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THE IMPACT OF SQF CERTIFICATION ON U.S. AGRI-FOOD EXPORTS

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Abstract

Many studies show that product quality plays an important role in determining the direction of trade. This paper uses the Safe Quality Food (SQF) certification as a proxy variable for quality to investigate its effect on U.S. exports. The results of this study show that only the highest level of SQF quality certification has a positive effect on U.S. agri-food exports. The results of this paper have three implications. Firms in the U.S. may want to become certified at the highest level of private standards if they are serious about increasing their exports. On the government side, they should consider employing high public standards or follow other strategies to promote development of high private standards. On the consumer side, SQF may have a signaling effect. SQF represents high quality in terms of food safety, which means that many consumers who want to buy high quality goods may enjoy the high quality products without risks of uncertain information.
Key words: *Exports, Poisson Pseudo-Maximum Likelihood (PPML), Product quality, SQF (Safe Quality Food) certification*
JEL Codes: *F14, Q17, L16*

1. Introduction

As consumer income increases, the demand for high quality products increases since the consumption of high quality goods enhances consumers satisfaction (Juran, 1999).[1] On the other hand, low income consumers do not have the economic ability to buy high quality goods compared to high income consumers since high quality goods are expensive compared to low quality goods (Abbott, 1956).[2] By considering the positive relationship between high quality demand and income, low income countries may not be able to consume as many high quality products as the high income countries (Trienekens & Zuurbier, 2008).

Differences in quality demand might exist among countries since incomes differ by country, especially between developing and developed countries. Furthermore, the supply of product quality might be different among countries. For example, Han-u (Korean native cattle), which is the beef being feed in Korea, is considered premium beef compared to U.S. or Australian beef (Kim, Rhee, Ryu, Imm, & Koh, 2001). In this case, Korea imports relatively low quality beef, such as U.S. or Australia, rather than high quality beef, such as Japanese wagyu. Therefore, product quality might affect trade flows among countries. In this sense, there is need for a study that deals with the relationship between product quality and trade.

Based on our knowledge, only a few papers, such as Linder (1961) and Hallak (2006), deal with a theoretical model which studies the relationship between product quality and trade flows. Linder (1961) argues that high quality goods are traded among high income countries based on intra-industry trade theory.[3] Hallak (2006) suggests a theoretical framework of product quality and trade, and derives the empirical model from this theoretical framework. He focuses on the demand side without considering the supply side and shows that rich countries tend to import more from countries that produce high quality products.

Most empirical works related to Linder (1961) focus on intra-industry trade and try to test the Linder hypothesis: countries will trade more with one another if they have similar demand structures. To test the Linder hypothesis, many previous empirical studies used the gravity model and took into account a Linder term which measures the income dissimilarity between trading partners.[4] However, most papers do not consider the role of quality as a catalyst in trade. The role of quality in trade has likely increased over time since Gross Domestic Product (GDP) for most developing countries has increased. As GDP increases, the demand of high quality products increases, so product quality can serve as a catalyst for trade.

The empirical model by Hallak (2006) considers the role of quality as a determinant of bilateral trade. He uses export prices as a proxy variable for quality in a number of manufacturing industries. However, export prices are not a good proxy variable for quality in agri-food industries because agricultural export prices can easily be affected by non-tariff barriers such as Sanitary and Phytosanitary (SPS) and Maximum Residue Limits (MRLs). Moreover, the competitiveness of agri-food products is often derived from food safety considerations (Busch & Bain, 2004). Therefore, a private certification may be a better proxy variable for quality in agri-food products since a private certification deals with food processing and food safety.

Most empirical studies related with private certifications and trade find that a private certification for a firm in developing countries has a positive effect on exports (Kleemann, Abdulai, & Buss, 2014; Zheng, Muth, & Brophy, 2013). Zheng et al. (2013) use a gravity model with private certification as an independent variable. Kleemann et al. (2014) use an endogenous switching regression model to test the returns on investment for organic certification. According to the theoretical model specification by Hallak (2006), an interaction effect between private certifications and income needs to be included to test quality effects on exports.

This paper investigates how the number of Safe Quality Food (SQF) certified U.S. firms affects U.S. agri-food exports considering the recipient's GDP. Because of data limitations, this study divides agri-food products into 24 sectors using the Harmonized Tariff System (HTS) 2 classification for 2014. The U.S. is chosen because it is a developed country and major agricultural exporter.[5] The SQF certification is used because it is the dominant private certification in the U.S. and private certifications may be a better proxy for quality than export prices.[6] This paper examines whether developing countries have a tendency to consume higher quality goods as their income increases by dividing U.S export destinations between developed and developing countries.[7]

The findings from this paper contribute to empirical discussions about the impact of product quality on U.S. agri-food exports. The empirical contribution differs compared to other studies since this paper focuses on exports from a developed country rather than developing countries, and on the agri-food sector rather than the entire economy. The next section provides a brief literature review. A discussion of the theoretical model, empirical model, and data used is followed by the results and conclusions.

2. Literature Review

Linder (1961) first introduced the role of product quality as a determining factor for the direction of trade. According to his argument, richer countries use more high-quality goods than poorer countries. However, Linder (1961) focused on explaining trade among similarly endowed countries. For this reason, most empirical papers related to Linder (1961) attempt to determine trade among similar income countries. These studies did not focus on product quality and trade. The empirical tests of the Linder hypothesis are mixed. Greytak and Tuchinda (1990) find strong evidence of a Linder effect using U.S data. Francois and Kaplan (1996) use data from 36 countries and find some evidence of the Linder hypothesis in terms of intra-industry trade. However, Chow, Kellman, and Shachmurove (1994) use East Asia data and find little evidence of a Linder effect.

Hallak (2006) first suggested a theoretical model which explains product quality impacting the direction of trade. The key feature is in the demand system where the utility function consists of a differentiated good sector and a homogeneous good sector. The country expenditure function for variety (quality) is defined by a share function of variety on the total expenditure of a country. He assumes if this share function has a larger value, then consumers spend a larger share of their income on the high-quality good. Finally, Hallak (2006) derives the empirical model with the interaction effect between product quality and income. He uses the unit export price as a proxy for product quality.

As mentioned in Wooldridge (2010), export prices can be used as indicators of product quality. Yet, export prices are not the best proxy variable for product quality in all cases, especially in the agri-food sectors when export prices might not contain full product information. Agri-food quality is often determined by hidden processing (Vorst, 2000; Ziggers & Trienekens, 1999). Moreover, there are many non-tariff barriers such as sanitary and phytosanitary barriers in agricultural industries, which distort export prices. To effectively capture agri-food product quality, there is a need for an integrated way to capture technological, logistical, economical, and organizational aspects of quality (Trienekens & Zuurbier, 2008).

Governments and the private sector have developed new standards to capture food safety, quality regulation, and management such as Hazard Analysis Critical Control Points (HACCP), SQF, and GAP (Henson & Reardon, 2005). Government standards and regulations have been developed as consumers are increasingly sensitive to food safety and quality (Jaffee & Henson, 2004). These government standards often concern previously unknown hazards or food quality concerns, which are normally through HACCP, such as pathogens, biotoxins, and chemicals. Private standards for quality and safety normally have higher criteria compared to government standards and regulations (Caswell & Johnson, 1991; Henson & Reardon, 2005). In this sense, private standards give companies a chance to differentiate themselves and open opportunities in new markets (Caswell & Johnson, 1991). Cao and Prakash (2011) also show that a private certification can signal product quality, such as using ISO 9000 (even if it is not labeled). Busch & Bain (2004) argue that the competitiveness of agri-food products comes largely from food safety. So private certifications may be a better proxy variable for product quality in the agri-food sector compared to public certifications or export prices.

There are some studies which relate private certifications with trade. Henson, Masakure, and Cranfield (2011) determined the quantitative effect of GlobalGAP certification and returns to fresh produce export firms of developing countries. Kleemann et al. (2014) tested the relationship between the investment for organic and GlobalGAP certifications, and export market access at the firm level. Both of these papers use certification as a dummy variable in their model. Zheng et al. (2013) tested the relationship between private certifications (ISO 22000, GlobalGAP, BRC) and exports using the gravity model and the number of certifications as independent variables. These papers, which are related with private certification and exports, focus on developing countries rather than developed countries. They assume that private certifications can be a catalyst for exports of developing countries to developed countries because private certifications are generally required by major retailers from developed countries (e.g., U.S. and UK), and firms in developing countries in particular need to certify through these private standards in order to export their products easily to developed countries.[8]

Yet, there is a possibility that developed countries can export more because of private certifications. Three possible reasons exist. One reason is that GDP of developing countries has increased, which allows them to consume more high quality goods. Secondly, developed countries likely make more high quality products than developing countries, which give developed countries an advantage in exporting to developing countries. Third, developed countries may export more high quality products to other developed countries since developed countries have many consumers who want to buy high quality goods.

3. Private Food Safety and Quality Standards

Each country has its own agri-food products standards. However, the globalization of the agri-food system makes it difficult for each nation to regulate food safety and quality practices individually (Hatanaka, Bain, & Busch, 2005; Reardon & Berdegue, 2002; Sporleder & Goldsmith, 2001). To construct a more globalized agri-food system, many private food safety and quality standards have been developed since the 1990s. Private standards can contain a variety of quality attributes whereas public standards do not (Farina & Reardon, 2000; Reardon & Berdegue, 2002; Sporleder & Goldsmith, 2001). Furthermore, food retailers and manufacturers want to not only decrease food safety risk, but also increase consumer confidence in food safety in their products using private certifications (Trienekens & Zuurbier, 2008). Vellema and Boselie (2003) suggested three major objectives of these private certifications: enhancing standards of suppliers and evading product failure, providing correct information for product processes in case of food incidents, and removing overlapping audits of food suppliers or manufacturers.

There are many private certifications and each certification has different aspects based on their key elements, part of the chain involved, and the level of recognition. Table 1 represents several private certifications by these attributes. PrimusGFS and SQF are the dominant private certifications in North-America and SQF is the leading certifier in the U.S. ISO 22000, FSSC 22000, and SQF are more comprehensive certifications compared to others and they involve more aspects of the supply chain. So, this paper focuses on SQF certification, rather than other private certifications, since the analysis focuses on the U.S. market.

The SQF code is a process and product certification standard based on the HACCP food safety and quality management system. The HACCP focuses on food safety in that it deals with biological, chemical, and physical hazards in production processes to prevent unsafe foods. HACCP compliance is regulated by 21 Code of Federal Regulation (CFR) Part 120 (juice) and Part 123 (fish and fishery products) in the U.S. However, SQF emphasizes the control of food quality hazards as well as food safety.

Table 1. Examples of Private Quality and Safety Standards

Name	Key Elements	Part of Chain Involved	Level of Recognition
BRC	HACCP	Processing firms	Global, but more prominent in Europe
IFS	HACCP	Primary production, processing firms	German and French Market
GlobalGAP	HACCP	Primary production, processing firms	Global, but more prominent in Europe
ISO 22000	HACCP	Primary production, processing firms, retail	Global
PrimusGFS	HACCP, Food Safety Management System (FSMS), GAP, GMP	Primary production, processing firms	North America
FSSC 22000	HACCP, GAP, GMP (Good Manufacturing Practice)	Primary production, processing firms, retail	Global
SQF	HACCP, ISO 9000	Primary production, processing firms, retail	Global, but more prominent in U.S.

Source: Trienekens and Zuurbier (2008) p. 112.and the website for each certification

The SQF code is defined on the primary production, manufacture, processing, transport, storage, distribution or retailing of food products and food-contact packaging. SQF certification is divided into three levels. Level 1 is an entry for new and developing businesses and it covers the basic food elements (http://www.sqfi.com/). In Level 2, suppliers have implemented HACCP in addition to food safety basics. Level 2 meets the benchmark requirements of the Global Food Safety Standard (GFSI). For Level 3 suppliers have satisfied more than the GFSI benchmark requirements in addition to HACCP and food safety basics. Thus, Level 1 is the lowest food safety standard, Level 2 is the middle food safety standard, and the Level 3 is the highest food safety standard.

4. Data

The SQF Institute releases data on certified firms through their website (http://www.sqfi.com/), but it does not offer time-series data. Therefore, this study uses data for 2014. In order to match SQF data with U.S. export data by sector, we reconstruct the U.S. SQF data by 2-digit HTS (Harmonized Tariff Schedule) code (chapter 1 to chapter 24). Table 2 shows the numbers of SQF certified U.S. firms according to HTS sectors (1 to 24). The share of level 1 certified firms is very low compared to the other levels. This is reasonable since the U.S. enforces high agri-food standards (a HACCP standard is mandatory for the juice and fish and fishery products sectors in U.S.). The U.S Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS) regulates a high safety standard for meat, poultry, and processed egg products. The Food and Drug Administration (FDA) takes charge of food safety for other products. Thus, most U.S. firms focus less on the lower certification than HACCP since U.S. already has the same level of mandatory food safety regulations for many products. Chapters 16 to 24 have a higher number of certified firms compared to other chapters. These chapters encompass prepared foods: Beverages, Spirits, and Vinegar; Tobacco and Manufactured Tobacco Substitutes. Processed food companies seem to have more incentives for SQF certification compared to other agri-food sector companies.

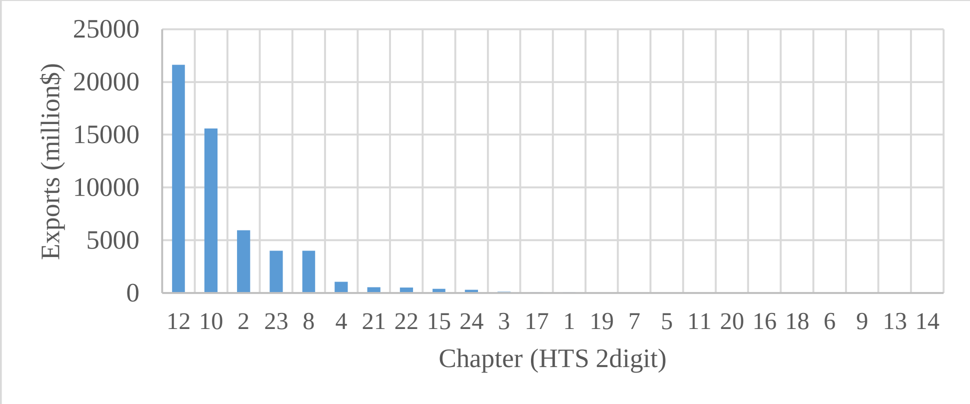
The data on agri-food exports of the U.S. came from the United States International Trade Commission (USITC). To match data between USITC and SQF, we use agri-food products at the 2-digit HTS level. According to the data, the U.S. exported agri-food products to 185 countries in 2014.

Among these trading partners, the Organization for Economic Co-operation and Development (OECD) countries accounted for 21 countries with a share of 29.95% in agri-food exports. The share of non-OECD countries was 70.05% in agri-food exports. This fact indicates that the average import for OECD countries are higher than non-OECD countries, and total imports of non-OECD countries is higher than OECD-countries. Figure 1 shows that most U.S. exports are accounted for two categories: 10 (Cereals) and 12 (Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruits; industrial or medicinal plants; straw and fodder).

Table 2. Numbers of SQF Certified U.S. Firms in 2014

Chapter	Description	Total SQF	Level 1	Level 2	Level 3
1	Live animals	727	18	517	192
2	Meat and edible meat offal	852	18	588	246
3	Fish and crustaceans, mollusks and other	943	18	680	245
4	Diary produce; bird eggs; natural honey;	2,959	21	981	1,957
5	Products of animal origin, not elsewhere	727	18	517	192
6	Live trees and other plants; bulb, roots	510	8	347	155
7	Edible vegetable and certain roots and	754	8	506	240
8	Edible fruit and nuts; peel of citrus fruit	1,399	8	908	483
9	Coffee, tea, mate and spices	.	.	.	.
10	Cereals	1,030	8	699	323
11	Products of the milling industry; malt;	496	8	336	152
12	Oil seeds and oleaginous fruits;	532	8	365	159
13	Lac; gums, resins and other vegetable	.	.	.	.
14	Vegetable plaiting materials; vegetable	.	.	.	.
15	Animal or vegetable fats an oil and their	692	8	469	215
16	Preparations of meat, of fish or of	2,288	13	1,342	933
17	Sugar and sugar confectionery	1,273	11	816	446
18	Cocoa and cocoa preparations	1,632	9	696	927
19	Preparations of cereals, flour, starch or	2,592	9	1,568	1,015
20	Preparations of vegetables, fruit, nuts or	2,140	9	1,339	792
21	Miscellaneous edible preparations	2,184	9	1,404	771
22	Beverages, spirits and vinegar	2,074	9	983	1,082
23	Residues and waste from the food	1,855	9	1,220	626
24	Tobacco and manufactured tobacco	965	9	659	297
Total		28,625	236	16,940	11,44

Source: Author’s calculation bases on SQF homepage database (www.sqfi.com



Source: author's calculation based on SQF website (www.sqfi.com)
Note: HTS chapter details are represented at table 2

Figure 1. U.S. Agri-food Exports by HTS Chapter

Data on distance, colony, contiguousness, and common language are gathered from Mayer and Zignago (2011). Bilateral distances between countries are measured by linear distances in kilometers between the most populated cities using the great circle formula. Dummy variables are used to identify colony, contiguousness, and common language. Data for GDP came from World Development Indicators of the World Bank.

5. Empirical Model and Estimation Method

The empirical model of this study is based on Hallak (2006). We modify Hallak's empirical model by adding fixed effects for each HTS chapter and a dummy variable for OECD countries:[9]

$$\text{Ln}(export_{ij}^{US}) = \alpha_0 + \alpha_i + \alpha_j + \beta_1 \cdot Ln\,(Distance_i) + \beta_2 \cdot Contig_i + \beta_3 \cdot Colony_i + \beta_4 \cdot ComLanguage_i + \beta_5 \cdot Ln(GDP_i) \cdot Ln\left(SQF_j^{us}\right) + \beta_6 OECD + \beta_7 OECD \cdot Ln(GDP_i) \cdot Ln(SQF_j^{US}) + \varepsilon_{ij} \quad (1)$$

where i is U.S. exporting partner country, j is HTS, α_i is fixed effects for importers, and α_j is fixed effects for HTS sectors. Distance measures country i's distance to the U.S., GDP is country i's GDP per capita, SQF is the number of certified firms in each U.S. agri-food sector, Contig is a dummy variable that is 1 if country i and the U.S are contiguous, Colony is a dummy variable that is 1 if country i and the U.S. have had a colonial link, ComLanguage is dummy variables measuring whether country i and the U.S have a common official language, and OECD is a dummy variable for OECD countries.

This study also uses another specification which differentiates the SQF level effect by dividing the number of SQF certified firms into the three levels.

$$\text{Ln}(export_{ij}^{US}) = \alpha_0 + \alpha_i + \alpha_j + \beta_1 \cdot Ln(Distance_i) + \beta_2 \cdot Contig_i + \quad (2)$$

$$\beta_3 \cdot Colony_i + \beta_4 \cdot ComLanguage_i + \beta_5 \cdot Ln(GDP_i) \cdot Ln(SQFlevel1_j^{us}) + \beta_6 \cdot Ln(GDP_i) \cdot Ln(SQFlevel2_j^{us}) + \beta_7 \cdot Ln(GDP_i) \cdot Ln(SQFlevel3_j^{us}) + \beta_8 \cdot OECD + \beta_9 OECD \cdot Ln(GDP_i) \cdot Ln(SQFlevel1_j^{US}) + \beta_{10} \cdot OECD \cdot Ln(GDP_i) \cdot Ln(SQFlevel2_j^{US}) + \beta_{11} \cdot OECD \cdot Ln(GDP_i) \cdot Ln(SQFlevel3_j^{US}) + \varepsilon_{ij}$$

The expected sign of the interaction effect between SQR and GDP is positive since product quality may have a key role in increasing exports. This paper also has other control variables such as distance, contiguity, colony, and common language. According to Montobbio and Sterzi (2013), Zheng et al. (2013), Khadaroo and Seetanah (2008); Patuelli, Linders, Metulini, and Griffith (2015), distance has a negative effect on exports since distance is a proxy variable for transport costs. The expected signs for contiguity and colony are mixed. Gómez-Herrera (2013) showed that contiguity has a positive or negative effect on exports. Montobbio and Sterzi (2013) find that colony has a positive effect on exports; however Zheng et al. (2013) find a negative effect on exports. The expected sign of common language is positive. Many previous studies showed that common language has a positive effect on exports (Gómez-Herrera, 2013; Montobbio & Sterzi, 2013; Picci, 2010; Stack, 2009; Zheng et al., 2013).

These model specifications show that equations (1) and (2) are very similar to the gravity model suggested by Burger, Van Oort, and Linders (2009) and Disdier and Marette (2010). They suggest the gravity model with time and country fixed effects instead of the exporting and importing country GDP. However, the gravity model specification with a log-linear form is criticized by Silva and Tenreyro (2006) for two reasons. The first reason is that there are often many zeros in trade data, and the log of zero is not defined under the log transformation. The second reason is the presence of heteroskedastic errors. Jensen’s inequality causes a biased elasticity estimation under heteroscedasticity (Silva & Tenreyro, 2006). To solve this problem, some studies add small positive values (for example, +1) to the zero observations, but this method has no theoretical background (Flowerdew & Aitkin, 1982). Some papers use a truncated regression method which causes a biased result since zero trade flows are rarely randomly distributed (Tran, Wilson, & Hite, 2013).

Silva and Tenreyro (2006) show that the Poisson pseudo-maximum likelihood (PPML) estimator gives consistent estimates. They find that PPML is robust to a wide range of heteroscedasticity since the robust variance-covariance matrix in the PPML estimator is easily estimated by using a multiplicative exponential model.[10] Furthermore, PPML provides a solution to the problem with zeros in trade data (Silva & Tenreyro, 2006). Silva and Tenreyro (2011) show that the PPML method performs powerfully for datasets with large numbers of zeros. Even though the Poisson model is commonly used in count data cases, Silva and Tenreyro (2006) argue that the PPML method is adaptable to the gravity model.

Shepherd (2013) also suggests that the Poisson estimator has many other desired characteristics. First, the Poisson estimator is consistent even if fixed effects are used. Second, the interpretation of the Poisson estimator is straightforward. The coefficient of the Poisson estimator can be interpreted as the simple OLS estimator. For these reasons, this paper uses the PPML estimation method for the above two models.

For a robustness check, this paper estimates models with GDP and GDP per capita. Moreover, this paper also checks the robustness by excluding European country data from U.S. bilateral trade since European countries have European based certifications, such as BRC. In other words, we check the robustness by excluding European countries since this paper does not contain Europe based private certifications. Robust standard errors are estimated with clustering or without clustering based on a multiplicative exponential model by Silva and Tenreyro (2006).

The PPML estimator may not exist when the maximization algorithm does not converge (Silva & Tenreyro, 2010). Even if the PPML estimator exists, there is a probability that this convergence is due to the number of zero observations (Silva & Tenreyro, 2010). The simple way to solve this problem is dropping problematic regressors because those regressors lead to perfect collinearity with other variables in the sub-sample. This paper identifies perfectly collinear explanatory variables in ordinary squares regression using a three step procedure based on Silva and Tenreyro (2010) to solve the non-existence of estimators. Step 1 is the estimation of $Ln(Export\ in\ U.S.)_i$ on all explanatory variables, x_{ij}, for observations with $(Export\ in\ U.S.)_i > 0$. Step 2 is the construction of a subset of explanatory variables ($\widetilde{x_i}$) from the regressors in Step 1. In step 3 the Poisson regression $(Export\ in\ U.S.)_i$ on ($\widetilde{x_i}$) is run.[11]

6. Results

The PPML estimation results of SQF certification effects on U.S. agri-food exports are represented in Table 3. Results are divided into two parts: models with the total number of SQF certified firms and models with the number of SQF certified firms by each level. Variables measuring contiguity are dropped in both models to solve the non-existence of the maximum likelihood estimation in the Poisson model (Silva & Tenreyro, 2010).[12] The variable contiguity is identified and dropped by the three-step method suggested by Silva and Tenreyro (2010).[13] These factors are covered through the models' fixed effects. According to the Pseudo log-likelihood and R-square values, there are no big differences between the two models in terms of efficiency since adding variables do not cause significant differences in log-likelihood values. The R-square for all models is higher than 0.94, thus the dependent variable is well explained by the independent variables in these models.[14]

The estimator of colony has negative signs for three of the four models. This is consistent with related literatures such as Montobbio and Sterzi (2013). Estimators for distance in models with the total number of SQF certified firms have a positive effect on exports. Montobbio and Sterzi (2013), Zheng et al. (2013), Khadaroo and Seetanah (2008); Patuelli et al. (2015) found a negative relationship between exports and distance. The estimator of common language has mixed signs depending on the model. Picci (2010) and Stack (2009) consistently found a positive effect of common language on exports. English as a common language might not be as important across the world because it is so commonly practiced, even in countries with a different official language.

Table 4 is presented for checking the robustness and choosing the way to calculate standard errors. It shows that there is no significant difference in the interaction effect estimators. Table 6 also shows that the robust standard errors without a cluster have the smallest robust standard errors. So, this paper estimates the model with the robust standard errors, which is suggested in Silva and Tenreyro (2006).

This paper investigates the effects that the number of SQF certified U.S. firms have on U.S. exports. Because of data limitations, this study divides agri-food products into 24 HTS 2 digit sectors and uses the year of 2014. Moreover, this paper examines whether developing countries have a tendency to consume higher quality goods as their incomes increase by dividing U.S export partner countries into developed and developing countries.

Table 3. The Estimation Results of SQF Certification Effect on U.S. Agri-Food Exports

	Models with total numbers of SQF		**Models with numbers of SQF by levels**	
$Ln(GDP_i) \cdot Ln(SQF_j^{us})$	0.022*** (0.0079)	0.021** (0.0104)	--	--
$Ln(GDP_i) \cdot Ln(SQFlevel1_j^{us})$	--	--	-0.015 (0.0114)	-0.014 (0.0147)
$Ln(GDP_i) \cdot Ln(SQFlevel2_j^{us})$	--	--	-0.036 (0.0224)	-0.040 (0.0278)
$Ln(GDP_i) \cdot Ln(SQFlevel3_j^{us})$	--	--	0.042*** (0.0167)	0.040** (0.0179)
$Ln(Distance_i)$	0.335 (0.2281)	0.284* (0.1635)	-0.399 (0.3269)	-0.008 (0.1883)
$Contig_i$	Dropped	Dropped	Dropped	Dropped
$Colony_i$	-0.580** (0.2703)	-0.577** (0.0531)	-0.298 (0.3872)	0.470*** (0.0528)
$ComLanguage_i$	0.076 (0.2169)	0.109 (0.0934)	-0.631** (0.3123)	0.246*** (0.0826)
OECD	--	-0.328 (0.2087)	--	0.352 (0.2548)
$OECD \cdot Ln(GDP_i) \cdot Ln(SQF_j^{US})$	--	0.001 (0.0033)	--	--
$OECD \cdot Ln(GDP_i) \cdot Ln(SQFlevel1_j^{us})$	--	--	--	-0.0003 (0.0041)
$OECD \cdot Ln(GDP_i) \cdot Ln(SQFlevel2_j^{US})$	--	--	--	-0.0063 (0.0079)
$OECD \cdot Ln(GDP_i) \cdot Ln(SQFlevel3_j^{US})$	--	--	--	0.0085 (0.0058)
constant	-1.829 (2.4454)	-1.354 (1.8283)	6.263* (3.5679)	2.8270 (2.4895)
Pseudo log-likelihood	-634.452	-634.450	-634.336	-634.309
R-square	0.941	0.941	0.942	0.942
Observations	308	308	308	308
Number of parameters	147	149	148	152
Dropped fixed effects dummies	14	14	15	15

Note: ***, **, * Significant at the 1%, 5%, and 10% level, respectively. ( ) is robust standard error

Table 4. The Estimation Results for Robustness and Robustness Standard Errors

Data	Variable	Without Cluster	Cluster with countries	Cluster with products
Whole Data	Log of the interaction effect between SQF and GDP per capita	0.022*** (0.0079)	0.022*** (0.0081)	0.022*** (0.0086)
	Log of the interaction effect between SQF and GDP	0.022*** (0.0079)	0.022*** (0.0081)	0.022*** (0.0086)
Without Euro	Log of the interaction effect between SQF and GDP per capita	0.019* (0.0110)	0.019 (0.0123)	0.019** (0.0097)
	Log of the interaction effect between SQF and GDP	0.019* (0.0110)	0.019 (0.0123)	0.019** (0.0097)

Note: ***, **, * Significant at the 1%, 5%, and 10% level, respectively. ( ) is robustness standard error

Table 5. The Median GDP per Capita by Income Levels of Country

World Bank Criteria for countries		GDP per capita : median	Ln(GDP per capita) : median
Low-income	$1,045 or less	$666.2918	6.501728
Lower-middle-income	$1,046 to $4,125	$2021.738	7.611713
Upper-middle-income	$4,126 to $12,735	$7402.392	8.909559
Upper-income	$12,736 or more	$23962.58	10.08425

Source: Author's calculation based on 2014 GDP per capita dataset

Models with the total number of SQF certified firms show that product quality (SQF certifications) has a positive effect on U.S. exports (see columns 1 & 2 in table 3). This paper categorized 4 different income groups based on World Bank definitions: Low-income economies ($1,045 or less per capita GDP), Lower-middle-income economies ($1,046 to $4,125), Upper-middle-income economies ($4,126 to $12,735), and High-income economies ($12,736 or more).[15] In order to interpret the interaction effect between number of SQF certified firms and GDP per capita, a country with an income near the median is chosen for each group, and the coefficient is interpreted using that median income. For example, a 10% increase in SQF certified firms in the U.S. is associated with 1.43% (column 1) and 1.37% (column 2) change in exports considering the median income country among low-income economies.[16] This result is consistent with the theory of Linder (1961) and Hallak (2006), and the empirical work of Zheng et al. (2013).

The empirical results of models with the number of SQF certified firms by levels are shown in table 3. The results show that SQF level 1 and level 2 do not have a significant effect on U.S. exports at the 10% level.[17] However, the SQF level 3 certification has a positive effect on U.S. exports at the 5% significance level. To be specific, a 10% increase in the number of level 3 SQF certified firms in the U.S. is associated with a 2.73% (column 3) and 2.6% (column 4) change in exports considering the median income country among low-income economies.[18] These are plausible results since HACCP standards are mandatory in many U.S. agri-food sectors. Moreover, the FDA and FSIS also regulate food safety standards in the U.S. Thus, only the highest level of certification has a positive effect on exports. Most empirical studies that analyze private certification and trade flows focus on developing countries which can satisfy the high food standards in developed countries using a private certification. This paper looks at certification from a different aspect since it looks at how a developed country, the U.S., can increase agri-food exports using the highest level of SQF certification.

The coefficients for the interaction between GDP and the SQF level 3 in columns 3 and 4 are much larger than the coefficients in models with the total number of SQF firms by levels. Considering quality as one of the most important factors in purchasing products, a new food quality standard, which is a higher standard than SQF, might be beneficial to increase exports. Furthermore, a food safety standard may have a signaling role. So, consumers can enjoy high quality products without risks or uncertain information using a food safety standard.

According to Linder (1961), high-quality products dominate trade among high-income countries. However, GDPs in developing countries have increased in recent decades, giving many consumers in developing countries the wherewithal to consume high quality goods. This study hypothesizes that there is no difference in quality effect between developing and developed countries in terms of trade. In both models, the coefficient dummies for OECD countries are not significant at the 10% level.[19] Based on increasing world GDP, the demand for high-quality agri-food products will continue to increase in developing and developed countries. Regional Trade Agreements (RTAs) also will affect the increasing trends for high quality demand since reductions in tariffs lead to upgrading the quality in the domestic market (Amiti & Khandelwal, 2013).[20] Therefore, quality competition will play an important role in future competition within the agri-food industry.

7. Conclusions

This paper investigates whether the number of SQF certified U.S. firms affect U.S. exports. The results of this paper show that SQF certification has a positive effect on U.S. agri-food exports conditioned on recipients' GDP. This result makes sense since many consumers want to buy high quality goods based on increased incomes. In this study, only the level 3 (highest level) certification has a positive effect on U.S. agri-food exports. This is a reasonable result since developed countries like the U.S. have high standards (such as HACCP) for all products, so lower levels of certification do not positively affect exports.

Our results also show that there is no significant difference in quality effects between developing countries and developed countries in the sense of product quality demand. These results imply that firms in the agri-food sector should focus on quality competition in order to increase exports. Demand for high quality goods will certainly increase in developed and developing countries over time as incomes continue to grow. It seems that only high levels of certification increase agri-food exports (at least for the U.S.).

The results of this paper have implications for firms, governments, and consumers. Firms in the U.S. might consider certification with the highest level of private standards if their purpose is to increase their exports (since SQF certification has a positive effect on U.S. agri-food exports). Governments also have incentives to employ high public standards or promote developing high private standards compared to existing ones. This is because there is a possibility that firms can increase their exports due to high public or private standards.

Considering that world GDP (per capita) has been increasing and should increase in the future, the possibility of increasing exports will improve by uplifting public standards or promoting higher private standards. On the consumers' side, food quality standard is beneficial since food quality standards may have a signaling effect. In other words, many consumers who want to buy high quality goods enjoy the high quality products without risks of uncertain information.

This paper has a limitation in that data on SQF certification is not offered on a yearly basis, so this study uses only cross section data for 2014. Cross section data have a problem with omitted variable bias. Therefore, there is a need to update the dataset each year to solve this omitted variable bias. This study also has a potential problem with endogeneity in the quality variable. An instrumental variable is needed to solve the endogeneity problem. However, there is no proper instrumental variable for quality (to our knowledge). An alternative is to solve this endogeneity using the lagged variable as the instrumental variable. Therefore, updating the data will also be helpful to solve the potential endogeneity. Another problem is that non-tariff barriers of importing countries are not considered. Swinnen, Vandemoortele, Deconinck, and Vandeplas (2015) show that some public standards have a similar role to non-tariff barriers. However, this paper could not take their approach since there is a problem separating public standards and other non-tariff barriers because only one year is included. If we find a way of measuring public standards and other non-tariff barriers, then we can consider public standards of importing countries. Further research also should consider improving product quality using other factors which are not connected with food safety and food processing. If such factors are found, then we can understand more about quality competition.

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[1] It is assumed in this study that food products are normal or luxury goods.

[2] According to Abbott (1956), differences in the quantity of desired ingredients and attributes account for differences in product quality. Using more desired ingredients and attributes in a production process increases costs on the supply side

[3] Intra-industry trade occurs when there is two-way trade of products within the same industry.

[4] The basic gravity model in international trade predicts bilateral trade flows (exports or imports) using economic sizes and distance between the two countries.

[5] This paper focuses on exports of developed countries for two reasons. First, the Linder hypothesis focused on trade among high-income countries. Second, most empirical studies which are related to private certifications and trade focus on developing countries.

[6] This paper assumes that sector A's products have higher quality than sector B's products if sector A has more certified firms than sector B. Zheng et al. (2013) deal with private certification effects on the exports in a similar way.

[7] Normally, high quality products are consumed by high income people. For this reason, most studies for quality and trade focus on high income countries. However, we think that low income countries are also important importers for high quality products since GDP is increasing rapidly in some low income countries.

[8] For example, SQF certifications are supported by Costco, CVS pharmacy, Kellogg

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Company, Sam's Club, Target, and Walmart. It is a business to business standard.

[9] This paper adds the intercept and slope dummy for OECD countries. We assume that the quality effect on the trade is not different between OECD or non-OECD countries. Instead the demand for the high quality product depends on income. Because GDP for developing countries has an increasing trend, our assumption means that the quality demand in non-OECD countries is moving toward the quality demand in OECD countries.

[10] The general form of a multiplicative exponential model is represented by Silva and Tenreyo (2006).

$$y_i = \exp(x_i\beta) + \varepsilon_i$$

This is expressed as the following equation.

$$y_i = \exp(x_i\beta)\eta_i$$

Taking the logarithm of both sides.

$$\ln(y_i) = x_i\beta + ln\eta_i$$

[11] Statistical software packages such as STATA automatically drop the perfectly collinearity variables using these three steps.

[12] The contiguity variable may be perfectly collinear with the fixed effect dummies.

[13] See the section of Empirical Model and Estimation Method

[14] We do not show the fixed effects estimator because of page limitations. This paper reports the number of parameters for each equation. These numbers are different by equation since some regressors are dropped to obtain parameter estimates.

[15] See table 5.

[16] The coefficients for the interaction effect multiplied by the median income of low income countries are 0.143 (=0.022*6.501728) and 0.137 (=0.021*6.501728).

[17] The number of level 1 certified firms is very small.

[18] The coefficients for the interaction effect multiplied by the median income of low income countries are 0.273 (=0.042*6.501728) and 0.260 (=0.040*6.501728).

[19] This paper does not consider trade barriers of partner countries. Most OECD countries have higher trade barriers compared to non-OECD countries as measured by Sanitary and Phytosanitary (SPS) notifications in WTO. It is possible that high trade barriers of OECD countries cause lower imports from the U.S. But, the U.S. is an OECD country and has high food quality standards, which might help the U.S. overcome trade barriers of other OECD countries. So, this result might support the hypothesis of this paper.

[20] The major liberalization that comes from RTAs is the reduction of tariffs.