Are SPS Standards Always Barriers to Trade? The Interaction between Demand-enhancing Effect and Cost-increasing Effect

A Dissertation
SUBMITTED TO THE FACULTY OF
UNIVERSITY OF MINNESOTA
BY

Lan Liu

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Chengyan Yue

March 2016

Acknowledgements

Foremost, I would like to express my deepest gratitude to my advisor Prof. Chengyan Yue for the continuous support of my Ph.D study and research, for her patience, motivation, enthusiasm, and providing me with an excellent atmosphere for doing research.

Besides my advisor, I would like to thank the rest of my thesis committee: Prof. Donald Liu, Prof. Metin Çakır, and Prof. Changbin Chen, for their encouragement, insightful comments, and hard questions.

Finally, I must express my very profound gratitude to my parents and to my husband for providing me with continuous support and encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

Dedication

This thesis is dedicated to my parents, my husband, and my kids for their constant support and unconditional love. I love you all dearly.

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Introduction

Sanitary and phytosanitary (SPS) measures refer to any of the laws, rules, standards, and procedures that governments employ to protect humans, other animals, and plants from diseases, pests, toxins, and other contaminants. SPS standards as concealed protectionist tools and barriers to trade have been extensively investigated in the literature. Many studies indicate that SPS standards are becoming significant barriers to international trade of food and agricultural products (Calvin and Krissoff, 1998; Liu and Yue, 2009; Yue, Beghin and Jensen, 2006). A common concern is that unnecessarily strict health and safety regulations would increase the production or trade costs of imports, distort international trade, and cause mercantilist losses in exporting countries due to reduced exports, as well as welfare losses for importing countries (Yue, Beghin and Jensen, 2006). In this article, this negative effect of SPS standards on international trade is called "COST-INCREASING EFFECT." Yet, product safety and sanitary standards can beneficially resolve imperfect information problems, and may stimulate consumers' demand by increasing their confidence in product safety and quality (Beghin and Bureau, 2001; Roberts, Josling and Orden, 1999; Thilmany and Barrett, 1997). Consumers desire a safe food supply and are willing to pay a premium for safer food (Baker, 1999; Buzby, Skees and Ready, 1995; Eom, 1994; Hayes, Jason, Shin et al., 1995; Misra, Huang and Ott, 1991). However, consumers usually lack complete information about food safety. Food safety standards can not only increase the food safety level provided by the market, but also help consumers make more informed purchasing decisions. Consumers would be more willing to buy food products that meet certain standards because they can get safer produce for their money spent (Unnevehr, 2000). In such cases, food safety standards may improve food safety and enhance consumer demand for safer food products, which in turn can increase mercantilist gains in exporting countries and consumer welfare in importing countries. We call this positive impact of SPS standards on international trade "DEMAND-ENHANCING EFFECT."

Consequently, the direction of change in consumer welfare after imposing food safety standards in an importing country would depend on relative magnitudes of the standards' negative cost-increasing effect and positive demand-enhancing effect, whichever dominates. Compliance with a standard involves additional costs such as human and financial capital investments, testing and detection, and higher rejection rates due to stricter standards. Producers in exporting countries often transfer these costs to consumers by increasing product prices. If regulatory standards do not resolve consumer uncertainty about imported product quality and safety, trade volume would decline due to increased prices and consumer welfare would decline in importing countries. However, if regulatory standards increase consumer confidence in imported product quality and safety, stimulate demand, and the positive demand-enhancing effect of the standards is large enough to dominate the negative cost-increasing effect, then trade volume and consumer welfare would be greater than when the standards were not in place. Therefore, both the cost-increasing and demand-enhancing effects of food safety standards are key to understanding the changes of trade volume and consumer welfare of the importing country after standards are implemented. Ignoring the demand-enhancing effect of food safety standards could lead to biased estimations.

Most of the existing literature on standards and regulations focus on their roles as non-tariff barriers and negative impacts on trade flow due to the cost-increasing effect without considering the demand-enhancing effect, which can greatly affect the trade flow and total welfare estimation results. In this article, we extend the framework used by Yue, Beghin and Jensen (2006) and Liu and Yue (2009) by incorporating food safety standards' demand-enhancing effect and its interaction with the cost-increasing effect in the analysis of trade flow and welfare changes caused by food safety standards. The extended model is applied to investigate how the stricter European Union (EU)[1] aflatoxin standards in the nut industry affect consumer confidence in product safety and quality, product prices, trade flow, and consumer welfare.

Our article also contributes to the literature that evaluates the economic impact of food safety standards. The introduction of food safety standards is likely to affect product prices and quality, and ultimately consumer consumption patterns and overall welfare. Several studies have utilized conjoint analysis, contingent valuation, or experimental markets to measure consumer willingness to pay for specific safety attributes. For example, Lin and Milon (1995) use contingent valuation to show that on average consumers would be willing to pay a premium of 18% to 20% for a dozen oysters with reduced risk levels. Halbrendt, Pesek, Parsons et al. (1995) use conjoint analysis to assess consumer acceptance of genetically-engineered pST (porcine somatotropin)-

1 EU refers to the European Union, which currently is a politico-economic union of 28 member states that are located primarily in Europe.

supplemented pork products in Australia. Experimental auction markets (Fox, Shogren, Hayes et al., 1995; Hayes, Jason, Shin et al., 1995) are also used to estimate customer willingness to pay for specific food safety attributes. However, the results from those survey-based methods or auction markets might not reflect consumers' actual marketplace behavior because consumers' attitudes in surveys or experimental auctions sometimes differ from their actual actions (Caswell, 2002). In this article, our model allows us to explicitly estimate consumer confidence changes due to stricter food safety standards. Using revealed price and consumption data, a more objective ex post valuation of how consumers respond to food safety standards is provided.

Our empirical analysis results have important policy implications. The number of trade disputes has been increasing between countries over SPS standards. Therefore, understanding the trade impact of these standards is of great significance. Our results suggest that removing SPS standards will not necessarily achieve sufficient consumer welfare gains to overcome losses from a reduced standard level. While scientific assessment of the human health risk associated with food safety should be considered in setting standards, the fact that the subjective assessment of food safety by consumers also plays an important role in consumer demand and the international trade flow should not be ignored. Our results suggest that in some cases, more stringent food safety standards can facilitate trade and increase consumer welfare, and that increased food safety standards and trade flow are likely to be compatible and even mutually reinforcing (Buzby and Unneveh, 2003).

Background Information

In this section, we briefly present an overview of the EU nut market, EU aflatoxin standards, and previous studies on how EU aflatoxin standards affect EU nut imports.

The EU Nuts Market

In botany, a nut is a fruit composed of a hard shell and a seed and that the shell does not open to release the seed. Common usage of the term is much less restrictive than in botany. It often refers to any hard-walled, edible kernel as a nut. There are two segments for edible nuts: groundnuts (peanuts) and tree nuts. Tree nuts include, but are not limited to, almonds, Brazil nuts, cashews, chestnuts, hazelnuts, macadamia nuts, pecans, pistachios, and walnuts.

Consumption

The consumption of nuts (including groundnuts and tree nuts) in the EU has shown an upward trend in recent years as more Europeans are turning to nuts as an alternative protein source and 'healthy' snack (CBI, 2009). Figure 1 shows how total and per capita EU nuts consumption (volume) changes over time. In 2011, the consumption of nuts in the EU was around 3.2 million tonnes. Germany has the largest market, accounting for 21% of total EU consumption in 2011, closely followed by Italy (18%), Spain (12%), France (11%) and the United Kingdom (8%).

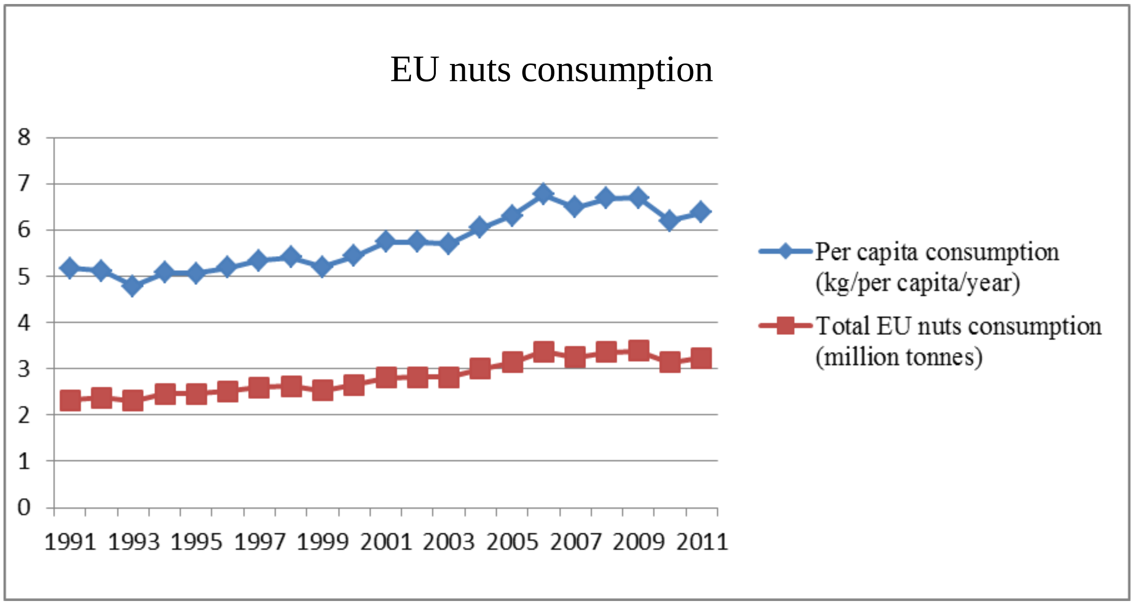

Figure 1. EU consumption of edible nuts. Source: FAOSTAT, 2015

Germany consumed 642,133 tonnes of nuts in 2011. Groundnut is the most consumed nut in Germany. The other two most consumed nuts are almonds and hazelnuts. Consumption of pistachios and chestnuts is somewhat smaller[2]. A large variety of edible nuts is used as an ingredient for chocolate products in the German industrial sector. Germany is also a leading EU producer of marzipan, which has almond paste as the main component.

Italy is also one of the leading nut consuming EU member states. Italian consumption of edible nuts in 2011 amounted to 538,692 tonnes. Groundnuts, almonds, and hazelnuts are the largest consumed nuts in the country.

Spanish consumption of edible nuts amounted to 349,203 tonnes in 2011. Nuts are traditional ingredients in the Mediterranean cuisine, which has been heavily promoted as a particularly healthy diet. As a result of the increased health awareness, edible nut

2 The consumption data from FAO is up to 2011. The detailed consumption data for each species of tree nuts is not available at the moment author accessed. The introduction about the consumption quantity of each species of tree nuts is from the CBI report (2009).

consumption has grown in Spain over the past several years. Almonds, groundnuts and walnuts are the leading products, followed by pistachios and hazelnuts.

French consumption of edible nuts amounted to 329,534 tonnes in 2011. France is a leading EU consumer of edible nuts, particularly of walnuts. Walnuts consumption uses include snacking and home cooking, by-products consumption, such as walnut oil, and shelled walnuts used as ingredients in the pastry, bakery and cheese industries for example. The French market for snacking products has increased significantly over the past few years.

Compared to other EU member countries, the United Kingdom is an average consumer of edible nuts, with groundnuts being the most popular item. Volume consumption of edible nuts in the United Kingdom amounted to 234,801 tonnes in 2011. The highly developed taste for Indian and other Asian cuisine in the UK has stimulated the demand for edible nuts, as ingredients in ethnic dishes and sauces. As in other EU member countries, British consumers show a preference for shelled nuts while, in-shell nuts, being a traditional Christmas food product, are popular during the Christmas period.

Production

EU countries produce substantial quantities of nuts. In 2013, total nuts production in the EU amounted to around 740,926 tonnes. Almond is, by far, the most produced nut, accounting for 35% of production in 2013. Other main varieties are walnuts (23% of EU production in 2013), hazelnuts (19%) and chestnuts (17%). The EU produces relatively small amounts of groundnuts. Italy, Spain and Greece are the largest producers of nuts in the EU.

In 2013, Italy was the leading EU producer of edible nuts with a total of 250,923 tonnes (34% of EU production in 2013). Almonds and hazelnuts are the leading product groups grown in Italy. Italy is the second largest hazelnuts producer in the world in 2013, just ahead the U.S. and behind Turkey. Italian farms that cultivate hazelnut trees have been increasingly improving their production techniques hence enhancing the average yield per hectare and maintaining the Italian competitiveness in the world market.

In 2013, Spain was the second leading EU producer of edible nuts with a total of 200,800 tonnes (27% of EU production in 2013), with almonds being, by far, the largest cultivated product group. Hazelnuts are the second leading nut product cultivated in Spain.

Greece represents the third leading EU producer of edible nuts. In 2013, total edible nuts production amounted to 90,800 tonnes (12% of EU production in 2013). Greece is the EU's leading groundnut as well as pistachio producer. Due to its exceptional flavor, shapely form, and full kernel, the Greece pistachio has been identified by the European Commission as a Protected Origin Product, distinguishing it from all other pistachio varieties world-wide.

France is also one of the leading EU producers of edible nuts, with total production amounting to 51,186 tonnes in 2013. France is the foremost EU producer of walnuts, with production mainly based in the south-western and south-eastern regions of France. Figure 2 shows how the EU nuts production changes over time. On the whole, production of edible nuts in the EU is quite stable (CBI, 2009). Table 1 shows the major EU producers of each species of nuts. On the whole, production of edible nuts in the EU is quite stable (CBI, 2009)

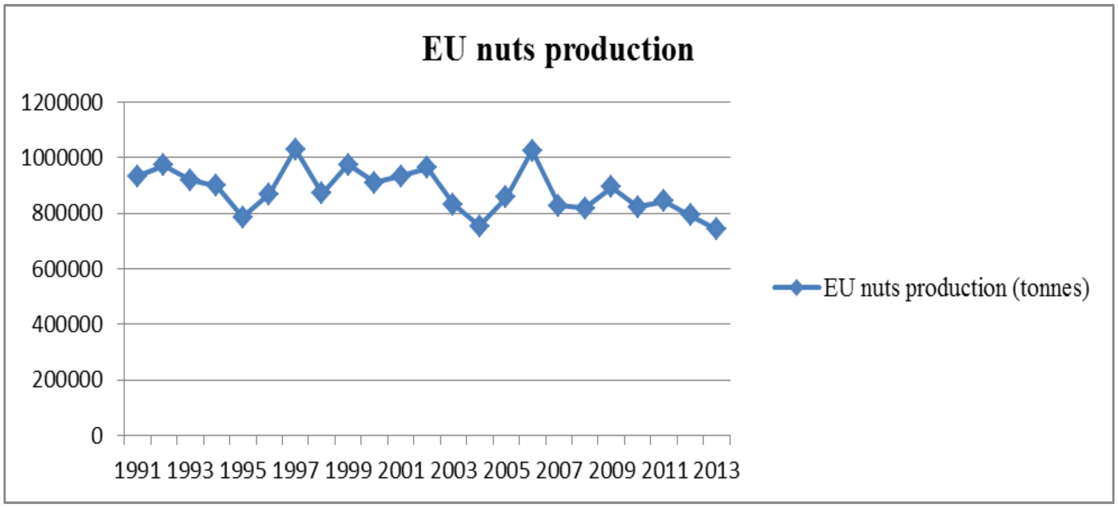

Figure 2. EU production of nuts. **Source: FAOSTAT, 2015**

Table 1. Major EU Producers by Item and Volume (tonnes)

Item	Country	2011	2012	2013
Almonds	Spain	208,800	211,700	149,000
	Italy	104,790	89,865	72,633
	Greece	29,800	29,000	29,900
Chestnuts	Italy	50,134	52,000	49,459
	Greece	21,500	28,700	29,900
	Portugal	18,271	19,100	24,700
Groundnuts	Greece	1,000	1,000	1,000
Hazelnuts	Italy	128,940	85,232	112,643
	Spain	17,590	14,600	15,300
	France	7,337	10,030	7,619
Pistachios	Greece	9,580	10,000	11,000
	Italy	3,079	2,850	3,202
Walnuts	France	38,314	36,476	33,716
	Romania	35,073	30,546	31,764
	Greece	29,800	24,200	18,800

Source: FAOSTAT, 2015

Imports

The EU is a net importer of nuts. In 2013, total nut imports by EU member countries amounted to 1.4 million tonnes. Since 2002, imports have increased by an average annual rate of 17% in terms of value and 4% in volume. Germany was the leading EU importer of edible nuts in 2013, accounting for about 29% of the total import volume, followed by Italy (15%), Spain (13%), the United Kingdom (12%) and France (9%). Groundnuts are, by far, the leading edible nut products imported by EU member countries, accounting for around 46% of the total import volume in 2013. Other important products are almonds, accounting for 16% of total edible nut import volume in 2013, hazelnuts (10%), and walnuts (6%). Table 2 shows the leading suppliers to the major EU importers of edible nuts. Table 3 shows the leading suppliers of different nuts EU imported. Figure 3 shows the trend of EU imports by nuts item and volume. Figure 4 shows the trend of EU import price of edible nuts.

Table 2. Leading suppliers to the top-5 EU importers of edible nuts, 2013, share in % of imported volume

Importing country	Import quantity of edible nuts (tonnes)	Leading suppliers in 2013
Germany	411,399	USA (31%) Argentina (18%) Turkey (11%) India (5%)
Italy	220,016	USA (22%) Turkey (16%) Spain (11%) Argentina (6%) Chile (5%) France (5%)
Spain	190,758	USA (53%) China (14%), France (6%)
United Kingdom	174,369	USA (21%) Argentina (14%) China (10%) Netherlands (7%) Nicaragua (7%)
France	136,367	USA (22%) Argentina (14%) Turkey (12%) Spain (11%)

Total EU	1,397,588	USA (33%) Argentina (21%) Turkey (8%) China (7%)

Source: COMTRADE, 2015

Table 3. Leading suppliers of EU importers of edible nuts, 2013, share in % of imported volume

Item	Import quantity (tonnes)	Leading suppliers in 2013
Almonds	302,200	USA (68%), Spain (16%)
Chestnuts	36,157	Italy (30%), Spain (22%) Portugal (14%)
Groundnuts	724,794	Argentina (55%), China (14%)USA (7%) Brazil (4%)
Hazelnuts	151,675	Turkey (63%) Georgia (9%) Italy (7%)
Pistachios	101,992	USA (47%) Iran (30%)
Walnuts	130,836	USA (42%) France (19%) Chile (6%)

Source: COMTRADE, 2015

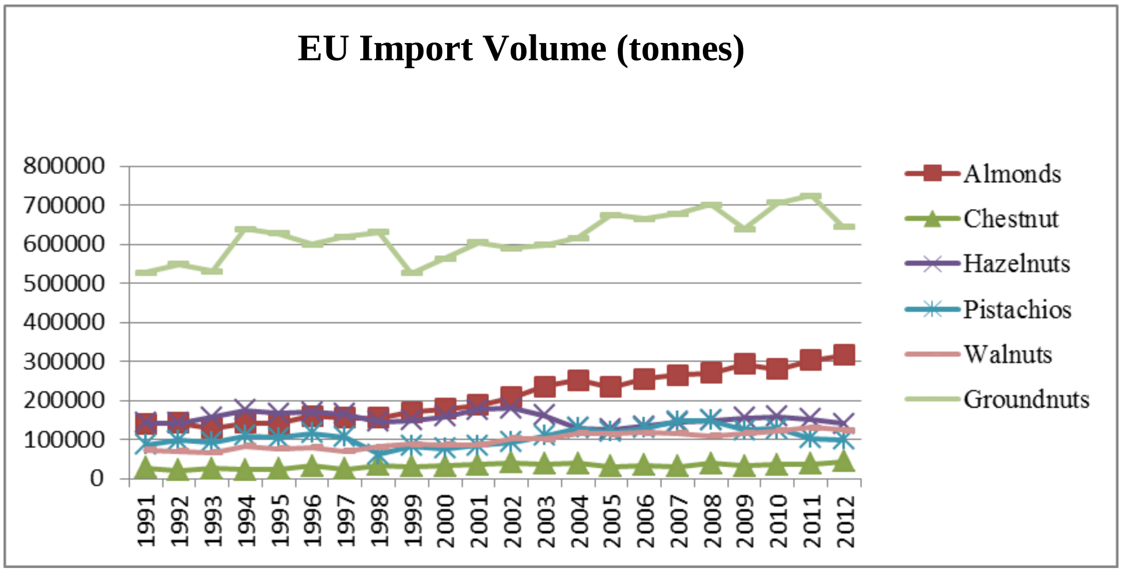

Figure 3. EU import volume of different species of nuts. Source: FAOSTAT, 2014

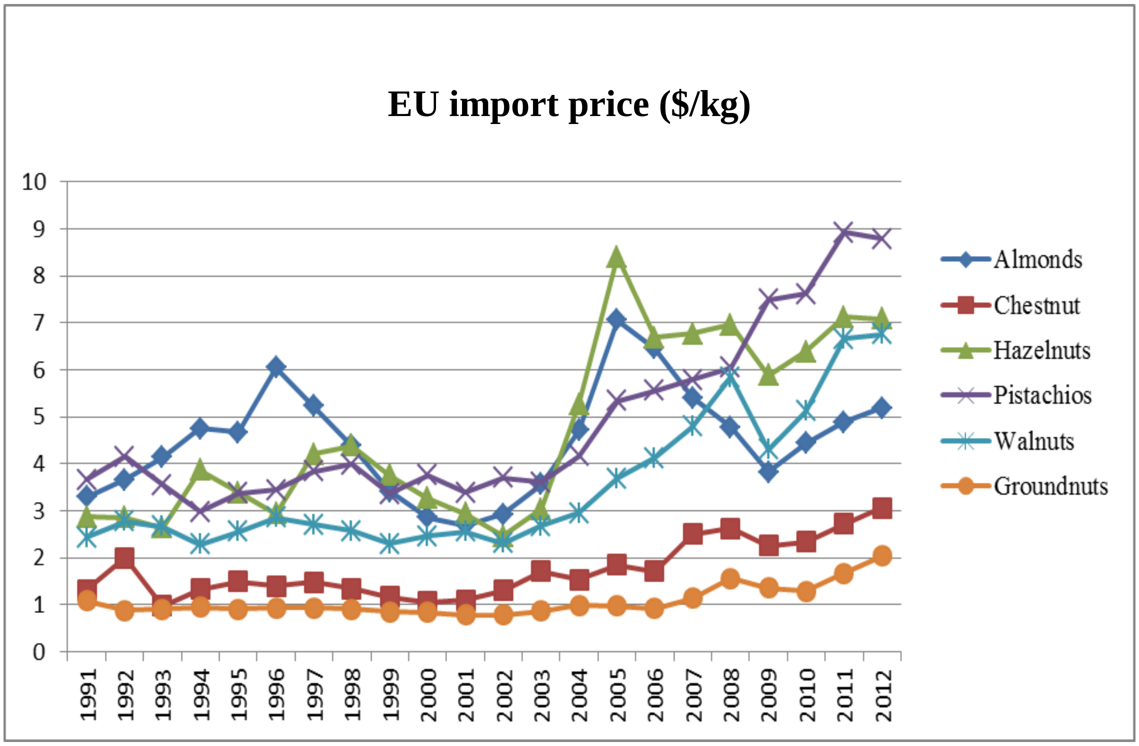

Figure 4. EU-27 import price of nuts. Source: FAOSTAT, 2015

Foods safety standards related to edible nuts

When exporting edible nuts to the European Union, the following food safety legislative requirements are relevant(CBI, 2005)[3]:

1) General Food Law

2) Aflatoxin levels

3) Maximum Residue Levels (MRLs)

General Food Law

In 2002, regulation EC 178/2002 has been adopted, laying down the general principles and requirements of food legislation and procedures in matters of food safety.

3 We only list the compulsory standard related to food safety issue. Some regulation such as packaging and labeling are not listed here.

The regulation is commonly known as the General Food Law, which prohibits the placing of unsafe food on the EU market. Food imported into the EU must comply with the relevant requirements of the general food law.

Aflatoxin levels

The most important food safety issue related to nuts is the possibility of aflatoxin contamination. In general, the main European quality requirements for edible nuts are maximum levels of aflatoxins. Aflatoxins, a subcategory of mycotoxins, are toxic chemicals that appear in the food chain as a result of fungal infection. High humidity which are conducive to proliferation of mould and development of aflatoxins should be avoided, particularly during storage. Aflatoxins are highly resistant to decomposition, temperature treatments (cooking and freezing), or being broken down in digestion. Food contaminated with aflatoxins can cause short-term and long-term adverse health effects, ranging from headaches, fatigue, skin irritations and organ damage to increased cancer risk from longer term exposure. At least 13 different types of aflatoxins are produced in nature and consist primarily of aflatoxins B1, B2, G1, G2 and M1. Aflatoxin B1 is considered the most toxic and has been directly correlated to adverse health effects, such as liver cancer, in many animal species. Crops which are frequently affected include cereals (maize, sorghum, pearl millet, rice and wheat), oilseeds (peanut, soybean, sunflower and cotton), spices (chilli peppers, black pepper, coriander, turmeric and ginger), and nuts (groundnuts and tree nuts). Aflatoxins were first discovered in England in 1960 when more than 100,000 turkeys and ducks died within a few months. In 1974, in northwest India, 108 people reportedly died from consuming aflatoxin-contaminated corn.

In 2004, 125 Kenyan people died and nearly 200 others were treated after eating aflatoxin-contaminated maize.

Since the discovery of aflatoxins in the 1960s, regulations have been established in many countries to protect consumers from aflatoxin-related health risks. The United States began regulating the concentration of aflatoxins in food and feed in 1968. Now at least 77 countries have regulations for aflatoxins, but the stringency of standards in these countries varies widely from 0 parts per billion (ppb) to 35 ppb (Food and Agriculture Organization, 2004). In the U.S., the maximum allowable concentration of total aflatoxins (sum of the aflatoxins B_1, B_2, G_1 and G_2) in foodstuffs is 20 ppb. The Canadian and Australian limits for total aflatoxins in nuts and nut-related products are 15 ppb. The Codex established a level of 15 ppb for total aflatoxins in food.

Until 1998, members of the EU implemented different standards for aflatoxins in foodstuffs. In 1997, the European Commission (European Commission, 1997) proposed new harmonized standards for total aflatoxins in food products which were finally enacted in 2002 (European Commission, 2001a). The new standards established a maximum allowable level of 4 ppb (2 ppb for Aflatoxin B1) of total aflatoxins in cereals, edible nuts, and dried and preserved fruits. The level represented stricter standards than the standards in most EU countries (although some country such as Austria had stricter aflatoxin standards than the harmonized standards), and was considerably lower than Codex recommendations and standards in many developing countries. For example, the new maximum allowable level of total aflatoxins in food was more than 50% lower than the original standards of eight EU members (Belgium, Greece, Ireland, Italy, Luxembourg, The Netherlands, Spain, and Sweden).

The EU's harmonized regulations for aflatoxins in food also include stricter sampling procedures and criteria for methods of analysis. The regulation requires that three 10kg samples must be taken and analyzed. The total aflatoxins content of any of the samples cannot exceed 4 ppb for total aflatoxins or 2 ppb for aflatoxin B1. If higher levels are found in any sample, the whole consignment is rejected. This leads to higher compliance costs and rejection rates of imports at the border. For example, complying with the new EU sampling method was estimated to result in an additional $150 cost per lot (a lot contains on average 16 tons) for peanut producers in USA (National Peanut Council of America, 1997).

A number of trade partners expressed concerns about the new EU aflatoxin standards to the WTO. For example, Peru emphasized that the new standards constituted an unjustifiable trade barrier and a violation of the WTO Agreement on SPS standards. India stated that the new regulations were unrealistic and impractical, and led to creation of non-tariff trade barriers. Thailand requested that the EU assist developing countries to comply with the new regulations.

On 26 February 2010, the European Union (EU) published Commission Regulation No. 165/2010 amending Commission Regulation No. 1881/2006 to increase the maximum aflatoxin levels for almonds and pistachios as well as apricot kernels, hazelnuts and Brazil nuts. For other tree nuts, maximum EU aflatoxin levels remain unchanged. Maximum limits on groundnuts, dried fruits, milk, spices, baby and infant foods remain unchanged. For example, the maximum EU levels of total aflatoxin for ready-to eat almonds, pistachios, hazelnuts and Brazil increased from 4 to 10ppb and increased from 10 to 15ppb for those nuts for further processing.

Maximum Residue Levels (MRLs)

Imports of edible nuts to the EU have to comply with the legislation for Maximum Residue Levels (MRLs) of a large number of pesticides. The maximum limits for pesticide residues in and on certain products of plant origin, including edible nuts, are laid down in Regulation (EC) No. 396/2005. In establishing a MRL, the EU takes into account GAP (good agricultural practices) recommendations, data on consumer residue intake, physico-chemical and biological properties of the chemical.

Previous Studies on EU Aflatoxin Standards

The EU's adoption of stricter harmonized standards for aflatoxins has been frequently cited as an example of how standards that exceed international standards requirement serve as "trade barriers" and result in large losses for exporting countries. It has been argued that stricter standards would impose serious costs or technical difficulties on the suppliers. Otsuki, Wilson and Sewadeh (2001b) employ a gravity model to estimate the impact of the implementation of the new aflatoxin standards in the EU on the changes in trade flow of groundnut products using trade data from Europe and Africa during 1989–1998. Their results suggest that the new EU regulations on aflatoxins would result in a trade flow that is 63% lower than when the Codex Alimentarius international standards were followed. A later article (Otsuki, Wilson and Sewadeh, 2001a) extends the analysis by broadening the product to cereal, edible nuts, and dried and preserved fruits, based on trade and regulatory survey data for 15 European countries and 9 African countries between 1989 and 1998. Their results suggest that African export revenue from the 15 European countries would likely decrease by 59% for cereals and 47% for dried and preserved fruits and edible nuts. The total loss is estimated to be nearly $400 million for cereals, dried and preserved fruits, and nuts under the Commission's new standards.

After six years of the implementation of EU harmonized aflatoxin standards, a new report from the World Bank (Rios and Jaffee, 2008) re-examines the effects of EU aflatoxin standards on edible groundnut exports from Sub-Saharan Africa. The conclusions of this article differ sharply from the "standards as barriers" hypothesis. It argues that the "lost" trade, which is attributed to the EU standards, is very low and the aggregate effects of the new EU regulation, in terms of intercepted trade, are small and vastly overstated by prior research.

Similarly, our article re-examines the impact of EU harmonized aflatoxin standards. In addition to estimating their impact on trade flow due to increased costs associated with complying with the standards, we take into account the standards' impact on consumer confidence in food safety.

Analytical Framework

In this section, we start with the introduction of a general model, then narrow down to the specific model and estimations of this article. In next section, we will apply the specific model to the sample data and discuss the estimation results.

The Basic Set-up

To gauge the impact of the EU harmonized aflatoxins standards on prices, trade flows, and consumer welfare, we start with a graphical illustration. First, we consider the cost-increasing effect in a small country case, supposing that domestic goods and imported goods are homogeneous. Compliance with this regulation is assumed to involve a cost *C*. The cost-increasing effect acts like a tariff on the quantity of trade (but without tariff revenue). Figure 5 shows the impacts of the cost-increasing effect on domestic market and world market. We will use price-wedge method to estimate the cost-increasing effect in this article. The left diagram in figure 5 shows upward-sloping supply and downward-sloping demand for a good inside a country. The world price, P_W, is assumed to be below the country's autarky price, so that it has excess demand at the world price and will import the good if it is free to do so. The impacts of the standard on the domestic market depend on whether the standard induces any change in the world price. In the small-country case, the country's imports are too small to matter for the world market and the world price remains unchanged. If the importing country is large, however, its reduced demand for imports causes the world price to fall. In the small-country case, the world price remains unchanged, and therefore the domestic price must rise by the full amount of the cost of compliance *C*. This rise in price causes domestic supply to rise and domestic demand to fall, along the respective supply and demand curves. Since the quantity of imports is the difference between demand and supply, imports are reduced by both of these changes.

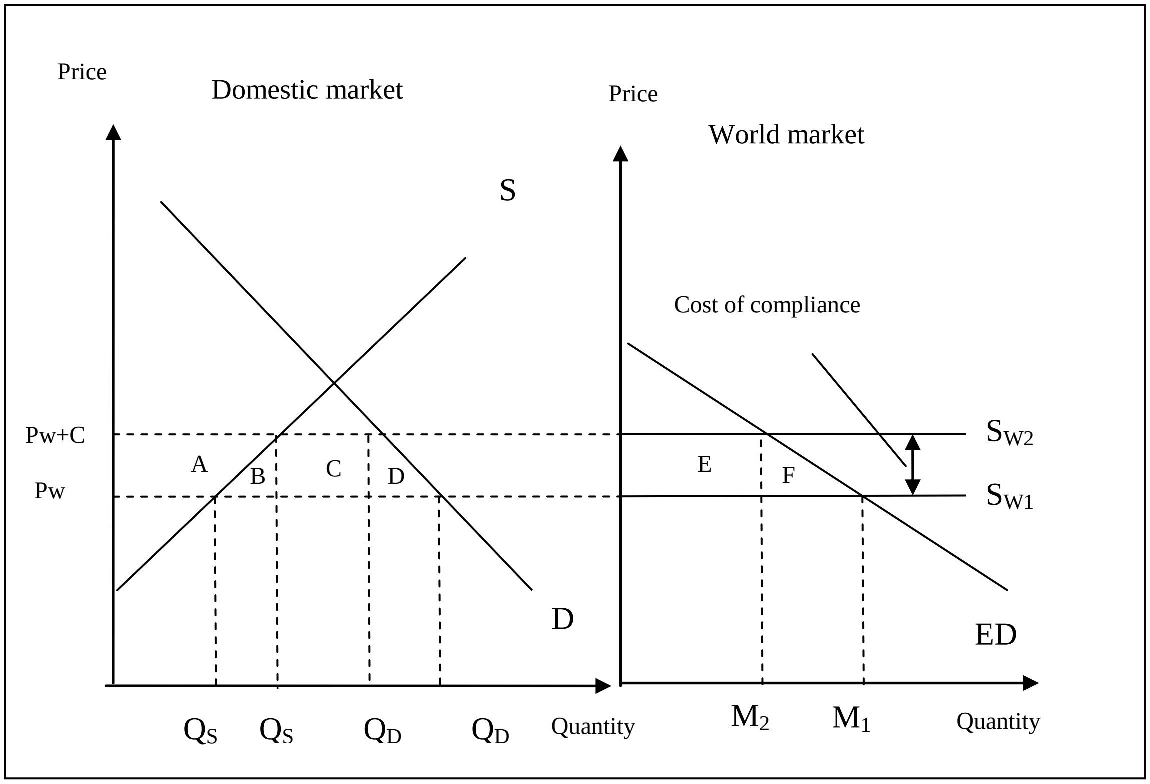

Figure 5. Cost-increasing effect in a small country case

As in figure 5, at price P_W, the quantity demanded is Q_{D1}, the quantity supplied by domestic producers is Q_{S1}, and the difference between these two amounts is the quantity imported (Q_{D1}- Q_{S1} in the left diagram and M_1 in the right diagram). When this importer (a small country) alone adopts a universal SPS regulation, the price in the importing country increases by the cost of compliance C. In this scenario, imports fall to M_2 (Q_{D2}- Q_{S2} in the left hand panel), which is also the intersection of the excess demand curve ED and the new compliance cost-inclusive product price P_W+ C (world supply curve shift from S_{W1} to S_{W2}). Consumer surplus also falls, by the area A + B + C + D, while producer surplus increases by A. The regulation therefore results in net welfare losses (or a reduction in the gains from trade relative to the free trade equilibrium at the intersection of ED and P_W) equal to the area E + F.

As discussed earlier, the demand-enhancing effect would increase consumer's demand through increased confidence in product safety and quality, and therefore shifts outward the demand curve. When the cost-increasing effect and demand-enhancing effect are jointly in place, the net welfare effect of the SPS standard (versus trade without the regulation) is ambiguous, depending on whether the consumer benefits from the information are greater than the cost of compliance. Figure 6 shows the impacts of SPS standard when considering both the cost-increasing and demand-enhancing effect in a small country case.

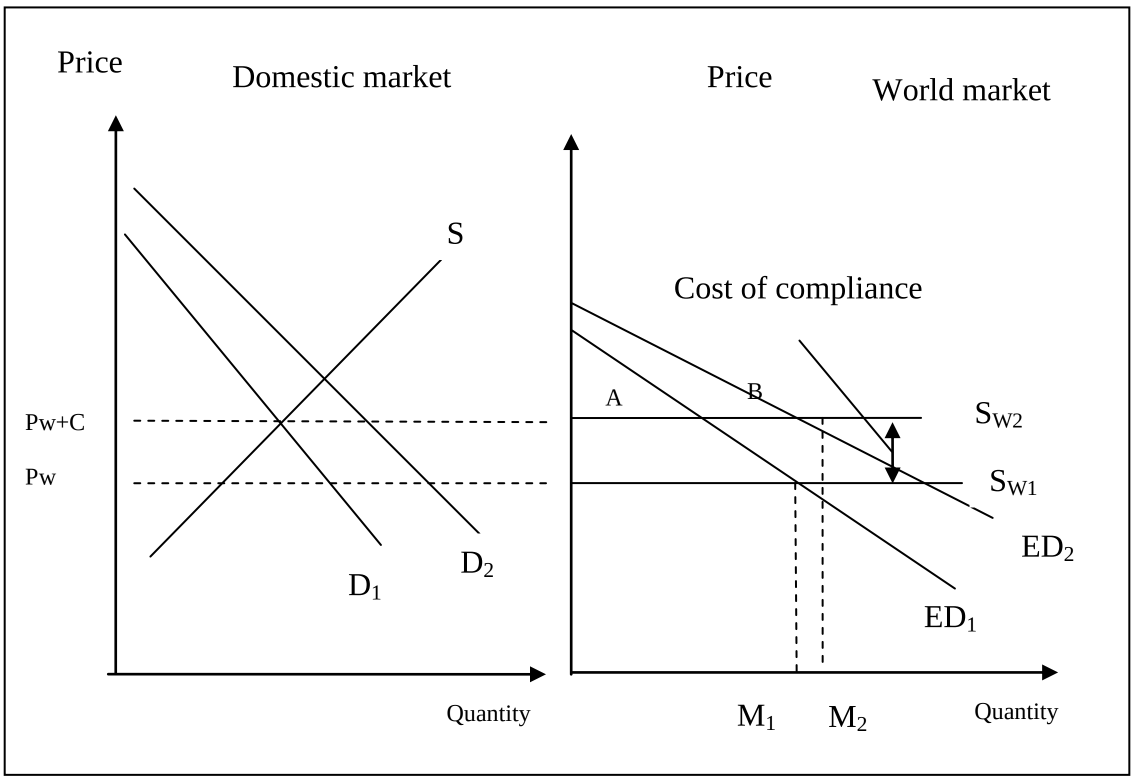

Figure 6. Cost-increasing and demand-enhancing effect in a small country case

As in figure 6, without the demand-enhancing effect, original demand curve is D_1, corresponding to the import demand curve ED_1 that is derived from domestic demand D_1 and supply S. Trade flow is given by M_1, derived from $ED_1$and world supply S_{W1}. SPS standard's demand enhancing effect raises the demand to D_2, but incurs the cost of compliance C, which raises the domestic price in the importing country to P_W+ C. This leads to trade of M_2, which can be above or below M_1. The domestic supply curve does not shift, as the regulation does not change the cost of domestic production. The gains from trade are now unambiguously larger (area A + B) than if the compliance costs had been borne with no shift in demand (area A).

Next, we relax the small country assumption. If a country changes the world price by its decision to adopt a SPS standard that affects the quantity of the product it imports, or if importers uniformly impose a barrier against all exporters, then the small country assumption is not appropriate. Considering only the cost-increasing effect in a large country case, the cost-increasing effect would reduce import demand of a country of any size from the world market. This reduced demand from the world market, if the country is large enough to matter at all, causes the world price to fall. The fall in world price implies that the domestic price rises by less than the cost of compliance *C*. Qualitatively, the rising domestic price has the same effects on domestic suppliers and demanders as in the small-country case, but quantitatively both the gain to suppliers and the loss to demanders are reduced, since the price increase is smaller. When there is demand-enhancing effect besides cost-increasing effect, the impacts on world price, trade flow, and consumer welfare are ambiguous.

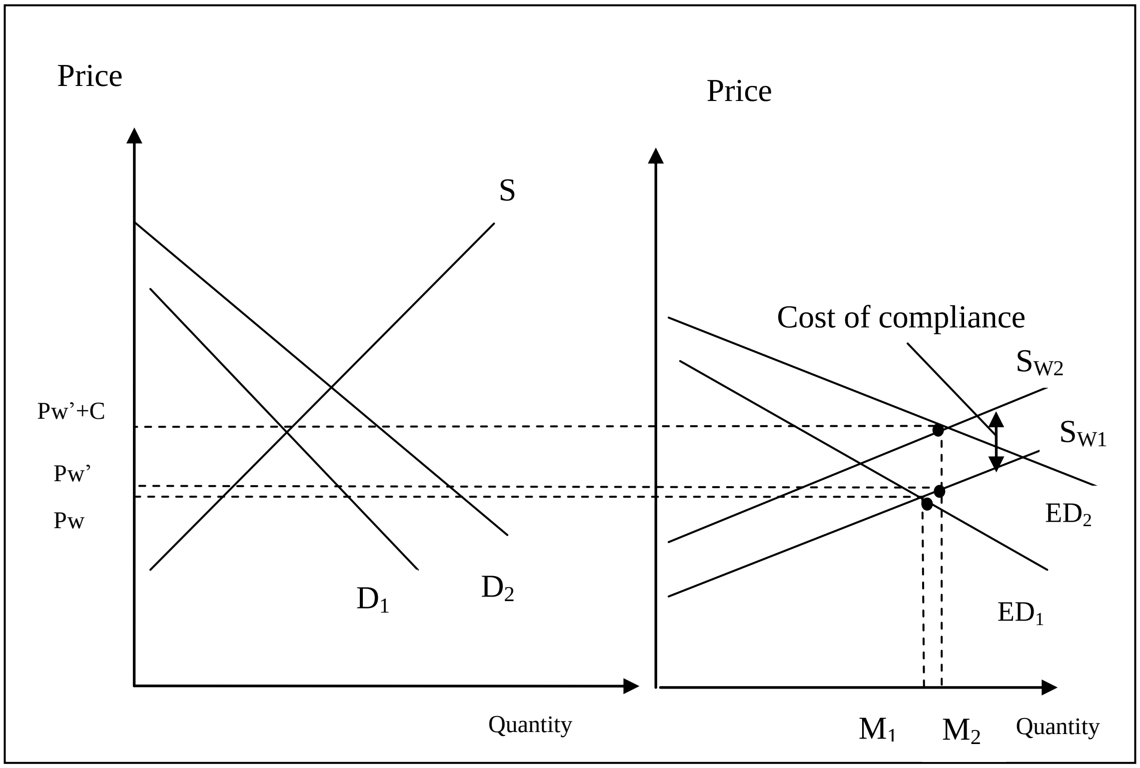

Figure 7. Cost-increasing effect and demand-enhancing effect in a large country case

For example, as shown in figure 7, in a large country case, the cost-increasing effect would shift the world supply curve from S_{W1} to S_{W2}. The demand-enhancing effect would shift the excessive demand curve from ED_1 to ED_2. If the demand-enhancing effect dominates, the world price would increase from P_W to P_W', trade flow would increase from M_1 to M_2, and domestic consumer surplus would decrease compared to the small country case. If the demand-enhancing effect is large enough, the world price would increase, the trade flow would increase, domestic consumer surplus would decrease compared to the small country case. If the cost-increasing effect dominates the demand-enhancing effect, the world price would decrease, trade flow would decrease, and domestic consumer surplus would be larger than the small country case. The domestic supply curve does not shift, as the regulation does not change the cost of domestic production.

Measuring the cost-increasing effect--The price-wedge method

In order to measure the cost-increasing effect, which is the cost of compliance *C* discussed in figures of last section, we use a price-wedge method. Price-wedge methods rely on the idea that NTBs can be gauged in terms of their impact on the product price in comparison to a reference price. The price wedge is estimated by comparing the price that would prevail without the NTB to the price that would prevail in the presence of the NTB if the price paid to suppliers were to remain unchanged (Deardorff and Stern, 1998). The estimate of the price wedge can be used as an input in a partial or a general equilibrium welfare effect of NTBs.

The price wedge is the difference between the nuts price exported to EU market P_{EU} and the export price to Non-EU market $P_{Non\text{-}EU}$. The price wedge is divided into the cost of complying with the EU aflatoxin standard and other factors[4].

(1) $$\text{Price Wedge} = P_{EU} - P_{Non-EU} = Cost_{SPS} + v_{other\ factors}$$

where P_{EU} is the average Free on Board (FOB) price of nuts exported to EU market; $P_{Non\text{-}EU}$ is the average FOB price of the same species of nuts to Non-EU countries; $v_{\text{other factors}}$ measures the price difference caused by other factors rather than aflatoxin standards of EU, such as other EU food safety standards and packing and labeling requirements; $Cost_{SPS}$ measures all the average cost incurred by complying with the aflatoxin standards

4. EU aflatoxin standard also leads to higher rejection rate after landed, but the percentage is quite small (Rios and Jaffee, 2008), so we ingore this part of cost.

of EU compared to Non-EU markets. $Cost_{SPS}$ exists before and after the harmonization of EU aflatoxin standard but could be different since the aflatoxin standards in EU became stricter in 2002. To measure the cost-increasing effect of the EU's adoption of stricter harmonized standards for aflatoxins in 2002, we measure how the price wedge change due to standards. As shown in equation (1), we need to consider other factors that contribute to the price wedge and change over time. For example, some big events that just affect the export price to EU market happened some year will contribute to the price wedge. Referring to literature (CBI, 2009; USDA, 2012) about the EU nuts market, as far as we know, there are no big events before and after 2002 during our sample period that might affect the price of nuts and thus contribute to the estimated price wedge over time. So, assuming other factors remain unchanged, equation (2) is estimated to measure the cost-increasing effect.

(2) $$\begin{array}{c}\text{price wedge}\\ \text{(adjusted for inflation)}\end{array} = a_0 + \sum_i b_i \cdot item_i + \sum_i c_i \cdot item_i \cdot SPS + u$$

SPS is a dummy variable that equals to 0 before 2002 and 1 after. $Item_i$ is indicator variable for nut *i*. We add this variable considering the cost-increasing effect could be different for different nuts. Estimated parameters c_i measures the cost-increasing effect of the standard for nut i. Considering other factors that contribute to the price wedge such as inflation may change over time, we use the GDP deflator to convert current value to real dollar value.

Calvin and Krissoff (1998) estimated the tariff rate equivalents of the technical regulations in the apple sector. In order to do so, they compared Cost, Insurance and

Freight (CIF) prices (landed prices including freight and insurance costs) of U.S. apples in a foreign country with wholesale prices in the foreign market. They assumed that the price gap consists of the tariff and technical barrier tariff rate equivalent. This approach was also used in a study by the European Commission which compared monthly CIF prices of U.S. pig and poultry meat with their wholesale price in the EU market (European Commission, 2001b). The difference in price between the U.S. product and the wholesale price of the comparable product was calculated as the price wedge in percentage terms.

Measuring the demand-enhancing effect

Further, we relax the homogeneous commodity assumption. To incorporate the heterogeneity of goods in consumers' preferences, we employ a CES model that is similar to Yue, Beghin and Jensen (2006) and Liu and Yue (2009). We introduce possible changes in the consumer confidence in product safety due to stricter standards to the basic CES utility function that incorporates the heterogeneity in consumer's preference for EU (hereafter referred to as "domestic") and imported nuts. Domestic and imported nut quantities are defined as *D* and *I*, respectively. A representative consumer maximizes the following utility function, subject to a budget constraint:

(3) $$\underset{D,I}{Max}\,U(D,I)=\left[\alpha D^{\rho}+(1-\alpha)I^{\rho}\right]^{\frac{1}{\rho}}+AOG \qquad s.t. \quad P_D D+P_I I+AOG=M_T$$

M_T is the expenditure on all goods; $\rho = 1-1/\sigma$, with σ measuring the elasticity of substitution between domestic and imported nuts; P_I and P_D are prices of imported and domestic nuts, respectively; AOG is the aggregate numéraire good; α and $1-\alpha$ are indicators of consumer confidence in domestic and imported nuts, respectively. They capture consumer confidence in product safety and quality, and the combination of all product characteristics other than price of a product. The indirect utility function is

(4) $$V(P_D, P_I, M) = (M_T - AOG^*)\left[\alpha^{\sigma} P_D^{1-\sigma} + (1-\alpha)^{\sigma} P_I^{1-\sigma}\right]^{\frac{1}{\sigma-1}}$$

and the corresponding expenditure function is

(5) $$e(P_D, P_I, u) = (u - AOG^*)\left[\alpha^{\sigma} P_D^{1-\sigma} + (1-\alpha)^{\sigma} P_I^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

The expenditure function and indirect utility function are used to estimate consumer welfare. The associated Marshallian demand functions are

(6) $$D = \frac{M_T - AOG^*}{P_D + P_I^{1-\sigma} P_D^{\sigma} \cdot \left(\frac{1-\alpha}{\alpha}\right)^{\sigma}}$$

(7) $$I = \frac{M_T - AOG^*}{P_I + P_D^{1-\sigma} P_I^{\sigma} \cdot \left(\frac{\alpha}{1-\alpha}\right)^{\sigma}}$$

These demand functions are used to estimate the new equilibrium quantities of imported and domestic nuts if the stricter standards were removed.

The marginal rate of substitution is equal to the relative price of the substitute goods or

(8) $$MRS = \frac{MU_D}{MU_I} = \frac{P_D}{P_I}$$

where *MRS* is the marginal rate of substitution, and MU_I and MU_D are the marginal utility of imported and domestic nuts, respectively. *MRS* is calculated from (3) and then substituted back into (8) and result in

(9) $$P_I = P_D \cdot (\frac{D}{I})^{\frac{1}{\sigma}} \cdot \left(\frac{1-\alpha}{\alpha}\right)$$

To estimate the parameters, we rearrange equation (9) and take natural logarithm to obtain

(10) $$\ln\left(\frac{D}{I}\right) = \sigma \cdot \ln(\frac{P_I}{P_D}) + \sigma \ln\left(\frac{\alpha}{1-\alpha}\right)$$

To measure the demand-enhancing effect of stricter food safety standards, we assume that the ratio $\alpha/(1-\alpha)$ is a function of *SPS*, which is a dummy variable that equals 1 when the stricter harmonized EU standards are in place, and 0 otherwise. We also consider other factors that may affect consumer demand over time such as GDP, exchange rate, and population. Some trade models such as gravity model also consider factors such as distance between importing and exporting countries, common languages between import and export countries, etc. Since these variables do not typically change over a short period of time, we do not consider how these variables might affect consumer demand over time in our model. Specifically, we assume that

(11) $$\frac{\alpha}{1-\alpha} = (\frac{\alpha_0}{1-\alpha_0}) \cdot \exp(\beta_1 \cdot SPS + \beta_2 \cdot GDP + \beta_3 \cdot Exchange\ Rate + \beta_4 \cdot Population)$$

β_1 measure changes in the relative consumer confidence in domestic and imported nuts due to stricter standards. It captures the demand-enhancing effect of SPS standards. If it is positive, it means that the stricter standards increase consumer confidence in domestic products more than in imported products; if it is negative, it means the stricter standards increase consumer confidence in imported products more than in domestic products. α_0 and $1- \alpha_0$ are consumer confidence in domestic and imported products. β_2 measures the impact of GDP on consumer confidence in imported and domestic products. β_3 measures the impact of exchange rate on consumer confidence in imported and domestic products. β_4 measures the impact of population on consumer confidence in imported and domestic products. Substitute equation (11) into (10), we get

(12)

$$\ln(\frac{D}{I}) = \sigma \cdot \ln(\frac{\alpha_0}{1-\alpha_0}) + \sigma \cdot \ln(\frac{P_I}{P_D}) + \sigma \cdot \beta_1 \cdot SPS + \sigma \cdot \beta_2 \cdot GDP + \sigma \cdot \beta_3 \cdot Exchange\ Rate + \sigma \cdot \beta_4 \cdot Population + u$$

We regress the left-hand side of equation (12) on $\ln(P_I /P_D)$, *SPS*, GDP, exchange rate, population, and use the regression coefficients to recover parameters σ, α_0, β_1, β_2, β_3 and β_4. The parameters' standard deviations are derived using the Delta method.

Estimating the impact of a change in EU aflatoxin standard on prices, trade flows, and welfare.

We conduct comparative statics to estimate the impact of a change in SPS standard on prices, trade flows, and welfare by assuming how the prices, trade flows, and consumer welfare changes if the SPS standard were removed while other things remain unchanged.

Under the small country assumption, if the EU aflatoxin standard was removed, the price of imported nuts would decrease by the full amount of cost of compliance since the world price is not affected by the standards. EU is assumed to be a small country in this analysis. Magee and Magee (2008) argue that being the largest country in world trade with 17% of world imports, the United States is a small country in world trade in that its trade policies have negligible impacts on world prices. Bradburd and Over (1982) report critical values of concentration of 50%-60% to be able to influence market prices. The U.S. courts have adopted a 50% market share as ability to control prices in a market (Cameron and Glick, 1998). The total EU import volume of the six species of nuts is around 23% of world import volume. Since 23% is comparable to the US share of 17% as in Magee and Magee (2008) and below the critical value of 50% reported in Bradburd and Over (1982) and Cameron and Glick (1998), So we assume that EU is a small country in the nuts trade market.

Then we can derive the new imported price P_I. Let S be the supply of EU domestic nuts (excluding the exports), which is an increasing function of the price of domestic nuts and exogenous parameter γ

(13) $$S(P_D, \gamma) = \gamma P_D^{\varepsilon_S}$$

Parameter ε_S represents the own-price elasticity of the domestic nut supply. Equilibrium domestic price P_D^e and quantity D are determined by the market equilibrium condition:

(14) $$D(P_D^e, P_I) = S(P_D^e, \gamma)$$

By substituting equation (6) into the left-hand side of equation (14), which is a function of P_D^e,and substituting equation (13) into the right-side of equation (14), which is also a function of P_D^e, we can get equation (15) with unknown variable P_D^e.

(15)
$$\frac{M_T - AOG*}{P_D^e + P_I^{1-\sigma} P_D^{e\sigma} \cdot \left(\frac{1-\alpha}{\alpha}\right)^{\sigma}} = \gamma P_D^{e\varepsilon_s}$$

All the other variables are known, so solving for P_D^e in equation (15), one can derive the new equilibrium domestic price P_D^e. Substitute new P_D (P_D^e) and new P_I into equation (6), we can get new quantity *D* after the removal of standards.

After get the new P_I and P_D, we substitute back into equation (7) to get the new import quantity. Compare the new import quantity to the old one, we can learn how the trade flow changes. For the welfare analysis, the Equivalent Variation (EV) is used to measure consumer welfare change, with $EV = e(P_0, u_1) - m_0$, where $P = (P_D, P_I)$ and subscripts 0 and 1 indicate initial and new prices, respectively. $e(P_0, u_1)$ is estimated by equation (5). Equivalent variation (EV) is a measure of welfare change by estimating how much more money a consumer would pay before a price increase to avert the price increase. We can learn from this estimation how EU consumer welfare changes.

In the next section, we will apply the framework introduced above to the data we collected and discuss the results. First, we estimate the cost-increasing effect (cost of compliance *C*). The estimation results will be used to estimate the new P_I supposing the standards were removed. That is, if the standards were removed, we suppose the P_I would decrease by *C*. Then we use equation (12) to estimate the demand-enhancing effect and other parameters. From this estimation, we can learn if there is demand-enhancing effect or not (whether parameter α changes). After obtain the estimates of cost-increasing effect and demand-enhancing effect, we proceed to estimate how the trade flows and consumer welfare would change if the standard were removed. By equation (15), we get new P_D. Using new P_I, P_D, and new parameter α (if there is demand-enhancing effect, α would change), along with estimates of other parameters, we can calculate the new trade flow by equation (7) and new consumer welfare by Equivalent Variation (EV) method introduced above.

Empirical Analysis

Data

We apply the framework developed in the analytical framework section to the EU aflatoxin standards harmonization case. Products included in this analysis are almonds, chestnuts, groundnuts, hazelnuts, pistachios and walnuts. We use data for the time period between 1991 and 2009. Trade, consumption and price data from 9 European countries are used in the analysis. They are obtained from FAOSTAT (Food and Agriculture Organization, 2015). We include those countries whose corresponding data are available and those countries whose pre-harmonized standards were not as strict as the EU harmonized aflatoxin standards. The European countries included in this article are Bulgaria, Cyprus, France, Germany, Greece, Hungary, Italy, Portugal, and Spain. Bulgaria, Cyprus, and Hungary joined the EU after 2002. However, they implemented the harmonized EU aflatoxin standards in 2002 as candidate EU countries. So we include those countries in our estimation. Those countries are included both before and after 2002 like all other countries that without standard before 2002 and with standard after 2002. So, we argue that this should not affect the results. Our dataset is disaggregated by country (not aggregated as EU). For each country and each nut, domestic production minus exports (consumption of domestic supplied products) is used to estimate D and the producer price is used to estimate P_D. The total import quantity for each nut product from around the world is utilized to estimate I. The weighted average CIF price is used to estimate P_I. Since the harmonized EU aflatoxin standards came into force in 2002, the dummy variable *SPS* equals 0 between 1991 and 2001 and 1 between 2002 and 2009. Data to calculate P_{EU} and $P_{Non\text{-}EU}$ is obtained from COMTRADE database, where P_{EU} is the average FOB price of nuts exported to EU market; $P_{Non\text{-}EU}$ is the average FOB price of the same species of nuts to Non-EU countries.

Estimation results

Cost-increasing effect

To estimate the cost-increasing effect of the aflatoxin standards, we first calculate the price wedge between the export price of each nut to EU market and Non-EU markets during our sample period 1991-2009. Then we pooled those data and run an OLS regression on equation (2) and estimated parameters c_i measures the cost-increasing effect of the standard for nut i. We then calculate the weighted average $\sum_i s_i c_i$ of the six nuts ($341.41/tonne), where s_i is average share of imports of nut i during 2002-2009. Estimation results are listed in table 4. The estimation results of cost of compliance for groundnuts and almonds are smaller than those for other four nuts. This may due to the economies of scale that groundnuts and almonds are the largest two traded nuts in terms of volume. Economies of scale are the cost advantages that enterprises obtain due to size, throughput, or scale of operation, with cost per unit of output generally decreasing with increasing scale as fixed costs are spread out over more units of output (incremental production).

Table 4. Cost-increasing effect of EU aflatoxin standard in 2002

Item	Estimated value	Standard Error	Import Share (average value 2002-2009)
Almond	205.29**	84.67	20.20%
Chestnut	633.92***	148.14	2.84%
Groundnut	284.40***	58.97	46.08%
Hazelnut	563.07***	84.14	11.83%
Pistachio	406.80***	112.90	10.03%
Walnut	484.56***	101.56	9.02%
Weighted Average	341.41***	36.84	

Demand-enhancing effect

We run two stage least square regression (2SLS) on (12) since the right hand side variable $ln(P_I/P_D)$ is endogenously determined. The instruments we use are wage index, price index of total agricultural inputs, and year dummy variables. The estimated results for σ and consumer confidence indicator parameters are shown in table 5. As shown in equation (11), the coefficient β_1 of dummy variable *SPS* in our model captures the change in consumer preference in imported and domestic nuts ($\frac{\alpha}{1-\alpha}$) associated with the implementation of EU aflatoxin standards. The coefficient β_1 for dummy variable *SPS* is significant and negative, which indicates that the implementation of the stricter harmonized EU aflatoxin standards has significantly increased consumer's preference for imported nuts relative to domestic nuts. This is consistent with the fact that consumers in the EU want to make more informed purchasing and consumption decisions. Variety, convenience, nutrition and health are important factors for making purchase decisions. These factors have an impact on the consumption of edible nuts (USDA, 2012).

The coefficient β_2 is positive and significant. GDP measures the economy of a country. Usually the higher the GDP, the more developed the country is. The positive sign of β_2 means that the more developed a country is, the consumers in that country like the domestic products more. The coefficient β_4 is negative and significant. It means that the more population a country has, the country would more like imported products.

Table 5. Estimated parameters of elasticity of substitution and consumer preference

Parameter	Estimated Value	Approximate Standard Deviation
σ	1.15***	0.19
β_1 (SPS)	-0.90***	0.25
β_2 (GDP)	1.95**	0.82
β_3 (Exchange Rate)	0.015	0.017
β_4 (Population)	-0.06***	0.02
α_0	0.74***	0.07

Note: *** means the coefficient is significant at 1%, ** means the coefficient is significant at 5%, *means the coefficient is significant at 10%. Number of observations: 332. Wald chi2(5) = 71.17, Prob > chi2 = 0.0000

Trade flow and welfare changes

Compliance costs and costs associated with higher rejection rate due to the EU aflatoxin standards increase the import prices of nuts. If the higher standards do not resolve consumer uncertainty about product quality and safety, the trade volume and consumer welfare would decline. Furthermore, the net welfare often decreases compared to before the implementation of the stricter standards. This explains why SPS standards are often considered a barrier or protectionist tool. However, if the regulatory standards of imports resolve consumer uncertainty about product quality and safety, thereby stimulating demand, and if the standards' demand-enhancing effect is sufficiently large, then the trade volume and consumer welfare could be greater than under unregulated trade. This implies that exporting countries may benefit through the demand-enhancing regulatory standards imposed by the EU.

In this section, we analyze the impact of the stricter harmonized EU aflatoxin standards on EU nut imports, EU domestic consumer welfare, and EU nut producer surplus. The welfare analysis is conducted by estimating the impact on welfare if the standards were removed while the other factors remain unchanged. If the stricter EU aflatoxin standards were removed, price of imported nuts P_I would decrease by the cost of compliance (estimated in previous section). However, if the standards were removed, consumer confidence in imported nuts would also decrease, since the analysis indicates stricter EU aflatoxin standards are demand-enhancing and increase consumer confidence in the safety and quality of imported nuts. Decreased import prices have a positive effect on import quantity demanded and consumer welfare. Conversely, decreased consumer confidence in imported nuts has a negative effect on import quantity and consumer welfare. Therefore, how the trade volume and consumer welfare would change after the removal of the EU higher aflatoxin standards is ambiguous and depends on the interaction between the demand-enhancing effect and cost-increasing effect.

For EU domestic nut producers, the supply function is specified in equation (13). The supply elasticity of almond is around 0.97, and that of walnut is around 0.74 (Russo, Green and Howitt, 2008). The average, 0.85, is used as the supply elasticity in the following welfare analysis. The consumer welfare changes of 9 EU countries between 2007 and 2009 with the removal of the stricter harmonized EU aflatoxin standards are estimated. Estimation method is introduced in the analytical framework. The results of the welfare analysis are shown in table 6.

Table 6. Import and Welfare Changes with Elimination of EU Aflatoxin Standards*

Year	Changes in Import (tonnes)	EV ($)	Changes in Producer Surplus ($)
2007	-170,139 (-18.33%)	-463,607,950	745,366,692
2008	-165,765 (-17.97%)	-589,667,533	897,222,655
2009	-163,175 (-17.47%)	-433,674,567	787,300,151

*Note: The results are for the 9 sample EU countries in our analysis rather than the whole EU.

The results show that for all of the years from 2007 to 2009, if the harmonized EU aflatoxin standards were removed, the imported quantity of nuts would decrease, the EU consumer would be worse off, the EU nut producers would be better off. For example, for year 2009, if the EU aflatoxin standards were removed, the nut imports of those 9 EU countries would decrease by 163,175 tonnes (around 17.5%) and the consumer welfare would decrease by $433 million, which is contrary to the findings from previous studies showing that the implementation of the stricter EU standards would decrease imports (Otsuki, Wilson and Sewadeh, 2001a, b). Because the cost-increasing effect would restrict trade and decrease consumer welfare and demand-enhancing effect would promote trade and increase consumer welfare, the results of the welfare analysis that removing the aflatoxin standards would decrease trade flow and consumer welfare indicate that in this case of stricter aflatoxin standards, the demand-enhancing effect of stricter food safety standards dominates its cost-increasing effect, resulting in increasing exporting and importing countries' consumer welfare.

One important contribution of our article is that both the demand-enhancing effect and cost-increasing effect of food safety standards are considered in the import and welfare estimations. So we compare the results to the situation when only considering the cost-increasing effect and when only considering the demand-enhancing effect. Table 7 shows the import and welfare changes when only the cost-increasing effect is considered. That is we suppose if the standard were removed, the imported price P_I would decrease by the cost of compliance *C*, but the parameter α and 1-α remain unchanged. Table 8 shows the import and welfare changes when only considering the demand-enhancing effect. That is we suppose if the standard were removed, the import price would remain unchanged, but the parameter α would increase (1-α would decrease).

Table 7. Import and Welfare Changes with Elimination of EU Aflatoxin Standards* (Only consider the cost-increasing effect)

Year	Changes in Import (tonnes)	EV ($)	Changes in Producer Surplus ($)
2007	91,724 (9.88%)	360,883,713	-56,569,869
2008	92,860 (10.06%)	321,851,970	-35,941,829
2009	108,243 (11.59%)	333,567,271	-31,273,000

*Note: The results are for the 9 sample EU countries in our analysis rather than the whole EU.

Table 8. Import and Welfare Changes with Elimination of EU Aflatoxin Standards*(Only consider the demand-enhancing effect)

Year	Changes in Import (tonnes)	EV ($)	Changes in Producer Surplus ($)
2007	-242,001 (-26.08%)	-677,607,945	797,020,103
2008	-230,787 (-25.01%)	-771,584,258	924,644,981
2009	-235,991 (-25.27%)	-642,668,784	870,486,916

*Note: The results are for the 9 sample EU countries in our analysis rather than the whole EU.

As shown in table 7, without considering the demand-enhancing effect, the estimation results are opposite to the results considering the demand-enhancing effect. That is the stricter EU aflatoxin standards would impede imports, which is similar to findings from previous studies (Otsuki, Wilson and Sewadeh, 2001a, b). Also, consumer welfare is decreased by implementing the stricter standards. The notable change in results suggests that when the demand-enhancing effect of the standards is ignored, the negative impact of SPS standards is overestimated. These results show that it is very important to consider the impact of SPS standards on consumer confidence in food safety, and ignoring it could lead to biased estimations of imports and welfare changes.

Our comparative statics analysis replies on the assumption that EU is a small country. If this assumption is relaxed, our estimation results may be biased. For example, if the demand-enhancing effect dominates, then the new P_I would be over-estimated, and new equilibrium price P_D would also be over-estimated. Consumer welfare change would be over-estimated.

Conclusion

Product safety has become an increasing concern in many countries. Consumers desire a safe food supply and are willing to pay a premium for safer food, and thus many governments have established food safety standards. Standards are designed to facilitate information exchange, ensure quality, and achieve the provision of public goods. In particular, SPS standards can improve human health and quality of life. SPS standards can also improve information symmetry between suppliers and consumers about safety and quality of products, thereby facilitating market transactions and expand export opportunities (Wilson, 2001). However, standards can also be used for merely protection purposes in practice. For example, SPS standards may discriminate against foreign suppliers or help domestic firms gain strategic trade advantages over foreign competitors. Unnecessary standards could impose excessive costs on consumers and reduce net social welfare.

Both the standards that resolve information-based market failures (e.g. standards that resolve consumer uncertainty with food safety) and the standards that merely protect domestic producers have the same cost-increasing effect on international trade (i.e. increase the import price). However, the former may increase consumer welfare, and the later could reduce consumer welfare. In this article, we extend the framework used by Yue, Beghin, and Jensen (2006) and Liu and Yue (2009) to incorporate the stricter food safety standards' demand-enhancing effect, and its interaction with cost-increasing effect in trade flow and welfare analysis. The extended model is applied to investigate how the stricter harmonized EU aflatoxin standards in nut industry affect consumer confidence in product safety and quality, imported price and quantity, and consumer welfare. Our results reveal that while the stricter standards increase production and trade costs and lead to higher import prices, they also significantly increase the consumer confidence in the imported nuts, and increase the trade and consumer welfare the importing countries.

Most of the existing literature on food safety standards emphasizes standards' roles as non-tariff barriers and the negative impacts on trade flow due to the cost-increasing effect without considering their demand-enhancing effect, which may overestimate the standards' negative effect on trade flow and consumer welfare estimation. Our results suggest that by removing stricter standards, the efficiency gains might not overcome losses from reduced food safety. Our analysis could be useful in the continuing debate over the "precautionary principle" and the SPS Agreement. Scientific risk assessment to human health associated with food safety issues should be considered in setting standards, but the fact that the consumers' positive subjective assessment of food safety also plays an important role in enhancing demand for food should not be ignored. They both impact the international trade flow. Our results suggest that sometimes more stringent food safety standards can facilitate trade and increase consumer welfare. Our article provides policymakers and analysts with an example of how the increased food safety and expanded trade can be compatible and even mutually reinforcing (Buzby and Unneveh, 2003).

One limitation of our study is that this is a single-market partial equilibrium analysis, so our results may overstate the welfare gain of EU consumers. Therefore, our estimation may provide an upper limit of welfare gain from implementing the harmonized EU aflatoxin standards.

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