# The Impacts of Food Safety Incidents on U.S. Beef Trade: A Gravity Model Approach

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## Abstract

The present paper examines the impacts of food safety incidents on U.S. beef trade using a gravity model approach. With the variable of food safety incidents (BSE and FSIS beef recalls) and free trade agreements, the gravity models of export and import equations are estimated by the random-effect estimation. The estimated results confirm the general intuition of the gravity model in beef export equation and indicate that the occurrence of BSE could make a huge loss for U.S. beef exports. Furthermore, the volumes of beef that U.S. imports from other countries could have benefit from the free trade agreement.



**Key words**: Beef Trade, Gravity Model, Food Safety, FSIS Recall

## 1. Introduction

Global meat and poultry consumption has been gradually increasing for decades, driven by rising incomes and populations as well as productivity growth of meat production. Changes in meat consumption in one country have implications for production and trade in other countries. Nowadays, the meat and poultry industry is the biggest portion of United States agriculture (American Meat Institute, 2011). The U.S. produced more than 92.5 billion pounds of red meat and poultry in 2012 (USDA-ERS, 2013). While the U.S. is the world's largest supplier of high-quality beef, it also maintains a high volume of beef imports (Figure 1). Most of the beef produced and exported from the U.S. is grain-feed and marked as high-value cuts while most imported beef is "lower-valued and grass-fed" beef used for processing as ground beef (USDA-ERS). Typically, U.S. beef demand largely consists of demand for ground beef and steaks. Ground beef production requires additional lean to mix with the trim products from fed cattle in order to produce ground beef of targeted leanness. It is not efficient for beef producers feed cattle to higher quality and then grind the meat back into ground beef (Beef Magazine, 2010). The imported beef from Australian range beef, New Zealand dairy beef or Canadian cull cows can provide competitively priced ground beef in the market.

Historically, the volume of U.S. beef import and export varies significantly among last two decades (Figure 1): the volume of beef import went up and the volume of beef exports dropped down dramatically after 2003. Such instability not only because the impacts of trading policies (e.g. tariff, barriers, and quotas), but also due to the meat safety issues. As one of the world's largest producers and exporters of beef, the issue of

food safety is of particular concern to the United States. The outbreak of BSE (Bovine Spongiform Encephalopathy) in 2003 in the state of Washington directly resulted in the cutoff of U.S. beef import in some countries, such as Japan and South Korea. Food safety leads to human illness which causes the loss of billions of US dollars to the society annually (Marsh *et al.*, 2004). Economists have investigated the impacts of a single food safety event on domestic consumption of beef (meat). Generally, these studies applies demand models (such as Almost Ideal Demand System or Rotterdam Model) with meat consumption data and figure out the food safety incidents have a negative and significant shock on consumers' demand (Marsh *et al*., 2004; Smed and Jensen, 2005; Tonsor *et al*., 2010). But these researches only focus on how food safety incidents influence U.S. domestic beef (meat) demand and fail to answer a detailed question how such incidents affect the U.S. beef international trade (volume of U.S. beef imports and exports).

The present study empirically examines the impact of food safety incidents which including BSE and USDA Food Safety Inspection Service (FSIS) food safety recall on U.S. beef imports and exports. The interest in this issues stems from two reasons. First, the impact of food safety incidents on U.S. beef trade could be ambiguous, which necessitates an empirical study of this problem. BSE and FSIS recalls are a proxy of meat safety incidents that the occurrence of these issues indicates serious food safety issues. Such incidents may impact the volume of U.S. beef exports and imports because of the spillover effects. Therefore, how food safety issues can affect beef international trade is of particular interest to meat producers, manufacturers and the government. However, this issue has received limited attention in agricultural economics and trade literatures.

Second, the case of U.S. beef trade is considered in this study because of potential policy implication. If food safety incidents lessen trade, the application of quality controls such as HACCP (Hazard Analysis Critical Control Points), and other food safety standards are necessary and crucial in food trade. The food safety standards conventionally act as "trade barriers" in literatures, but more recent views revealed that these standards could behavior like a "catalyst" to incite countries to modernize their export sector and strength the level of food safety standard (Anders and Caswell, 2009).

## 2. Methodology and Literature Review

The gravity model is one of the most effective trade models which are widely used over last decades (Sun and Reed, 2010). As the name indicates, the gravitational concept was adapted in physics and advanced by Newton in 1686 (Dascal *et al*., 2002). Tinbergen (1962) first performed the gravity model on international trade independently. Then the gravity model has inspired many researchers to explain bilateral trade flows. The basic form of the gravity model is an increasing function of income and a decreasing function of transaction cost such as geographic distance. Furthermore, in the empirical analysis of last three decades, numbers of researchers have used various additionally variables that improve or resist bilateral trade flows, such as population, whether the pair-countries share the boarders, free trade agreement, and etc. (Dascal *et al*., 2002). For the applications of gravity model in agricultural commodities trade, Koo *et al*. (1994) revised the gravity model and made the model fit for a single agricultural commodity effectively by using panel data. Their study revealed that trade policies, meat production capacity in countries and distances are important in determining trade flows of meat. Some articles have examined the relationship between food safety standards and food trade. Anders and

Caswell (2009) applied panel data into gravity model to study the effect of introducing HACCP on U. S. seafood imports. They confirmed that the leading seafood exporters had positive HACCP effects regardless the development status. However, no studies investigated the impact of food safety incidents on beef trade using gravity.

The most common specification of the gravity model is a double log form. The empirical estimation methodologies of gravity model involve various ways. Some literatures such as Otsuki *et al*. (2001), Wilson and Otsuki (2004), Disdier *et al*. (2008), and Wei *et al*. (2012) used OLS estimation. But recent literature on estimation of gravity model have indicated that ignoring the zero trade issue can results in biased estimates. The existence of zero trade between country-pairs might be a problem for the model specification. Some researchers argued that the most obvious reason for the zero trade flows is the high trade costs of the country pairs (Helpman *et al*., 2008). Sun and Reed (2010) also addressed that the existence of zero-valued trade flows are more significant if the volume of trade is a specific good. The zero value observation cannot be simply omitted because it may delete some important information on the zero levels of trade and cause biased estimates and inconsistency. Recent literatures (Silva and Tenreyro, 2006; Sun and Reed, 2010) suggested using Pseudo Poisson Maximum Likelihood (PPML) to solve the inefficient OLS estimation. However, since the U.S. beef exports data in this study does not contains zero trade volume and the beef import data have a fairly small proportion of zero observations (less than 0.5% of total observation). Ignoring the zero import volumes in the gravity model estimation will not cause severe inefficiency and inconsistency.

## 3. Empirical Gravity Model and Data Description

The current study uses a variant of the classic gravity model for both import and export equations to analyze the effects of the food safety incidents on logarithms of bilateral trade flows. The general gravity model for import and export is specified as two equations:

$$lnEXP_{it} = \alpha_0 + \alpha_1 Time_t + \alpha_2 lnGDP_{it} + \alpha_3 lnDIS_i + \alpha_4 BD_i + \theta_i \quad (1)$$

$$lnIMP_{jt} = \beta_0 + \beta_1 Time_t + \beta_2 lnGDP_{jt} + \beta_3 lnDIS_j + \beta_4 BD_j + \varepsilon_j \quad (2)$$

The panel of U.S. beef trade data is estimated across eleven beef importing countries and ten exporting countries (Table 1) for the time period 1989 – 2012 using gravity model equations. Models 1 are equation (1) and (2) which is the benchmark specification of the exporting and importing gravity equations. They control the base gravity model requirement on beef trade flows in the United State. *Time* has the value one to twenty-four to capture the beef trade tendency. Other includes are GDP of exporting countries and importing countries, geographical distance (DIS), and if the countries *i* (export equation) and *j* are contiguous with the United State. The other two additional models are specified based on models 1. The other models add variables for food safety incidents and bilateral free trade agreement (FTA) allowing for tests of the hypotheses in this research: whether food safety incidents have significant effects on U.S. beef exports and imports.

In order to quantify the food safety issues as a variable in the empirical analysis, some studies constructed food safety media indices from newspaper articles, which has been a common method in focusing on the effect of food safety information (Piggott and Marsh, 2004; Smed and Jensen, 2005). However, the most recent studies take advantage of the recall information from Food Safety Inspection Service (FSIS) and use the number

of recall as a proxy of the degree of food safety issues (Tonsor *et al*., 2010; Tselepidakis, 2012). The present study follows the suggestion of Tonsor *et al*., (2010) and applies FSIS recall data for the gravity analysis because the recall information is easy to access. Starting in 1906, the Food Safety Inspection Service (FSIS) mandates Federal Meat Inspection Act to inspect all meat products sold in interstate commerce, and re-inspects imported products to ensure that they meet U.S. food safety standards. Furthermore, as a federal authority responsible for food safety, as soon as the potential risks have been discovered, the FSIS ranks the level of threat by three classifications: Class I, II, and III. Specifically, Class I indicates the highest risk level of foodborne disease which may cause health problems or even death; Class II represents a health hazard condition where the use of the food may lead to a remote probability of adverse health problems; and Class III describes the situation in which eating the food will not cause the health issues (USDA Recall Classifications). Based on the levels and severity of health hazard conditions, only the yearly numbers of Class I recall (variable *FSIS*) are taken into consideration in this study. Beside FSIS beef safety recall, BSE (Bovine Spongiform Encephalopathy) is not only a deadly healthy treat to human, but also cause serious political issues among the world. Thus, the variable *BSE* are used as an important food safety variable in both import and export equations.

Table 2 presents definitions and descriptive statistics of the dependent and independent variables. The total numbers of observation in the U.S. beef export equation are 264 (24×11) in the U.S. beef export equation and 240 (24×10) in the U.S. beef import equation. All of the volumes of beef import and export data come from USDA-ERS. The Data of per capita gross domestic product (GDP) come from the World Bank

Development Indicators databases in 2012 U.S. dollars. In addition, the variable *FTA* accounts for the free trade agreement between the import/export countries and the United State which is collected from the Office of the United State Trade Representative.

Models 2 add variables for beef safety incidents (FSIS, BSE, and USBSE) allowing for tests of whether these safety incidents have significant effects on U.S. beef export (equation 3) and import (equation 4):

$$lnEXP_{it} = \alpha_0 + \alpha_1 Time_t + \alpha_2 lnGDP_{it} + \alpha_3 lnDIS_i + \alpha_4 BD_i + \alpha_5 lnFSIS_t + \alpha_6 BSE_t + \alpha_7 USBSE_t + \theta_i \quad (3)$$

$$lnIMP_{jt} = \beta_0 + \beta_1 Time_t + \beta_2 lnGDP_{jt} + \beta_3 lnDIS_j + \beta_4 BD_j + \beta_5 lnFSIS_t + \beta_6 BSE_t + \beta_7 USBSE_t + \varepsilon_j \quad (4)$$

Models 3 introduces the variables of free trade agreements (FTA) into both export and import equation in order to test if the free treat agreements play an significant role in the U.S. beef trade:

$$lnEXP_{it} = \alpha_0 + \alpha_1 Time_t + \alpha_2 lnGDP_{it} + \alpha_3 lnDIS_i + \alpha_4 BD_i + \alpha_5 lnFSIS_t + \alpha_6 BSE_t + \alpha_7 USBSE_t + \alpha_8 FTA_{it} + \theta_i \quad (5)$$

$$lnIMP_{jt} = \beta_0 + \beta_1 Time_t + \beta_2 lnGDP_{jt} + \beta_3 lnDIS_j + \beta_4 BD_j + \beta_5 lnFSIS_t + \beta_6 BSE_t + \beta_7 USBSE_t + \beta_8 FTA_{jt} + \varepsilon_j \quad (6)$$

**4. Estimations and Findings**

The panel data has separate time-series and cross-sectional effects which may have heterogeneity biases and requires appropriate estimation. In gravity model, the OLS panel estimates could reveal significant first order serial correlation (Anders and Caswell, 2009). The selection of estimation procedure is motivated by different factors. Initially, the Hausman Test indicates that there is no significant difference between fixed-effect

estimators and random effect estimators in both beef export and import equations. However, fixed-effect models are inappropriate when time invariance variables such as geographic distance and border dummies are included. The fixed-effects estimators eliminate all time-invariant variation. So given the importance of the geographic distance variable and border dummy variable for the gravity model analysis, the random-effects estimators are applied consequently.

Table 3 and 4 presents estimation results for Models 1 to 3 in two groups of equations. The first group is gravity model of the U.S. beef export equations, while the second is the gravity model of U.S. beef import equations.

*U.S. Beef Export*

The results presented in table 3 indicates that among the eleven beef importing countries, the rich countries (with higher GDP per capita) are likely to import more volumes of U.S. beef. Or we could say that the U.S. exports more volumes of beef to the rich countries. The benchmark Model 1 and alternative Models 2 and 3 support a positive and significant relationship between U.S. and the beef importers, which corresponds to the traditional intuition of gravity model. The border dummy also tells us that the geographic conjunctions play a positive and significant role for U.S. beef exports. The shared borders between two countries have obvious geographic advantage which may reduce the logistic cost in trade. The gravity models in literature also confirmed such relationship.

Table 3 also supports the hypothesis that, given all else equal, the occurrence of BSE in U.S. (USBSE) has an overall negative and significant effect on U.S. beef exports. The incidents of BSE in the U.S. dramatically reduce almost 60% of its beef exports.

When BSE outbreak in the state of Washington in 2003, the importing countries such as Japan and South Korea just banned the U.S. beef export directly and found the substitute suppliers from Australia and New Zealand. The other proxy of food safety incident, FSIS beef recall, does not have a significant a significant effects on the volumes of U.S. beef export. Failure to find the relationship between U.S. beef exports possibly due to the FSIS beef recalls is mainly noticed by the U.S. consumers and rather than the international beef importers. Recent literatures have confirmed that the FSIS beef recalls have negative and significant impacts on U.S. beef consumption (Tonsor *et al*., 2010; Shang and Tonsor, 2013). The free trade agreement (FTA) between U.S and the beef importing countries does not significantly boost U.S. beef exports from the estimated results of the three models.

*U.S. Beef Import*

Table 4 presents estimation results for Model 1, 2, and 3 of U.S. beef import equations. These results show that among the ten countries exporting beef to the U.S., the GDP per capita does not have statistically significant influence on the volumes of beef import. The U.S. imports beef from other beef exporting countries regardless their developing status. Surprisingly, the variables of geographic distance (*ln*DIS) indicate statistically positive and significant effects on the volume of U.S. beef imports, which is not matching with the intuition of conventional gravity model because the geographic distance is always considered as a kind of logistic cost in the trading behavior. But if we pay more attention on these ten exporting countries, the percentages of beef that U.S. imported from Australia and New Zealand contribute over 60% overall U.S. beef import. But Australia and New Zealand located in Oceania, which is far away from the mainland

of North America geographically. Such great volumes from Australia and New Zealand may explain why the distance variables have positive and significant effects on U.S. beef imports. Similarly with table 3, the positive and significant border dummy variables in the three models shows that U.S. is also likely to import beef from Canada and Mexico, which confirm the traditional intuition of the gravity model.

The food safety incidents BSE and FSIS beef recalls do not affect U.S. beef imports significantly. Like most of the beef importing countries, if BSE occurs in a trading partner, the U. S. banned beef imports from the specific countries and found some alternative countries as the substitute beef suppliers. For example, as a result of the first Canadian-born case of BSE was reported in May, 2003, the U.S. placed import restriction toward Canadian beef and increase the volumes imported from other countries for three month significantly[1]. The variables FSIS beef recalls may have the same reason as the export equations to explain why they do not have significant effect in the three import equations. Table 3 provides the evidence to support the assumption that free trade agreement has positive and significant effect on the beef imports. The U. S. is more likely to import beef from its trading partners who has signed the free trade agreements with the United States.

## 5. Conclusions and Implications

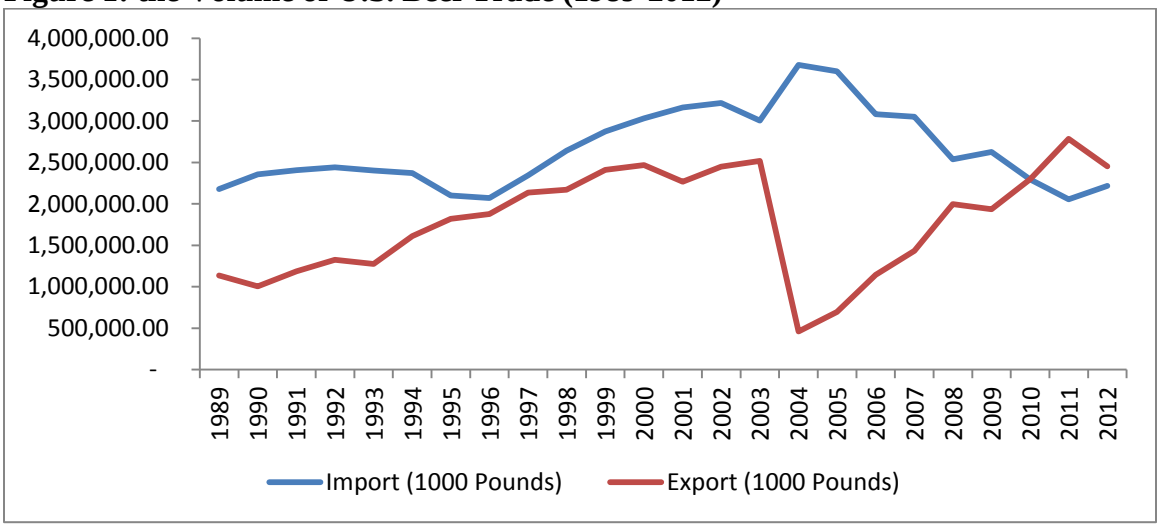
The United State is not only an exporter, but also an importer in the world's beef trade market. Understanding how food safety incidents impact the U.S. beef trade is meaningful to the beef producers and policy makers. In this paper, the occurrence of BSE

[1] The imports from Canada dropped from 60260 to 88, 178, and 88 thousand pounds in June, July, and August, 2003, while the import from Australia jumped from 89162 to 92242, 97216, and 92338 thousand pounds at the same periods.

and FSIS beef recalls are chosen to be the proxies of food safety incidents. By adding the variables of food safety incidents and free trade agreement into the gravity model, both export and import equations are estimated using U.S. beef trade panel data. The random-effect estimations of the gravity model reveals that the developing statuses of different countries have positive and significant effect on U.S. beef exports not beef imports. Also, other conventional variables such as border dummy in gravity model positively and significantly affect U.S. beef exports and imports. The U.S. is more likely to export (import) beef from (to) Mexico and Canada. Additionally, the estimated results of export equations support the hypothesis that if BSE happened in the U.S., its beef exports suffer huge negative impacts on the exporting volumes. As the other food safety proxy, FSIS beef recalls fail to provide enough evidence to support the assumption. In addition, the U.S. beef import volumes could benefit from the free trade agreement.

If BSE outbreaks in the U.S. created huge loss for U.S. beef exports, the higher level of beef safety standard and more advanced test technics for BSE are necessary for the U.S. beef industry. The industry also needs a more advanced quality control in the whole production and supply chains such as cattle feeding, slaughtering, and logistics in order to reduce the risk of foodborne illness contamination. Also, the free trade agreements between U.S. and other countries make U.S. increase beef imports from the corresponding countries. The policy makers need to focus on the implements of free trade agreements and make sure that the U. S. beef imports are maintained in a suitable level in the overall beef trade.

**Figure 1: the Volume of U.S. Beef Trade (1989-2012)**




(Source: USDA-ERS)

**Table 1: List of Countries in US Beef Trade**

| Countries Import Beef From the US | | Countries Export Beef To the US | |
|---|---|---|---|
| Japan | Netherland | Australia | Costa Rica |
| South Korea | China | New Zealand | Honduras |
| Mexico | Taiwan | Mexico | Uruguay |
| Canada | Saudi Arabia | Canada | Nicaragua |
| The Bahamas | Switzerland | Argentina | |
| Singapore | | Brazil | |

**Table 2: Definitions of Variables and Sample Statistics**

| Variables | Variable Description | Mean | Standard Error |
|---|---|---|---|
| | **US Beef Export Equation** | | |
| $lnEXP_{it}$ | Annual volume of beef export from the US to country *i* (measured in 1000 pounds) in logarithm | 9.79 | 2.45 |
| $Time_t$ | Trend 1989-2012 | 12.50 | 6.94 |
| $lnGDP_{it}$ | GDP per capital of country *i* (1,000 US$, in 2012 dollars), in logarithm | 2.41 | 1.21 |
| $lnDIS_i$ | Geographical distance between country *i* and the US (in logarithm) | 8.33 | 0.78 |
| $BD_i$ | Dummy variable if the countries share the same border | 0.18 | 0.39 |
| $lnFSIS_t$ | Number of FSIS Class I beef recall in logarithm | 2.44 | 0.82 |
| $BSE_t$ | Dummy variable for the occurrence of BSE outside the US | 0.38 | 0.49 |
| $USBSE_t$ | Dummy variable for the occurrence of BSE in the US | 0.17 | 0.37 |
| $FTA_{it}$ | The introduction of free trade agreement between country *i* and the US. | 0.20 | 0.40 |
| | **US Beef Import Equation** | | |
| $lnIMP_{jt}$ | Annual volume of beef import to the US from country *j* (measured in 1000 pounds) in logarithm | 11.37 | 1.84 |
| $Time_t$ | Trend 1989-2012 | 12.50 | 6.94 |
| $lnGDP_{jt}$ | GDP per capital of country j (1,000 US$, in 2012 dollars), in logarithm | 1.79 | 1.21 |
| $lnDIS_j$ | Geographical distance between country j and the US (in logarithm) | 8.05 | 0.76 |
| $BD_j$ | Dummy variable if the countries share the same border | 0.20 | 0.40 |
| $lnFSIS_t$ | Number of FSIS Class I beef recall in logarithm | 2.44 | 0.82 |
| $BSE_t$ | Dummy variable for the occurrence of BSE outside the US | 0.38 | 0.49 |
| $USBSE_t$ | Dummy variable for the occurrence of BSE in the US | 0.17 | 0.37 |
| $FTA_{jt}$ | The introduction of free trade agreement between country *j* and the US. | 0.30 | 0.46 |

**Table 3: Gravity model Random-Effects Estimates of U.S. Beef Export, 1989 – 2012**

| | US Beef Export Equations | | |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| $Time_t$ | 0.023* | 0.031 | 0.029 |
| | (0.014) | (0.020) | (0.021) |
| $lnGDP_{it}$ | 0.402** | 0.441** | 0.440** |
| | (0.156) | (0.156) | (0.157) |
| $lnDIS_i$ | 0.188 | 0.031 | 0.016 |
| | (0.584) | (0.584) | (0.595) |
| $BD_i$ | 3.597** | 3.353** | 3.269* |
| | (1.697) | (1.697) | (1.815) |
| $lnFSIS_t$ | | 0.015 | 0.017 |
| | | (0.136) | (0.136) |
| $BSE_t$ | | -0.062 | -0.062 |
| | | (0.169) | (0.169) |
| $USBSE_t$ | | -0.597** | -0.594** |
| | | (0.218) | (0.218) |
| $FTA_{it}$ | | | 0.084 |
| | | | (0.321) |
| Rho | 0.695 | 0.699 | 0.727 |
| R | 0.382 | 0.392 | 0.391 |
| No. of Obs. | 264.000 | 264.000 | 264.000 |

**Table 4: Gravity model Random-Effects Estimates of U.S. Beef Import, 1989 – 2012**

| | US Beef Import Equations | | |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| $Time_t$ | 0.0136 | 0.0120 | 0.0033 |
| | (0.0152) | (0.0222) | (0.0233) |
| $lnGDP_{it}$ | 0.0918 | 0.1165 | 0.0171 |
| | (0.2392) | (0.2530) | (0.2570) |
| $lnDIS_i$ | 1.9800*** | 1.9402*** | 2.1744*** |
| | (0.5159) | (0.5332) | (0.5567) |
| $BD_i$ | 2.3359** | 2.2660** | 2.3973** |
| | (0.9338) | (0.9632) | (0.9990) |
| $lnFSIS_t$ | | 0.0116 | 0.0218 |
| | | (0.1227) | (0.1219) |
| $BSE_t$ | | 0.0509 | 0.0517 |
| | | (0.1483) | (0.1464) |
| $USBSE_t$ | | 0.0332 | 0.0217 |
| | | (0.1897) | (0.1874) |
| $FTA_{it}$ | | | 0.4084** |
| | | | (0.2266) |
| Rho | 0.2551 | 0.2526 | 0.2873 |
| R | 0.4806 | 0.4843 | 0.4863 |
| No. of Obs. | 240.0000 | 240.0000 | 240.0000 |

Note: (*), (**), and (***) denote significance at 10%, 5%, and 1%, respectively.
The standard errors are in parenthesis.

**Reference**


Anders, S. M., and J. A. Caswell. 2009. "Standard as Barriers versus Standard as Catalysts: Assessing the Impact of HACCP Implementation on U.S. seafood Imports". *American Journal of Agricultural Economics*. 91(2): 310-321.

American Meat Institute. 2011. "The United States Meat Industry At a Glance". Available online: http://www.meatami.com/ht/a/GetDocumentAction/i/89473

Beef Magazine. 2010. "Why Does the U.S. Both Import and Export Beef?". Available online: http://beefmagazine.com/cowcalfweekly/0611-why-does-us-import-export-beef

Dascal, D., K. Mattas, and V. Tzouvelekas. 2002. " An Analysis of EU Wine Trade: A Gravity Model Approach". *International Advances in Economic Research.* 2002(8).

Disdier, A., L. Fontagné, and M. Mimouni. 2008. "The impact of regulations on agricultural trade: evidence from the SPS and TBT agreements". *American Journal of Agricultural Economics* 90: 336-350.

Jones, K., A. Hagerman and A. Muhammad. 2013. "Theme Issue Overview: Emerging Issues in Global Animal Product Trade". *CHOICES* (published by Agricultural and Applied Economics Association). 28(2013).

Helpman, E., M. Melitz, and Y. Rubinstein. 2008. "Estimating Trade Patterns and Trading Volumes". *Quarterly Journal of Economics* 123 (2): 441-487

Koo, W.W., D. Karemera, and R. Taylor. 1994. "A Gravity Analysis of Meat Trade Policies'. *Agricultural Economics*. 1994 (10): 81-88.

Marsh, T. L., T Schroeder and J Mintert. 2004. "Impacts of Meat Product Recalls on Consumer Demand in the USA". *Applied Economics*, 2004 (36): 897-909.

Otsuki, T., J. Wilson, and M. Sewadeh. 2001. "Saving two in a billion: quantifying the trade effect of European food safety standards on African exports". *Food Policy*. 26: 495-514.

Piggott, E. and T Marsh. 2004. "Does Food Safety Information Impact U.S. Meat Demand?". *American Journal of Agricultural Economics*. 86 (1): 154-174.

Smed, S. and J. D. Jensen. 2005. "Food Safety Information and Food Demand". *British Food Journal*. 107(3): 173-186

Sun, L. and M. R. Reed. 2010. " Impacts of Free Trade Agreement on Agricultural Trade Creation and Trade Diversion". *American Journal of Agricultural Economics*. 92 (5): 1351-1363.

Shang, X., and G. T. Tonsor. 2013. "Consumer Meat Safety Concerns: Impacts of Beef *E. coli* O157: H7 Recalls on Meat Consumption". Selected Poster Presented in 2013 AAEA Annual Meeting, Washington DC.

Tinbergen, J. 1962. "Sharping the World Economy: Suggestions for an International Economic Policy". New York: The Twentieth Century Fund.

Tonsor, G. T., J. R. Mintert, and T. C. Schroeder. 2010. "U.S. Meat Demand: Household Dynamics and Media Information Impacts". *Journal of Agricultural and Resource Economics* 35(1): 1-17.

Tselepidakis, E. 2012. "Food Safety and the Demand for Meat Products". Selected Paper Presented in 2012 AAEA Annual Meeting, Seattle, Washington.

USDA Recall Classifications, "What is FSIS' Role during a Recall". Available online: http://www.fsis.usda.gov/FACTSheets/FSIS_Food_Recalls/index.asp#7

USDA-ERS Reports. Available online: http://www.ers.usda.gov/topics/food-safety/foodborne-illness/readings.aspx

USDA-ERS. Livestock & Meat Domestic Data. Available online: http://www.ers.usda.gov/data-products/livestock-meat-domestic-data.aspx#26056

Wilson, J. and T. Otsuki. 2004. "To spray or not to spray: pesticides, banana exports, and food safety". *Food Policy*. 29: 131-146.

Wei, G., J. Huang, and J. Yang. 2012. "The impacts of food safety Standards on China's tea exports". *China Economic Review*. 23: 253-264.