farm accountability must be assessed as part of a comprehensive approach to tackling food safety and quality issues. A key step in this process is quantifying producer preferences towards production practices that yield a desired product characteristic. Understanding producer preferences towards practices, and verification processes, is crucial to developing food safety systems that incentivize producers appropriately to yield desired behaviors. This information regarding producer preferences can then be used to inform effective food policy both domestically and internationally aimed at inducing producers (and other agents along the supply chain) to producing safe, high quality products. An example of this approach is the US FDA Food Safety Modernization Act (US FDA FSMA), which shifts the focus of federal regulators from responding to safety incidents to prevention. Within the context of the present study, the US FDA FSMA acknowledges the importance of monitoring the safety of imported foods and puts emphasis on foreign government and third party oversight of production processes (Figure 3). Similarly, as stated in the EU code of regulations, food products of animal origins are allowed into the EU only if they come from an approved establishment in an exporting country.

Our results show that a small price premium can give farmers the needed incentive to comply with higher product safety and quality standards. The establishment of in-country certification by importing country government would provide necessary screenings and monitoring of product safety and quality prior to shipment. Furthermore, mandated importing country third party

certification will not significantly increase the costs of imported food products from China as a majority of producers are willing to comply when given a modest product premium. Given the fragmented nature of food production importing countries will need to rely on certifying Chinese entities in-country so that products and production practices comply with specific importing country regulations. Our results show that a significant proportion of farmers are willing-to-change and adopt certain practices; the main issue surrounding this group of producers is certification. While a segment of producers are willing to change, the certification process may ultimately affect their course of action.

This study provides a first step in assessing Chinese aquaculture producer behavior and their preference for government and third party certification. Further work is needed in this area to better understand and assess product safety and quality along the import supply channel. Specifically, assessment of import compliance and import/export agent behavior is missing in the literature.

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Table 1. Sample Descriptive Statistics

Variable	Mean (% were noted)	Standard Deviation
Male	90.6%	
Age	47.15	9.80
Education (years)	8.52	2.64
Years in Aquaculture	10.89	7.48
Farm Size (<i>mu</i>)	120.17	312.31
Net Income (RMB/year)	81286.00	112277.00
Net Income from Aquaculture (RMB/year)	58825.37	94693.00
Number of Workers	3.18	4.41
Contract Farming	12.3%	
Cooperative Member	6.5%	
Export Oriented	28.3%	
Antibiotic Free Operation	60.1%	
Sample Size (n)	138	

Table 2. Parameter estimates from RPL and LCM

Variable	RPL		Latent Class Model			
			Class 1 <i>(Rational Producers)</i>		Class 2 <i>(Verification Averse Producers)</i>	
PremDisc	0.112	(0.008)***	0.226	(0.027)***	0.036	(0.005)***
FS	-0.138	(0.061)**	-0.316	(0.088)***	0.010	(0.050)
ANT	0.184	(0.084)**	0.269	(0.107)***	-0.007	(0.041)
ENV	0.109	(0.061)**	-0.031	(0.092)	0.156	(0.054)***
IMPC	-0.191	(0.084)**	-0.157	(0.157)	-0.417	(0.063)
PRIV	-0.219	(0.066)***	-0.194	(0.095)***	-0.189	(0.064)***
OptOut	8.427	(0.736)***	18.613	(2.404)***	1.475	(0.529)***
STDEV(FS)	0.258	(0.115)**				
STDEV(ANT)	0.704	(0.094)***				
STDEV(ENV)	0.251	(0.137)*				
STDEV(IMPC)	0.355	(0.136)***				
STDEV(PRIV)	0.021	(0.351)				
Class Prob.			0.587		0.413	

Notes: Presented models (log likelihoods of -781 and -761) were estimated using NLOGIT 5.0. Standard errors are presented in parentheses. *, **, *** denotes statistical significance at the 0.10, 0.05 and 0.01 level, respectively.

Table 3. Willingness-to-change estimates, mean [95% confidence interval]

Attribute	RPL		Latent Class Model			
			Class 1 <i>(Rational Producers)</i>		Class 2 <i>(Verification Averse Producers)</i>	
FS	-2.49	[-4.58, -0.21]	-2.81	[-4.35, -1.25]	0.51	[-4.84, 5.87]
ANT	3.22	[0.15, 6.04]	2.38	[0.49, 4.24]	-0.42	[-4.87, 3.96]
ENV	1.95	[-0.19, 4.21]	-0.25	[-1.86, 1.55]	8.72	[2.70, 16.22]
IMPC	-3.38	[-6.35, -0.29]	-1.37	[-3.93, 1.24]	-23.57	[-34.03, -15.25]
PRIV	-3.99	[-6.58, -1.56]	-1.75	[-3.50, -0.10]	-10.68	[-19.16, -3.52]

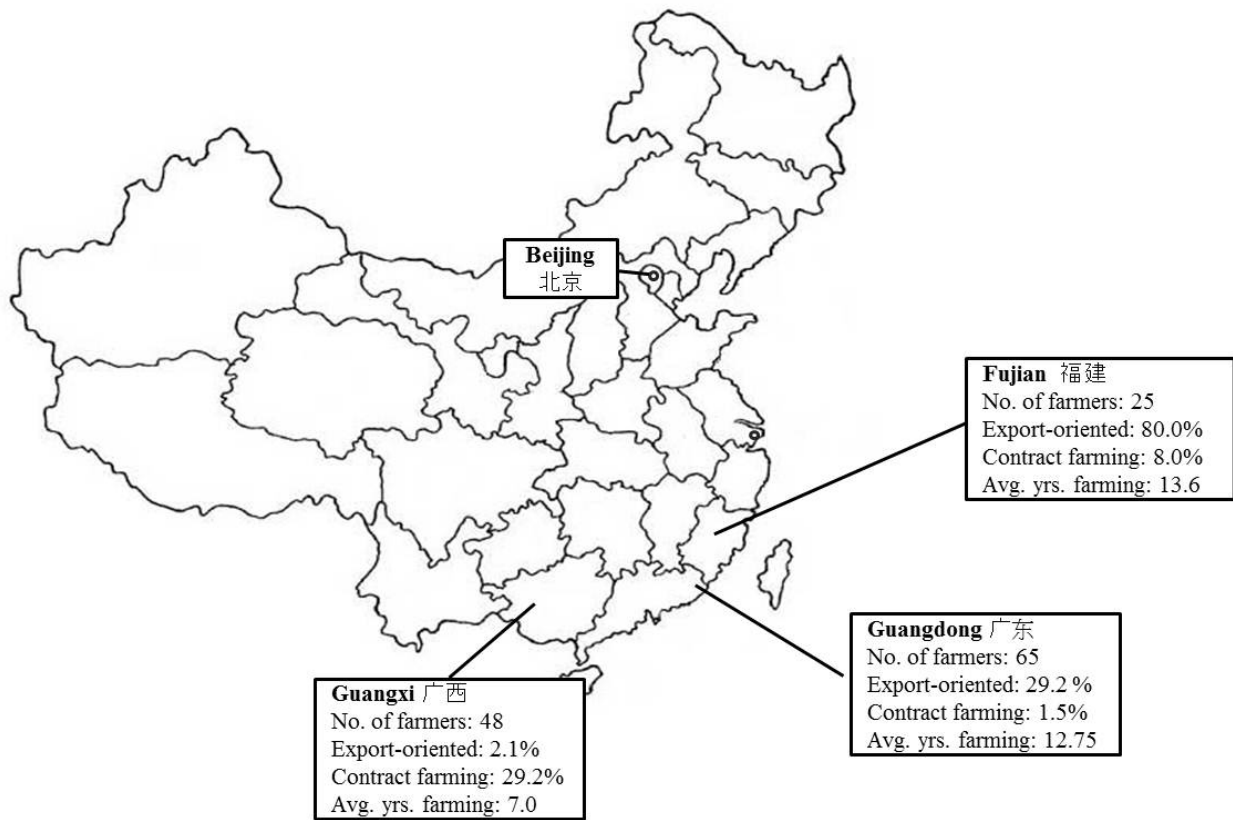


Figure 1. Sample Location and Distribution

	选项 A	选项 B	选项 C
价格	低于市场价格 15%	市场均价	我不养鱼了
食品安全	高标准	高标准	
抗生素使用	允许使用	允许使用	
环境可持续性	生态和谐	普通方法	
认证机构	中国政府	进口国（比如美国）政府	
我选择:	_____	_____	_____

Figure 2. Sample Choice Scenario

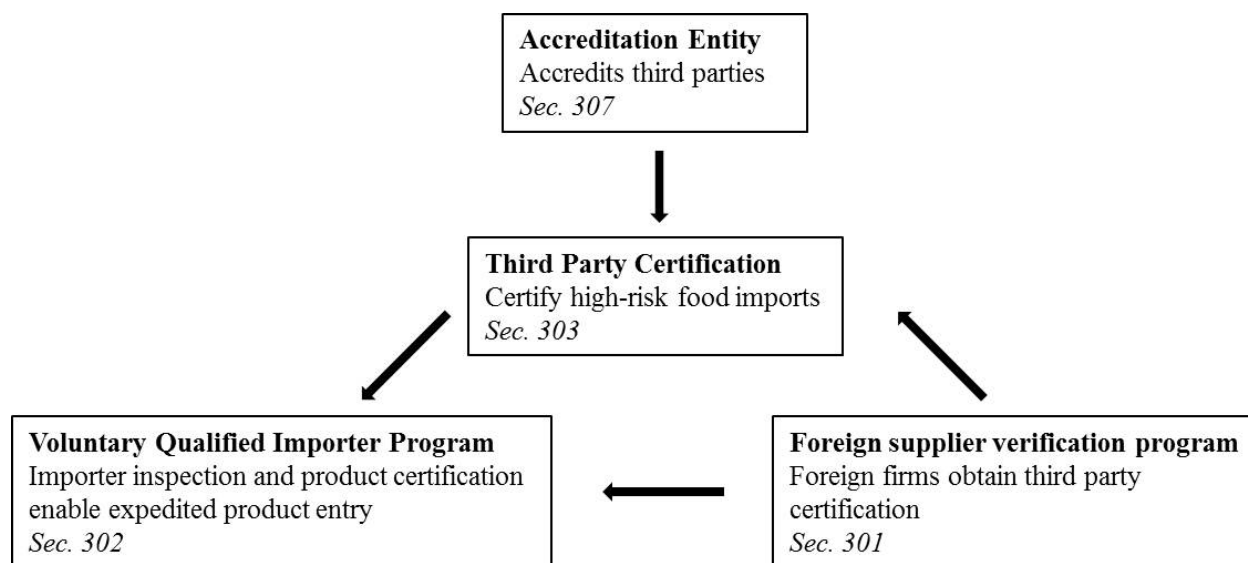


Figure 3. U.S. Food Safety Modernization Act Food Import Provisions (Torrence, 2012).