International Diffusion of Food Safety Standards:

The Role of Domestic Certifiers and International Trade

Rezgar Mohammed

Ph.D. Student, Department of Agricultural and Applied Economics, Texas Tech University, 124 Agricultural Sciences Building, Lubbock, TX, USA 79409-2132. Phone: (517) 580-9172; e-mail: rezgar.mohammed@ttu.edu.

Yuqing Zheng, Ph.D.*

Assistant Professor, Department of Agricultural Economics, University of Kentucky, 317 Charles E. Barnhart Building, Lexington, KY, USA 40546-0276. Phone: (859) 257-8842; fax: (859) 257-7290; e-mail: yuqing.zheng@uky.edu. *Corresponding author.

Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2016 Annual Meeting, San Antonio, Texas, February 6-9, 2016

Abstract: We examined the cross-national adoption of six major private food safety standards, focusing on the role of certifiers and international trade. Results based on a negative binomial model show that the number of domestic certification bodies, total food exports, and the proportion of food exports to North America had a positive effect on a country's adoption of food safety standards. We also found that distance creates product differentiation for standards and therefore disadvantages developing countries in Africa and Asia for adopting standards. Providing these countries with better access to certifiers can alleviate this geographic disadvantage.

Key words: adoption, certification bodies, food exports, food safety standard, third-party certification

JEL codes: Q13, Q17, Q18

1. INTRODUCTION

1.1 Motivation

Food safety breaches can cause massive economic losses to producers, sickness to consumers, diminished consumer confidence in the safety of food supply, and wide-spread social distress. In 2014 alone, the United States had 94 recalls of meat and poultry and 491 recalls of other food products, up from 53 and 225 in 2005 respectively, exposing our weakness in food safety net.[1] Private food safety certification has emerged as a prominent and influential regulatory mechanism in both the private (e.g., requirement imposed on suppliers by major retailers) and public spheres (e.g., the new Food Safety Modernization Act) of the contemporary agri-food system.

The certification process starts with a producer (farmer or food manufacturer) choosing a food safety standard, out of their own interest or as a requirement of government or buyers (e.g., retailers or importers). The major private food safety standards recognized by the Global Food Safety Initiative, an important international benchmarking institution, are British Retail Consortium Food (BRC), Food Safety System Certification (FSSC 22000), Global Good Agricultural Practices (GlobalGAP), International Featured Standards Foods (IFS), International Organization for Standardization 22000 (ISO 22000), PrimusGFS, and Safe Quality Food (SQF). After deciding on the standard, the producer needs to choose an accredited third-party certifier (also known as certification body) under that standard that will conduct an audit. Certification bodies are firms that offer independent verification that the producers meet the requirements of a certain standard.

The aim of this article is to examine cross-national adoption of private food safety standards, focusing on the role of certifiers and international trade. The cost of obtaining certification largely consists of auditing fees (usually billed by hour), preparation and compliance cost, and auditors' travel expenses. Although normally the smallest cost of the three, travel cost can be cumbersome especially to developing countries. For example, suppliers in developing countries who are seeking certification sometimes have to pay for travel and living expenses of certifiers from industrialized nations (Barrett et al., 2002). In Ghana, most growers

[1] Source: United States Department of Agriculture (USDA, 2015), and the Food and Drug Administration FDA (FDA, 2015).

seeking third-party food safety certification are required to bring in certifiers from Europe (Hatanaka et al., 2005). As mentioned by Barrett et al. (2002), the likelihood of adopting certificates might increase with the existence of local auditor. In fact, Herzfeld et al. (2011) showed that the existence of domestic certification body had a significant impact on the cross-national adoption of both GlobalGAP and BRC certificates. In this article, we aim to further quantify how the number of domestic certification bodies and the distance to standard holder's country affect a country's adoption of the major food safety standards.

Though there are many studies empirically examining how food safety requirements (e.g., sanitary measures and maximum residual limit) can affect food imports (e.g., Otsuki et al., 2001a, 2001b; Jongwanich, 2009; and Peterson et al., 2013), only two studies examined the relationship between food safety certification and food trade. Both studies focus on how certification affects food exports. Henson et al. (2010) found that GlobalGAP certification had a positive effect on firm export sales performance for the fresh produce industry in sub-Saharan Africa countries. Zheng et al. (2013) found that China's aggregate food exports to the United States were positively associated with the number of BRC, GlobalGAP, or ISO 22000 certified sites in China. We will address the important, but yet unanswered, question of whether international relationship of food trade affects the adoption of a country's food safety certification. In particular because food safety certification requirement has been imposed by developed countries on suppliers in developing countries, we hypothesize that a country's food exports to the European Union and/or North America would positively affect the adoption of food safety certification.

Our study builds on Herzfeld et al.'s (2011) study of cross-national adoption of GlobalGAP and BRC standards but extends the analysis in three significant ways. First, our sample size is much larger by covering all the aforementioned food safety standards except IFS. Second, we use the number of domestic certification bodies rather than the presence of a domestic certification body for a standard, allowing us to quantify the impact of adding an additional certification body. Third, by including a country's food exports to each continent, we specifically model the impact of trade relation on the diffusion of food safety standards. We found that an increase of one domestic certification body increased the number certified sites by 4.5, highlighting the importance of providing easy access to trained auditors in developing

countries. Furthermore, a country's adoption of certification is negatively related to the distance to standard holder's country, and positively affected by total food exports and by the proportion of food exported to North America.

1.2 Adoption of Standards by Country

We include in Table 1 the top ten countries for each standard (except IFS which we do not have data for), by the number of certified sites for the year of 2013. Note that because a producer can have multiple sites certified to the same standard or different standards, adding the numbers up for a country does not yield the number of certified producers.

Several patterns emerge from the data. First, standards have very different geographic coverage, with some primarily being adopted by own and surrounding countries while some others enjoying much wider international adoption. For examples, PrimusGFS and SQF are U.S. based standards. Almost all of the top three countries adopting the two standards are in North America. Similarly, United Kingdom is the top country adopting BRC standard, which is a British standard. The other three standards are also Europe based standards as the headquarters of FSSC 22000, GlobalGAP, and ISO 22000 are located in Netherlands, France, and Switzerland.[2] However, FSSC 22000 and ISO 22000 are widely adopted by countries outside Europe such as the United States, China, and India. Second, producers within the same country can have a disperse taste for standard. This is evident by observing many countries, such as the United States, China, India, Poland, Japan, appear in the top ten lists for multiple standards in the table.

The rest of the paper is organized as follows. Sections 2 and 3 describe the model and data we used respectively. Section 4 presents the results and section 5 contains concluding remarks and discussion.

2. A MODEL OF CERTIFICATION ADOPTION

Because our dependent variable is count data that unlikely have unequal mean and variance (Table 1 shows a mean of 162.44 and a standard deviation of 479.64), we use a negative binomial model in the follow specification rather than a Poisson model:

(1) $$E(y_{ic}|x_{ic}) = \exp(x'\beta + e_{ic})$$

[2] IFS is a Germany based standard.

where *i* (i = 1, …, 6) indexing the six standards in Table 1), *c* indexes country, and y_{ic} is the number of sites in country *c* certified to standard *i*, $x'\beta$ are explanatory variables to be defined, and e_{ic} is the error term. The probability mass function is

$$(2) \qquad \Pr(Y_{ic} = y_{ic}|x_{ic}, \alpha) \frac{\Gamma(\alpha^{-1}+y_{ic})}{\Gamma(\alpha^{-1})y_{ic}!} \left(\frac{\alpha^{-1}}{\alpha^{-1}+\exp(x'\beta)}\right)^{\alpha^{-1}} \left(\frac{\exp(x'\beta)}{\alpha^{-1}+\exp(x'\beta)}\right)^{y_{ic}}$$

where α, the overdispersion parameter to be estimated, serves as a formal test of overdispersion in the data. The conditional variance is

$$(3) \qquad \mathrm{Var}(y_{ic}|x_{ic}) = \exp(x'\beta)\,(1 + \alpha \exp(x'\beta)).$$

We specify a country's adoption of certification in the following manner where β_i^s are parameters:

$$(4) \qquad x'\beta = \beta_0 + \beta_1 CB_{ic} + \beta_2 Dist_{ic} + \beta_3 GDP_c + \beta_4 Exp\_EU_c + \beta_5 Exp\_NA_c + \beta_6 Exp\_SA_c +$$
$$\beta_7 Exp\_AS_c + \beta_8 Exp\_AF_c + \beta_9 Exp\_wld_c + \beta_{10} Agland_c + \beta_{11} Language_{ic} +$$
$$\beta_{12} Colony_{ic} + \beta_{13} Contig_{ic} + \beta_{14} Landlocked_{ic} + \beta_{15} Dummy_{ic}.$$

We included three sets of explanatory variables in the model. The first set is three core variables we hypothesize to determine the adoption of certification: the number of certification bodies in country *c* that are accredited to certify to standard *i* (CB_{ic}), the capital-to-capital distance between country *c* and the home country of standard *i* ($Dist_{ic}$), and the per capita gross domestic product of country *c* (GDP_c). The number of certification bodies is counted at the headquarters level. For example, two BRC accredited certification body with five and twenty five respective offices in India would count as two in our data for India for BRC adoption. Most multi-national certification bodies have multiple offices in a country, some even reaching over 100 offices (not all offices offer food safety certifications though). Counting at the headquarters level makes the data less noisy to the above complications.

The second set of variables include the six trade related variables, Exp_EU, Exp_NA, Exp_AS, Exp_SA, Exp_AF, and Exp_wld. The variable Exp_wld is a country's total food exports ($) to the world. The other five variables represent the proportions of a country's food exports to European Union, North America, South America, Asia, and Africa. These six

variables combined, capture the impacts of the food export size as well as the destination region on certification adoption.

Third, building on the two most related studies, Neumayer and Perkins's (2005) work on the cross-national adoption of ISO 9000 certification, and Herzfeld et al.'s (2011) study of cross-national adoption of GlobalGAP and BRC standards, we include a country's agricultural land size (*Agland*), a dummy variable indicating whether sharing a common language with the standard holder's country, a dummy variable for being colonized by the standard holder's country, a dummy variable for sharing border with the standard holder's country, and another dummy variable for being a landlocked country. These variables intend to control for a country's scope of agriculture (land endowment), closeness, and adjacency with the standard holder's country.

We have data for 131 countries for the six standards. To increase the predictive power, we pooled the country over the standards so we have a total sample size of 786 (in the sense of panel data, country is cross sectional observation while standard is treated as time here). The variable $\boldsymbol{Dummy_{ic}}$ in equation (1) is a vector of dummy variables controlling for standard and the continent where country *i* is located.

3. DATA DESCRIPTION

We combined data from different sources. Table 2 presents the definitions and summary statistics for the variables used. We present the data for certified sites and certification bodies by each standard and present the rest data at the aggregate level to preserve space. Data are for the year of 2013. For the dependent variable, we collected the data from personal communications with GlobalGAP, and ISO Survey of Certifications 2013, and from standard holders' Web sites for the other four standards. We obtained the number of accredited certification bodies in each country mainly from the standard holders' Web sites augmented by our own Web search.

Table 2 shows that on average, GlobalGAP was the most adopted standard, followed by a distant second of ISO 22000 and third of BRC. SQF were the least adopted standard. Note that although the six standards cover all food products, their coverages at the production stage are different. GlobalGAP is primarily a farming standard that does not cover food manufacturing or

processing stage. BRC, FSSC 22000, and ISO 22000 are standards for food manufacturing and processing **(**see the Global Food Safety Initiative, 2015). PrimusGFS and SQF cover both farming and food manufacturing/processing. Therefore, the rank of farming standards in terms of adoption is GlobalGAP, PrimusGFS, and SQF. The rank of manufacturing and processing standards is ISO 22000, BRC, PrimusGFS, FSSC 22000, and SQF.

Data on GDP and agricultural land came from the World Bank's (2013) World Development Indicators. Data on food exports were obtained from the United Nations Commodity Trade Statistics Database, known as UN Comtrade. UN Comtrade contains detailed import and export statistics reported by statistical authorities in approximately 200 countries or areas. The food exports are exports reported by the exporting country under the Standard International Trade Classification (as reported) code zero, which is food and live animals. This code covers live animals, meat, dairy products and eggs, seafood, cereals, vegetables and fruits, sugar products, coffee and tea, and animal feeds, and does not include beverages or tobacco products. Finally, data on distance, colony, contiguousness, common language, and landlocked status were from Mayer and Zignago (2011, also known as the CEPII GeoDist data). After merging the data, we have observations for 131 countries for all the six standards.

4. RESULTS

4.1 Main Specification

We estimated the negative binomial model using STATA version 13. Table 3 displays the results of our model. We estimated three variations of the model by adding one set of variables at a time, where all specifications include the dummy variables controlling for standards and continents. In column (1), we present a base specification that includes our main three variables of interest (certification bodies, distance, and GDP). The effects are all statistically significant (at the 5% default level or better) with the expected signs. The number of domestic certification bodies and per capita GDP both have a positive effect on the adoption of food safety certification. On the other hand, we found that the effect of distance to standard has a negative impact on certification adoption. That is, countries prefer adopting standards that are based in nearby countries. This result indicates that geography helps create product differentiations and

provides market power to the standard holder (e.g., PrimusGFS and SQF's success in North America and GlobalGAP's success in Europe).

In column (2) we added the set of six trade variables. The three core variables remain statistically significant. We found total food exports had a positive impact on certification adoption. Such result shows higher food exports create larger demand for food safety certification, very likely due to importers' requirements and/or exporters' strategy of using certification to create competitive advantage. As to the export destinations, this specification show that higher proportions of food exports to North America or to Asia increased the demand for certification. Surprisingly, the proportion of food exports to Europe was not found statistically significant. This is probably because some U.S. retailers (e.g., Wal-Mart in 2008) were the first to require that all private brand suppliers become certified to one of the major food safety standards. In addition, the new Food Safety Modernization Act signed into law in 2011 provides the U.S. Food and Drug Administration the authority to require that high-risk imported foods be accompanied by a credible food safety certification. Such policy also helps explain the significant impact of export proportion to North America.

Column (3) includes the additional set of control variables such as agricultural land size and colonial relationship. Again, the three core variables remain robust. The effect of export proportion to Asia becomes statistically insignificant in this case. We found that agricultural land size had a positive impact on certification adoption, which is consistent with our expectation. Sharing border with a standard holder increased a country's demand for that standard. Being a landlocked country has less demand for certification. Language or colonial relationships were not found statistically significant. One reason for the insignificant language effect is that many standards have versions for multiple languages.

The pseudo R^2 gradually increased from 0.08 for column (1) to 0.11 for column (3), which is reasonable for cross sectional data. The improvement in the log likelihood from column (1) to column (2) is significant while the improvement from column (2) to column (3) is much smaller, highlighting the importance of including the trade related variables. Table 3 also reports the estimated value for α, the overdispersion parameter, which is larger than one in all specifications. The null hypothesis of equidispersion, that is equal conditional mean and

variance, is conclusively rejected because α is statistically significant. Such result justifies the use of negative binomial model over the Poisson model.

Overall, a comparison of the three specifications shows that the main factors affecting a country's adoption of food safety certifications are availability of domestic certification bodies, distance to standard holder's country, degree of development measured by GDP and land endowment, total food export value, and the weight of trade to North America. Column (4) reports the marginal effects based on the estimates in column (3), the full estimates. We found that that an increase of one domestic certification body increased the number certified sites by 4.5; an increase of 1,000 km in the distance to standard holder reduced 1.7 certified sites; a $1,000 increase in per capita GDP increased 0.2 certified sites; a $1 million increase in total food exports increased 0.5 certified sites; a one percentage point increase in the food export proportion to North America increased 0.8 certified sites; an increase of one million square kilometers in agricultural land increased 7.6 certified sites; and sharing border with a standard holder increased 37.3 certified sites.

4.2 Some Robustness Check

We further estimated several subsamples to examine the robustness of our results to different combinations of the standards. In the first robustness check, we excluded GlobalGAP for two reasons. First, the scale of its adoption is about ten times that for the other standards (Tables 1 and 2). So it is possible that the results are largely driven by the pattern of GlobalGAP adoption. Second, GlobalGAP is the only standard that exclusively focuses on farming. All the other six standards can be applied to food manufacturing and processing. Column (1) of Table 4 reports the results for this specification. We found that when GlobalGAP was excluded, the results changed little from the base specification (column 3 in Table 3). The only noticeable changes are that the proportion of food exports to South America becomes statistically significant now and colonial relationship turns significant from at the 10% to the 5% level. Both effects are positive.

In the second robustness check, we broke the sample into farming standards (GlobalGAP, PrimusGFS, and SQF) versus exclusive manufacturing/processing standards (BRC, FSSC 22000, and ISO 22000) to investigate whether the adoption process is different between farming and manufacturing/processing standards. The last two columns of Table 4 report the findings. For

farming standards, the results changed quite a bit from the full sample estimates. The factors remaining statistically significant are certification bodies, GDP, and proportion of food exports to North America (at the 10% for this variable). It is interesting to note that total food exports become statistically insignificant in this case. One possible reason is that the total food exports include both raw agricultural products as well as processed products, with the latter value generally being higher than the former one. As to the results for the exclusive manufacturing/processing standards, both the distance and GDP effects turn statistically insignificant, while the rest of the results largely are similar to the full sample estimates.

5. CONCLUSION

We examined the cross-national adoption of private food safety standards, focusing on the role of certifiers and international trade. Applying a negative binomial model to pooled cross-sectional data for 131 countries over six major standards, we obtained several results that might have important policy and marketing implications. First, we found that distance to the standard holder will negatively affect the number of certified sites in a country to that standard. In other words, distance created product differentiation for standards. Meanwhile, per capita GDP has a positive impact on a country's certification adoption. The entire major private food safety standards are either based in the United States or Europe. Developing countries in Africa and Asia clearly are at a disadvantage in adopting food safety standards because they are poorer (less GDP) and are further away from the standard holders (likely face with a higher certification cost).

From the perspectives of development and food safety, what can we do to accelerate the adoption of food safety certification in developing countries (given that there is not much we can change about GDP)? One policy recommendation is to create a competing food safety standard that is based in a developing country in Africa and/or Asia. However, given that there are already a handful of established standards in the market, establishing a new competing standard seems difficult. A better, more cost effective alternative is to provide developing countries with better access to the existing standards. We found that the number of domestic certification bodies had a positive and very robust effect on a country's adoption of food safety standards. In fact, the

marginal effects show that an increase of one domestic certification body increased the number certified sites by 4.5, which is equivalent to the effect of a $18,000 increase in per capita (calculated as 4.459 divided by 0.248 in Table 3). Training

Second, we found total food exports had a positive impact on a country's certification adoption, likely due to importers' requirements and/or exporters' strategy of using certification to create gain market access. We also found that in additional to the total size of food exports, the composition of exporting partners matter. In particular, a higher proportion of food exports to North America increased the demand for certification, suggesting that probably North America has the strongest demand or requirements for food safety certification.

6. REFERENCES

Barrett, H.R., A.W. Browne, P.J.C. Harris, and K. Cadoret. 2002. "Organic Certification and the UK Market: Organic Imports from Developing Countries." *Food Policy*, 27: 301–318.

Food and Drug Administration, Archive for Recalls, Market Withdrawals & Safety Alerts, http://www.fda.gov/safety/recalls/archiverecalls/default.htm, accessed May 1st, 2015.

Global Food Safety Initiative, Recognized Schemes, http://www.mygfsi.com/schemes-certification/recognised-schemes.html, accessed April 1st, 2015.

Hatanaka, M., C. Bain, and L. Busch. 2005. "Third-party Certification in the Global Agrifood System." *Food Policy*, 30(3): 354–69.

Henson, S., O. Masakure, and J. Cranfield. 2010. "Do Fresh Produce Exporters in Sub-Saharan Africa Benefit from GlobalGAP Certification?" *World Development*, 39(3): 375–86.

Herzfeld, T., L. S. Drescher, and C. Grebitus. 2011. "Cross-national Adoption of Private Food Quality Standards." *Food Policy*, 36(3): 401–411.

International Organization for Standardization. 2013. ISO Survey of Certifications.

Jongwanich, J. 2009. "The Impact of Food Safety Standards on Processed Food Exports from Developing Countries." *Food Policy*, 34(5): 447–57.

Mayer, T. and S. Zignago. 2011. "Notes on CEPII's Distances Measures (GeoDist)." CEPII Working Paper 2011-25.

Neumayer, E., and R. Perkins. 2005. "Uneven Geographies of Organizational Practice: Explaining the Cross-National Transfer and Adoption of ISO9000." *Economic Geography*, 81: 237–259.

Otsuki, T., J. Wilson, and M. Sewadeh. 2001a. "Saving Two in a Billion: Quantifying the Trade Effect of European Food Safety Standards on African Exports." *Food Policy*, 26(5): 495–514.

_____2001b. "What Price Precaution? European Harmonisation of Aflatoxin Regulations and African Groundnut Exports." *European Review of Agricultural Economics*, 28(2): 263–84.

Peterson, E., J. Grant, D. Roberts, and V. Karov. 2013. "Evaluating the Trade Restrictiveness of Phytosanitary Measures on US Fresh Fruit and Vegetable Imports. *American Journal of Agricultural Economics*, 95(4): 842–58.

United Nations Commodity Trade Statistics Database. http://comtrade.un.org/db/. Accessed January 2, 2015.

United States Department of Agriculture, Recall Case Archives, http://www.fsis.usda.gov/wps/portal/fsis/topics/recalls-and-public-health-alerts/recall-case-archive, accessed May 1st, 2015.

World Bank. 2013. World Development Indicators (The World Bank).

Zheng, Y., M.K. Muth, and J. Brophy. 2013. "The Impact of Food Safety Third-Party Certifications on China's Food Exports to the United States." Agricultural and Applied Economics Association Annual Meeting, Washington, D.C.

Table 1. Top Ten Countries by the Number of Certified Sites (2013)

Country	BRC	Country	FSSC 22000	Country	GlobalGAP	Country	ISO 22000	Country	PrimusGFS	Country	SQF
UK	3,786	USA	951	Spain	32,149	China	9,406	USA	8,720	USA	4,354
Italy	2,328	China	775	Italy	20,218	Greece	1,720	Mexico	3,402	Australia	869
USA	1,833	Japan	701	Greece	11,367	India	1,489	Canada	162	Canada	546
China	1,738	India	491	Germany	9,008	Romania	1,014	Belize	9	Japan	294
Spain	1,551	Netherlands	367	Netherlands	8,625	Japan	825	Chile	8	Mexico	178
Netherlands	1,312	Mexico	353	Peru	6,462	Italy	781	Guatemala	3	S. Korea	41
Poland	796	Germany	299	India	6,225	Turkey	733	Dom. Rep.	2	New Zealand	19
Germany	603	Russia	263	Chile	3,195	Poland	640	Argentina	2	India	15
Belgium	585	S. Africa	259	Belgium	3,185	Spain	525	Austria	0	Peru	14
Turkey	537	Brazil	237	Poland	3,163	Malaysia	389	Portugal	0	Thailand	14

Table 2. Definitions and Summary Statistics of Variables

Variables	Definition	Source	Mean	Std. Dev.	Min.	Max.
y	Number of sites certified to BRC	Standard's Web site	162.44	479.64	0	3,786.00
	Number of sites certified to FSSC 22000	Standard's Web site	63.98	141.91	0	951.00
	Number of sites certified to GlobalGAP	Communications with GlobalGAP	1,025.25	3,659.99	0	32,149.00
	Number of sites certified to ISO 22000	ISO Survey of Certifications	191.97	850.13	0	9,406.00
	Number of sites certified to PrimusGFS	Standard's Web site	93.95	815.63	0	8,720.00
	Number of sites certified to SQF	Standard's Web site	48.78	390.46	0	4,354.00
CB	Number of BRC certification bodies	Standard's Web site; web search	3.40	5.56	0	30.00
	Number of FSSC certification bodies	Standard's Web site; web search	0.79	1.90	0	10.00
	Number of GlobalGAP certification bodies	Standard's Web site; web search	0.98	2.79	0	19.00
	Number of ISO 22000 certification bodies	Standard's Web site; web search	1.28	3.12	0	21.00
	Number of PrimusGFS certification bodies	Standard's Web site; web search	0.05	0.44	0	5.00
	Number of SQF certification bodies	Standard's Web site; web search	0.06	0.48	0	5.00
Dist	Distance to standard holder (1,000 km)	CEPII	6.80	4.12	0.08	19.26
GDP	Per capita GDP ($1,000, 2005 US$)	World Development Index	12.41	16.63	0.16	79.53
Exp_EU	Proportion of food exports to EU	UNCOMTRADE	0.33	0.28	0	0.97
Exp_NA	Proportion of food exports to North America	UNCOMTRADE	0.11	0.18	0	0.84
Exp_SA	Proportion of food exports to South America	UNCOMTRADE	0.03	0.09	0	0.73
Exp_AS	Proportion of food exports to Asia	UNCOMTRADE	0.29	0.28	0	1.00
Exp_AF	Proportion of food exports to Africa	UNCOMTRADE	0.12	0.19	0	0.99
Exp_wld	Total food exports (million US$)	UNCOMTRADE	7.75	15.47	0	103.07
Agland	Agricultural land (million square km)	World Development Index	0.32	0.78	0.00001	5.15
Language	Dummy variable for sharing a common language	CEPII	0.21	0.41	0	1.00
Colony	Dummy variable for being colonized	CEPII	0.09	0.28	0	1.00
Contig	Dummy variable for sharing border	CEPII	0.02	0.14	0	1.00
Landlocked	Dummy variable for being a landlocked country	CEPII	0.21	0.40	0	1.00

Table 3. Estimation Results using the Negative Binomial Model

Dependent Variable: Number of Certified Sites	**(1) Core Variables**	**(2) Trade Included**	**(3) More Controls**	**(4) Marginal Effects for (3)**
Number of CBs	0.519***	0.315***	0.309***	4.459***
	(0.06)	(0.05)	(0.05)	
Dist. to standard holder's country (1,000 km)	-0.302***	-0.138***	-0.117***	-1.693***
	(0.04)	(0.03)	(0.04)	
Per capita GDP ($1,000)	0.015**	0.015**	0.017**	0.248**
	(0.01)	(0.01)	(0.01)	
Proportion of food exports to EU		0.25	0.145	2.097
		(0.78)	(0.78)	
Proportion of food exports to NA		9.290***	5.246***	75.640***
		(1.14)	(1.45)	
Proportion of food exports to SA		3.579*	2.745	39.580
		(1.96)	(1.83)	
Proportion of food exports to Asia		2.488***	1.111	16.025
		(0.83)	(0.86)	
Proportion of food exports to Africa		0.649	0.456	6.581
		(0.93)	(0.90)	
Total food exports ($1 million)		0.057***	0.033***	0.469***
		(0.01)	(0.01)	
Agricultural land size (million sq. km)			0.527***	7.597***
			(0.16)	
Common language			-0.124	-1.781
			(0.27)	
Colonial relationship			0.644*	9.280*
			(0.34)	
Contiguous border			2.584***	37.263***
			(0.80)	
Landlocked country			-1.017***	-14.659***
			(0.23)	
Constant	1.684***	-0.225	0.575	
	(0.43)	(0.67)	(0.67)	
Alpha	4.963***	4.075***	3.778***	
	(0.27)	(0.23)	(0.22)	
Log likelihood	-2872.56	-2799.90	-2776.53	
Pseudo R2	0.08	0.10	0.11	
N	786	786	786	

Notes: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are in parentheses. Estimates of dummy variables for continents and standards are suppressed.

Table 4. Some Robustness Checks

Dependent Variable: Number of Certified Sites	(1) GlobalGAP Excluded	(2) Farming Standards (GlobalGAP, PrimusGFS, and SQF)	(3) Exclusive Manufacturing Standards (BRC, FSSC 22000, and ISO 22000
Number of CBs	0.295***	0.433**	0.279***
	(0.05)	(0.19)	(0.03)
Dist. to standard holder's country (1,000 km)	-0.167***	-0.134	0.036
	(0.03)	(0.09)	(0.04)
Per capita GDP ($1,000)	0.020***	0.043***	-0.002
	(0.01)	(0.02)	(0.01)
Proportion of food exports to EU	-0.134	-0.742	1.001
	(0.75)	(2.39)	(0.67)
Proportion of food exports to NA	5.048***	7.644*	2.600**
	(1.35)	(4.01)	(1.03)
Proportion of food exports to SA	4.692**	-2.525	4.524***
	(1.89)	(5.90)	(1.62)
Proportion of food exports to Asia	0.778	1.066	0.718
	(0.86)	(2.48)	(0.67)
Proportion of food exports to Africa	0.659	-1.06	0.716
	(0.90)	(2.45)	(0.80)
Total food exports ($1 million)	0.033***	0.033	0.040***
	(0.01)	(0.02)	(0.01)
Agricultural land size (million sq. km)	0.570***	0.376	0.326**
	(0.16)	(0.36)	(0.13)
Common language	-0.068	-0.061	0.056
	(0.26)	(0.58)	(0.28)
Colonial relationship	0.798**	0.19	0.829***
	(0.34)	(0.96)	(0.31)
Contiguous border	3.290***	1.074	-0.458
	(0.79)	(1.87)	(0.59)
Landlocked country	-1.045***	-0.693	-1.053***
	(0.23)	(0.56)	(0.20)
Constant	0.839	-1.467	3.532***
	(0.65)	(1.96)	(0.52)
Alpha	2.946***	2.031***	1.689***
	(0.20)	(0.10)	(0.12)
Pseudo R2	0.13	0.12	0.11
N	655	393	393

Notes: * p<0.10, ** p<0.05, *** p<0.01. Standard errors are in parentheses. Estimates of dummy variables for continents and standards are suppressed.