An Empirical Assessment of the Effects of SPS Regulations on U.S. Fresh Fruit and Vegetable Exports

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ABSTRACT

A fundamental requirement in agricultural trade is that imported products are safe, and do not pose a risk to human, animal and plant health. To address this issue, all countries maintain measures to ensure that imported food is safe for consumers, and to prevent the spread of disease among animals and plants. These measures, by their nature, can affect competitiveness by increasing the costs of imports or prohibiting them altogether. To ensure that these measures are used for their intended purpose and not as protectionist measures, WTO member countries signed the Agreement on the Application of Sanitary and Phytosanitary measures.

A growing number of studies attempt to quantify the effects of SPS regulations on international trade flows. However, precious little research is dedicated to determining the effects of specific phytosanitary regulations on trade flows and, more importantly, questions regarding SPS regulations and their impact as “trade barriers” or “trade catalysts” remain to be settled.

This thesis contributes to existing literature in two ways. First, a comprehensive and user friendly database on specific phytosanitary regulations faced by U.S. exports of onions, peas, walnuts, apples, cherries, grapes, peaches/nectarines, oranges and strawberries to 176 countries is developed for the period 1999-2009. Second, this database is used for an empirical investigation to determine how existing SPS regulations affect U.S. fruit and vegetable exports.

The results indicate that initially, phytosanitary treatments act as “barriers” to trade. However, as exporters’ experience grows, the negative impact of treatments is reduced and eventually eliminated.

EXECUTIVE SUMMARY

A fundamental requirement in agricultural trade is that imported products are safe, and do not pose a risk to human, animal and plant health. To address this issue, all countries maintain measures to ensure that imported food is safe for consumers, and to prevent the spread of disease among animals and plants. These measures, by their nature, can affect competitiveness by increasing the costs of imports or prohibiting them altogether. To ensure that these measures are used for their intended purpose and not as protectionist measures, WTO member countries signed the Agreement on the Application of Sanitary and Phytosanitary measures.

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To achieve the first objective, country, commodity and year specific SPS regulations are obtained from the Export Certification Project (EXCERPT) database. EXCERPT is a comprehensive database of phytosanitary import requirements of more than 250 countries collected on behalf of the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) by Purdue University. A custom computer application written in the Java programming language was developed to extract, analyze and store monthly phytosanitary requirements of 176 partner countries for U.S. exports of onions, peas, walnuts, apples, cherries, grapes, peaches/nectarines, oranges and strawberries. Phytosanitary requirements contained in the database consist of: phytosanitary treatments, origin and destination restrictions, systems approaches to pest risk management and sampling requirements.

To achieve the second objective, country, commodity and year specific phytosanitary regulations are matched to U.S. bilateral fresh fruit and vegetable exports and a product line gravity equation that accounts for zero trade flows is developed to investigate their impact on trade. Additionally, because there may be fixed costs associated with the establishment of phytosanitary treatment facilities as well as possible “learning-by-doing” effects, an “experience” variable is specified. This variable records the commodity specific cumulative number of importers requiring phytosanitary treatments and allows for the calculation of a threshold value i.e. the point at which exporters have accumulated enough phytosanitary treatment experience such that they are able to treat larger shipments more efficiently.

The results indicate that initially, phytosanitary treatments have a significant negative effect on trade relative to unencumbered exports and can therefore be categorized as "trade barriers". However, as exporters' treatment experience grows, the negative effect diminishes dramatically and eventually disappears. This occurs at a threshold level of 16, meaning that phytosanitary treatments do not restrict trade once an exporter reaches 16 cumulative treatments during the 1999-2009 time period. On average, U.S. exporters attain the cumulative phytosanitary treatment threshold of 16 in the second year, suggesting that after two years, U.S. exporters have accumulated sufficient phytosanitary treatment experience such that phytosanitary treatment requirements no longer present a barrier to trade.

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List of Abbreviations

ACO	Authorized Certification Official
AD	Additional Declaration
CAFTA	Central America Free Trade Agreement
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales
CERIS	Center for Environmental and Regulatory Information Systems
ERS	Economic Research Service
EXCERPT	Export Certification Project
FOB	Free On Board
FTA	Free Trade Agreement
HS	Harmonized Tariff System
IATRC	International Agricultural Trade Research Consortium
IP	Import Permit
ISPM	International Standards for Phytosanitary Measures
MB	Methyl Bromide
NAFTA	North American Free Trade Agreement
NAPPO	North American Plant Protection Organization
NIFA	National Institute of Food and Agriculture
NPPO	National Plant Protection Organization
NTM	Non Tariff Measure
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PPML	Poisson Pseudo-Maximum Likelihood
PPQ	Plant Protection and Quarantine
SPS	Sanitary and Phytosanitary
TBT	Technical Barrier to Trade
TRAINS	Trade Analysis and Information System
UNCTAD	United Nations Conference on Trade and Development
URAA	Uruguay Round Agreement on Agriculture
URL	Universal Resource Locator
USDA	United State Department Of Agriculture
USITC	United States International Trade Commission
WTO	World Trade Organization

1. Introduction

We have witnessed a dramatic shift in the focus of agricultural trade policy concerns from border related costs such as simple tariffs that dominated much of the research and policy agenda in the lead up to the Uruguay Round Agreement on Agriculture (URAA), to non-tariff measures and other policies that have the potential to be even more trade restricting. Most economists now agree that as tariffs are reduced, new obstacles of protection have surfaced that are more obscure in nature and have the potential to be more trade restricting (Baldwin, 2000, Lawrence, 1996; Preeg, 1998).

Among the potential list of non-tariff measures affecting the competitiveness of U.S. agricultural exports, sanitary and phytosanitary (SPS) measures occupy a special place. First, SPS measures are particularly prominent in agricultural markets because of the sensitive nature of issues such as food safety and the protection of plant and animal health from pest and disease risks. Second, the World Trade Organization (WTO) Agreement on the Application of SPS Measures permits countries to adopt their own set of standards to protect human, animal, or plant health provided these standards are based on risk assessment, not discriminatory between countries with similar conditions, and are minimally trade distorting to prevent the disingenuous use of these standards as instruments for protectionism. While this "national sovereignty" principle was instrumental to securing ratification of the SPS Agreement by WTO members, it has led to contentious trade disputes when countries have adopted measures that severely limit market access to achieve extremely incremental or speculative health or safety benefits. The WTO reports that members have lodged some 277 official complaints related to

SPS measures since 1995. Over 20 percent of these complaints are related to fruits and vegetables, a disproportionately high share for a sector that has accounted for roughly ten percent of global agri-food trade over the past two decades (WTO, 2009).

U.S. fresh fruit and vegetable exports have faced substantial SPS regulations in international markets. Phytosanitary measures are one of the most serious constraints facing U.S. exports of fruits and vegetables. The long history of the U.S-Japan apple dispute over such pests as fire blight and codling moth, and mitigation procedures such as orchard inspections, buffer zones, and chlorine treatment, provides just one prominent example of SPS standards and certification procedures that has seriously affected U.S. competitiveness, and in some cases, has completely shut-off exports (Calvin and Krisoff 2005). SPS requirements for a single commodity can vary widely across trading partners. For example, U.S. apples must undergo a chlorine dip if exported to Chile; face regional bans in Canada; and undergo cold treatment and methyl bromide fumigation if shipped to Egypt (Export Project Certification Database (EXCERPT)). Extensive technical discussions between trading partners provide the basis for determining the specific elements of an import protocol, and disagreements over specific requirements can persist for years. For example, the U.S. government has registered a number of official complaints at the WTO about measures that that have increased costs or limited market access for its fruit and vegetable exports, including Australia’s restrictions on U.S. exports of table grapes; Indonesia’s policies for recognition of pest-free areas; Japan’s restrictions on U.S. citrus exports, and China’s varietal restrictions on exports of U.S. apples (WTO, 2009).

Production of fruit, vegetables, and tree nuts has grown significantly in the United States over the past twenty years. From 1990 to 2009, cash receipts have nearly doubled from $21.3 billion in 1990 to $40.5 billion in 2009 (USDA/ERS). While a significant portion of this growth may be attributed to increases in domestic consumption of fresh fruits and vegetables, exports have also contributed to this growth. As shown in Figure 1.1, exports of fresh fruits, tree nuts and vegetables tripled from 1991 to 2010. Exports of fresh fruit and tree nuts increased from $3.4 billion in 1991 to almost $11 billion in 2010 while vegetable exports have increased from $1.97 billion to $5.4 billion over the same period. Over the last ten years, the growth rate of all U.S. fruits and tree nuts exports has been nearly 9 percent while the growth rate of vegetables exports was close to 6 percent.

Figure 1.1 Exports of Fruits and Vegetables (in millions of USD)

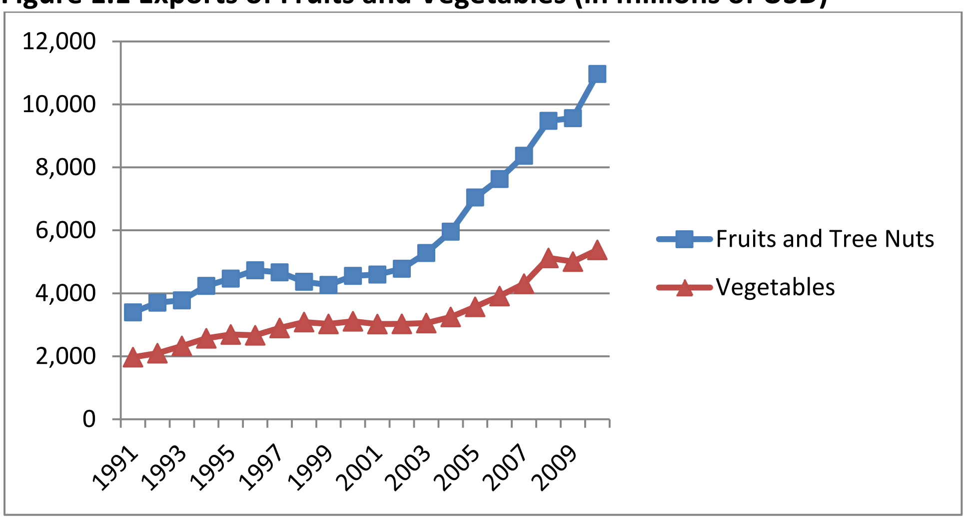


Figure 1.2 reports the top 20 fruit and vegetables product exports by value at the HS6-digit level for the period of 2006 to 2010. Unshelled almonds have the largest value of exports, averaging $1.6 billion annually. The leading fresh fruit exports are apples, grapes, and oranges (including tangerines), with combined sales averaging nearly $2.0 billion annually, or about a quarter of the value of total fresh fruit exports. Apples and grapes averaged over $700 million

and $400 million, respectively, in annual export sales during 2006-2010 and oranges averaged over $400 million. Export sales of fresh berries are led by strawberries, at $304 million USD. Among vegetables, lettuce is the largest fresh export (with an average of $298 million) followed by tomatoes, the second-largest fresh export (with an average of $196 million). Exports of dried beans and onion each have an average of $190 and $157 million in exports.

Figure 1.2 Top 20 Average U.S. Exports from 2006 to 2010 by Value (in millions of USD)

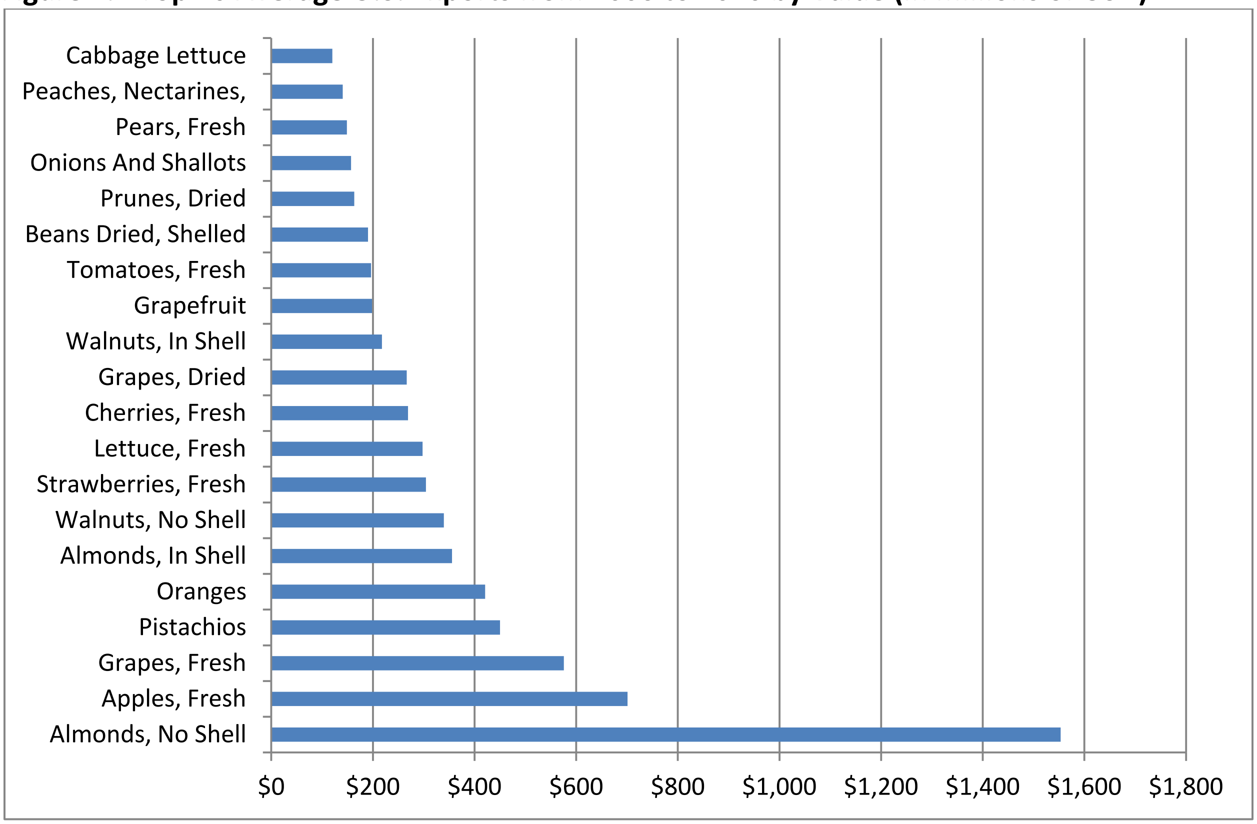


Figure 1.3 shows the growth rate of the top 20 U.S. exports of fresh fruits and vegetables over the last five years. Exports of tree nuts have been the fastest growing, with four of the top five largest growth rates. At slightly over one percent, exports of fresh grapes and oranges, which are relatively large in terms of export values, are not growing as fast as other fresh fruits, such as fresh apples and cherries whose growth rates are over two percent. For fresh vegetables, exports of onions and shallots grew the fastest while exports of cabbage

had a negative growth rate. An interesting point to be made is that the five year average growth rate of the products listed in Figure 1.3 is well above the growth rate of their individual sectors. For example, the growth rate of fresh vegetable exports over the period of 2006 to 2010 was 4.44 percent which is approximately half of the growth rate of fresh apples or cherries. The growth rate of tree nuts exports was 8.93 percent, three times lower than the growth rate of unshelled walnuts.

Figure 1.3 Growth Rates of Top 20 U.S. Fruits and Vegetables Exports

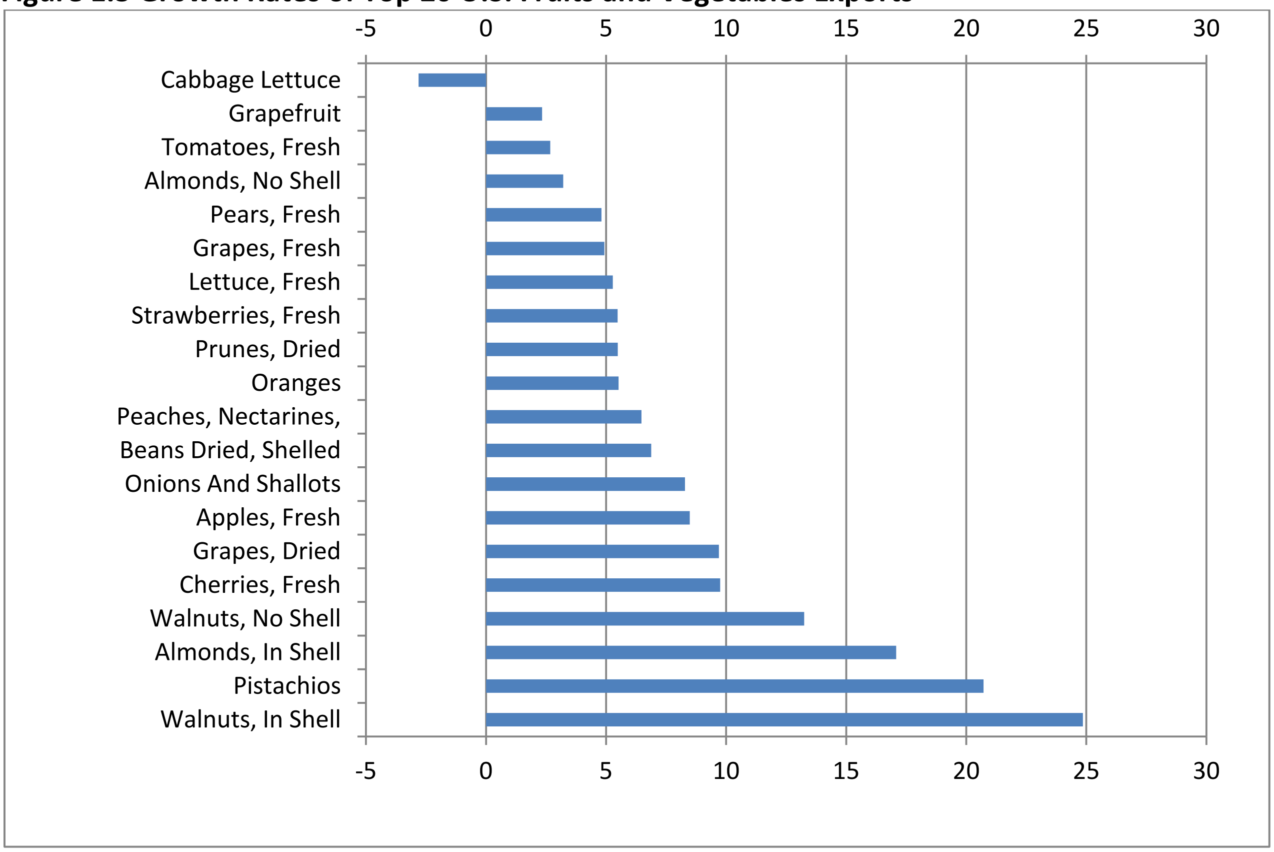
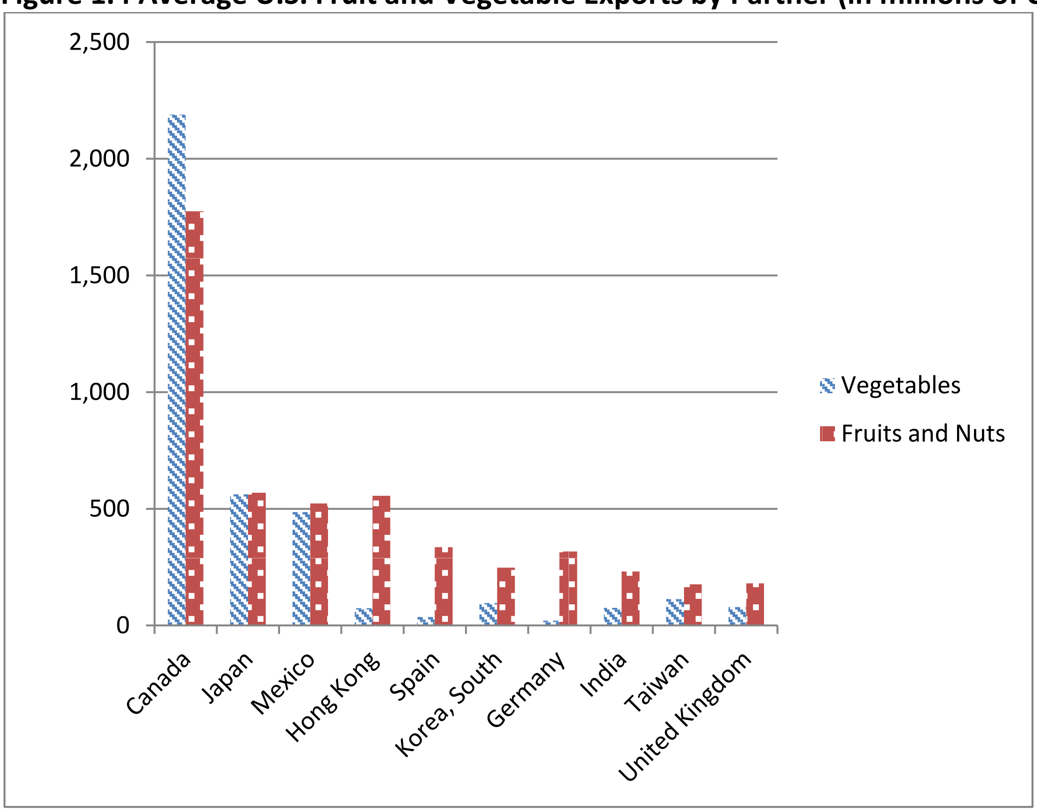


Figure 1.4 reports U.S. average exports of fruit and vegetables to its top partner countries over the period 2006-2010. Compared to all other partners, Canada is by far the most important export market for U.S. fruits and vegetables. U.S. exports to Canada averaged over $2 billion for vegetable products and $1.8 billion for fruit and nuts products. Canada is followed in importance by Japan and Mexico. However, combined U.S. exports of fruits or vegetables to Japan and Mexico is still well short of the average fruit or vegetable export totals to Canada. Another important feature that is not apparent in Figure 1.4 is the large number and the diverse set of partner countries. If we consider 2010, the most recent year for which data are available, the U.S. has a diverse set of destinations to which it ships fresh fruits and vegetable products. In 2010, the U.S. exported fruit and vegetables to 194 different countries (counting each EU member as a different country).

Figure 1.4 Average U.S. Fruit and Vegetable Exports by Partner (in millions of USD)



Several factors have been posited to explain the growth in U.S. fruit and vegetable exports. These include increasing consumer incomes in partner countries, shifting dietary preferences, increased consumer demand for year-round access to fruits and vegetables, and the aggressive pursuit of bilateral and multilateral free trade agreements, such as the North American Free Trade Agreement (NAFTA), to improve market access conditions for U.S. exports (Huang and Huang, 2007). These determinants suggest there is strong growth potential for fruit and vegetable exports among a diverse group of wealthy and growing middle-income countries. However, with the growth in US exports of fruits and vegetables comes increased concern for the introduction of pests and diseases in partner countries via shipments of these products abroad. Lack of data precludes ranking the relative importance of various pest transmission pathways, but trade is believed to be an important vector (e.g. National Research Council 2002). Thus, competition will be intense for these markets and SPS and other Technical Barriers to Trade (TBTs) in foreign countries will impact the competitiveness of U.S. fruit and vegetable sectors in international markets.

1.1 Non-Tariff Measures, Phytosanitary Regulations and the Export Certification Process for U.S. Fresh Fruits and Vegetables

Countries that are members of the World Trade Organization (WTO) are allowed to adopt regulations under the Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) agreements to protect human, animal and plant health as well as environmental, wildlife and human safety. SPS regulations are particularly prominent in agricultural markets because of the sensitive nature of concerns relating to the protection of plant and animal health from pest and disease risks. Because trade is believed to be an important transmission pathway

(National Research Council 2002), the promulgation of SPS regulations to address these risks also has the potential to affect the competitiveness of exporting countries. For example, Japanese SPS regulations to control codling moth and fire blight infestation in apples, was found to have seriously affected U.S. export competitiveness (Calvin and Krissoff, 2005).

Phytosanitary regulations faced by U.S. exporters of fresh fruits and vegetables vary across countries and commodities. These regulations include destination/origin restrictions, seasonal restrictions, treatment requirements, preclearance procedures, and system approaches to pest risk management. For example, in addition to meeting documentation requirements in the form of a phytosanitary certificate; cherries exported to Japan must be fumigated with methyl bromide and strawberries exported to Argentina must originate in a certified pest free area (EXCERPT).

Table 1.1 summarizes the total number of importers requiring phytosanitary treatments for U.S. exports of peas, walnuts, oranges, grapes, apples, cherries, peaches/nectarines and strawberries over a period from 1999 to 2009. The figures are calculated by summing the number of partner countries that require treatments across commodities and across treatment types. So for example, in 11 years from 1999 to 2009, there are 15 instances of importers requiring methyl bromide fumigation for U.S. pea exports. Over this period, peaches/nectarines have the highest frequency of treatment requirements, followed by oranges and apples. The most common required treatment is fumigation with methyl bromide followed by cold treatment. Onions are not included in Table 1.1 because they do not face phytosanitary treatment requirements from any partner countries included in our study.

Table 1.1 Frequency of Phytosanitary Treatment Requirements

Treatment	Peas	Walnuts	Oranges	Grapes	Apples	Cherries	Peaches and Nectarines	Strawberries	Totals
Methyl Bromide Fumigation	15	42	63	20	19	59	97	40	355
Cold Treatment	33	0	54	25	120	25	64	25	346
Methyl Bromide Fumigation or Cold Treatment	11	0	43	11	12	13	33	11	134
Cold Treatment or Fumigation Plus Refrigeration	0	0	0	11	0	11	0	11	33
Fumigation with Methyl Bromide or Phosphine	33	11	0	0	0	0	0	0	44
Fumigation with Sulfur Dioxide and Carbon Dioxide Mix and Cold Treatment	0	0	0	11	0	0	0	0	11
Vapor Heat or Cold Treatment or Quick Freeze	0	0	276	0	0	0	0	0	276
Totals	92	53	160	78	151	108	194	87	1199

Source: EXCERPT

Note: Each observation consists of a country by commodity by year occurrence.

However, there are origin restrictions other than treatments on U.S. exports of fresh onions so they are included in the final analysis.

Because it is costly to perform phytosanitary measures or provide documentation for origin restrictions, SPS regulations have the potential to restrict trade while protecting local producers. Jayasinge, Beghin, & Moschini (2009) found that all trade costs, including compliance with SPS regulations, had a negative impact on U.S. corn seed exports. While similar results may or may not hold for fresh fruits and vegetables, it does illustrate the potential impact of SPS regulations on U.S. exports.

1.2 Commodities Included in Analysis

In order to focus this analysis on a manageable set of fruit and vegetable commodities, several different factors are considered: the value of exports, export growth rates, the number of export destinations, and the number of importers with SPS regulations for a particular commodity. The first two factors are used to identify the fruit and vegetable commodities that are economically important for U.S. competitiveness. The last two factors are used to ensure adequate variability in the data to permit econometric identification of the effects of different SPS regulations on U.S. exports. For example, the bulk of U.S. exports of fresh vegetables, such as lettuce, spinach, tomatoes, carrots and turnips, mushrooms, cucumbers, cabbage, fresh beans, celery, and peppers, were exported to just two countries: Canada and Mexico. With little variation in country destinations and treatment requirements, we do not consider these fresh vegetable commodities to be useful to help identify the competitiveness effects of different SPS regulations facing U.S. exports.

Similarly, for some dried commodities, such as any tree nuts, very few importers impose SPS regulations. Thus, commodities that faced a very limited number of importing country SPS regulations cannot help to identify the impacts of SPS regulations. Finally, due to categorical heterogeneity that would preclude a unique mapping of detailed SPS regulations to U.S. HS6-digit trade flows, all "not elsewhere specified" (NES) 6-digit *HS* fruits and vegetables are not considered.

Based on these criteria, nine fruit and vegetable commodities are included in the analysis: fresh apples, fresh strawberries, fresh grapes, dried and shelled peas, fresh cherries, oranges, fresh onions, fresh peaches and nectarines, and in-shell walnuts. These nine commodities accounted for $2.8 billion in U.S. exports in 2010, or nearly 20 percent of total U.S. fruit and vegetable exports. Figure 1.5 shows the value of grapes, strawberries, cherries apples oranges and peaches and nectarines exports over a time period from 1996 to 2010 and Figure 1.6 shows the value of onions (fresh and dried), walnuts (shelled and unshelled) and peas exports from 1996 to 2010.

Figure 1.5 Fruit Export Value (in millions of U.S. dollars)

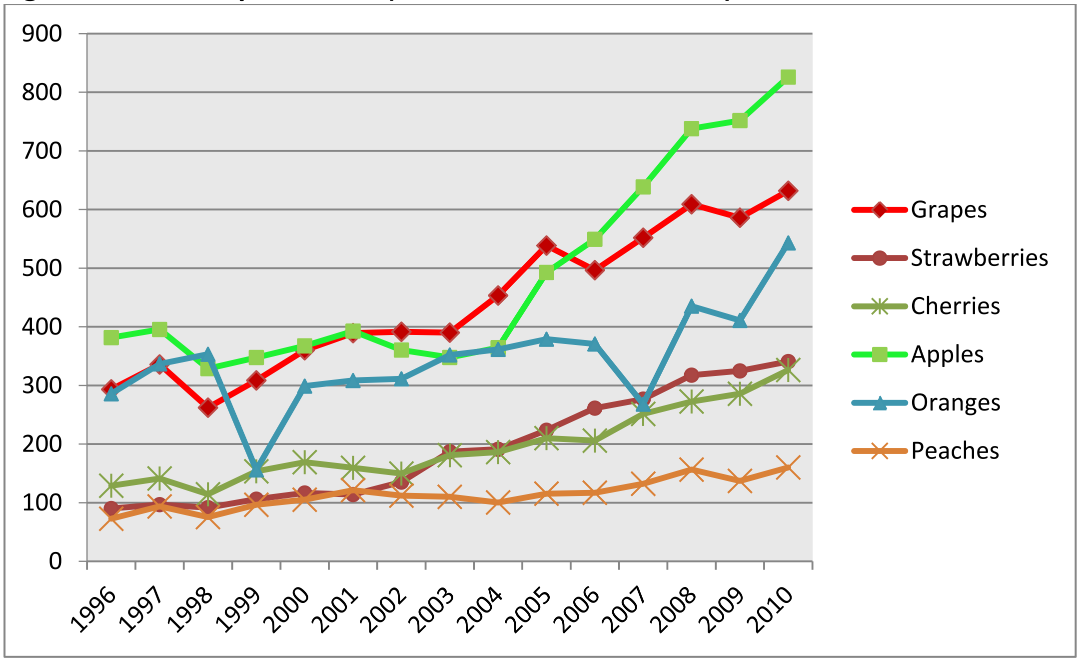


Figure 1.6 Vegetable Export Value (in millions of U.S. dollars)

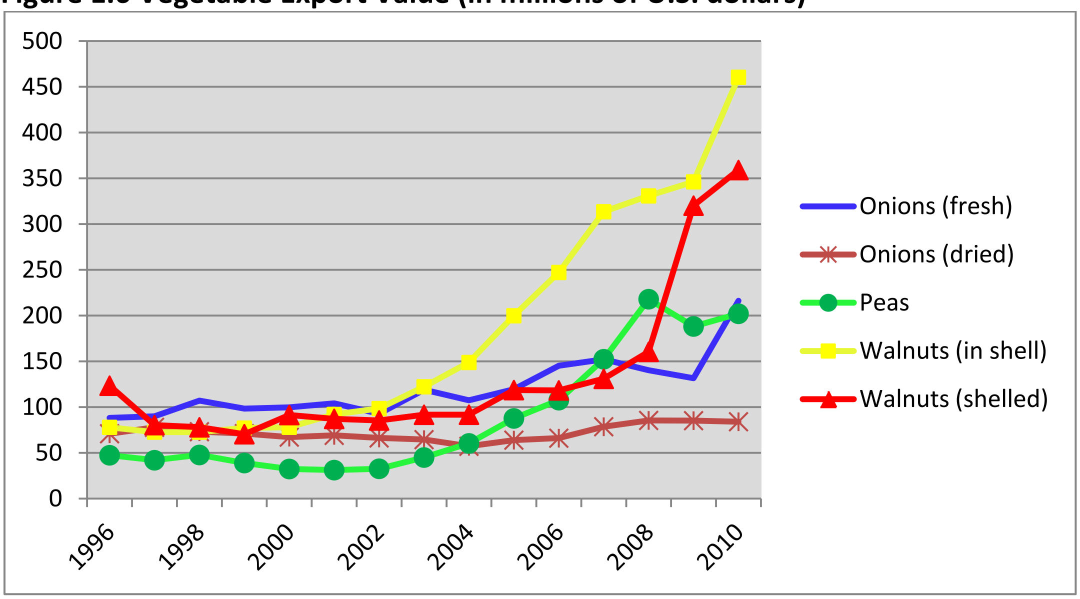


Table 1.2 shows that there is considerable variation in the percentage of exports subject to at least one SPS requirements as well as in the number of partner countries that impose SPS restrictions. Peaches and nectarines have the highest percentage of exports subject to at least

one SPS requirement while grapes have the largest number of partner countries that have at least one SPS requirement.

Table 1.2 Variation in Partner Countries and Exports Subject to SPS Treatment by Commodity

Commodity	HS-6 Codes	Number of Partner Countries[a]	U.S. Exports in Thousands of USD	% of Exports with at least one SPS requirement[b]
Onions (fresh)	071220	76	72,042	30.4
Peas (dried and shelled)	071310	110	88,873	33.4
Walnuts (in shell)	080231	75	133,808	6.5
Oranges	080510	75	344,705	52.2
Grapes (fresh)	080610	101	439,898	15.0
Apples (fresh)	080810	99	485,498	80.5
Cherries (fresh)	080920	71	195,738	45.7
Peaches and Nectarines	080930	58	113,732	96.0
Strawberries	081010	69	191,525	10.2

Source: Authors' calculations from USITC Data Web and EXCERPT
[a]Number of countries imposing SPS restrictions over a period of 11 years from 1999 to 2009.
[b] SPS requirements include five types of regulations; phytosanitary treatments, geographical restrictions on origin and/or destination, pre-clearance procedures and system approaches to pest risk management.

1.3 Thesis Objectives

Given the prominence of SPS treatments being applied to U.S. exports of the nine commodities identified in the previous section, the empirical question that arises is how and to what extent these measures affect U.S. exports? While there is now an established literature that assesses the effects of SPS measures on trade (e.g., Disdier, Fekadu, Murillo and Wong, 2008; Disdier, Fontaigne and Mimouni, 2008; Anders and Caswell, 2009;), these studies have used coverage ratios[1] and/or frequency[2] measures based on an "inventory approach" to indicate the presence of SPS regulations. For example, Jayasinghe, Beghin and Moschini (2009) employ a count variable that sums the number of SPS measures applied to a particular product (corn seed trade in this case). Other studies (e.g. Disdier, Fekadu, Murillo and Wong, 2008)

[1] Coverage ratios calculate the volume or value of imported goods subject to standards and are usually expressed as a percentage of total imports in the particular product category or tariff line.
[2] Frequency measures count the number of regulations or the proportion of products (or tariff lines) that are subject to standards within a given product classification.

have relied on a generic dummy variable equal to one if at least one SPS measure is notified within a given product category, and zero otherwise; while studies such as Fontagne, von Kirchbach and Mimouni (2005) use import coverage ratios to identify potential trade impacts of different types of environmentally related non-tariff measures (NTMs).

The use of coverage ratios or frequency measures are attractive because of their simplicity. Additionally, data on NTMs is readily available in the UNCTAD-TRAINS database, which is considered to be the most comprehensive source of information about standards (Korinek, Melatos, & Rau, 2008). However, there are several major limitations in using this approach. First, the TRAINS database has not been updated since 2001 and is based on an obsolete classification which does not adequately and accurately reflect new forms of NTMs (UNCTAD, 2010). Secondly, there are two main limitations on the use of coverage ratios or frequency measures. First is the assumption that the greater the number of restrictions and the broader their application, the larger their likely restrictive impact on trade (Korinek, Melatos, & Rau, 2008). In fact, the opposite may be true; a SPS regulation may lead to an increase in exports due to increased consumer confidence in the importing country and/or improved product characteristics (Liu & Yue, 2009). Second, it is not possible to identify which SPS regulation has the greatest impact on trade.

To address the drawbacks of using coverage ratios and frequency measures as well as problems in the use of the TRAINS database, this study constructs a detailed dataset of SPS regulations faced by U.S. exporters of fresh fruits and vegetables. Similar to the work of Karov, Peterson, and Grant (2009) our database will cover individual product lines defined at the six digit level of the HS 1996 code classification and includes 10 phytosanitary treatments as well as documentation requirements for approximately 140 U.S. trading partners over the period 1999 through 2009.

Because SPS regulations require exporters to incur additional costs to bring a product into compliance and these compliance costs may vary by type of treatment, the main objective of this thesis is determine how and to what extent SPS measures impact U.S. fruit and vegetable exports and to identify the types of SPS measures that have the largest impact on trade. The specific objectives of this study are

1) To construct a comprehensive database that maps SPS measures on U.S. export flows by individual product lines in the Harmonized System (HS) of commodity codes, importer, and year. The database will be available at the National Institute of Food and Agriculture (NIFA).
2) To determine whether existing SPS regulations affect the structure and composition of U.S. apples, cherries, grapes, oranges, peaches, strawberries, walnuts, onions and peas exports and to determine what types of SPS treatments matter in affecting their competitiveness.

To achieve these objectives, a gravity model based on the work of Jayasinge, Beghin, and Moschini (2009) will be developed for the nine fruit and vegetable commodities identified above. Information on SPS regulations will be obtained from the Export Certification Project (EXCERPT) database. EXCERPT is a comprehensive database of SPS regulations collected on behalf of the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) by Purdue University.

1.4 Thesis Organization

This thesis is organized as follows. Chapter 2 discusses the literature and relevant empirical applications. Chapter 3 develops the empirical method used to estimate the trade flow effects of phytosanitary treatments. Chapter 4 discusses the data. Chapter 5 presents the results, and Chapter 6 concludes with some policy implications, and discusses limitations and future areas for research.

2. Literature Review

NTM quantification strategies can be broadly grouped into two categories: *ex-post* and *ex-ante. Ex post* analyses tend to attribute *observed* changes in trade to the imposition or redesign of standards, while controlling for other factors that may simultaneously have an impact on trade flow. Such analyses typically estimate econometric models of the relationship between standards and trade or construct frequency[3] and coverage measures[4] of standards based on historical trade data. On the other hand, *ex-ante* methods such as simulations involving the calculation of tariff equivalents are usually employed to predict the impact of standards regimes whose effects are, as yet, unobserved (Korinek, Melatos, & Rau, 2008).

Econometric approaches used to quantify the trade effects of NTMs often use gravity models in which case historical trade flow data is matched to policy regulations to recover estimates of the impact of these policies on bilateral trade (e.g., Jayasinghe, Beghin and Moschini, 2009; Chevassus-Loza et al, 2005; Chen, Otsuki and Wilson, 2006; Disdier, Fontagne and Mimouni, 2008; Fontagne, Mimouni and Pasteels, 2005; Moenius, 2000; Otsuki, Wilson and Sewadeh, 2001a; Otsuki, Wilson and Sewadeh, 2001b; Wilson and Otsuki, 2004; Wilson, Otsuki and Majumdasar, 2003; etc.). The effect of regulatory regimes in these studies is indentified by comparing a test group (trade flows subject to SPS measures) and a control group (trade flows not being a subject to SPS measures). As opposed to partial equilibrium models, econometric

[3] Frequency measures count the number of regulations or the proportion of products that are subject to standards within a given product classification.
[4] Coverage measures calculate the volume or value of imported goods subject to standards and are usually expressed as percentage of total imports in that product category or tariff line.

gravity equations are typically used to assess the impacts of existing SPS measures when sufficient data is available across time and regions.

On the other hand, *ex-ante* analyses are generally employed to predict the likely impact of regulatory change before it is introduced. This usually involves simulating a partial or general equilibrium model to determine how individual consumers and producers will react to price changes arising from a change to the regulatory regime (Korinek, Melatos, & Rau, 2008). For example, using a partial equilibrium model, Peterson and Orden (2008) examined the trade effects of a November, 2004 APHIS phytosanitary regulation that partially removed seasonal and destination restrictions on U.S. imports of fresh Hass avocados from approved orchards in Mexico.

In addition to the two main approaches (econometric and partial/general equilibrium modeling), a small number of studies also use a price wedge method, as discussed in Beghin and Bureau (2001). This method calculates a tariff rate equivalent based on the price discrepancy between a domestic product in the importing region and the equivalent imported product due to the impact of a NTB (Karov, Peterson, & Grant, 2009).

The remainder of the chapter is divided into six sections. The first three sections discuss *ex-post* econometric approaches; the fourth section looks at *ex-ante* approaches; the fifth section discusses limitations of the current literature; and finally, the last section proposes contributions of this study to current literature on the effects of SPS regulations.

2.1 Frequency and Coverage Measures of Standards

Few studies systematically apply frequency and import coverage measures to identify the potential trade impact of standards. Fontagné, von Kirchbach and Mimouni (2005) use NTM (including standards) notification data from the TRAINS database to calculate the import coverage index for groups of NTMs applied for different reasons. NTMs applied for human health reasons potentially affect 24 percent of world trade. In order of declining import coverage index value, NTMs applied for animal health, plant health, human safety, wildlife and environmental reasons follow.

Fontagné, von Kirchbach and Mimouni (2005) also calculate the import coverage index for different types of environmentally-related NTMs. While product standards are the most widely used environmentally-related NTM, affecting trade in the most number of items, their import coverage index is lowest (17 percent). On the other hand, less frequently employed NTMs such as authorization and technical measures related to testing, inspection and quarantine requirements potentially impact on 18 percent and 20 percent respectively of world trade in agri-food products. This is significantly higher than the import coverage index for the entire range of products (6 percent) suggesting that these NTMs may be designed to protect local agri-food producers.

2.2 Ex-Post Econometric Estimation Using the Gravity Model of Trade

Gravity models exploit panel data to regress bilateral trade values (exports or imports) on a variety of explanatory variables including the GDPs of trade partners, the distance between them as well as some quantitative measure of standards. Tariffs and other trade policies are often omitted in gravity models of trade in part because detailed and reliable data is difficult to obtain. Country-specific fixed effects[5] are usually employed to correct for the influence of trade policy, and all other country-specific factors, on bilateral trade. Notable exceptions in the NTM

[5] Marchant and Kumar (2004) employ country-specific fixed effects to identify demand determinant for U.S. processed food exports to emerging/low and middle-income countries.

literature include Fontagné, Mimouni and Pasteels (2005) and Disdier, Fontagné, and Mimouni (2008) who explicitly account for trade policies and market access.

Anderson and van Wincoop (2003) provide a theoretical foundation for the gravity model arguing for the inclusion of individual importing and exporting country fixed effect variables which capture the extent to which countries are resistant to trade with other countries. In the standards literature, this approach is employed by Disdier, Fontagné and Mimouni (2008). Chevassus-Lozza et al. (2005) seek to correct for so-called multilateral resistance by explicitly including prices in the gravity equation.

Reflecting the literature's lack of agreement on the best way to measure standards, gravity model analyses employ a number of different approaches. Some studies try to capture the stringency of standards by incorporating frequency and coverage measures or explicit standards requirements such as maximum residue levels into the regression model. As discussed in the previous section, however, such measures can often involve an unsatisfactory trade-off between accuracy and simplicity. If no appropriate measure for a particular standard exists, dummy variables are often used instead to indicate whether or not a standard exists (e.g. Chevassus-Lozza et al., 2005). Such dummy variables provide little information on the extent of the standards at issue. Nevertheless, inclusion of such dummy variables might mitigate econometric problems such as estimation biases arising from omitted variables. The coefficients associated with such variables can also provide a useful initial estimate of the mean difference in trade due to the presence of standards. The choice of standards measure ultimately depends on data availability, the extent of commodity and country coverage, and the types of products being analyzed (Korinek, Melatos, & Rau, 2008).

Gravity model based analyses typically use frequency and coverage measures, and not only do they cover a wide range of products at a highly aggregated level but also gather standards and technical regulations under the same broad category of NTMs. One recent study to adopt this approach is Moenius (2004) who examines the trade effect of country specific standards and bilaterally shared standards in 12 OECD countries over the period 1985-1995. The panel data set covers 471 industries including the agri-food sector. He estimates a gravity model in which the value of bilateral trade is regressed on the number of bilaterally-shared and country specific standards in the exporting and importing country.

Aggregating across industries, Moenius (2004) finds that trade significantly increases with the number of bilaterally shared standards. Country-specific (i.e. non-shared) standards implemented by the importing or exporting country are also trade-promoting on average. The latter result runs contrary to the commonly held belief that importer-specific standards imply additional adaptation costs and, hence, should hamper trade. Exporter-specific standards, meanwhile, are generally associated with trade promotion because they raise the comparative advantage of an industry. At the industry level, the only variation to the aggregate results is that importer-specific standards have the expected negative trade effect in non-manufacturing sectors such as agriculture. In manufacturing industries, however, the positive impact of importer-specific standards on trade is confirmed.

Other studies that employ frequency and coverage measures within a gravity model framework include Fontagné, Mimouni and Pasteels (2005) and Disdier, Fontagné, and Mimouni (2008). Both studies correct for bilateral market access using information extracted from the Market Access Map (MAcMap). Unlike Moenius, therefore, these studies decompose the impact of trade barriers into distinct tariff and NTM effects. Both studies adopt a frequency index to measure the impact of NTMs on trade. These indices are constructed using the share of products within a particular product category for which the importing country has reported at least one SPS or TBT barrier. Information regarding the incidence and frequency of NTMs is extracted from the TRAINS database.

Fontagné, Mimouni and Pasteels (2005) collect data on 61 product groups, including agri-food products, and classify these as “sensitive products” (at least 40 countries have notified NTMs to the WTO), “suspicious products” (fewer than 11 notifying countries) and “remaining products” (11-39 notifying countries). The final category comprises a large share of processed agri-food products. In order to correct for the different levels of development of importing countries, they differentiate between least developed countries (LDCs), developing countries (DCs) and OECD countries.

Fontagné, Mimouni and Pasteels confirm the findings of Moenius (2004): NTMs, including standards, have a negative impact on agri-food trade but not on trade in other products. While no significant trade effects exist for “suspicious products”, negative trade effects are observed for pork meat, cut flowers, vegetables and wheat/pastry in the group of “sensitive products” as well as for a variety of processed agri-food products (e.g. chocolate, beverages) in the group of “remaining products”. Over the entire product range, LDCs, DCs and OECD countries seem to be equally affected. However, OECD agri-food exporters tend to benefit from NTMs, at the expense of exporters from DCs and LDCs. The authors also find that tariffs matter more than NTMs, particularly for agri-food products on which comparatively high tariffs are levied.

Disdier, Fontagné, and Mimouni (2008) restrict their analysis to the trade effect of standards and other NTMs on 690 agri-food products (HS 6-digit level). Their data covers bilateral trade between importing OECD countries and 114 exporting countries (OECD and others) in 2004, excluding intra-EU trade. As well as a frequency index, they use two alternative approaches to measure NTMs: (i) a dummy variable that records whether the importing country has notified the WTO of at least one NTM and (ii) ad-valorem tariff equivalent measures of NTMs which use import demand elasticities to impute the price impact of NTMs. For all three measures they find that the NTMs imposed by OECD countries have a negative impact on agri-food trade and affect trade more than other trade policy measures such as tariffs. The tariff equivalent shows the smallest effect.

Next, Disdier, Fontagné, and Mimouni (2008) differentiate between exports originating from LDC, DC and OECD countries and use the tariff equivalent as a measure for NTMs. They find that a one percent (tariff equivalent) increase in the restrictiveness of NTMs increases agri-food exports from OECD countries by about 0.16 percent but reduces exports from LDCs and DCs by approximately 0.23 percent. For the subsample of EU imports, NTMs no longer influence OECD exports positively. NTMs imposed by the EU reduce exports from other OECD countries by 0.14 percent and those from LDCs and DCs by 0.37 percent.

Finally, Disdier, Fontagné, and Mimouni (2008) analyze the effect of NTMs on trade in individual agri-food products. They estimate that NTMs have a negative influence on trade in cut flowers, processed food products (e.g. beverages) and meat, but a strong positive influence on trade in cereals, wool and albuminoids/starch.

2.2.1 Gravity Model Estimation Using Maximum Residue Levels

Many studies employ maximum residue levels to measure the stringency of standards within a gravity-type modeling framework. These studies tend to focus on specific cases of standards for particular products and countries. Wilson and Otsuki (2004) and Otsuki, Wilson and Sewadeh (2001a, b) analyze the trade impact of maximum residue levels for aflatoxin, a toxic fungus that typically contaminates cereals, spices and nuts. Wilson and Otsuki (2004) analyze maximum residual levels relating to chlorpyrifos, a pesticide used in banana production to kill ants, mites and cockroaches. Wilson, Otsuki and Majumdsar (2003) analyze residue regulations on tetracycline, a widely used antibiotic to promote animal health and growth. Wilson and Otsuki (2004) and Otsuki, Wilson and Sewadeh (2001a, b) examine the trade effect of aflatoxin standards in groundnuts and other agricultural products (vegetables, fruits and cereals). Chen, Yang and Findlay (2008) use the gravity model to test the effect of maximum residue level standards of chlorpyrifos and oxytetracycline on China's export of vegetables and aquatic products. All four studies show that imports are greater when the importing country imposes less stringent aflatoxin standards on foreign products. Additionally; Otsuki, Wilson and Sewadeh (2001b) also find an increasing impact of aflatoxin standards on groundnuts over time. They conclude that the rigor of standards enforcement at the border has increased.

The estimated coefficients of the effects of aflatoxin standards on trade are used to predict changes in trade flows resulting from changes in the maximum permitted levels of aflatoxin. Changes in trade flows are predicted under different levels of harmonization, e.g.

worldwide harmonization towards Codex[6] standards for aflatoxin (9 parts per billion) or towards the lower maximum level of aflatoxin allowed in the EU (2 parts per billion). These are then compared to the status quo of maximum aflatoxin levels in 1995. If the maximum level of aflatoxin was equal to that permitted within the EU, for example, Otsuki, Wilson and Sewadeh (2001a) approximate a total loss of $400 million US dollars in cereals, fruits and nuts exports from African countries. In contrast, trade in these products would increase by almost $700 million US dollars if the EU imposed less stringent aflatoxin standards than those prescribed by Codex.

Similarly, Wilson, Otsuki and Majumdsar (2003) analyze the effect of standards for tetracycline residues on beef trade. Independent of the various maximum residue levels of tetracycline, they consider that standards imposed by importing countries restrict trade only if the importer standard is stricter than the standard prevailing in the exporting countries. In order to account for exporter standards exceeding the standards requirements of importing countries, they introduce an additional dummy variable. Results show that regardless of the exporter standards, the standards of tetracycline imposed by the importing countries have the same negative trade impact on beef trade.

Chen, Yang, and Findlay (2008) study the effect of Chlorpyrifos maximum residue level standards on China's exports of garlic, onions and spinach as well as the effect of Oxytetracycline maximum residue level standards on China's exports of fish and aquatic products. In both cases, the coefficients of Chlorpyrifos as well as Oxytetracycline standards

[6] The Codex Alimentarius refers to food standards, guidelines and codes of practice recommended under the Joint FAO/WHO Food Standards Program. Codex standards are negotiated internationally, providing a benchmark for government and private standards. The Codex aims to protect consumer health and promote the international coordination of agri-food standards, thereby facilitating agri-food trade.

are positive and statistically significant. These results imply that tighter standards (smaller values) of the maximum residue limits for Chlorpyrifos and Oxytetracycline imposed by the importing countries have significant negative effects on China's exports of vegetables and fish and aquatic products.

2.2.2 Other Econometric Approaches

In addition to gravity models, other approaches are based on recent insights into the link between trade costs, export quality and variety (Hummels and Skiba, 2004) and firm heterogeneity (Melitz, 2003). These approaches tend to evaluate standards from the point of view of a firm deciding whether or not to export to a particular market (and, therefore, comply with its standards). If standards differ across importing countries, producers must satisfy several different and, perhaps, inconsistent import regulations.

A different approach is taken by Chen et al. (2006) to investigate how, for individual firms, the share of exports in total sales is influenced by the following: the existence of standards, whether a testing procedure is employed, inspection time, labeling requirements and the ease with which exporters can access information about the standard. Correcting for firm characteristics and bilateral trade policies (e.g. regional trade agreements), either of which might influence a firm's export decision; it is shown that exporter access to information has the greatest impact reducing the average firm's export share by 18 percent. Exporting firms subjected to testing procedures and lengthy inspections export, respectively, nine and five percent less than other firms. Moreover, access to information about standards requirements is relatively more important for exporters of manufactures than agri-food products. In contrast, testing procedures and lengthy inspections have a stronger negative impact on the export share of agri-food producers. Finally, standards and labeling requirements have an insignificant impact on firm exports – increased production costs for producers are offset by lower information costs for consumers.

2.3 Ex-Ante Simulations

In contrast to *ex post* econometric analyses*, ex ante* analyses are generally employed to predict the likely impact of a regulatory change before it is introduced. This usually involves simulating a partial or general equilibrium model to determine how individual consumers and producers will respond to the price changes arising from a change to the regulatory environment. Two widely used *ex ante* quantification strategies include: the calculation of tariff equivalents and the measurement of demand and supply shifts. By adding-up the behavioral responses of all economic agents, it is possible to obtain the aggregate impact on trade of a given change in regulation. However, the focus on individual behavior also makes it possible to decompose the aggregate impact of standards into welfare effects on individual economic agents. That is, one can analyze the distributional impact of a regulatory change. This is typically not possible in *ex post* (i.e. econometric) analyses which, for the most part, can only measure the aggregate impact of regulation on trade (Korinek, Melatos, & Rau, 2008).

The choice of which quantification strategy is used depends entirely on the researcher. If the goal is to measure the trade impact of proposed NTMs then calculation of tariff equivalents would be quantification method of choice. On the other hand, modeling supply and demand shifts is more suitable if the objective is to measure the welfare impacts of NTMs.

2.3.1 Modeling the Impact of Standards Using the Tariff Equivalent Method

All NTMs restrict imports either directly by prohibition (as with a quota, for example) or indirectly by raising the transactions costs of trade. *Ceteris paribus*, this raises domestic prices in the importing country relative to world prices creating a price "wedge" similar to that which arises when an import tariff is imposed. One way to measure the impact of a standard, therefore, is to calculate the size of this price wedge. Correcting for other possible reasons (i.e. unrelated to the NTM) for this price difference, such as transport and distribution costs or perceived quality differences, it may be possible to determine the "equivalent" (*ad valorem* or specific) tariff rate that reproduces both the restricted import level and the higher domestic price induced by the standard. Apart from providing an intuitive (i.e. price-based) measure of the trade impact of a standard, tariff equivalents also facilitate comparison of heterogeneous standards imposed by different countries. Under perfect competition, there exists an equivalent tariff for every quota. This is the theoretical motivation for the tariff equivalents approach to quantifying the impact of NTMs such as standards. It has been proven, however, that this premise breaks down under imperfect competition (Bhagwati, 1995; Harris, 1985; Krishna, 1989) or when firms can select both the quantity and quality of output (Hummels and Skiba, 2004). That is, a tariff rate may not exist that reproduces both the higher domestic price and the lower import level induced by the quota (Korinek, Melatos, & Rau, 2008).

In 1994, Japan opened its market to U.S. Red and Golden Delicious apples from Washington and Oregon under a restrictive phytosanitary protocol directed at preventing the import of codling moth and fire blight. Limited demand for Red and Golden Delicious apples in Japan, a high tariff, and the costly and risky phytosanitary requirements combined to make U.S. apple exports to Japan less profitable than originally anticipated (Calvin & Krisoff, 2005).

Several studies have sought to calculate tariff equivalents on SPS measures applied by Japan to U.S. apple imports.

Calvin and Krissoff (1998) quantify the trade effects of SPS standards on fire blight by simulating the removal of SPS requirements on exports of US apples to Japan, South Korea and Mexico. To do this, they obtain estimates of *ad valorem* tariff equivalents for the SPS requirements within a partial equilibrium model. They show that these standards considerably restricted US apple exports in 1994/95 and 1995/96. If all importing countries lifted their SPS regulations relating to fire blight, the value of US apple exports would have increased by 23 percent in 1994/95 and 14 percent in 1995/96; an increase of $97 and $53 million respectively.

Yue, Beghin and Jensen (2006) identify four potential sources for differences in domestic and foreign prices: tariffs, NTMs, quality differences and marketing costs. They develop a methodology for apportioning observed price differences among these four sources. A partial equilibrium model is defined and simulated in which consumer preferences are defined over domestically-produced and imported apples. Domestic (here, Japanese) consumers are assumed to have an inherent preference for home produced apples. The consumption of these, therefore, is weighted more heavily in the utility function of domestic consumers. The simulation model is parameterized using estimates of this weight and the elasticity of substitution between local and foreign apples. Two scenarios are examined: one where fire blight is not transmitted to Japan and one where it is.

For different degrees of domestic preference and values for the elasticity of substitution, Yue, Begin and Jensen (2006) calculate the *ad valorem* tariff equivalent for the SPS requirements for US apples. As the degree of domestic preference falls due to, say, smaller quality differences between US and Japanese apples, the tariff equivalent rises. Intuitively, US apple exports become less sensitive to Japanese SPS requirements as Japanese consumer tastes become more biased towards local production. On the other hand, as the elasticity of substitution falls, the tariff equivalent rises. This is because, as preferences become more inelastic, consumers maintain purchases of their preferred apple regardless of changes in the relative price of local and imported produce.

For the year 2000, elimination of SPS requirements, assuming that fire blight is not transmitted, results in an increase in the value of US apple exports into Japan of between $1.8 million and $60 million depending on the degree of domestic preference and the elasticity of substitution between US and Japanese apples. As the degree of domestic preference declines, eliminating SPS measures raises the value of US imports by more (the tariff equivalent was higher). Similarly, as the elasticity of substitution declines, removing SPS measures also encourages US exports to rise further (again, the tariff equivalent rises) (Korinek, Melatos, & Rau, 2008).

2.3.2 Modeling the Impact of Standards by Measuring Supply and Demand Shifts

As discussed previously, the main reason for calculating a tariff equivalent is to measure the trade, not welfare, impact of an NTM. Consequently, when calculating tariff equivalents, standards tend to be represented as pure trade costs. Any impact on the demand and supply curves of exporting and importing countries, arising from the imposition of the standard, is not explicitly modeled as part of the tariff equivalent calculation. In fact, standards do influence production decisions at the firm level. Moreover, such regulation tends to raise product quality and reduce asymmetric information. It is reasonable, therefore, to expect changes in the nature of consumer demand and producer supply (Korinek, Melatos, & Rau, 2008).

Compliance with standards can influence production in a number of ways. First, in satisfying regulatory requirements, firms invariably incur additional production costs (e.g. labeling, testing, certification etc.). Second, firms may be compelled to adopt new production techniques for environmental or health and safety reasons. Standards can alter input requirements; implementing the Hazard Analysis Critical Control Point (HACCP) system, for example, involves substantial additional labor for documenting the production process in detail. On the other hand, adherence to standards may reduce a firm's marginal costs of production by encouraging it to upgrade its facilities. In short, standards have the potential to impact firm supply curves in both importing and exporting countries. They may lead a firm to increase or decrease quantity supplied at any given price (i.e. shift the firm's supply curve to the right or left) (Korinek, Melatos, & Rau, 2008).

Compliance with standards also alters the nature of consumer demand. As already discussed, standards are motivated, in part at least, by a desire to improve product quality and the distribution of information between buyers and sellers. To the extent that the introduction of a standards regime achieves these goals, consumers should be willing *ex post* to consume more at any given price than they were *ex ante*. Equivalently, if consumers gain greater utility from consuming high-quality (i.e. compliant) products, they will be willing to pay higher prices for these. The introduction of standards, therefore, is likely to shift consumer demand curves (usually to the right). The likely magnitude of this shift is difficult to model as it requires the explicit inclusion of quality into the specification of consumer preferences. One simplistic approach would involve the inclusion of an exogenous quality parameter in consumer preferences which ensures that consuming a certain amount of one (high-quality) good provides a greater utility benefit than the consumption of an identical amount of another (low-quality) product (Korinek, Melatos, & Rau, 2008).

Lusk and Anderson (2004) apply supply and demand shift analysis to determine the welfare impact of standards. They investigate the impact of country-of-origin labeling (COOL) on meat producers and consumers by simulating a partial equilibrium displacement model that links consumption in the beef, pork and poultry industries. The main contribution of their study is to show that the welfare impacts of COOL will vary significantly depending on how the standard is implemented. In particular, if implementation costs are concentrated on marketers, consumers will suffer a disproportionately large welfare decline (as prices rise), while meat producers will be only slightly impacted. On the other hand, if COOL is implemented in such a way that increased costs are borne mostly by producers, both meat producers and consumers will suffer a significant negative welfare impact (higher costs for producers and higher prices for consumers).

Peterson and Orden (2006) model supply and demand shifts arising from changes to the SPS standards regime applied to the import of Mexican Haas avocados into the US. Using a static partial equilibrium model, Peterson and Orden consider three possible standards regimes and estimate the welfare impact of each. The net welfare gain to the US arising from the 2004 reform is calculated at $72 million – the result of US consumers facing lower prices and consuming more. In addition, compliance costs for Mexican producers are estimated to decline by half as a result of the opening up of the US market. While they must still demonstrate compliance with certain risk management production procedures, their per-unit compliance costs are lower overall as a result of their increased exports to the US.

Finally, Peterson and Orden (2006) consider the case where, in addition to the removal of geographic and seasonal constraints, all risk management production procedures in Mexico are also eliminated. The net welfare outcome for the US in this case depends on the assumed level of risk of pest infestation. A high level of risk can lead to a lower net welfare gain to the US of up to $16 million compared to the other scenarios considered. Assuming an average level of risk, however, the net welfare gain to the US will be greater than $80 million. Increased consumer benefits (low prices, higher import volumes) outweigh the increased costs faced by US producers in the face of an increased risk of pest infestation (producer surplus declines by $5.2 million).

Studies by Yue, Beghin and Jensen (2006) and Calvin and Krissoff (1998) on US apple exports to Japan demonstrate how estimates of the tariff equivalent can be combined with demand and supply shift analysis to obtain estimates of the welfare impact of standards. Yue, Beghin and Jensen (2006) find that if fire blight is not transmitted the removal of SPS requirements results in higher Japanese welfare irrespective of the degree of domestic preference or the elasticity of substitution. The lost producer surplus from lower domestic prices is more than offset by the increase in consumer surplus resulting from lower domestic apple prices and higher imports. Moreover, as the degree of home bias in consumption and the elasticity of substitution decrease, Japan gains more. In the case where fire blight is transmitted, Japan suffers a net welfare loss from the elimination of regulation on apple imports. This reflects the production loss due to the disease which swamps any welfare gains arising from the removal of the SPS requirements.

2.4 Limitation of Current Literature

Although there is an increasing number of *ex post* econometric studies on the effects of NTMs on trade, it was recognized by UNCTAD that there is little understanding of the exact implications of NTMs on trade flows, export led growth and social welfare in general. This lack of understanding is in large part due to the fact that, with the exception of the UNCTAD-TRAINS database, there is no global mechanism to obtain comprehensive and continuously updated information on NTMs. (UNCTAD, 2010).

Typically, studies on the effects of NTMs use share variables (coverage ratios and frequency indices), count, and dummy variables calculated based on more aggregate trade data obtained from the UNCTAD's TRAINS database. One major problem with this approach, as noted by Anderson and van Wincoop (2004), is that the information on SPS requirements contained in this database, which is mostly based on WTO notifications, is extremely fragmentary and is subject to a large measurement error with respect to NTMs. A major reason for this problem in the TRAINS data is that WTO members are only required to notify changes to their regulations since 1995, which means that some of the most trade-restrictive measures adopted before 1995 have never been notified to the WTO. The UNCTAD-TRAINS database has not been updated regularly since 2001, and the data is based on an obsolete classification which does not adequately and accurately reflect new forms of NTMs. Moreover, new SPS regulations, such as specific phytosanitary treatments, are not recorded. In addition, most SPS measures, particularly those adopted by high-income OECD countries, are defined at the detailed product line level. For example, phytosanitary treatment requirements facing fresh strawberry exports to Australia are defined at the HS-six digit level. As a result, a disaggregated product level empirical approach is required rendering results obtained from empirical analyses based on TRAINS data unsuitable to inform policy makers of the trade effects of specific types of SPS regulations since in most studies it is not possible to distinguish between important and unimportant measures (Karov, Peterson, & Grant, 2009). Additionally, the TRAINS database does not distinguish between SPS treatment requirements such as different types of fumigation, cold treatment, quick freeze, etc. which can carry a different cost of compliance and in turn have a different impact on trade.

Another issue with current literature is their treatment of zero trade flows. With the exception of Jayasinghe, Beghin and Moschini (2009) and Karov, Peterson and Grant (2009), previous studies either drop zero trade flows, estimate the model using T_{ij}+1 (where T_{ij} is the volume of trade from country i to country j) or use a Tobit estimator. The problem with these approaches is determining the reason for zero trade flows e.g. whether the two partners never traded or whether there is a rounding error or whether the zero trade flow can be attributed to a NTM. If the reason is the latter and the observations are dropped, the regression analysis may lead to an inconsistent estimator (Silva & Tenreyro, 2005).

3. Empirical Model

The majority of *ex post* econometric studies on the effects of SPS regulations rely on the gravity model of trade which, borrowing from Newton's "Law of Universal Gravitation" defines the volume of trade between two partners as a decreasing function of distance and an increasing function of economic size. The gravity model made its first empirical trade appearance in Tinbergen (1962) and quickly gained widespread acceptance because of its explanatory power. Eichengreen and Irwin (1998) refer to the gravity model as the "workhorse" model for empirical econometric studies in international trade. Examples of empirical studies framed on the gravity equation include the evaluation of trade protection (e.g., Harrigan, 1993), regional trade agreements (e.g., Frankel, Stein, and Wei, 1995; Frankel, 1997), exchange rate variability (e.g., Frankel and Wei, 1993; Eichengreen and Irwin, 1995), and currency unions (e.g., Rose, 2000; Frankel and Rose, 2002; and Tenreyro and Barro, 2002).

3.1 Microeconomic Foundations of the Gravity Model

Since the gravity model's introduction by Tinbergen (1962), various efforts have been made to reconcile its empirical success with microeconomic theory (Linnemann, 1966; Leamer and Stern, 1970). Anderson (1979) first derived the gravity equation based on a constant elasticity of substitution (CES) utility function that assumes goods are differentiated by geographic origin. Following Anderson (2003), the demand for the k^{th} fresh fruit or vegetable commodity from supply region *i* in demand region *j* is derived from the following CES utility function:

$$U_j^k = \left(\sum_{i=1}^{J} \left(c_{ij}^k \right)^{\frac{\sigma_k - 1}{\sigma_k}} \right)^{\frac{\sigma_k}{\sigma_{k-1}}} \quad (1)$$

where c_{ij}^k denotes the quantity consumed, σ_k is the elasticity of substitution between the different varieties of commodity *k* and is assumed to take a value greater than one, and *J* is the number of varieties available. The budget constraint faced by consumers in region *j* for commodity *k* is

$$E_j^k = \sum_{i=1}^{J} p_{ij}^k c_{ij}^k \quad (2)$$

where E_j^k is the total expenditure on commodity *k* and p_{ij}^k is the price paid by consumers in region *j*, which can be written as

$$p_{ij}^k = p_i^k t_{ij}^k \quad (3)$$

where p_i^k is the export unit price (FOB) of commodity *k* sourced in country *i* and $t_{ij}^k > 1$ is the trade cost factor that reflects all costs of shipping commodity k from origin to final destination (i.e., tariffs, distance, NTMs, informational costs, etc.).

Maximizing (1) subject to (2) we derive the following expression for the demand of each variety *k*.

$$c_{ij}^k = \frac{\left(p_{ij}^k \right)^{-\sigma_k}}{\left(P_j^k \right)^{1-\sigma_k}} E_j^k \quad (4)$$

where the price index P_j^k is

$$P_j^k = \left(\sum_{i=1}^{J} \left(p_{ij}^k \right)^{1-\sigma_k} \right)^{\frac{1}{1-\sigma_k}} \quad (5)$$

Multiplying equation (4) by the price paid by consumers (p_{ij}^k) yields the value of bilateral imports (V_{ij})

$$V_{ij}^{k} = E_j^k \left(\frac{p_i^k t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} \quad (6)$$

While equation (6) represents the demand for a given variety, the supply side of the gravity model uses the condition that production in the exporting country equals the sum of the quantity demanded for that variety in all regions such that markets clear. The value of total output for the *i*th exporter (y_i^k) is defined as

$$y_i^k = \sum_{j=1}^{J} V_{ij}^k \quad (7)$$

Substituting equation (6) into equation (7) yields

$$y_i^k = \left(p_i^k\right)^{1-\sigma_k} \sum_{j=1}^{J} \left(\frac{\left(t_{ij}^k\right)^{1-\sigma_k}}{\left(P_j^k\right)^{1-\sigma_k}}\right) E_j^k \quad (8)$$

Following Anderson and van Wincoop (2003) we can solve for $\left(p_i^k\right)^{1-\sigma_k}$ in equation (8) and substituting into equation (6) yields

$$V_{ij}^k = \frac{y_i^k}{\Gamma_i^k}\left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k \quad (9)$$

where $\Gamma_i^k = \sum_{j=1}^{J}\left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k$.

Note that by summing across all commodities, y_i^k becomes GDP in region *i* (Y_i), and E_j^k becomes GDP in region *j* (Y_j). Thus

$$V_{ij} = f\left(Y_i, Y_j, t_{ij}\right) \quad (10)$$

This leads to the simplest form of the gravity model introduced by Tinbergen (1962),

$$V_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} D_{ij}^{\beta_3} \quad (11)$$

where D_{ij}, the distance between countries *i* and *j* is used as a proxy for t_{ij}; β_1, β_2 and β_3 are elasticities; and β_0 is a constant whose value depends on the units on which the variables are measured.

To develop the commodity level gravity model used in our study, we start with the derived gravity model of (11) and modify it in several aspects. First, whereas typical gravity equations are estimated for *ij* country pairs in world trade, our dataset focuses on U.S. product line exports at the 6-digit level of the Harmonized Tariff System Code (HTS) such that *i* = U.S. is constant and we can omit this subscript. Second, because this study covers a period of 11 years from 1999 to 2009, a time dimension *t* is added to the basic gravity equation to reflect the panel nature of the data. Thus, for the purpose of our study, the value of U.S. exports of commodity *k* to country *j* in time period *t* is as a function of country size and transportation costs. Or, more explicitly

$$V_{jkt} = f\left(Y_{it}, Y_{jt}, t_{jkt}\right) \tag{12}$$

This leads to the commodity specific gravity model

$$V_{jkt} = \beta_0 Y_{ikt}^{\beta_1} Y_{jkt}^{\beta_2} D_{jkt}^{\beta_3} \tag{13}$$

Where $D_{jkt}^{\beta_3}$ serves as a proxy for trade cost t_{jkt}. Taking logs of both sides yields a traditional, linear in parameters gravity equation that can be easily estimated

$$\ln\,(V_{jkt}) = \beta_0 + \beta_1 \ln(Y_{ikt}) + \beta_2 \ln\left(Y_{jkt}\right) + \beta_3 \ln\left(D_{jkt}\right) + \varepsilon_{jkt} \tag{14}$$

Furthermore, similar to the work of Anderson and van Wincoop (2003), we model the price paid by consumers in region *j* on commodity *k* sourced from country *i* as a function of the FOB price and a trade cost factor which will include several proxies for NTMs as discussed further below.

3.2 Benchmark Specification

By further developing (14) and operationalizing the trade cost component t_{jkt} of (12), the benchmark specification of the gravity model is as follows

$$\ln(CVALUE_{jkt}) = \beta_0 + \beta_1 \ln\left(USPROD_{ikt}\right) + \beta_2 \ln\left(PROD_{jkt}\right) + \beta_3 \ln\left(GDPPC_{jkt}\right) + \beta_4 \ln\left(ER_{jt}\right) + \beta_6 \text{NAFTA}_{jt} + \beta_7 \text{CAFTA}_{jt} + \beta_8 \text{FTA\_OTHR}_{jt} + \beta_9 \text{LDLOCK}_j + \beta_{10} \ln\left(1 + TARIFF_{jkt}\right) + \beta_{11} \ln\left(DIST_j\right) + \beta_{12} \text{TREAT}_{jkt} + \beta_{13} \ln(\text{COUNT}_{kt}) + \beta_{14} \ln(1+\text{COUNT}_{kt}) * \text{TREAT}_{jkt} + \alpha_{jk} + \varepsilon_{jkt} \tag{15}$$

where $TARIFF_{jkt}$, $DIST_j$ and $TREAT_{jkt}$ are specified multiplicatively in the trade cost function as

$$t_{jkt} = \left(1 + TARIFF_{jkt}\right)^{\alpha_1} \left(DIST_j\right)^{\alpha_2} \left(TREAT_{jkt}\right)^{\alpha_3} \tag{16}$$

The model described in (15) will be estimated. Table 3.1 contains definitions of all dependent and independent variables and their expected signs. The economic mass of the importing and exporting countries are represented by two independent variables ($PROD_{jkt}$ and $USPROD_{jkt}$) which are the natural logarithm of the value of production of commodity *k* in the importing and exporting countries. It is expected that greater domestic availability will lead to a lower price for the domestic variety and thereby reduce the importing country's demand for imports. Similarly, for a large country who can influence world prices, an increase in production by the exporting region (e.g., the U.S.) will lead to more exportable goods available and will put downward pressure on FOB and CIF prices, leading to an increase in demand in the importing region. Because the demand for fresh fruits and vegetables tends to be income elastic (Huang, 1985), the natural logarithm of per-capita

Table 3.1 Variable Definitions

Variable	Variable Definition	Expected Sign
	Dependent Variable	
$CVALUE_{jkt}$	Value of U.S. product *k* exports to importer *j* in year *t*, expressed as FOB customs value.	
	Independent Variables	
$DIST_{j}$	Geographical distance between the U.S. and the importing country *j* expressed in Km.	<0
$PROD_{jkt}$	Value of Importer *j* production of product *k* in yeart *t*, expressed in millions of USD.	<0
$USPROD_{kt}$	Value of U.S. production of commodity *k* in year *t*, expressed in millions of USD.	>0
$GDPPC_{jt}$	Importer *j*'s per-capita GDP in year *t* expressed as constant 2000 USD.	<0
ER_{jt}	Importer *j* exchange rate in year *t* expressed as the value of one U.S. dollar in terms of foreign currency.	<0
$TARIFF_{jkt}$	Tariff imposed by importer *j* on commodity *k* at time period *t.*	<0
$LDLOCK_{j}$	Dummy variable equal to one if importer *j* has no access to a navigable waterway.	<0
$CAFTA_{jt}$	importer *j* is a member of CAFTA at time *t.*	>0
$OTHR\_FTA_{jt}$	Dummy variable equal to one if importer *j* is a member of any FTA other than NAFTA or CAFTA at time *t*.	>0
$TREAT_{jkt}$	Dummy variable equal to one if importer *j* requires a phytosanitary treatment for commodity *k* imports in	<0
$ORESTRICTION_{jkt}$	Dummy variable equal to one if importer *j* imposes origin restrictions on commodity *k* in year *t*.	<0
$COUNT_{jkt}$	Commodity specific annual cumulative frequency of phytosanitary treatment requirements.	>0

note*:* *j* =1,2,….,139 represents the importing country; *k=1,2,…..,9* represents the commodity; *t* =1, 2,…..,11 represents the year.

Table 3.1 Continued

Variable	Variable Definition	Expected Sign
$t101_{jkt}$	Dummy variable equal to one if importer *j* requires fumigation with methyl bromide for commodity *k* in year *t*.	<0
$t107_{jkt}$	Dummy variable equal to one if importer *j* requires cold treatment for commodity *k* in year *t*.	<0
$t101ort107_{jkt}$	Dummy variable equal to one if importer *j* requires fumigation with methyl bromide or cold treatment for commodity *k* in year *t*	<0
$t101orphosphine_{jkt}$	Dummy variable equal to one if importer *j* requires fumigation with methyl bromide or phosphine for commodity *k* in year *t*.	<0
$t106ort107ort110_{jkt}$	Dummy variable equal to one if importer *j* requires vapor or cold or quick freeze treatments for commodity *k* in year *t*.	<0
$COUNT\_t101_{kt}$	Interaction term between frequency count and fumigation with methyl bromide	?
$COUNT\_t107_{kt}$	Interaction term between frequency count and cold treatment.	?
$COUNT\_t101ort107_{kt}$	Interaction term between frequency count and fumigation with methyl bromide or cold treatment.	?
COUNT_t101orphosphine	Interaction term between frequency count and fumigation with methyl bromide or phosphine.	?
COUNT_t106ort107ort11(	Interaction term between frequency count and vaport heat, cold treatment or quick freeze.	?

note: *j* =1,2,….,139 represents the importing country; *k=1,2,…..,9* represents the commodity; *t* =1, 2,…..,11 represents the year.

GDP for importer *j* in time t, $GDPPC_{jt}$, is included as an independent variable. An increase in per-capita GDP is expected to increase the import demand for fresh fruits and vegetables.

Following Anders and Caswell (2009), the independent variable ER_{jt}, defined as the natural logarithm of the value of one U.S. dollar in terms of currency of importer *j* in year *t* is included to control for variation in the price competitiveness of U.S. exports. Exchange rates are an important factor affecting price competitiveness of exporters even if they are not commodity specific. A depreciation of the U.S. dollar will reduce the value of *ler* and will make U.S. fresh fruits and vegetables relatively less expensive on the world market thereby increasing import demand.

The findings of Grant and Lambert (2008) support the hypothesis that FTAs have a positive and significant impact on agricultural trade. Therefore, we include two distinct variables to control for regional biases for U.S. exports of fresh fruits and vegetables. Specifically, we account for membership in the Central America Free Trade Agreement (CAFTA) by including the dummy variable $CAFTA_{jt}$ which is equal to one if the importing countries are Costa Rica, Nicaragua, Honduras, Guatemala, El Salvador and the Dominican Republic. Finally, we account for membership in all other FTAs with the dummy variable $OTHR\_FTA_{jt}$ which is equal to one if the partners are (dates of entry into force in parentheses): Australia (2005), Bahrain (2006), Chile (2004), Israel (1985), Jordan (2001), Morocco (2006) and Singapore (2004). We expect the coefficients for all three FTA variables to be positive.

Three independent variables are specified to determine the effects on trade of alternative SPS regulations. The variable $TREAT_{jkt}$ is a dummy variable that is equal to one if at least one phytosanitary treatment is required on U.S. exports of commodity *k* to country *j* in time *t*. In addition, alternative specifications are considered where the effect of phytosanitary treatments on U.S. exports is allowed to vary by treatment type. These include dummy variables for: $t101_{jkt}$ fumigation with methyl bromide, $t107_{jkt}$ cold treatment, $so2co2_{jkt}$ fumigation with sulfur dioxide and carbon dioxide, $t101ort107_{jkt}$ fumigation with methyl bromide or cold treatment, $t107ort108_{jkt}$ cold treatment or fumigation plus refrigeration, $t107andso2co2_{jkt}$ cold treatment and fumigation with sulfur dioxide and carbon dioxide, $t101orphosphine_{jkt}$ fumigation with methyl bromide or phosphine and $t106ort107ort110_{jkt}$ vapor heat or cold treatment or quick freeze. In general, it is expected that the requirement of phytosanitary treatments will reduce U.S. exports because the additional compliance costs may reduce the competitiveness of U.S. exports. However, there could also be an increase in demand in the importing country when consumers know that the product has been tested, inspected and in some cases treated for pests. This could act as a quality signal and if consumers are sensitive to SPS and food safety issues, then SPS regulations could increase trade and so the effect of non-tariff barriers could be ambiguous.

The variable $ORESTRICTION_{jkt}$ is equal to one if the importing country *j* imposed origin restrictions on the exports of commodity *k* in time *t*. For example, in 2010 Australia prohibits the importation of cherries from all states other than California, Idaho, Oregon and Washington. These types of restrictions are expected to reduce U.S. exports. However, we note that the trade restrictiveness of origin restrictions depends on where the bulk of U.S. production occurs. For example, in the case of cherries, if the bulk of U.S. production occurs in the States of California, Idaho, Oregon and Washington then an origin restriction which limits production to these States may not be that trade distorting. On the other hand, if the bulk of

U.S. cherry production comes from states that are not on the approved list, then the origin restriction might be very trade distorting. Future research should attempt to incorporate state level production in conjunction with origin restrictions.

The variable $DIST_j$ denotes the natural logarithm of the geographical distance in kilometers between the U.S. and its trade partner *j* and is used to capture the effect of transportation costs. Greater geographical distance between the U.S. and its partners is expected to decrease fresh fruit and vegetable trade. Following the work of Raballand (2003), who found that the lack of a navigable waterway implies a high transport cost burden, we include the variable $LDLOCK_j$, which is a dummy variable equal to one if the importing country is landlocked and zero otherwise. We expect the coefficient for $ldlock_j$ to be negative. Finally $NAFTA_{jt}$ is a dummy variable which accounts for a partners' membership in the North American Free Trade Agreement. The estimated coefficient of this variable is expected to be positive. Finally, it is important to note that while distance, landlocked and NAFTA likely have important impacts on U.S. exports, they are time-invariant such that when we move to an econometric specification that includes country-by-commodity fixed effects these variables, along with other time-invariant country-and-commodity specific omitted variables not accounted for on the right-hand side of equation (15) will be absorbed by the fixed effects.

Finally, borrowing from the work of Peterson, Grant, Roberts and Karov (2011), we introduce $COUNT_{kt}$ which varies by commodity *k* and year *t* and represents a cumulative treatment frequency. This variable is introduced to account for any fixed costs that may be associated with the establishment of phytosanitary treatment facilities as well as possible "learning-by-doing" effects. As a proxy for exporter experience the cumulative frequency variable is expected to have an inverse relationship with the trade flow effects of phytosanitary treatments. In other words, as U.S. exporters gain experience the negative effect of treatment requirements will decrease. By interacting the binary treatment variable with the cumulative count variable ($COUNT_{kt*}$ $TREAT_{jkt}$), the coefficient term will allow us to measure this 'learning' effect. If the estimated coefficient for $TREAT_{jkt}$ is negative and statistically significant, but the interaction term with $COUNT_{kt}$ is positive and statistically significant, then the threshold experience level where the learning effects offset the negative impacts of phytosanitary treatments can be determined.

3.3 Econometric Issues Related to Heteroskedasticity and Zero Trade Flows

One difference between Newton's "Law of Universal Gravitation" and the gravity model of trade is that while the gravitational force can sometimes be infinitesimally small, it can never be zero. However, trade between countries can be zero for reasons and this presents a problem if zero trade flow observations are correlated with any of the trade cost variables on the right-hand side of equation (15). If the reason for zeros is due to trade costs then countries may not select into exporting which gives rise to the classic sample selection bias (Heckman 1979). Additionally, the frequency of observations with zero trade increases as the degree of commodity disaggregation increases in the data. In a 2007 study, Baldwin and Harrigan find that 92.6 percent of potential import flows to the U.S. at the HS 10-digit level are zero. While some zero trade flows can be attributed to missing data or rounding errors associated with low valued trade, it appears that most of the occurrence of zero trade flows reflects a true absence of trade (Martin & Pham, 2008).

Santos Sylva and Tenreyro (2006) note, however, that a large number of zeros poses no problem for the estimation of gravity equations in multiplicative form. However, sample selection issues will arise when employing the log-linear specification. Two approaches to address this issue are either to drop all observations of zero trade or to add one to the value of all trade flows so that the dependent variable takes on a value of zero when the logarithmic transformation is applied.

The first solution results in a conditional model in the sense that the dependent variable is no longer a measure of bilateral trade but rather bilateral trade conditional on a trade relationship actually existing. A key problem with the estimation of the gravity equation in the presence of sample selection is that its residuals no longer meet the zero mean assumption of standard regression theory in which case the estimates suffer from omitted variable bias because they omit relevant explanatory variables (Martin & Pham, 2008). On the other hand, adding one to the dependent variable and estimating by OLS will lead the error term being correlated with the independent variables and will therefore cause OLS estimators to be inconsistent (Santos Silva & Tenreyro, 2006).

Heteroskedasticity in the error term is suspected when the magnitude of the residuals appear proportional to the regression function, the latter being a common property of empirical models in this area (Jayasinghe, Beghin, & Moschini, 2009). A solution to this issue, advocated by Santos Silva and Tenreyro (2006), relies on the Poisson Pseudo-Maximum Likelihood (PPML) estimation method. This approach estimates the model in levels, with a multiplicative error term and the additional assumption that the conditional variance is proportional to the conditional mean. According to Santos Sylva and Tenreyro (2006), this method is robust to different patterns of heteroskedasticity and, additionally, provides a natural way to address the “zeros” issue.

3.4 Econometric model

There are two options to estimate the gravity model when there is a high frequency of zero trade flows. The first option is the use of a Poisson pseudo-maximum-likelihood (PPML) estimator similar to Santos Silva and Tenreyro (2006); the second option is to use a Tobit model as described by Martin and Pham (2008). Even though a Tobit model may be more appropriate to deal with the issue of a left-censored sample due to high density (frequency) of “zeros”, the PPML estimator is more robust to heteroskedasticity than estimators based on normal distribution (i.e. the Gamma-Pseudo Maximum Likelihood estimator) even when residuals are normally distributed (Martin & Pham, 2008).

This thesis adopts the PPML model of Santos Silva and Tenreyro (2006). Even though the PPML estimator is typically used in cases of count data, Santo Silva and Tenreyro (2006) show that it yields consistent estimates for trade flow data where “zeros” are frequent. The PPML estimator is defined by solving the following set of first order conditions:

$$\sum_{i=1}^{n}\left[y_i - e^{x_i\beta}\right]x_i = 0, \tag{17}$$

which is consistent if the conditional mean is:

$$E[y_i|x] = \exp\left(\beta_0 + \beta_1 x_1 + \ \dots + \beta_i x_i\right) \tag{18}$$

Moreover, because the dependent variable enters in level form (and not in natural logarithms) the PPML estimator can handle zero trade flows, however numerous they may be.. Although the dependent variable is entered in level form and some regressors in natural logarithmic form, coefficient estimates may still be interpreted as elasticities (Cameron & Trivedi, 2005). In other words, taking the log of equation (18) shows that

$$\log(E[y_i|x]) = \beta_0 + \beta_1 x_1 + \ \dots + \beta_i x_i \tag{19}$$

so that the log of expected value is linear. Therefore, using the approximation properties of the log function,

$$\%\Delta\, E[y_i|x] \approx (100\beta_j)\Delta x_j \tag{20}$$

In other words, $100\beta_j$ is roughly the percentage change in $E[y_i|x]$ given a one-unit increase in x_j. For cases where $x_j = \log{(z_j)}$ for some variable $z_j > 0$, then its coefficient, β_j, is interpreted as an elasticity with respect to z_j.

This thesis proposes various specifications of the gravity model to identify the impact of SPS treatments on U.S. exports of fresh fruits. To accomplish this task, the following PPML gravity model is specified:

$$cvalue_{jkt} = \exp\left(A_{jkt}\beta\right) + \varepsilon_{jkt} \tag{21}$$

where $cvalue_{jkt} \geq 0$ is the value of U.S. exports to country *j* of commodity *k* in time *t*, $E\left[\varepsilon_{jkt}|cvalue_{jkt}\right] = 0$, and the vector A_{jkt} contains all of the variables defined in equation (15) above (i.e., U.S. and importer production values, importer per capita GDP, distance, the bilateral exchange rate, FTAs, dummies for landlocked importers, origin restrictions, and phytosanitary treatments including the important interaction effect of treatments and the U.S. cumulative experience variable ($COUNT_{kt}$).

Additionally, we account for unobserved factors by introducing in our model a *country/commodity-type* specific fixed effects variable (α_{jk}) and performing conditional likelihood estimation. The choice of performing fixed-effects estimation is motivated by the fact that there may be a considerable amount of unobserved heterogeneity not accounted for in equation (21). Such factors could include information barriers, geographical ties, historical, colonial, or political linkages, and natural trading partner effects (i.e., the U.S. and Canada) (Eggert, 2000). The advantage of using *country/commodity-type* fixed effects is that each importer and commodity are allowed to deviate from the common intercept in the model to control for naturally higher or lower levels of trade with the U.S.

The reason for employing *country/commodity-type* fixed effect rather than *country/commodity* fixed effect is that there is little to no within variation of the phytosanitary treatment variables which increases the risk of near collinearities with the *country/commodity* fixed effects. While there is a small amount of variation in some treatment variables, most do not vary over time in which case they will be almost perfectly correlated with the country-commodity fixed effects. This presents a dilemma. Do we specify a naive version of the gravity equation without fixed effects, knowing that it could be biased? Or do we attempt to control for unobserved heterogeneity by creating commodity-type fixed effects so that we don't absorb the effects of phytosanitary treatments? For this work we chose the latter option and created three groups divided by commodity type to be used in the fixed effects framework. The groups consist of the following types: vegetables and nuts (type 1) and fruits (types 2 and 3). Type 1 includes onions, peas and walnuts; type 2 includes oranges, grapes and strawberries; and type 3 includes of apples, peaches/nectarines and cherries.

More specifically, given the dependent variable y_{it} varies over individual (*i=1,2,3,…n),* and time (*t=1,2,3,…m)*, it is assumed to have a Poisson distribution with parameter μ_{it} which in turn depends on a vector $\boldsymbol{x}_{it}$ of exogenous variables according to the log-linear function

$$\ln \mu_{it} = \delta_i + \boldsymbol{x}_{it}\beta \qquad (22)$$

where δ_i is the fixed effect.

One way to estimate this model is to do conventional Poisson regression by maximum likelihood, including dummy variables for all individuals (less one) to directly estimate the fixed effects. An alternative method, described by Allison and Waterman (2002), is conditional maximum likelihood, conditioning on the count total $\sum_t y_{it}$ for each individual. For the Poisson model, this yields a conditional likelihood that is proportional to

$$\prod_i \prod_t \left(\frac{exp(\boldsymbol{x}_{it}\beta)}{\sum_s exp(\boldsymbol{x}_{is}\beta)}\right)^{y_{it}} \tag{23}$$

for individuals *i* = 1, 2, 3…n over time periods *t* = 1, 2, 3….m and *s* = 1, 2, 3…m.

Consistent estimates of β for fixed m and n → ∞ can then be obtained by maximization of (23). Differentiating (23) with respect to β yields the first order conditions

$$\sum_{i=1}^{N} \sum_{t=1}^{T} \boldsymbol{x}_{it} \left(y_{it} - \frac{\lambda_{it}}{\bar{\lambda}_i} \bar{y}_i\right) = 0 \tag{24}$$

where $\lambda_{it} = exp(\boldsymbol{x}'_{it}\beta)$ and $\bar{\lambda}_i = T^{-1} \sum_t exp(\boldsymbol{x}'_{it}\beta)$.

The first order conditions imply that the Poisson MLE for β is equivalent to the moment estimator in a model where the ratio of individual, or within group, means is used to approximate individual specific effects. This *mean scaling model* is given by

$$y_{it} = \frac{\lambda_{it}}{\bar{\lambda}_i} \bar{y}_i + \lambda^*_{it} \tag{25}$$

where $\lambda^*_{it} = \lambda_{it} - \frac{\lambda_{it}}{\bar{\lambda}_i} \bar{\lambda}_i$. Note that conditioning has eliminated the δ_i parameter from the likelihood function while preserving Poisson pseudo-likelihood results (Blundell, Griffith, & Windmeijer, 2000).

4. Data

This study collects data on phytosanitary measures faced by U.S. exporters of cherries, grapes, strawberries, apples, peaches and nectarines, oranges, peas, walnuts and onions for a period of 11 years starting in May, 1999 and ending in December, 2009. The data is compiled using information from the Export Certification Project (EXCERPT) database maintained by the Center for Environmental and Regulatory Information Systems (CERIS), at Purdue University, and by the Plant Protection and Quarantine (PPQ) branch of the United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS). The EXCERPT database contains summaries of phytosanitary import requirements for more than 250 countries which, when combined with official communications and instructions found in the Export Program Manual (XPM) is used by US exporters and PPQ authorized certification officials (ACOs) in the preparation and issuance of export certificates (USDA-APHIS, Export Program Manual, 2011). Import requirements of each country may consist of all or a combination of the following nine items: import permit (IP), geographic restrictions on origin and/or destination, system approaches to pest risk management (work plans), seasonal restrictions, phytosanitary treatments, and additional declarations (ADs) (USDA-APHIS, Export Program Manual, 2011).

The information contained in the EXCERPT database is updated on a monthly basis by PPQs Export Services (ES), who is responsible for analyzing official communication from the various importing countries' National Plant Protection Organization (NPPO) offices (USDA-APHIS, Export Program Manual, 2011). Any changes to a country's import regulations are explicitly indicated in the “Last Updated” field of the product requirements or general information page.

4.1 Data Extraction

Because of the large number of country/year/month/commodity observations, (approximately 140x11x12x9=155,320) data on the importers’ phytosanitary requirements was extracted from EXCERPT using a custom application programmed in Java and compiled and executed in the Netbeans Integrated Development Environment (IDE). The application accepts the EXCERPT data in HTML format after which it extracts and stores the year, month and ISO-3 alpha country code from the Universal Resource Locator (URL) file path. For example, given the URL for El Salvador’s phytosanitary requirements in January, 2000, http://minorleague.ceris.purdue.edu/archive/200001/SLV the ISO-3 country code is extracted from the last three characters of the URL while year and month are extracted from characters 45 through 48 for the year and 49 through 50 for the month. Rather than accessing the database directly through a broadband connection, for the purpose of speed and accuracy, the entire database was downloaded and stored on a hard drive with the folder structure and file names being kept intact. Thus, rather than starting with *http://*, all URLs will now be noted as starting with C:\, which is the letter of the hard drive where the EXCERPT database is stored. For example; El Salvador’s phytosanitary requirements in January, 2000 is C:\minorleague.ceris.purdue.edu\archive\200001\SLV.

Following this operation, the commodity specific import requirements are extracted (where available) from the *Commodity Menu* for each importer. Each commodity is listed according to its scientific name i.e. *Vitis Vinifera* for Grapes, *Fragaria Spp.* or *Fragaria X*

Ananassa for Strawberries and *Prunus Avium* or *Prunus Spp.* for Cherries. In addition to commodity specific information, the program also extracts and stores information on whether U.S. exports are prohibited and other phytosanitary requirements that are found in each importer's *Category Menu*.

4.1.1 EXCERPT Database Layout

The EXCERPT database is located at http://excerpt.ceris.purdue.edu and it is accessed by ACOs free of charge. All others (e.g. private entities or other Federal or State government agencies such as the Food and Drug Administration (FDA) or the Environmental Protection Agency (EPA)) may access the EXCERPT database through a subscription (USDA-APHIS, 2011). A subscription to EXCERPT includes acces to the current year's phytosanitary regulations in addition to EXCERPT archives starting in May, 1999.

Individual country product requirements can be accessed from the EXCERPT home page by following the Export Summary Inquiry hyperlink. By accessing this link, the user is presented with a web page containing the export summaries of all countries available to EXCERPT at that particular time. Each country's Export Summary page has links to Product Requirements, General Information and Subsidiary Information pages. The Product Requirements section includes the phytosanitary requirements for specific commodities based on the botanical name of the plant or plant part. Commodities may be listed by their family, genus or genus and species. In isolated cases, commodities may be listed at a higher taxon, e.g., order, class, etc.

Each Product Requirements file is further broken down into plant parts. The identified plant parts are specified by each country. Each plant part may be defined in the "Definitions of Terms and Coded Abbreviations" within the General Information section of an export summary.

Plant parts which may be included in an Export Summary are: Cut Flower, Fruit, Grain, Miscellaneous, Nursery Stock, Vegetables, Wood, etc. The requirements under a plant part can be further broken down into subparts. For example, the fruit plant part of Australia's product requirements for oranges (*Citrus x sinensis*) is subdivided into three sub parts according to the place of origin of the consignment within the United States; i.e. from AZ, from CA and from all other states.

The General Information section primarily contains information that does not pertain to specific commodities or information that cannot be placed in the Product Requirements section. This section may include country specific information such as definitions of terms and abbreviations, areas and hosts regulated for specific pests, harmful organisms that are prohibited, etc. Additionally, the General Information page for each country (with the exception of Iraq and Iran) will typically always include Prohibited, Restricted and Unrestricted Products sections.

Unlike the Product Requirements section, which can be searched by the botanical name, the Prohibited Products, Restricted Products, and Unrestricted Products sections are searched by subject. Under each subject will be a list of commodities prohibited or unrestricted by a country or in the case of the Restricted Products section, there will be commodity or subject-wide guidelines. Subjects that may be included in the Prohibited, Restricted and Unrestricted Products sections can include Cut Flowers, Fruits and Vegetables, Grain, Miscellaneous, Nursery stock, etc. Each subject may be defined in the "Definitions of Terms and Coded Abbreviations" within the General Information section of an Export Summary. Additionally, the requirements under each subject may be further broken down into topics. These topics can refer to specific species, origin of the commodity at the county or state level, or the physical state of the commodity i.e. frozen, dried or fresh.

The Prohibited Products section identifies commodities that are prohibited from entering a country. Prohibited products must not be certified unless an import permit or other form of official communication from the NPPO of the importing country is presented and all conditions can be met. The Restricted Products section contains import requirements that are general in nature and pertain to a broad category of commodities. For example, Requirements pertaining to all "Annual and Biennial Plants" would be contained in the Restricted Products section, rather than in the Product Requirements section. Finally, The Unrestricted Products section lists commodities that a country does not regulate and, therefore, does not require an export certificate. These commodities, however, are still subject to inspection on arrival at a PPQ designated site. The commodities may be listed by botanical name or as a broad category (grain, flour, wood, etc.).

Information contained in the Prohibited, Restricted and Unrestricted Products section may not be in the Product Requirements section, especially, if the information pertains to a broad category of commodities. It is therefore recommended by the Export Certification Program Manual that ACOs review both the Product Requirements and the General Information sections of EXCERPT for any commodity to be certified (USDA-APHIS, 2011).

4.1.2 Extracting Data from the Product Requirements Section

The *Commodity Menu* file contains a list of HTML hyper-links to a specific country's individual commodity SPS regulations. In plain text, each hyper-link is presented in this form: PRUNUS AVIUM where href indicates the name of the commodity's phytosanitary regulations web page and PRUNUS AVIUM represents the scientific name[7] of the commodity. Table 4.1 lists the common and scientific names of all the commodities included in our study. In this particular example, the hyper-link indicates that the name of the phytosanitary regulations web page for cherries by Australia in December, 2009 is CMD00522.HTM. In some cases, e.g. The Dutch Antilles, the country does not have commodity specific phytosanitary requirements and so the Product Requirements page will contain the string "ALL COMMODITIES ----------". This is noted in a Boolean[8] variable and phytosanitary regulations are extracted directly from the text available on the Product Requirements page and applied to all commodities of interest to our study. The absence of individual commodities in the Product Requirements page indicates the need to search the General Information pages for additional phytosanitary requirements.

Table 4.1 Common and Scientific Names

Common Name	Family	Genus	Species
Cherries	Rosaceae	Prunus Spp.	Prunus avium
Peaches/Nectarines	Rosaceae	Prunus Spp.	Prunus persica
Strawberries	Rosaceae	Fragaria Spp.	Fragaria x ananassa
Apples	Rosaceae	Malus Spp.	Malus domestica
Peas	Fabaceae	Pisum Spp.	Pisum sativum
Oranges	Rutaceae	Citrus Spp.	Citrus x sinensis
Onions	Alliaceae	Allium Spp.	Allium cepa
Walnuts	Juglandaceae	Juglans Spp.	Juglans regia
Grapes	Vitaceae	Vitis Spp.	Vitis Vinifera

[7] All commodities in EXCERPT are referred to by their scientific names.

[8] A Boolean variable is of a primitive data type having True or False value; also known as a binary variable.

Following this process, commodity page HTML code is analyzed and simple text is extracted and stored in a temporary variable using HTML Parser, an open source Java library used to parse HTML code for the purpose of transformation or extraction of data (SourceForce.Net, 2006). Each phytosanitary regulation is divided into subsections by plant part e.g. dried fruit, fruit, nursery stock, seeds, etc. with each subsection separated by a horizontal rule HTML tag “<hr />”.

Because this study focuses on fresh fruits and vegetables, only the information available in the fruit, vegetable or nuts plant part sections is extracted. When extracting plain text, only those sections which begin with the string “FRUIT ----plant part----“ or “NUTS ----plant part----“ or “VEGETABLES ----plant part----“ and end at the first occurrence of a Horizontal Rule HTML tag are extracted. Occasionally, the commodity’s phytosanitary regulations page does not contain a fruit, nuts or vegetables subsection; in such a case the program flow will branch to Category Menu after noting this absence in a Boolean variable.

Following the extraction and storage of the plain text phytosanitary data into a temporary string variable, a Java object[9] is created and instantiated[10] with the country’s name, the date and the string variable containing the subsection of the commodity’s phytosanitary regulations page. In addition to this information, the Java object also stores the last modified or updated date of the commodity’s phytosanitary regulations page. Only the phytosanitary data for which the last updated date has changed over time is stored and processed by the program.

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[9] A Java object is a set of data combined with methods for manipulating those data.
[10] Instantiation reserves memory space for an object’s data and methods.

The instantiation of the commodity object begins the process of parsing, analyzing and extracting relevant data from the plain text subsection object; a process that involves the detection of origin or destination specific phytosanitary requirements, followed by the detection of individual phytosanitary requirements and finally the output of final results to a plain text file or directly to the Netbeans IDE console.

The next step in the process is to pass the plain text subsection String object to a Java method[11] called *SearchForOriginOrDestination(String fruitSectionText)* that determines if origin and/or destination restrictions are applied. In such a case, the Java method creates an ArrayList[12] object to store multiple phytosanitary regulations by origin and/or destination. The start of a section covering geographic restrictions begins with the string "FROM State Name ----sub part----"and ends either with the start of a new geographic restrictions section or a horizontal rule HTML tag. To match U.S. state names for origin restrictions, we use an ArrayList of State objects which contains either the full state name such as New York or the abbreviated state name (NY). Determining origin restrictions takes into consideration various other possibilities for State Name such as when more than one state is being presented in abbreviated form or the presence of phrases "OTHER THAN State Name" and "ALL OTHER STATES". In all cases however, each line indicating the origin restriction subpart starts with the word "FROM" and ends with "----sub part----". Once an occurrence of "\r\nFROM\sState Name\s----sub\spart----" is found, the method stores all text until the next occurrence of the origin identifier line or until the first occurrence of a Horizontal Rule which indicates the end of

[11] A Java method is a series of statements that perform repeated tasks.
[12] See Java SE 6 ArrayList API http://download.oracle.com/javase/6/docs/api/java/util/ArrayList.html for proper use.

the phytosanitary regulations for fruit for the specific commodity. In addition to plain text of the regulations, all state names associated with origin restrictions are also extracted.

Extracting destination restrictions follows the same principle but instead of searching for the string “FROM State Name ----sub part----“we search for “TO Country or Territory ----sub part----.“ However, because of only two occurrences of destination restrictions were found in the EXCERPT database, the creation of an array list of country and territory names was not necessary.

Following the extraction of the origin and/or destination restrictions, text containing information on specific phytosanitary regulations is extracted. To accomplish this, a Boolean variable, *isRegulated* is created; this variable will take on a value of true if a specific phytosanitary regulation is found and false otherwise. A string object is used to store the name of the phytosanitary regulation, e.g. methyl bromide Fumigation. The stored text is then assigned to 14 different possible treatment options, including ten different phytosanitary treatments, whether an import permit is required, whether there are additional declarations, whether the commodity is prohibited, or whether a workplan is required. A value of 0 or 1 is then assigned to a binary variable for each of the 17 different treatment options depending on whether that treatment option is specified in the EXCERPT database or not. Because annual trade data will be utilized in the empirical analysis, if any treatment option is observed at any time during a given year, it is assumed that this option is required for the entire year.

4.1.3 Extracting Data from the General Information Section

Extracting phytosanitary regulations data from EXCERPT’s General Information section follows a process similar to the process of extracting data from the Products Requirements section. However, as the General Information section is divided by category rather than commodity, we will search for three particular categories (Prohibited Products, Restricted Products and Unrestricted Products) that contain commodity specific or general phytosanitary regulations relevant to our study.

Each of the three categories is divided by subject with each subject addressing phytosanitary regulations concerning plant parts e.g. Cut Flowers and Branches, Fruit and Vegetables, Grain, Seeds etc. Additionally, each subject is divided by topic according to: origin or destination restrictions, product type, e.g. Fresh or Frozen Fruits and Vegetables, and host status of a commodity, e.g. *Ceratitis Capitata* Host Material. Moreover, as presented by the case of Canada's restricted products section, fruit subject, topics may serve as subtopics as well i.e. Hosts of *Epiphyas Postvittana* is the main topic followed by a destination restriction to British Columbia as a subtopic which in turn contains an origin restriction from CA and HI as a subtopic.

To locate individual category pages in EXCERPT, the category menu page is accessed and a string search on each category hyper link for the occurrence of the words "prohibited", "restricted" and "unrestricted" is performed. Similar to the Product Requirements section, the HTML page for the General Information section is located in the country folder on the fifth level of the EXCERPT database and is named CATMENU.HTM; for example, the canonical path *C:/minorleague.ceris.purdue.edu/archive/200912/JPN/CATMENU.HTM* points to Japan's General Information section for December, 2009. After reading the HTML code of CATMENU.HTM, the *href* field of all anchor tags whose text consists of *PROHIBITED PRODUCTS, RESTRICTED PRODUCTS OR UNRESTRICTED PRODUCTS* is scanned and the contents are stored in a temporary variable. For example, the *href* field of the following anchor tag contains a pointer to the restricted products general information page RESTRICTED PRODUCTS which, when combined with the canonical path of the current working directory will serve as a pointer to Japan's December, 2009 restricted products general information page i.e. *C:/minorleague.ceris.purdue.edu/archive/200912/JPN/CAT00009.HTM.*

After determining the location of each general information page, a *Category* java object is created and instantiated with the values of the country being observed, the EXCERPT year and month, the canonical path of a particular general information page, and the type of category i.e. prohibited, restricted or unrestricted. The instantiation process follows three steps; reading the HTML code of the general information page, extracting plain text from HTML code, and finally, determining whether any phytosanitary regulations exist.

To read the HTML code and extract plain text information, the page's canonical path is passed to an HTML parser object which returns an unformatted string representation of the page. The string is then passed to a local routine within the Category object which searches and extracts the subdivision or subject discussing phytosanitary regulations for fruits and vegetables. The subject extracting routine determines the starting position of the section on phytosanitary regulations of fruit by performing a text search for a string starting with the characters "FRUIT" for fruits, "NUTS" for walnuts and "VEGETABLES" for peas and onions, and ending with the characters "----subject----". Similarly, the same routine determines the end position of the section by locating either the first instance of a horizontal rule or the beginning of the next subject section following the starting position determined in the previous step.

Using these positions, the entire plain text portion referring to phytosanitary requirements is stored in a temporary string variable named *fruitSectionText*.

Following this process, *fruitSectionText* is passed to a subroutine where it is scanned for the existence of subtopics such as origin or destination restrictions, product type, and host status of a commodity. In each of these cases, the starting position of the subtopic is determined by the string "----topic----" while the ending position is determined by either the next occurrence of the string "----topic----" or the occurrence of a horizontal rule. Once a subtopic is found, the subroutine determines whether it is classified as destination by searching for the string "TO", origin by searching for the string "FROM", host status by searching for the string "HOST" or product type by searching for the strings "FRESH", "FROZEN" and "DRIED"; in the case of "FROZEN" the subtopic is ignored. If the subtopic refers to an origin or destination restriction, the name of the state or region is extracted from the subtopic name and stored in a string variable or in a one dimensional array of string variables should the subtopic refer to multiple states. For subtopics addressing restrictions by host material, the name of the pest or pathogen is extracted from the subtopic title and stored in a string variable. To determine whether strawberries, cherries, grapes, apples, peaches and nectarines, oranges, peas, walnuts and onions are considered host materials we scan the entire text of the subtopic for the occurrence of a list of species considered host materials by the importing country; and should such a list be absent, we compare the host name to a list of commodity-specific pests compiled with information available on the USDAs Plant Pest Information System (USDA-APHIS, Plant Health, 2010). Finally, if any of the nine commodities of concern to our study are found to be hosts for the pest to which the subtopic refers, nine Boolean variables, one for each commodity are set to either true or false e.g. the variable grape*IsHost* will be set to true if the pest of concern is Mediterranean Fruit Fly while *cherryIsHost and strawberryIsHost* will be set to false.

Once all subtopics are extracted and the commodity of reference is determined, a new routine will perform a string search using regular expressions to determine the phytosanitary restrictions that apply to the commodities from the previous step. The routine will search for any existing phytosanitary treatments, import permit and additional declaration requirements as well as any existing workplans between the importing country and the United States. Should any of these requirements be present, a Boolean variable is create and set to true i.e. if the importing country requires that a commodity be fumigated with methyl bromide, a variable called *fumigationWithMB* will be set to true.

In a process identical to the extraction of phytosanitary regulations from commodity pages, an array of regular expressions[13] representing phytosanitary treatments are accessed sequentially and compared to the string of the subtopic extracted in the previous step. If a match is found, a Boolean variable is set to true. For example, the regular expression for treatment schedule T108 "FUMIGATION\\s*(PLUS|AND)\\s*REFRIGERATION" will return true if the required treatment is Fumigation plus Refrigeration. In this particular case we take into account the possibility that either conjunction PLUS or AND may be used in the sentence. The entire list of regular expressions for phytosanitary treatment requirements can be found in the RegulationsList class in Appendix A. Additionally, regular expressions for Import Permit, Additional Declaration and Work Plan are also run on the subtopic string. In each of these cases, we take into consideration the different ways in which these requirements may be

[13] A regular expression, often called a pattern, is an expression that describes a set of strings.

written i.e. Import Permit can be written simply as IP while Additional Declaration may be written as AD or in the case of multiple additional declarations we may see it written and AD's; work plan on the other hand may be written as such or it may be written in one word: workplan.

Finally, after each regular expression has been compared to the string, Boolean variables corresponding to individual treatment, documentation or workplan requirements are stored for printing. This operation is accomplished from the Main Java class by running a print subroutine whose output consists of the ISO-3 country code, followed by the year and month for which the country's regulations were valid, followed by the name of the commodity to which the regulations apply, followed by 0's or 1's separated by a pipeline (|) character and indicating if the specific regulation is required (1) or not (0). The reason that this particular output format was chosen is the way it easily lends itself to processing using spreadsheet software such as Microsoft Excel or statistical analysis using Stata.

4.2 Phytosanitary Treatments

The USDA *Treatment Guide* identifies ten (see Table 4.2) phytosanitary treatments for fruits, nuts, and vegetables to control plant pests which are of "quarantine significance." Each treatment is categorized as either chemical or non-chemical (USDA-APHIS, 2009). Chemical treatments include fumigation with methyl bromide (T101), fumigation plus refrigeration of fruits (T108) and cold treatment plus fumigation of fruits (T109) while non-chemical treatments include water treatment (T102), high temperature forced air (T103), irradiation (T105), vapor heat (T106), cold treatment (T107) and quick freeze (T110).

Of the ten treatment types listed in Table 4.2, methyl bromide fumigation, vapor heat, cold treatment, quick freeze, and fumigation plus refrigeration are the only phytosanitary treatments required by importers. Additionally, Australia and New Zealand require fumigation with a mixture of Sulfur Dioxide and Carbon Dioxide while Australia, Mexico, Malaysia and Chile require fumigation with Phosphine; two treatments that are not listed in the USDA Treatment Guide.

Table 4.2 Treatment Schedules for Fruits, Nuts and Vegetables

Schedule	Treatment Type
T101	Methyl Bromide Fumigation
T102	Water Treatment
T103	High Temperature Forced Air
T104	Pest Specific/Host Variable
T105	Irradiation
T106	Vapor Heat
T107	Cold Treatment
T108	Fumigation Plus Refrigeration of Fruits
T109	Cold Treatment Plus Fumigation of Fruits
T110	Quick Freeze

Source: USDA-APHIS 2009

Table 4.3 lists nine commodity treatment groups which were created to account for all possible combinations of treatments identified from the EXCERPT data. Groups one, two and three indicate the required use of only one type of treatment; group six indicates the required use of two treatments i.e. fumigation with carbon dioxide and sulfur dioxide as well as cold treatment; groups four, five and seven indicate the option of two different treatments, while group eight indicates that the exporter has an option of three phytosanitary treatments i.e. vapor heat, cold treatment or quick freeze.

Table 4.3 Commodity Treatment Groups

Group	Definition	T100 Series Code
Group 1	Methyl Bromide Fumigation	T101
Group 2	Cold Treatment	T107
Group 3	Sulfur Dioxide/Carbon Dioxide Fumigation	SO2CO2
Group 4	Methyl Bromide Fumigation or Cold Treatment	T101 or T107
Group 5	Cold Treatment or Fumigation Plus Refrigeration of Fruits	T107 or T108
Group 6	Cold Treatment and Sulfur Dioxide/Carbon Dioxide Fumigation	T107 and SO2CO2
Group 7	Fumigation with Methyl Bromide or Phosphine	T101 or Phosphine
Group 8	Vapor Heat or Cold Treatment or Quick Freeze	T106 or T107 or T110

Sources: USDA Treatment Manual, EXCERPT

Table 4.4 lists the frequency of treatments associated with positive and zero export values. Of all the treatments included in the study, fumigation with methyl bromide is associated with the largest number of positive trade flows while fumigation with sulfur dioxide and carbon dioxide is associated with the lowest number of observations. While not apparent in Table 4.4, fumigation with methyl bromide and cold treatment requirements are associated with the highest export values.

Table 4.4 SPS Treatment Frequency

Treatment Type	Frequency Associated with Positive Exports	Frequency Associated with Zero Exports
T101	269	86
T107	252	94
SO2CO2	10	1
T101 or T107	99	35
T107 or T108	33	0
T107 and SO2CO2	11	0
T101 or Phosphine	43	1
T106 or T107 or T110	61	215
Total:	778	432

Source: EXCERPT, USITC 2011

Table 4.5 breaks down by commodity the total value of U.S. exports subject to SPS treatments. After observing that the total value of exports not requiring SPS treatments is more than three times greater than the value of exports requiring SPS treatments, one may reach the conclusion that SPS treatments do not affect U.S. exports in a negative way. However, because at this point in the study other factors that may affect U.S. trade are not being controlled for, any conclusions drawn from the data in Table 4.5 may be premature. Overall, there are 1210 observations, or approximately 15% of the sample, which are subject to at least one type of SPS treatment requirement. Of these observations walnuts and grapes account for the least number of observations at 53 and 78 respectively while oranges and peaches/nectarines account for the largest number of observations with any kind of phytosanitary requirement at 160 and 194, respectively. In terms of share of total value of exports subject to an SPS treatment, strawberries have the lowest share at 0.6% while peaches/nectarines exports have the highest share at 64 percent.

Approximately forty countries require at least one kind of SPS treatment; with methyl bromide fumigation accounting for 29% of all treatment requirements and cold treatment accounting for 28 percent. The remaining four percent of all treatment requirements is accounted for by fumigation with phosphine, fumigation plus refrigeration, quick freeze and fumigation with sulfur dioxide and carbon dioxide or a combination of the above treatments.

Fumigation with methyl bromide and cold treatment are required for the greatest number of observations with positive trade value; and, additionally these two treatments have the highest value of exports subject to them (i.e. $3.7 billion are subject to fumigation with methyl bromide and $2.4 billion are subject to cold treatment).

Table 4.5 Value of U.S. Exports by Commodity and Treatment (in thousands of USD)

Treatment	Dried Peas	Apples	Oranges	Grapes	Walnuts	Cherries	Peaches and Nectarines	Strawberries	Total
T101	278	70,627	1,461,377	183,688	33,354	1,054,554	892,315	9,235	3,705,428
T107	1,846	1,570,319	710,329	120,810	0	728	7,295	19	2,411,345
SO2CO2	0	0	0	183,531	0	0	0	0	183,531
T101 or T107	6	42,676	696,009	298	0	34	2,860	54	741,938
T107 or T108	0	0	0	204,590	0	211,533	0	4,117	420,240
T107 and SO2CO2	0	0	0	78,407	0	0	0	0	78,407
T101 or Phosphine	8,976	0	0	0	39,316	0	0	0	48,292
T106 or T107 or T110	4,254	0	15,245	0	0	0	0	0	19,499
Total With Treatment	15,360	1,683,622	2,882,960	771,324	72,670	1,266,850	902,470	13,425	7,608,680
Total Without Treatment	795,436	3,480,769	2,138,976	4,481,819	1,309,817	963,252	506,258	2,240,402	15,916,729

Source: EXCERTP, USITC (2010)

New Zealand is the only country requiring fumigation with carbon dioxide and sulfur dioxide for the importation of fresh grapes. Additionally Australia and New Zealand are large importers of grapes. Generally speaking, foreign regulatory regimes require one particular treatment schedule; e.g. fresh cherries headed to Korea must be fumigated with methyl bromide (T101). However, in some cases, the exporter is given the option of choosing between two or more treatment schedules. For example, fresh grapes headed to Taiwan may be fumigated with methyl bromide or undergo cold treatment.

4.3 Other Requirements

In addition to phytosanitary treatments, commodities exported by the U.S. may be required to meet various additional restrictions. If the commodity being exported to a foreign country is determined by an Accredited Certification Official (ACO[14]) to be eligible for certification, additional import requirements must be determined by reviewing the EXCERPT database or from official communication presented by the exporter; usually in the form of an Import Permit. For the purpose of our study and because of the nature of official communications presented in the form of an IP, we relied solely on import requirements data available in the EXCERPT database.

Typically, additional import requirements take the form of geographic restrictions on origin and/or destination, seasonal restrictions, systems approaches to pest risk management i.e. workplans and documentation requirements such as Additional Declarations and Import Permits. Additionally, the importation of certain commodities may be prohibited. In this case,

[14] A public officer who is authorized by the National Plant Protection Organization (NPPO) to issue the signing of phytosanitary certificates, who 1) possesses the required education, experience, and training; and 2) has written confirmation of having successfully passed an approved examination (NAPPO, 2008).

the ACO must refuse to issue an export certificate unless official communication in the form of an IP from the importer is presented. Table 4.6 presents the frequencies of other import permit, additional declaration and workplan requirements by commodity. In all cases an import permit is required more often than an additional declaration and workplans exist only for oranges, grapes, walnuts, cherries, peaches and nectarines and strawberries. Onions, dried peas and apples do not present a workplan and, in addition, have a lower frequency of import permit and additional declaration requirements than all other commodities.

Table 4.6 Frequency of All Other SPS Requirements

HTS-6	Commodity	IP	AD	Workplan
70310	Onions	423	411	0
71310	Dried Peas	537	416	0
80231	Apples	109	59	0
80510	Oranges	1,064	609	56
80610	Grapes	953	445	43
80810	Walnuts	688	385	78
80920	Cherries	981	420	51
80930	Peaches and Nectarines	780	515	59
81010	Strawberries	766	306	24

Source: EXCERPT

4.4 Import Permits

Import permits (IPs) are official documents authorizing importation of a commodity in accordance with specified phytosanitary requirements. The IP is issued to the consignee who is the importer in the receiving country, not to the exporter. If the IP is in a foreign language, it must be translated in the United States and notarized as a true translation (USDA-APHIS, Phytosanitary Certification FAQs, 2008). As official documents, import permits replace or supplement information available in EXCERPT (USDA-APHIS, Export Program Manual, 2011). Typically, IPs must be presented to ACOs by exporters when a commodity is listed as prohibited in EXCERPT; however, this is not always the case. For example, sweet cherries originating in the states of California, Idaho, Oregon and Washington and being exported to Mexico while not prohibited, do require an import permit. On the other hand, cherries originating in the state of Hawaii and headed to Brazil are prohibited and may not be issued a Phytosanitary Certificate unless an IP is presented by the exporter. IPs are identified and recorded by searching for the key words: *Import Permit* or *IP*.

4.5 Systems Approaches to Pest Risk Management

A systems approach to pest risk management (or workplan) is an official document specifying the phytosanitary measures agreed to by the National Plant Protection Organization (NPPO[15]) of both importing and exporting countries and it is intended to prevent the movement of pests while facilitating trade of plants and plant products (USDA-APHIS, Export Program Manual, 2011). In general, workplans must contain a list of regulated pests for the commodity covered by the workplan. Additionally, a workplan must state the participants and their responsibilities in meeting the requirements of the workplan. Most importantly however, a workplan must describe all pest risk management measures which are intended to ensure that the exporting commodity is free of quarantine pests and meets the tolerances specified by the importing country for regulated non-quarantine pests (NAPPO, 2003). Phytosanitary measures included in bilateral workplans often include pre-harvest, post-harvest and safeguarding measures. However, because of the heterogeneity in requirements across workplans, this study will not attempt to incorporate the details of each plan but rather note whether a bilateral workplan is in effect for a specific country/commodity pair. For example,

[15] See Appendix D for Article IV of the November, 1997 Plant Protection Convention (PPC) which details the responsibilities of an official national plant protection organization.

sweet cherries from the continental U.S. headed to Japan are subject to the U.S.-Japan Sweet Cherry Workplan.

4.6 Additional Declarations

An Additional Declaration (AD) is a statement that is required by an importing country to be entered on an export certificate that provides specific additional information on a consignment in relation to regulated pests (USDA-APHIS, Export Program Manual, 2011). Generally, ADs confirm that the requirements for a pest free place of production or a pest free production site have been met, and the issuance of a phytosanitary certificate by an ACO is considered an official document supporting any statements made in Additional Declarations (IPPC, 2009). Methods used to achieve a pest free production place may include yearly surveys, preventive measures such as the elimination of host material, exclusion measures such as screens or physical barriers and pest control measures such as in-field treatments and resistant cultivars (USDA-APHIS, 2011). Finally, ADs may differ according to commodity, pests of concern, origin and destination. For example, table grapes originating in the California counties of Fresno, Kern, Kings, Madera, Riverside and Tulare and exported to China must have an additional declaration stating that "All fruit in this shipment complies with relevant regulations of China and originates from approved participating vineyards and counties."

4.7 Origin and Destination Restrictions

Origin and destination restrictions can consist of any type of SPS regulation (i.e. phytosanitary treatments, visual inspection, additional declarations and prohibition) and may be applied on products at the state, county or geographic region level. For example, fresh strawberries exported to Taiwan and originating in California must be certified as free of Stem

Nematode, Western Flower Thrips and Plum curculio while strawberries originating in Hawaii must be certified as free of Mediterranean fruit fly in addition to being free of Stem Nematode and Western Flower Thrips (EXCERPT, 2009). However, in some cases origin restrictions can refer to products at the county level as well. For example, fresh cherries exported to Chile and originating in the California counties of Calaveras, Contra Costa, Fresno, Kern, Kings, Madera, Merced, Sacramento, San Benito, San Joaquin, Santa Clara, Stanislaus and Tulare must have an AD stating that the shipment is in compliance with the requirements established in Resolution 4506, dated September 25, 2006 (EXCERPT, 2009). This resolution specifies that the shipment must be free of various pests and must be subjected to a post harvest fungicide treatment. Fresh cherries originating in all other counties of California are prohibited from being exported to Chile. Finally, origin restrictions can be applied to an entire region known to be affected by specific pest i.e. fresh fruit imports into Australia must be sourced and packaged in an area that is free of all economically significant fruit fly infestations (EXCERPT,2009).

4.8 Sample Countries

Our final country sample consists of 176 countries (see Table 4.7) based on the criteria that each country imported at least one of the commodities of interest for at least one year over the entire observation period of 11 years. Serbia and Montenegro are treated as a single country because individual data becomes available in 2007 and both countries have identical phytosanitary regulations. The phytosanitary regulations for Serbia and Montenegro can be found in EXCERPT under the country heading for Yugoslavia from 1999 to 2003 and under separate country headings from 2003 to 2010. Similarly, Belgium and Luxembourg are treated as one country following the phytosanitary regulations of the European Union. In the case of the Southern African Customs Union, which consists of the Republic of South Africa, Botswana, Lesotho, Swaziland and Namibia, EXCERPT has a separate entry for the Republic of South Africa while the remaining four countries are classified under the Inter-African Group whose membership consists of the following countries: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Zaire, Ivory Coast, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Lesotho, Liberia, Mali, Mauritania, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, Somalia, Swaziland, Togo and Zimbabwe.

In several cases, the EXCERPT database combines countries with identical phytosanitary requirements. For example, all members of the European Union (EU) have harmonized phytosanitary regulations. Thus, following the EU expansion of 2004, the new member countries (Czech Republic, Cyprus, Estonia, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia) adopted the same phytosanitary regulations as existing EU members. The same changed occurred when Bulgaria and Romania entered the EU member in 2007. Similarly, the Inter-African Group (EXCERPT ISO-3 designation AFR) consists of thirty countries that also use the same phytosanitary requirements.

Former Soviet Union countries (Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyz, Latvia, Lithuania, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan) follow the same regulations. However, in 2004 Latvia, Lithuania and Estonia become members of the European Union and follow the same regulations as other EU member states. Finally, phytosanitary regulations for Kenya apply to Tanzania and Uganda as well up to and including 2005 after which Tanzania and Uganda appear under a common entry

Table 4.7 Partner Countries

Country	ISO Alpha-3 Country Codes	Country	ISO Alpha-3 Country Codes
Algeria	DZA	Congo	COG
Antigua and Barbuda	ATG	Costa Rica	CRI
Argentina	ARG	Croatia	HRV
Armenia	ARM	Cuba	CUB
Australia	AUS	Cyprus	CYP
Austria	AUT	Czech Republic	CZE
Azerbaijan	AZE	Denmark	DNK
Bahamas	BHS	Dominica	DMA
Bahrain	BHR	Dominican Republic	DOM
Bangladesh	BGD	Dutch Antilles	ANT
Barbados	BRB	Ecuador	ECU
Belarus	BLR	Egypt	EGY
Belgium	BEL	El Salvador	SLV
Belize	BLZ	Equatorial Guinea	GNQ
Benin	BEN	Eritrea	ERI
Bermudas	BMU	Estonia	EST
Bhutan	BTN	Ethiopia	ETH
Bolivia	BOL	Fiji	FJI
Bolivia	VEN	Finland	FIN
Bosnia Herzegovina	BIH	France	FRA
Botswana	BWA	French Polynesia	PYF
Brazil	BRA	Gabon	GAB
Brunei	BRN	Gambia	GMB
Bulgaria	BGR	Georgia	GEO
Burkina Faso	BFA	Germany	DEU
Burundi	BDI	Ghana	GHA
Cambodia	KHM	Granada	GRD
Cameroon	CMR	Greece	GRC
Canda	CAN	Guatemala	GTM
Cape Verde	CPV	Guinea	GIN
Central African Republic	CAF	Guniea-Bissau	GNB
Chad	TCD	Guyana	GUY
Chile	CHL	Haiti	HTI
China	CHN	Honduras	HND
Colombia	COL	Hong Kong	HKG

Source: EXCERPT

Table 4.7 Continued

Country	ISO Alpha-3 Country	Country	ISO Alpha-3 Country Codes
Hungary	HUN	Mexico	MEX
Iceland	ISL	Moldova	MDA
India	IND	Mongolia	MNG
Indonesia	IDN	Morocco	MAR
Iran	IRN	Mozambique	MOZ
Iraq	IRQ	Myanmar	MMR
Ireland	IRL	Namibia	NAM
Israel	ISR	Nepal	NPL
Italy	ITA	Netherlands	NLD
Ivory Coast	CIV	New Caledonia	NCL
Jamaica	JAM	New Zealand	NZL
Japan	JPN	Nicaragua	NIC
Jordan	JOR	Niger	NER
Kazakhstan	KAZ	Nigeria	NGA
Kenia	KEN	Norway	NOR
Kiribati	KIR	Oman	OMN
Kuwait	KWT	Pakistan	PAK
Kyrgyzstan	KGZ	Palau	PLW
Latvia	LVA	Palestinia Teritory	PSE
Lebanon	LBN	Panama	PAN
Lesotho	LSO	Papua New Guinea	PNG
Liberia	LBR	Paraguay	PRY
Libia	LBY	Peru	PER
Lithuania	LTU	Philippines	PHL
Luxembourg	LUX	Poland	POL
Macao	MAC	Portugal	PRT
Macedonia	MKD	Quatar	QAT
Madagascar	MDG	Romania	ROU
Malawi	MWI	Ruanda	RWA
Malaysia	MYS	Russia	RUS
Maldives	MDV	Saint Kitts and Nevis	KNA
Mali	MLI	Saint Lucia	LCA
Malta	MLT	Saint Vincent and the Grenadines	VCT
Mauritania	MRT	Samoa	WSM
Mauritius	MUS	San Marino	SMR

Source: EXCERPT

Table 4.7 Continued

Country	ISO Alpha-3 Country Codes	Country	ISO Alpha-3 Country Codes
Sao Tome and Principe	STP	Taiwan	TWN
Saudi Arabia	SAU	Tajikistan	TJK
Senegal	SEN	Thailand	THA
Serbia	SRB	Togo	TGO
Seychelles	SYC	Trinidad and Tobago	TTO
Sierra Leone	SLE	Tunisia	TUN
Singapore	SGP	Turkey	TUR
Slovakia	SVK	Turkmenistan	TKM
Slovenia	SVN	Ukraine	UKR
South Africa	ZAF	United Arab Emirates	ARE
South Korea	KOR	United Kingdom	GBR
Spain	ESP	Uruguay	URY
Sri Lanka	LKA	Uzbekistan	UZB
Sudan	SDN	Vanuatu	VUT
Suriname	SUR	Vietnam	VNM
Swasiland	SWZ	Yemen	YEM
Sweden	SWE	Zambia	ZMB
Switzerland	CHE	Zimbabwe	ZWE
Syria	SYR	--------------	------

Source: EXCERPT

in EXCERPT for a period of one year in 2006; following this, Tanzania and Uganda gain individual entries in EXCERPT starting in 2007 to the end of the study.

Several countries, while present in EXCERPT, could not be included in the sample because of a lack of phytosanitary requirements data. In the case of Iraq, phytosanitary requirements are unknown while for Iran, where U.S. exports of agricultural commodities are donations to relive human suffering that are approved by the United States Treasury Department, Office of Foreign Assets Control (OFAC) (EXCERPT, 2009).

4.9 Data Sources and Independent Variables

Values for annual U.S. exports of cherries, grapes, strawberries, onions, dried peas, oranges, peaches and nectarines, apples and walnuts are obtained from the U.S. International

Trade Commission (USITC) (USITC, 2010). Annual production data for the U.S. are obtained from the USDA's National Agricultural Statistics Service (USDA-NASS, 2010) while annual production data for importing countries are obtained from the Food and Agriculture Organization of the United Nations (FAO) (FAO, 2010). Geographical distances are obtained from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) and are calculated following the great circle formula, which uses latitudes and longitudes of the most important city (in terms of population) or its official capital (CEPII, 2010). Exchange rates data for all countries are obtained from the United Nations Statistical Division (UN, 2010) with the exception of exchange rates for Taiwan which were obtained from the USDAs Economic Research Survey (ERS, 2010). Data on regional trade agreements are collected from the WTO (WTO, WTO Regional Trade Agreements, 2010). Per capita GDP is obtained from the UN Statistical Division (UN, 2010).

4.10 Sample Size and Summary Statistics

A balanced panel with 176 countries, 9 commodities, and 11 years would contain 17,424 observations. However, many of these countries do not import one or several of the nine commodities for the entire sample period. Any country with a zero-trade flow for all years is deleted from the sample. This leaves a total of 8,052 observations. Even using this filter, 3,123 observations, or 39% of the sample are associated with zero U.S. exports.

Table 4.8 provides summary statistics for apples, cherries, grapes, oranges, peaches and nectarines, dried peas, onions, strawberries and walnuts FOB export values in thousands of U.S. dollars over the entire period of the study. The commodity with the largest average export value of $7.7 million is oranges, followed by strawberries with an average export value of $7.3 million.

Table 4.8 U.S. Export Values (in thousands of USD)

HTS-6	Commodity	Total	Mean	Std. Dev.	Min	Max
070310	Onions	1,300,743	2,530.63	10,340.26	3.00	91,495.00
071310	Dried Peas	841,124	1,048.78	4,006.28	3.00	59,323.00
080231	Apples	1,347,468	2,495.31	7,138.95	3.00	79,837.00
080510	Oranges	3,629,918	7,706.83	20,430.93	3.00	126,729.00
080610	Grapes	5,069,612	6,925.70	20,208.10	1.00	193,938.80
080810	Walnuts	5,079,039	6,364.71	20,205.68	3.00	204,571.00
080920	Cherries	2,230,102	5,034.09	16,269.58	2.52	112,160.00
080930	Peaches and Nectarines	1,303,008	3,809.97	12,290.83	3.00	77,401.00
081010	Strawberries	2,253,826	7,293.94	32,192.23	2.52	270,235.80

Source: USDA-NASS, 2011

Table 4.9 shows average U.S. production of apples, cherries, grapes, oranges, peaches and nectarines, dried peas, onions, strawberries and walnuts from 1996 to 2009. Over the eleven year study period, oranges, grapes and walnuts have the largest average values of production, respectively. It is interesting to note that oranges and walnuts present the largest number of observations with a positive value for the generic treatment variable (see Table 4.4). The top three markets for U.S. fresh grapes are Canada, Hong Kong, and Mexico with average import values of $143.6 million, $53.4 million and $40.7 million respectively. The top three markets for U.S. cherries are: Japan with an average import value of $77.9 million, followed by Canada with $57.1 million, and Taiwan with $19.2 million. When considering average values for strawberry exports, at $158 million, Canada is the largest market followed by Japan with an average of $22.6 million and Mexico with an average of $14.3 million.

Table 4.9 Average U.S. Production (in thousands of MT)

HTS-6	Commodity	Mean	Min	Max
070310	Onions	3,386.17	3,168.12	3,800.03
071310	Dried Peas	441.12	157.58	777.32
080231	Apples	300.53	216.82	395.53
080510	Oranges	9,642.22	6,917.29	11,790.68
080610	Grapes	6,310.13	5,657.51	7,088.47
080810	Walnuts	4,391.33	3,866.44	4,822.08
080920	Cherries	218.02	160.84	281.86
080930	Peaches and Nectarines	1,323.35	1,132.53	1,429.81
081010	Strawberries	986.75	748.89	1,148.53

Source: USDA-NASS, 2011

Table 4.10 lists the sample summary statistics. There are 307 observations where the exchange rate value is at least two standard deviations from the mean but their exclusion does not affect the value of the PPML or the OLS exchange rate estimator. Of the total number of observations, 735 were conducted under an FTA. Overall, 14 countries had an FTA with the U.S. during the observation period: Australia, Bahrain, Canada, Chile, the Dominican Republic, Guatemala, Honduras, Israel, Jordan, Morocco, Mexico, Nicaragua, Singapore and El Salvador (WTO).

Table 4.10 Sample Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
cvalue	8052	2863.23	13524.12	0	270235.80
production	8052	211.60	1316.13	0	31204.16
usproduction	8052	3118.52	3112.65	157.58	11790.68
gdppc	8052	11365.02	12403.21	107.03	72575.26
er	8052	747.86	3466.83	0.03	38733.25
tariff	8052	0.18	0.27	0	4.52
dist	8052	7747.25	4079.01	548.39	16180.32
ldlock	8052	0.05	0.22	0	1
NAFTA	8052	0.02	0.15	0	1
CAFTA_DR	8052	0.02	0.16	0	1
FTA_OTHR	8052	0.04	0.20	0	1
treat	8052	0.10	0.31	0	1
t101	8052	0.04	0.21	0	1
t107	8052	0.04	0.20	0	1
t101ort107	8052	0.02	0.13	0	1
t101orphosphene	8052	0.01	0.07	0	1
t106ort107ort110	8052	0.02	0.14	0	1
orestriction	8052	0.09	0.29	0	1
count	8052	6.17	10.02	0	78

note: Export value is expressed as Free on Board (FOB) and excludes freight and insurance. World imports represents partner's (i) total imports of commodity (k) in year (t) in thousands of U.S. dollars. Share represents country's share of global imports by year and commodity. Production represents country (i) production of commodity (k) in year (t). ER is the real exchange rate expressed as the value of foreign currency against the U.S. dollar. ldlock is a dummy variable that is equal to one if the importer has no access to navigable waterways. Distance is the distance in Km between the capitals of the trading partners. NAFTA is a dummy variable that is equal to one if the partner country is Canada or Mexico. CAFTA_DR is a dummy variable that is equal to one if the partner country is Costa Rica, Nicaragua, Honduras, Guatemala, El Salvador and the Dominican Republic. FTA_OTHR is a dummy variable equal to one if the trading partner is Australia, Bahrain, Chile, Israel, Jordan, Morocco or Singapore. Workplan is a dummy variable that is equal to one if a workplan is in effect between the U.S. and its partner and equal to zero otherwise. Treat is a dummy variable which is true if any treatment is required. Odrestriction is a dummy variable equal to one if the importer imposes origin restrictions. Count is a count variable equal to the number of countries that require phytosanitary treatments for a particular commodity at a specific time.

5. Results

The current chapter presents regression results for the preferred PPML mean scaling model[16] in equation (25) which accounts for country-commodity type fixed effects in a panel data framework (see chapter 3). Nine alternative scenarios are analyzed: scenarios one, two and three allow for a generic phytosanitary treatment effect; scenarios four, five and six test whether origin restrictions affect trade and scenarios seven, eight and nine test whether there are differences in the effects of individual treatment types. Additionally, all scenarios test whether phytosanitary treatment effects diminish as exporter experience grows.

Furthermore, because it is likely that a considerable amount of heterogeneity (consumer preferences, historical ties, climate, etc.) is not accounted for in the basic gravity model (Peterson, Grant, Roberts and Karov, 2011), the results of estimating equation (21) are likely to be biased. To control for possible bias, scenarios one through nine estimate various forms of the gravity equation. Scenarios one, three and seven estimate the naïve gravity model. Scenarios two, five and eight incorporate commodity fixed effects and scenarios three, six and nine employ country/commodity-type fixed effects.

As Table 5.1 shows, explanatory power of each model ranges from a pseudo R-squared of 0.48 for scenario one to 0.71 for scenario nine. Borrowing from Wooldridge (2009), we report an R-squared which is the squared correlation coefficient between y_i and $\hat{y}_i$. According to this measure, the models that account for country/commodity-type unobserved effects explain over 68 percent of the variation in U.S. exports while on the naïve models of scenarios

[16] According to Blundell, Griffith, & Windmeijer (2000) the Poisson mean scaling model is the standard panel data estimator for correlated fixed effects.

one, two, four, five, seven and eight explain from 48 to 57 percent of the variation in data.

Moreover, the estimated coefficients in the naïve and the commodity fixed effects models are not robust in sign. According to the results of scenarios one, two, four, five, seven and eight, the estimated coefficients for exchange rate positive and coefficients for membership to an FTA are negative. However, as the exchange rate represents relative price differences between local currency and the U.S. dollar, an increase in this variable is expected to have a negative effect on trade. Similarly, membership to an FTA is expected to increase trade. However, when controlling for unobserved heterogeneity across country/commodity-type groups, the estimate coefficients for exchange rate become negative and FTA membership positive. Finally, note that estimated coefficients for NAFTA, distance and landlocked status are absent from scenarios three, six and nine. This is because country/commodity-type fixed effects absorb all time invariant variables.

Table 5.1 PPML Regression Results

VARIABLES	Scenario (1)	Scenario (2)	Scenario (3)	Scenario (4)	Scenario (5)	Scenario (6)	Scenario (7)	Scenario (8)	Scenario (9)
Importer Production	-0.03**	-0.08***	-0.03*	-0.04***	-0.07***	-0.03*	-0.06***	-0.10***	-0.02
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
U.S. Production	0.34***	0.72***	0.28***	0.39***	0.71***	0.29***	0.42***	0.68***	0.29***
	(0.04)	(0.21)	(0.04)	(0.03)	(0.22)	(0.04)	(0.04)	(0.21)	(0.04)
Importer GDPPC	0.67***	0.67***	1.50***	0.68***	0.68***	1.52***	0.67***	0.67***	1.52***
	(0.06)	(0.06)	(0.32)	(0.06)	(0.06)	(0.32)	(0.05)	(0.05)	(0.32)
Exchange Rate	0.15***	0.15***	-1.08***	0.15***	0.15***	-1.17***	0.13***	0.13***	-1.25***
	(0.02)	(0.02)	(0.35)	(0.02)	(0.02)	(0.35)	(0.02)	(0.02)	(0.36)
CAFTA_DR	0.99***	1.03***	0.31**	0.97***	0.97***	0.30**	1.01***	1.02***	0.30**
	(0.16)	(0.14)	(0.15)	(0.15)	(0.14)	(0.15)	(0.15)	(0.14)	(0.14)
FTA_OTHR	-0.49***	-0.43***	0.34*	-0.48***	-0.43***	0.35*	-0.57***	-0.53***	0.32*
	(0.16)	(0.15)	(0.19)	(0.15)	(0.15)	(0.18)	(0.14)	(0.14)	(0.17)
NAFTA	3.32***	3.42***	--------	3.26***	3.32***	--------	3.20***	3.23***	--------
	(0.15)	(0.14)	--------	(0.15)	(0.15)	--------	(0.16)	(0.16)	--------
Distance	0.21***	0.23***	--------	0.20***	0.21***	--------	0.22***	0.21***	--------
	(0.07)	(0.06)	--------	(0.07)	(0.06)	--------	(0.07)	(0.07)	--------
Landlocked	-1.93***	-1.80***	--------	-1.93***	-1.83***	--------	-1.91***	-1.78***	--------
	(0.21)	(0.21)	--------	(0.21)	(0.21)	--------	(0.21)	(0.21)	--------
Generic Treatment	-0.07	0.28	-0.30	-0.24	0.21	-0.57*	--------	--------	--------
	(0.30)	(0.29)	(0.37)	(0.29)	(0.29)	(0.32)	--------	--------	--------
Count	0.35***	0.38***	0.11	0.33***	0.36***	0.05	0.36***	0.41***	0.03
	(0.04)	(0.04)	(0.08)	(0.04)	(0.04)	(0.08)	(0.04)	(0.04)	(0.08)
Count*Treatment	0.03	-0.09	0.16	0.02	-0.10	0.20*	--------	--------	--------
	(0.11)	(0.10)	(0.12)	(0.10)	(0.10)	(0.11)	--------	--------	--------
Origin Restriction	--------	--------	--------	-0.13	0.77***	0.66***	-0.20*	0.71***	0.67***
	--------	--------	--------	(0.11)	(0.15)	(0.16)	(0.11)	(0.15)	(0.16)
Origin Restriction*Peas	--------	--------	--------	-1.48***	-2.00***	-1.19***	-1.37***	-2.14***	-1.31***
	--------	--------	--------	(0.39)	(0.45)	(0.45)	(0.39)	(0.44)	(0.46)
Origin Restriction*Walnuts	--------	--------	--------	-1.28	-2.38***	-0.55	-1.14	-2.15***	-0.72
	--------	--------	--------	(0.81)	(0.83)	(0.89)	(0.81)	(0.82)	(0.90)
Origin Restriction*Oranges	--------	--------	--------	0.22	-0.45	-0.72***	0.14	-0.74	-0.83***
	--------	--------	--------	(0.38)	(0.42)	(0.24)	(0.43)	(0.49)	(0.25)

Table 5.1 Continued

VARIABLES	Scenario (1)	Scenario (2)	Scenario (3)	Scenario (4)	Scenario (5)	Scenario (6)	Scenario (7)	Scenario (8)	Scenario (9)
Origin Restriction*Grapes	--------	--------	--------	0.42**	-0.82***	-0.69***	0.47***	-0.75***	-0.49*
	--------	--------	--------	(0.20)	(0.24)	(0.24)	(0.18)	(0.22)	(0.25)
Origin Restriction*Apples	--------	--------	--------	0.84***	-0.50***	-0.07	0.88***	-0.39*	0.34
	--------	--------	--------	(0.13)	(0.18)	(0.23)	(0.17)	(0.20)	(0.27)
Origin Restriction*Cherries	--------	--------	--------	1.56***	0.22	0.29	1.48***	0.02	0.40
	--------	--------	--------	(0.28)	(0.34)	(0.30)	(0.25)	(0.31)	(0.28)
Origin Restriction*Peaches/Nectarines	--------	--------	--------	0.44	-0.19	-0.97***	0.52	0.15	-0.90**
	--------	--------	--------	(0.44)	(0.46)	(0.37)	(0.45)	(0.51)	(0.40)
Origin Restriction*Strawberries	--------	--------	--------	0.04	-1.31***	-1.25***	0.02	-1.42***	-1.07***
	--------	--------	--------	(0.25)	(0.32)	(0.28)	(0.25)	(0.33)	(0.30)
Fumigation with MB	--------	--------	--------	--------	--------	--------	0.13	0.87	-0.33
	--------	--------	--------	--------	--------	--------	(0.64)	(0.61)	(0.53)
Cold Treatment	--------	--------	--------	--------	--------	--------	-0.25	-0.05	-1.03**
	--------	--------	--------	--------	--------	--------	(0.37)	(0.33)	(0.41)
Fumigation with MB or Cold Treament	--------	--------	--------	--------	--------	--------	2.59***	2.39***	-0.20
	--------	--------	--------	--------	--------	--------	(0.70)	(0.72)	(0.73)
Fumigation with MB or Phosphine	--------	--------	--------	--------	--------	--------	-2.05***	-1.30**	-1.81***
	--------	--------	--------	--------	--------	--------	(0.41)	(0.51)	(0.48)
Vapor Heat, Cold Treatment or Quick Freeze	--------	--------	--------	--------	--------	--------	-5.03***	-4.90***	-3.89***
	--------	--------	--------	--------	--------	--------	(0.78)	(0.80)	(0.94)
Count*Fumigation with MB	--------	--------	--------	--------	--------	--------	0.03	-0.11	0.23
	--------	--------	--------	--------	--------	--------	(0.22)	(0.20)	(0.18)
Count*ColdTreatment	--------	--------	--------	--------	--------	--------	0.08	-0.00	0.18
	--------	--------	--------	--------	--------	--------	(0.12)	(0.11)	(0.11)
Count*Fumigation with MB or Cold Treament	--------	--------	--------	--------	--------	--------	-1.01***	-1.01***	0.10
	--------	--------	--------	--------	--------	--------	(0.23)	(0.24)	(0.24)
Count*Fumigation with MB or Phosphine	--------	--------	--------	--------	--------	--------	0.07	-0.16	0.32**
	--------	--------	--------	--------	--------	--------	(0.15)	(0.20)	(0.15)
Count*Vapor Heat, Cold Treatment or Quick Freeze	--------	--------	--------	--------	--------	--------	0.52	0.53	0.60
	--------	--------	--------	--------	--------	--------	(0.40)	(0.41)	(0.49)

Table 5.1 Continued

VARIABLES	Scenario (1)	Scenario (2)	Scenario (3)	Scenario (4)	Scenario (5)	Scenario (6)	Scenario (7)	Scenario (8)	Scenario (9)
Constant	-3.96***	-8.16***	-12.94***	-4.34***	-8.08***	-13.11***	-4.57***	-7.67***	-13.13***
	(1.02)	(1.83)	(3.22)	(1.06)	(1.84)	(3.27)	(1.07)	(1.81)	(3.31)
R-squared	0.48	0.56	0.68	0.50	0.55	0.69	0.50	0.57	0.71
Observations	8,052	8,052	8,052	8,052	8,052	8,052	8,052	8,052	8,052

Note: The dependent variable is the annual FOB value of U.S. exports of fruits and vegetables expressed in thousands of USD. Importer and exporter production is represented as the natural logarithm of their respective production in thousands of metric tones. Per capita GDP is represented as the natural logarithm of the importer's GDP per capita in USD. Importer's exchange rate is represented as the natural log of the real exchange rate to USD. Heteroskedasticity-robust standard errors are used for all scenarios. *** p<0.01, ** p<0.05, * p<0.1

Scenario (1) Generic phytosanitary treatment effects. No fixed effects model.
Scenario (2) Generic phytosanitary treatment effects. Commodity fixed effects model.
Scenario (3) Generic phytosanitary treatment effects. Country/commodity-type fixed effects model.
Scenario (4) Generic phytosanitary treatment effects and origin restriction effects. No fixed effects model.
Scenario (5) Generic phytosanitary treatment effects and origin restriction effects. Commodity fixed effects model.
Scenario (6) Generic phytosanitary treatment effects and origin restriction effects. Country/commodity-type fixed effects model.
Scenario (7) Individual phytosanitary treatment effects and origin restriction effects. No fixed effects model.
Scenario (8) Individual phytosanitary treatment effects and origin restriction effects. Commodity fixed effects model.
Scenario (9) Individual phytosanitary treatment effects and origin restriction effects. Country/commodity-type fixed effects model.

5.1 PPML Estimation Results

The estimated coefficients for the basic gravity model in a country/commodity-type framework are robust and of the correct sign and magnitude across scenarios three, six, and nine. Additionally, for the most part, the estimated coefficients are statistically significant. Coefficients for U.S. production, importer's GDPPC, membership in an FTA other than NAFTA or CAFTA and exchange rate have the expected signs and are statistically significant across all scenarios at the one percent level or better. More specifically, the effect on U.S. exports of an increase in importer production or exchange rate is negative and the effect of an increase in U.S. production, importer GDPPC or membership in CAFTA or any other FTA is positive. Coefficients for NAFTA membership, distance and land locked status are dropped from the estimation because they lack within group variation and are absorbed by country/commodity-type fixed effects estimators. Although the model employed by scenarios three, six and nine does not specifically account for distance, it is nevertheless a more general specification of the gravity model of trade since it account for any (possibly unobservable) time invariant bilateral effects.

In scenarios three, six and nine, estimated coefficients for CAFTA_DR are positive and statistically significant at the 5% level while coefficients for membership in any other FTA are positive and statistically significant at the 10% level across all scenarios. Using scenario nine as an example; a partner's membership to CAFTA or any other FTA has a similar effect. All things being equal, CAFTA membership increases the expected value of U.S. exports by 30% while membership to all other FTAs increase the expected value by 32%[17].

[17] Details on how percentage changes were calculated are described in Chapter 3.

Estimation results allow for the calculation of relative income and price[18] elasticities of demand for U.S. exports of fresh fruit and vegetables. The following derivation describes the process of calculating continuous variable elasticities in the PPML model. Given the likelihood function $E(cvalue \mid x) = e^{f(x)}$ where x is a continuous variable such as GDPPC or exchange rate, the change in the expected value of $cvalue$ with respect to x is:

$$\frac{\partial cvalue}{\partial x} = e^{f(x)} f'(x) \tag{26}$$

and the elasticity of the expected value of $cvalue$ with respect to x is:

$$\frac{\partial cvalue}{\partial x} \frac{x}{cvalue} = e^{f(x)} f'(x) \frac{x}{e^{f(x)}} = f'(x)x \tag{27}$$

If $f(x) = \beta_1 ln(x)$ then

$$f'(x)x = \left(\frac{\beta_1}{x}\right)x = \beta_1 \tag{28}$$

Thus, making use of equation (28) and according to the estimated coefficients GDPPC and exchange rate from scenario six, U.S. fruits and vegetables are income and price elastic with an income elasticity of demand of 1.52 and price elasticity of demand of 1.17. These results indicate that U.S. exports of fruits and vegetables have a more than proportional response to a 1% increase in partner's GDPPC suggesting that, on average, these nine products are luxury goods in foreign markets. Additionally, the elastic response to changes in exchange rates suggests a high level of price competition faced by U.S. exports.

[18] The exchange rate variable ER_{jt} reflects differences in relative prices such that the value of the currency will reflect the relative differences in price levels between the two countries and can be interpreted as price elasticities. Moreover, as this is a bilateral relationship the result is not a direct price elasticity but a relative price elasticity.

5.1.1 Generic Treatment Effects

As discussed in Chapter 4, phytosanitary treatments can vary by country and commodity and may consist of fumigation with methyl bromide or SO_2CO_2, cold treatment in the form of quick freezing or a more prolonged process during shipment and finally heat treatment in the form of steam or hot air. Each type of phytosanitary treatment incurs additional costs for the exporter to bring a product into compliance and consequently may reduce exports. This trade reducing impact of SPS measures is now well documented in the empirical literature (e.g. Jayasinghe, Beghin, & Moschini (2009); Anders & Caswell (2009); Karov, Peterson & Grant (2011)).

The estimated coefficients of the naïve models tested in scenarios one, two, four, five, seven and eight are not robust in sign or statistical significance and they are included only as comparison to the preferred models of scenarios three, six and nine which include country-commodity type fixed effects. Calculating percentage trade reduction from treatment when it is interacted with the cumulative frequency variable requires the specification of a value for $count_{kt}$. For example, according to the results of scenario six, at the mean level of $count_{kt}$ (6) the expected value of U.S. exports subject to a phytosanitary treatment is 18% lower than exports not subject to treatment, holding all else constant. However, the estimated generic treatment coefficient in scenarios one through five varies in sign and magnitude. These results suggest that the relationship between phytosanitary treatment and U.S. exports from scenarios one, two, four and five is not robust to alternative model specifications and may in fact suffer from omitted variable bias.

5.1.2 Origin Restriction Effects

Scenarios four, five and six test whether origin based phytosanitary regulations affect U.S. exports of fruits and vegetables and whether the effect differs by commodity type. In some instances, a country may impose different phytosanitary regulations based on a commodity's place of origin within the U.S. Because origin restrictions can range from prohibition to additional treatment requirements to visual inspections and they often correspond to high production areas, their effect on U.S. exports is most likely negative.

According to the results of scenario six, the estimated coefficient for $orestriction_{jkt}$ is positive and statistically significant indicating that for the base commodity (onions) origin restrictions do not have a negative impact on U.S. exports. Additionally, the sign and magnitude do not change across scenarios and, with the exception of walnuts, apples and cherries and interaction term coefficients are negative and statistically significant. According to scenario six; all else being equal, relative to onions, the effect of origin restrictions is positive for orange and grape exports and negative for peas, peaches, oranges and strawberries. However, because origin restrictions may also be coupled with an SPS treatment requirement as described in chapter 4, it is not clear whether a dummy variable alone can identify their impacts on trade. Additionally, the effect of an origin restriction will vary based on the affected region's production. For example, a prohibition on fruit grown in a minor producing region will likely not have a great impact when compared to a prohibition imposed on a major producing region in the U.S. Moreover, the unexpected sign for onions, oranges and grapes may be caused by the low number of observations with origin restrictions and the comparatively high value of trade for these observations e.g. there are 21 observations with an origin restriction for onions with an average trade value of $11.7 million. This compares to a mean flow over all commodities of $4.7 million.

5.1.3 Trade Induced Learning Effect

Borrowing from the work of Peterson, Grant, Roberts and Karov (2011) scenarios one through six test the hypothesis that there is a learning-by-doing effect for U.S. exporters when they face a phytosanitary treatment requirement. The idea behind the "learning-by-doing" effect is that the more exporting firms are required to treat (or the more experience they gain), the more proficient and less costly the treatment process becomes.

The assumption behind this model is that at a certain level of experience, negative phytosanitary treatment effects are offset by a learning effect. To test this assumption, scenarios one through six include a frequency count variable ($count_{jk}$) that records the cumulative number of partners requiring a treatment on commodity *k* in year *t*. Interacting the generic treatment variable with the cumulative frequency variable ($treat_{jkt}*count_{jkt}$), allows the measurement of this "learning" effect. If this interaction term is positive and statistically significant, a threshold experience level where learning effects offset the negative impacts of phytosanitary treatments can be determined. Using this information, average time it takes U.S. exporters to reach this level can be calculated, and thus the trade restrictiveness of phytosanitary treatment requirements can be determined. Note that we do not compute the threshold value for scenarios one through five since the treatment and its interaction with count is not significant in any of the scenarios.

Estimated coefficients for generic treatment and generic treatment-frequency interaction terms are statistically significant at the 10% level. According to the results of scenario six and holding all else constant, the effects of a generic treatment will become positive at a frequency count of 16[19]. Assuming that $\ln(y) = \beta_1 x_1 + \beta_2 c_2 + \beta_3 x_1 c_2$ where *y* is the value of trade (*cvalue*), x_1 is a binary variable for treatment, $c_2 = \ln(1 + count_{jk})$ is a cumulative count variable and $x_1 c_2$ is an interaction term between treatment and frequency, then the threshold level can be calculated by taking the derivative of $\ln(y)$ with respect to x_1, setting the resulting equation equal to zero then solving for the exponentiated value of the logarithm of $count_{kt}$.

Finally, using the calculated threshold level it is possible to determine how many years of treatment the U.S. requires before "learning-by-doing" effects counteract the trade restricting impact of phytosanitary treatments. On average, the U.S. attains the cumulative phytosanitary treatment threshold ($count_{kt}$) of 16 in the second year suggesting that after two years these measures cease to have a significant impact on exports. This period is similar for individual commodities with the exception of grapes and walnuts who reach the threshold level after three and four years of trade, respectively. This suggests that phytosanitary treatments impacting U.S. exports of fruits and vegetables are not that trade restricting since the negative effect of treatments vanishes within the first two years of exporting in most cases. In other words, phytosanitary treatments appear to be trade restricting only for new exporters.

These findings contrast with previous work that finds negative and significant effects of SPS regulations in international trade. Previous studies however have generally focused on the effects of SPS regulations on developing country exports which, unlike developed countries,

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[19] The following formula is used to calculate the threshold level: $-0.57 + 0.20 * ln(1 + count_{kt}) = 0 \rightarrow$ $0.20 * \ln(1 + count_{kt}) = 0.57 \rightarrow \ln(1 + count_{kt}) = 2.85 \rightarrow 1 + count_{kt} = e^{2.85} \rightarrow count_{kt} = 16.29$

may not have the infrastructure necessary to minimize the economic impact of phytosanitary treatment requirements.

5.1.4 Trade Induced Learning and Individual Treatment Effects

Scenarios seven, eight and nine test the hypothesis that the threshold level at which phytosanitary requirements cease to have a negative impact on trade is different across treatment types. To accomplish this task, the cumulative frequency variable $count_{jkt}$ is interacted with five dummy variables representing the five different treatment types discussed in chapter 1 (Table 1.1).

With the exception of fumigation with methyl bromide or phosphine which is statistically significant at the 5% level; estimated coefficients for the remaining interaction terms are insignificant. The calculated threshold level at which the negative effect of fumigation with methyl bromide or phosphine is reduced is 6. The average time it takes exporters to reach this level is one year suggesting that fumigation with methyl bromide or phosphine does not have a significant impact on trade. However, when interpreting these results it must be noted that the option of fumigation with methyl bromide or phosphine is given by 4 countries on dried peas and walnut exports, resulting in very little country/commodity-type variation.

6. Conclusion

According to the USDA's ERS, the U.S. fruit and vegetable industry accounts for nearly a third of U.S. crop cash receipts and a fifth of U.S. agricultural exports (Lucier, Pollack, Ali, & Perez, 2006), and while the domestic market remains the major outlet for almost all U.S. fruit and vegetable output, foreign market growth has outpaced domestic growth and brought with it a need to understand potential factors affecting competitiveness. Among a potential list of these factors, phytosanitary measures are quite possibly an important constraint facing U.S. exports of fruits and vegetables. While recent literature has shed some light on the impact of phytosanitary regulations on international trade (Korinek, Melatos, & Rau, 2008), there is a lack of literature examining the effects of SPS regulations on the competitiveness of U.S. fruit and vegetables exports.

One of the main reasons for the lack of quantitative empirical work on SPS regulations affecting U.S. fruit and vegetable exports is the lack of detailed datasets that match SPS measures to U.S. export flow data. This thesis provides an important step in this regard by constructing a novel dataset for empirical work that maps detailed qualitative information on regulatory regimes from the EXCERPT database into well defined variables for use in empirical economic analyses and develops a concordance between product line SPS regulations with US fruit and vegetable export flows.

The database developed for this thesis consists of phytosanitary requirements facing U.S. fruit and vegetables exports to 176 countries and matched these to nine commodities over a period of 11 years from 1999 to 2009. Commodities are defined at the HS-6 digit category and include: apples, cherries, grapes, oranges, peaches/nectarines, strawberries, onions, peas and walnuts. Phtosanitary regulations covered by the database consist of treatment requirements, origin and destination restrictions, documentation requirements, pre-clearance procedures and systems approaches to pest risk management.

Additionally, a product-line gravity equation of bilateral trade is developed to investigate the impacts of phytosanitary regulations on U.S. exports. Several specifications of the gravity model are employed to test whether: 1) a generic phytosanitary treatment affects trade flows, 2) origin based restrictions have an impact on trade, 3) an increase in exporter phytosanitary treatment experience counteracts the treatment effect i.e. whether there is a "learning-by-doing" effect and 4) this effect differs across treatment types.

The estimated results support the hypothesis that origin specific phytosanitary regulations have a negative effect on U.S. fruit and vegetable exports and that this effect differs by commodity. However, it must be noted that in this case, origin based phytosanitary restrictions are aggregated and may consist of a number of possible regulations faced by U.S. fresh fruit and vegetable exporters; regulations such as phytosanitary treatments, preclearance procedures, systems approaches to pest risk management or prohibition. This analysis can be improved in future works by incorporating detailed state level production data as well as by separating origin restrictions according to SPS regulation type i.e. phytosanitary treatment, workplan, preclearance procedures, etc.

This thesis also investigated whether phytosanitary treatment effects are decreasing (in absolute magnitude) as accumulated treatment experience grows. Analyzing the effect of an increase in the number of commodities requiring phytosanitary treatments finds that below a cumulative frequency count of 16 the effect of phytosanitary treatments on U.S. exports is negative. Additionally, the U.S. reaches this threshold level in two years. Thus, while phytosanitary treatments have a significant negative effect on trade relative to unencumbered exports, this effect diminishes as exporters' treatment experience grows. That is, there is an inverse relationship between U.S. exporters' treatment experience and the (negative) trade flow effects of phytosanitary treatments. This result is consistent with a "learning-by-doing" framework whereby exporters can treat larger volumes more efficiently as their cumulative experience grows. Finally, because of the lack of variation and the limited number of observations, analysis at the treatment type level is inconclusive.

6.1 Limitations

One drawback of this study is the limitation of the sample period from 1999 (the creation of the EXCERPT database) to present. Prior to this period, information on phytosanitary regulations was obtained by the exporter directly from the PPQ agency of the importing country. As such, major changes in trade partners' phytosanitary regulations requirements, which are more likely to have been implemented shortly after the introduction of the SPS Agreement in 1995, are not recorded.

Second, the cost of phytosanitary treatments or the choice of treatment for cases where an option of treatments are given is not recorded in the database. The reason for this is due to the lack of access to this type of information. Phytosanitary treatments are performed at each point of exit (typically a port) by private companies specializing in the application of these measures.

Furthermore, while the existence of systems approaches to pest risk management (workplans) are noted in the database, they are not accounted for in the empirical analysis because of a lack of access to cost of compliance data. The main reason for this is that workplan requirements consist of multiple pest mitigation techniques including: orchard inspections by PPQ staff, packaging requirements, origin restrictions and phytosanitary treatment requirements.

Finally, origin restrictions are coded as a binary variable in the database. However, this approach does not take into consideration that origin restrictions are a combination of phytosanitary treatments, pre-clearance procedures, workplans and prohibitions. This approach not only restricts the usefulness of the model but because origin restrictions are highly correlated with SPS regulations, the results will suffer from omitted-variable bias.

6.2 Policy Implications and Future Research

There is a growing body of literature on the impacts of SPS regulations on international trade and whether these regulations are "standards as barriers" or "standards as catalysts" (Anders and Caswell 2009; Beghin and Bureau 2001; Jaffee and Henson 2004; World Bank 2005; Calvin and Krisoff 1998; Otsuki, Wilson, and Sewadeh 2001; Disdier, Fontaigné, and Mimouni 2008; Peterson and Orden 2008; Josling, Roberts, and Orden. 2004). While the results of the current study suggest that SPS measures pose a "barrier" to U.S. fresh fruit and vegetable exports when introduced, several questions regarding the effects of SPS regulations remain to be answered in future reasearch. Two important questions ask whether a) the results of the current study apply to the entire U.S. fruits and vegetable sector and b) what would be the impact of eliminating phytosanitary treatment requirements?

The current study considers nine commodities chosen for their economic importance to U.S. competitiveness as well as to ensure variability in the data and to permit econometric identification of the effects of SPS regulations on U.S. exports. However, it was discovered during the course of this study that SPS regulations are not pervasive and they do not change over time. More importantly however, because estimations are not conducted on a random sample of commodities, one must be cautious about extending the results to other commodities or an entire sector. To better capture the impact of phytosanitary regulations on U.S. fruit and vegetables exports, future research can be conducted on an expanded set of commodities covering chapter seven (edible vegetables) and chapter eight (edible fruit and nuts) of the Harmonized Tariff Schedule at the six digit level. This approach will allow for more generalized conclusions applicable to the entire U.S. fresh fruits and vegetables sector rather than the restricted set of commodities included in this study.

While the results of the current study shed new light on the trade distorting nature of phytosanitary treatments, there are several reasons for which one must be cautious when referring to them as trade “barriers” or trade restricting measures. First, if it weren’t for phytosanitary treatments, in the case of a pest outbreak, the U.S. would not be allowed access to some markets. Second, regulations tend to raise product quality and reduce asymmetric information (Korinek, Melatos , & Rau, 2008). It is reasonable, therefore, to expect an increase in the nature of consumer demand and producer supply in the presence of phytosanitary treatment regulations. Future research employing simulation based studies can further clarify this point and help determine the impact on trade of removing phytosanitary treatment regulations.

One final suggestion for future research relates to the threshold levels at which phytosanitary regulations cease to be trade restricting. More specifically, finding the reasons why individual treatment types have the determined thresholds will help policy makers and industry leaders to implement procedures to eliminate or reduce the time required to reach these levels and thus increase the competitiveness of U.S. fruit and vegetable exports.

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Appendix B: Stata Code

```
clear
use working
quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR NAFTA ldist ldlock treat
lfreq lfreq_treat,rob
est store scenario1
quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR NAFTA ldist ldlock treat
lfreq lfreq_treat hts71310 hts80231 hts80510 hts80610 hts80810 hts80920 hts80930 hts81010
,rob
est store scenario2
quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR treat lfreq lfreq_treat
isohts2-isohts343,rob
est store scenario3

quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR NAFTA ldist ldlock treat
lfreq lfreq_treat odrestriction odrestriction_71310 odrestriction_80231 odrestriction_80510
odrestriction_80610 odrestriction_80810 odrestriction_80920 odrestriction_80930
odrestriction_81010,rob
est store scenario4
quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR NAFTA ldist ldlock treat
lfreq lfreq_treat odrestriction odrestriction_71310 odrestriction_80231 odrestriction_80510
odrestriction_80610 odrestriction_80810 odrestriction_80920 odrestriction_80930
odrestriction_81010 hts71310 hts80231 hts80510 hts80610 hts80810 hts80920 hts80930
hts81010,rob
est store scenario5
quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR treat lfreq lfreq_treat
odrestriction odrestriction_71310 odrestriction_80231 odrestriction_80510
odrestriction_80610 odrestriction_80810 odrestriction_80920 odrestriction_80930
odrestriction_81010 isohts2-isohts343,rob
est store scenario6

quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR NAFTA ldist ldlock lfreq
t101 t107 t101ort107 t101orphosphine t106ort107ort110 lfreq lfreq_t101 lfreq_t107
lfreq_t101ort107 lfreq_t101orphosphine lfreq_t106ort107ort110 odrestriction
odrestriction_71310 odrestriction_80231 odrestriction_80510 odrestriction_80610
odrestriction_80810 odrestriction_80920 odrestriction_80930 odrestriction_81010,rob
est store scenario7
quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR NAFTA ldist ldlock lfreq
t101 t107 t101ort107 t101orphosphine t106ort107ort110 lfreq lfreq_t101 lfreq_t107
lfreq_t101ort107 lfreq_t101orphosphine lfreq_t106ort107ort110 odrestriction
odrestriction_71310 odrestriction_80231 odrestriction_80510 odrestriction_80610
```

```
odrestriction_80810 odrestriction_80920 odrestriction_80930 odrestriction_81010 hts71310
hts80231 hts80510 hts80610 hts80810 hts80920 hts80930 hts81010,rob
est store scenario8
quietly poisson cvalue lproduction lusprod  lgdppc ler CAFTA FTA_OTHR lfreq t101 t107
t101ort107 t101orphosphine t106ort107ort110 lfreq lfreq_t101 lfreq_t107 lfreq_t101ort107
lfreq_t101orphosphine lfreq_t106ort107ort110 odrestriction odrestriction_71310
odrestriction_80231 odrestriction_80510 odrestriction_80610 odrestriction_80810
odrestriction_80920 odrestriction_80930 odrestriction_81010 isohts2-isohts343,rob
est store scenario9

outreg2 [*] using sps_effects, dec(2) drop(isohts2-isohts343) excel

*After each regression, pseudo R-squared is predicted in the following method*

predict fitted
corr cvalue fitted
di r(rho)^2
```

Appendix C: Java Code

```
package spsregulations;

import org.htmlparser.*;

/**
 *
 * @author Radu Ramniceanu
 */

public class AllCommodities {


    private String year;
    private String month;
    private String country;
    private String lastUpdatedDate;
    private String text;

    public AllCommodities(){

    }
    public AllCommodities(String commodityLink,String yr,String mo,String
co){
        year=yr;
        month=mo;
        country=co;
        MyVisitor visitor = new MyVisitor ();

                try{
                   Parser commodityParser = new Parser(commodityLink);
                   commodityParser.visitAllNodesWith(visitor);
                }
                catch(Exception ex){
                    System.out.println(ex);
                }
       lastUpdatedDate=visitor.getLastUpdated();
       text = this.extractAllCommoditiesRegs(visitor.getPageAsText());

    }
//*********************************************************************
*****
    public String GetLastUpdated(){
        return lastUpdatedDate;
    }
//*********************************************************************
*****
    private String extractAllCommoditiesRegs(String pageTxt){

               String temp="";
               String temp2="";
```

```
                temp = pageTxt.substring(pageTxt.indexOf("----------
"),pageTxt.indexOf("Horizontal Rule"));

                String[] strArray = temp.split("\\n");
                for(int i=0;i<strArray.length;i++)
                    if(!strArray[i].isEmpty())
                        temp2 += strArray[i];

            return temp2;
    }
//**************************************************************************
******
    public void printPage(){
        System.out.println(text);
    }

}


package spsregulations;

import org.htmlparser.*;
import java.util.regex.Pattern;
import java.util.regex.Matcher;
import java.util.ArrayList;

/**
 *
 * @author Radu Ramniceanu
 */

public class Category {

    private String year;
    private String month;
    private String country;
    private String category;
    private String lastUpdated;
    private String categoryPageURL;
    private boolean noFruitSection;
    RegulationsList regsList;
    private String fruitSectionText;
    private String pests;
   /* private String cherryProhibitedStatus;
    private String strawberryProhibitedStatus;
    private String grapeProhibitedStatus;
    private String cherryUnrestrictedStatus;
    private String strawberryUnrestrictedStatus;
    private String grapeUnrestrictedStatus;
    private String cherryRestrictedStatus;
    private String strawberryRestrictedStatus;
    private String grapeRestrictedStatus;*/
    private String pageText;
    private StateList states;
```

```
    private PestsList pestsList;
    private ArrayList <OriginOrHostRawText> originAndHostList;


    public Category(String catName, String categoryLink,String yr,String
mnth,String countryCode){
        category=catName;
        year=yr;
        month=mnth;
        country=countryCode;
        categoryPageURL=categoryLink;
        MyVisitor visitor = new MyVisitor();
        noFruitSection=false;
        regsList = new RegulationsList();
        fruitSectionText="";
        pests="";
        /*cherryProhibitedStatus="0";
        strawberryProhibitedStatus="0";
        grapeProhibitedStatus="0";
        cherryUnrestrictedStatus="0";
        strawberryUnrestrictedStatus="0";
        grapeUnrestrictedStatus="0";
        cherryRestrictedStatus="0";
        strawberryRestrictedStatus="0";
        grapeRestrictedStatus="0";*/
        originAndHostList = new ArrayList <OriginOrHostRawText>();
        states = new StateList();
        pestsList = new PestsList();



        try{
            Parser commodityParser = new Parser(categoryLink);
            commodityParser.visitAllNodesWith(visitor);
        }
        catch(Exception ex){
             System.out.println(ex);
        }
        pageText = visitor.getPageAsText();
        lastUpdated = visitor.getLastUpdated().trim();
        this.ExtractFruitRegs(pageText);
        this.extractOriginHostReqs();

        //if(originAndHostList.isEmpty())
            this.extractNoListText();
    }
//*********************************************************************
******
    public String GetLastUpdated(){
        return lastUpdated;
    }
//*********************************************************************
******
    private void ExtractFruitRegs(String text){
```

```
        Matcher matcher1;
        Matcher matcher2;
        Pattern pattern1 = Pattern.compile("FRUIT.*----subject----");
        Pattern pattern2 = Pattern.compile("Horizontal Rule");

        matcher1 = pattern1.matcher(text);
        matcher2 = pattern2.matcher(text);

        if(matcher1.find()){
            matcher2.find(matcher1.end());
            fruitSectionText = text.substring(matcher1.start(),
matcher2.end());

        }
        else
        {
            noFruitSection=true;
        }

      /* if(category.matches("UNRESTRICTED PRODUCTS")){
            if(noFruitSection){
                Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.(\\s(avium|cerasus))");
                Matcher cherryMatcher =
cherryPattern.matcher(text.toLowerCase());
                if(cherryMatcher.find())
                    cherryUnrestrictedStatus="1";
                Pattern strawberryPattern =
Pattern.compile("fragaria|strawberr(ies|y)");
                Matcher strawberryMatcher =
strawberryPattern.matcher(text.toLowerCase());
                if(strawberryMatcher.find())
                    strawberryUnrestrictedStatus="1";
                Pattern grapePattern =
Pattern.compile("vitis(\\ssp|\\svinifera|\\s)|vitaceae|grapes");
                Matcher grapeMatcher =
grapePattern.matcher(text.toLowerCase());
                if(grapeMatcher.find())
                    grapeUnrestrictedStatus="1";
            }
            else{
                Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.(\\s(avium|cerasus))");
                Matcher cherryMatcher =
cherryPattern.matcher(fruitSectionText.toLowerCase());
                if(cherryMatcher.find())
                    cherryUnrestrictedStatus="1";
                Pattern strawberryPattern =
Pattern.compile("fragaria|strawberr(ies|y)");
                Matcher strawberryMatcher =
strawberryPattern.matcher(fruitSectionText.toLowerCase());
                if(strawberryMatcher.find())
                    strawberryUnrestrictedStatus="1";
```

```
                Pattern grapePattern =
Pattern.compile("vitis(\\ssp|\\svinifera|\\s)|vitaceae|grapes");
                Matcher grapeMatcher =
grapePattern.matcher(fruitSectionText.toLowerCase());
                if(grapeMatcher.find())
                    grapeUnrestrictedStatus="1";
            }

        }
        else if(category.matches("PROHIBITED PRODUCTS")){
                    if(noFruitSection){
                Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.(\\s(avium|cerasus))");
                Matcher cherryMatcher =
cherryPattern.matcher(text.toLowerCase());
                if(cherryMatcher.find())
                    cherryProhibitedStatus="1";
                Pattern strawberryPattern =
Pattern.compile("fragaria|strawberr(ies|y)");
                Matcher strawberryMatcher =
strawberryPattern.matcher(text.toLowerCase());
                if(strawberryMatcher.find())
                    strawberryProhibitedStatus="1";
                Pattern grapePattern =
Pattern.compile("vitis(\\ssp|\\svinifera|\\s)|vitaceae|grapes");
                Matcher grapeMatcher =
grapePattern.matcher(text.toLowerCase());
                if(grapeMatcher.find())
                    grapeProhibitedStatus="1";
            }
            else{
                Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.(\\s(avium|cerasus))");
                Matcher cherryMatcher =
cherryPattern.matcher(fruitSectionText.toLowerCase());
                if(cherryMatcher.find())
                    cherryProhibitedStatus="1";
                Pattern strawberryPattern =
Pattern.compile("fragaria|strawberr(ies|y)");
                Matcher strawberryMatcher =
strawberryPattern.matcher(fruitSectionText.toLowerCase());
                if(strawberryMatcher.find())
                    strawberryProhibitedStatus="1";
                Pattern grapePattern =
Pattern.compile("vitis(\\ssp|\\svinifera|\\s)|vitaceae|grapes");
                Matcher grapeMatcher =
grapePattern.matcher(fruitSectionText.toLowerCase());
                if(grapeMatcher.find())
                    grapeProhibitedStatus="1";
            }
        }
        else if(category.matches("RESTRICTED PRODUCTS")){
        if(noFruitSection){
```

```
                Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.(\\s(avium|cerasus))");
                Matcher cherryMatcher =
cherryPattern.matcher(text.toLowerCase());
                if(cherryMatcher.find())
                    cherryRestrictedStatus="1";
                Pattern strawberryPattern =
Pattern.compile("fragaria|strawberr(ies|y)");
                Matcher strawberryMatcher =
strawberryPattern.matcher(text.toLowerCase());
                if(strawberryMatcher.find())
                    strawberryRestrictedStatus="1";
                Pattern grapePattern =
Pattern.compile("vitis(\\ssp|\\svinifera|\\s)|vitaceae|grapes");
                Matcher grapeMatcher =
grapePattern.matcher(text.toLowerCase());
                if(grapeMatcher.find())
                    grapeRestrictedStatus="1";
            }
            else{
                Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.(\\s(avium|cerasus))");
                Matcher cherryMatcher =
cherryPattern.matcher(fruitSectionText.toLowerCase());
                if(cherryMatcher.find())
                    cherryRestrictedStatus="1";
                Pattern strawberryPattern =
Pattern.compile("fragaria|strawberr(ies|y)");
                Matcher strawberryMatcher =
strawberryPattern.matcher(fruitSectionText.toLowerCase());
                if(strawberryMatcher.find())
                    strawberryRestrictedStatus="1";
                Pattern grapePattern =
Pattern.compile("vitis(\\ssp|\\svinifera|\\s)|vitaceae|grapes");
                Matcher grapeMatcher =
grapePattern.matcher(fruitSectionText.toLowerCase());
                if(grapeMatcher.find())
                    grapeRestrictedStatus="1";
            }

        }*/

   }
//**************************************************************************
******
    public void printRawText(){
        System.out.println(fruitSectionText);
    }
//**************************************************************************
******
    public String getPestNames(){
       Pattern pattern = Pattern.compile("§[A-Z\\s]*§");
       Matcher matcher = pattern.matcher(fruitSectionText.toUpperCase());
```

```
       while(matcher.find())
       {
            pests += country+"|"+category+"|"+year+"|"+month+"|"
+fruitSectionText.substring(matcher.start()+1,matcher.end()-
1)+"|file://localhost/" + categoryPageURL+ "\r\n";
       }
        return pests;
    }
//**********************************************************************
******
    public String getRegs(){
        //String results =
country+"|CHERRIES|"+category+"|"+year+"|"+month+"|"+cherryProhibitedStatu
s+"|"+cherryUnrestrictedStatus+"|"+cherryRestrictedStatus+"\n";
        //results += country +"|STRAWBERRIES|" +
category+"|"+year+"|"+month+"|"+strawberryProhibitedStatus+"|"+strawberryU
nrestrictedStatus+"|"+strawberryRestrictedStatus+"\n";
       // results += country +"|GRAPES|" +
category+"|"+year+"|"+month+"|"+grapeProhibitedStatus+"|"+grapeUnrestricte
dStatus+"|"+grapeRestrictedStatus+"\n";
        String results = country+"|"+category+"|"+year+"|"+month;
        for (int i=0;i<regsList.size();i++)
            results += "|" + regsList.get(i).getRegulationStatus();

            return results;
    }
//**********************************************************************
******
    public String getStates(){

        String allStates="";
        if(noFruitSection){
        for(int i=0;i<states.size();i++){
        Pattern pattern = Pattern.compile(states.get(i).getRegex());
        Matcher matcher = pattern.matcher(pageText.toUpperCase());
        if(matcher.find()){
            allStates += country +"|"+category+"|"+year+"|"+month +"|NO
FRUIT SECTION|"+states.get(i).getAbbreviation()+"|file://localhost/" +
categoryPageURL+ "\r\n";
                }
            }

        }
        else{
        for(int i=0;i<states.size();i++){
        Pattern pattern = Pattern.compile(states.get(i).getRegex());
        Matcher matcher = pattern.matcher(fruitSectionText.toUpperCase());
        if(matcher.find()){
            allStates += country +"|"+category+"|"+year+"|"+month +"|FRUIT
SECTION|"+states.get(i).getAbbreviation()+"|file://localhost/" +
categoryPageURL+ "\r\n";
                }
            }
        }
```

```
        return allStates;
    }
//**********************************************************************
******
    public String getLinkToRestrictedPage(){
    //returns the URL of all Restricted Category pages which mention our 3
    //commodities to be checked manually
            String results = "";
               if(category.matches("RESTRICTED PRODUCTS")){

            Pattern grapePattern = Pattern.compile("vitis|vitaceae");
            Matcher grapeMatcher =
grapePattern.matcher(pageText.toLowerCase());
            if(grapeMatcher.find()){
                results += country +"|"+category+"|"+year+"|"+month
+"|GRAPES|file://localhost/"+ categoryPageURL + "\r\n";
            }
            Pattern strawberryPattern = Pattern.compile("fragaria");
            Matcher strawberryMatcher =
strawberryPattern.matcher(pageText.toLowerCase());
            if(strawberryMatcher.find()){
                results += country
+"|"+category+"|"+year+"|"+month+"|STRAWBERRIES|file://localhost/" +
categoryPageURL + "\r\n";
            }
            Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.\\s(avium|cerasus)");
            Matcher cherryMatcher =
cherryPattern.matcher(pageText.toLowerCase());
            if(cherryMatcher.find()){
                results += country
+"|"+category+"|"+year+"|"+month+"|CHERRIES|file://localhost/" +
categoryPageURL + "\r\n";
            }
        if(results.isEmpty()){
            results += country +"|"+category+"|"+year+"|"+month+"|NO
COMMODITY|file://localhost/" + categoryPageURL+ "\r\n";
        }
        }

        return results;
    }
//**********************************************************************
******
    public String getPestsRestriction(){
        String results="";
if(noFruitSection){
        for(int i=0;i<pestsList.size();i++){
        Pattern pattern = Pattern.compile(pestsList.get(i).getRegex());
        Matcher matcher = pattern.matcher(pageText.toUpperCase());
        if(matcher.find()){
            for(int j=0;j<pestsList.get(i).getNumberOfHosts();j++)
            results += country
+"|"+year+"|"+month+"|"+category+"|"+pestsList.get(i).getHosts(j) +"|NO
```

```
FRUIT SECTION|"+pestsList.get(i).getCommonName()+"|file://localhost/" +
categoryPageURL+ "\r\n";

                }
            }
        }
 else{
        for(int i=0;i<pestsList.size();i++){
        Pattern pattern = Pattern.compile(pestsList.get(i).getRegex());
        Matcher matcher = pattern.matcher(fruitSectionText.toUpperCase());
        if(matcher.find()){
            for(int j=0;j<pestsList.get(i).getNumberOfHosts();j++)
                results += country +"|"+year+"|"+month
+"|"+category+"|"+pestsList.get(i).getHosts(j) +"|FRUIT
SECTION|"+pestsList.get(i).getCommonName()+"|file://localhost/" +
categoryPageURL+ "\r\n";
                }
            }
        }

        return results;
    }
//**********************************************************************
******
    public String getThereAreNo(){
        String results = "";
        Pattern pattern = Pattern.compile("\\sTHERE\\sARE\\sNO\\s");

        if(noFruitSection){
        Matcher matcher = pattern.matcher(pageText.toUpperCase());
        if(matcher.find()){
            results+= country +"|"+category+"|"+year+"|"+month+"|"+"NO
FRUITSECTION"+"\n";
        }
        }
        else
        {
        Matcher matcher = pattern.matcher(fruitSectionText.toUpperCase());
        if(matcher.find()){
            results+= country
+"|"+category+"|"+year+"|"+month+"|"+"FRUITSECTION"+"\n";
        }
        }
        return results;
    }
//**********************************************************************
******
    public String getPage(){
        String results = country +"|"+category+"|"+year+"|"+month+"|"+"All
Commodities CATMENU"+"\n"+pageText;

        return results;
    }
```

```
//*******************************************************************
******
    public void extractOriginHostReqs(){
    /*
     * Looks for instances of FROM or From or Host or HOST at the start of
line and extracts up
     * to the next FROM or From or Host or HOST or Horizontal Rule
     */
     String fromOrHost="";
     String fromOrHostText="";
     boolean flag=true;
     RegexVector temp = new RegexVector();
     RegexVector horizontalRule = new RegexVector();
     ArrayList <RegexVector> combinedVectorList = new
ArrayList<RegexVector>();

    Pattern pattern = Pattern.compile("(\\n|\\r\\n)F(ROM|rom)");
    Matcher matcher = pattern.matcher(fruitSectionText);
    while(matcher.find()){
        combinedVectorList.add(new
RegexVector(matcher.start(),matcher.end(),matcher.group().trim(),false,tru
e));
        //System.out.println(matcher.start());
    }
    Pattern pattern2 = Pattern.compile("(\\n|\\r\\n)H(OST|ost)");
    Matcher matcher2 = pattern2.matcher(fruitSectionText);
    while(matcher2.find()){
        combinedVectorList.add(new
RegexVector(matcher2.start(),matcher2.end(),matcher2.group().trim(),true,f
alse));
        //System.out.println(matcher2.start());
    }
    Pattern pattern3 = Pattern.compile("Horizontal Rule");
    Matcher matcher3 = pattern3.matcher(fruitSectionText);
    if(matcher3.find()){
        combinedVectorList.add(new
RegexVector(matcher3.start(),matcher3.end(),matcher3.group().trim(),false,
false));
    }

    //Sort the combined vector list in ascending order
     if(combinedVectorList.size()>1)
        while(flag){
            flag=false;
            for(int k=0;k<combinedVectorList.size()-1;k++){
                //sort the combined vector list

if(combinedVectorList.get(k).getStart()>combinedVectorList.get(k+1).getSta
rt()){
                    temp = combinedVectorList.get(k);
                    combinedVectorList.set(k,
combinedVectorList.get(k+1));
                    combinedVectorList.set(k+1, temp);
                    flag=true;
```

```
                }
            }
        }

     if(!combinedVectorList.isEmpty()){
         /*if(combinedVectorList.get(0).isFrom()){
             //first walk the list and find each instance of isFrom
             //and use as root nodes
            for(int i=0;i<combinedVectorList.size()-1;i++){
             if(combinedVectorList.get(i).isFrom()){
                fromOrHost =
fruitSectionText.substring(combinedVectorList.get(i).getStart(),
fruitSectionText.indexOf("\n",
combinedVectorList.get(i).getEnd())).trim();
                fromOrHostText =
fruitSectionText.substring(combinedVectorList.get(i).getStart(),
combinedVectorList.get(i+1).getStart()).trim();
                originAndHostTree.add(new TreeNode(new
OriginOrHostRawText(fromOrHost,fromOrHostText,false),combinedVectorList.ge
t(i)));
                }
            }
            //walk the regexvector list and find each instance of host or
origin
            //insert into tree as children
            for(int i=0;i<combinedVectorList.size()-1;i++){
            }
         }
         if(combinedVectorList.get(0).isHost()){
            for(int i=0;i<combinedVectorList.size()-1;i++){

            }
         }*/
         for (int i=0;i<combinedVectorList.size()-1;i++){
             fromOrHost =
fruitSectionText.substring(combinedVectorList.get(i).getStart(),
fruitSectionText.indexOf("\n",
combinedVectorList.get(i).getEnd())).trim();
             fromOrHostText =
fruitSectionText.substring(combinedVectorList.get(i).getStart(),
combinedVectorList.get(i+1).getStart()).trim();

             if(combinedVectorList.get(i).isHost()){
                for(int j=0;j<pestsList.size();j++){
                 Pattern patternPest =
Pattern.compile(pestsList.get(j).getRegex());
                 Matcher matcherPest =
patternPest.matcher(fromOrHost.toUpperCase());
                 if(matcherPest.find()){
                    originAndHostList.add(new
OriginOrHostRawText(fromOrHost,fromOrHostText,true));
                    }
                }
             }
```

```
            else
               originAndHostList.add(new
OriginOrHostRawText(fromOrHost,fromOrHostText,false));
         }
      }

   }

//*********************************************************************
******
    public void extractNoListText(){
       for(int j=0;j<regsList.size();j++){
          Pattern pattern = Pattern.compile(regsList.get(j).getRegex());
          Matcher matcher =
pattern.matcher(fruitSectionText.toUpperCase());
          if(matcher.find()){
            regsList.get(j).setIsRegulated();
           }
        }
        for(int j=0;j<pestsList.size();j++){
          Pattern pattern = Pattern.compile(pestsList.get(j).getRegex());
          Matcher matcher =
pattern.matcher(fruitSectionText.toUpperCase());
          if(matcher.find()){
            pestsList.get(j).setIsRegulated();
          }
        }

    }
//*********************************************************************
******
    public String printResults(){
        String result="";
        ArrayList <String> commodityPRUstat = new ArrayList<String>();

        if(originAndHostList.isEmpty()){
                Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.(\\s(avium|cerasus))");
                Matcher cherryMatcher =
cherryPattern.matcher(fruitSectionText.toLowerCase());
                if(cherryMatcher.find())
                    commodityPRUstat.add("80920");
                Pattern strawberryPattern =
Pattern.compile("fragaria|strawberr(ies|y)");
                Matcher strawberryMatcher =
strawberryPattern.matcher(fruitSectionText.toLowerCase());
                if(strawberryMatcher.find())
                    commodityPRUstat.add("81010");
                Pattern grapePattern =
Pattern.compile("vitis(\\ssp|\\svinifera|\\s)|vitaceae|grapes");
                Matcher grapeMatcher =
grapePattern.matcher(fruitSectionText.toLowerCase());
                if(grapeMatcher.find())
                    commodityPRUstat.add("80610");
```

```
            if(!commodityPRUstat.isEmpty()){
               for(int i=0;i<commodityPRUstat.size();i++){
                result += country +"|"+category+"|"+year+"|"+month+"|ALL 
STATES AND HOSTS|"+commodityPRUstat.get(i);
                   for(int a=0;a<regsList.size();a++)
                    result += "|"+regsList.get(a).getRegulationStatus();
                   for(int b=0;b<pestsList.size();b++)
                    result += "|"+pestsList.get(b).getRegulationStatus();
                result += "\n";
               }
         }

         }
        else{
            for(int i =0;i<originAndHostList.size();i++){
                if(originAndHostList.get(i).isHost()){
                    for(int 
j=0;j<originAndHostList.get(i).getHostListSize();j++){
                      if(!originAndHostList.get(i).cmdtPRUstatIsEmpty())
                        for(int 
l=0;l<originAndHostList.get(i).getCmdtPRUstatSize();l++){
                            result += country 
+"|"+category+"|"+year+"|"+month+"|"+originAndHostList.get(i).getHost(j)+"
|"+originAndHostList.get(i).getcmdtPRUstat(l);
                            for(int 
k=0;k<originAndHostList.get(i).getRegsListSize();k++)
                                result += 
"|"+originAndHostList.get(i).getRegulation(k).getRegulationStatus();
                            for(int 
p=0;p<originAndHostList.get(i).getPestsListSize();p++)
                                result += "|"+ 
originAndHostList.get(i).getPest(p).getRegulationStatus();
                                result += "\n";
                           }
                    }

                }
                else{
                    for(int 
m=0;m<originAndHostList.get(i).getOriginListSize();m++){

                      if(!originAndHostList.get(i).cmdtPRUstatIsEmpty())
                      for(int 
l=0;l<originAndHostList.get(i).getCmdtPRUstatSize();l++){
                       result += country 
+"|"+category+"|"+year+"|"+month+"|"+originAndHostList.get(i).getOrigin(m)
+"|"+originAndHostList.get(i).getcmdtPRUstat(l);
                        for(int 
j=0;j<originAndHostList.get(i).getRegsListSize();j++)
                           result += 
"|"+originAndHostList.get(i).getRegulation(j).getRegulationStatus();
                        for(int 
k=0;k<originAndHostList.get(i).getPestsListSize();k++)
```

```
                           result += "|"+
originAndHostList.get(i).getPest(k).getRegulationStatus();
                       result += "\n";
                      }
                    }

                }
            }
        }
        return result;
    }
//***************************************************************************
******
}


package spsregulations;

import org.htmlparser.*;
import java.util.regex.Pattern;
import java.util.regex.Matcher;
import java.util.ArrayList;

/**
 *
 * @author Radu Ramniceanu
 */

public class Commodity {

    private String plantPartText;
    private String lastUpdated;
    private String commodity;
    private String year;
    private String month;
    private String country;
    private String pests;
    private String pageURL;
    private String treatmentQuantities;
    private String pageText;
    private boolean noFruitSection;
    private RegulationsList regsList;
    private StateList states;
    private PestsList pestsList;
    private ArrayList <OriginOrHostRawText> originList;


    public Commodity(){

    }

    public Commodity(String comName, String commodityLink,String yr,String
mo,String co){
        /*
```

```
         * Extracts the text for each commodity and places it in
allCommoditesText
         * or plantPartText
         */
            regsList = new RegulationsList();
            states = new StateList();
            commodity=comName;
            year = yr;
            month = mo;
            country = co;
            noFruitSection=false;
            pests = "";
            plantPartText="";
            treatmentQuantities="";
            MyVisitor visitor = new MyVisitor ();
            pestsList = new PestsList();
            pageURL = commodityLink;
            originList = new ArrayList <OriginOrHostRawText>();

                try{
                   Parser commodityParser = new Parser(pageURL);
                   commodityParser.visitAllNodesWith(visitor);
                }
                catch(Exception ex){
                    System.out.println(ex);
                }
            pageText = visitor.getPageAsText();
            lastUpdated=visitor.getLastUpdated();
            this.extractFruitRegs(pageText);

            if(!noFruitSection){
            this.extractOriginReqs();
            for(int j=0;j<regsList.size();j++){
               Pattern pattern =
Pattern.compile(regsList.get(j).getRegex());
               Matcher matcher =
pattern.matcher(plantPartText.toUpperCase());
                 if(matcher.find()){
                     regsList.get(j).setIsRegulated();
                        }
                }
            for(int p=0;p<pestsList.size();p++){
                Pattern pattern =
Pattern.compile(pestsList.get(p).getRegex());
                Matcher matcher =
pattern.matcher(plantPartText.toUpperCase());
                  if(matcher.find()){
                     pestsList.get(p).setIsRegulated();
                  }
                }

            }
    }
```

```
//**********************************************************************
*****
    public String GetLastUpdatedDate(){
        return lastUpdated;
    }
//**********************************************************************
*****
    public boolean isAllCommodities(){
      if(commodity.matches("All Commodities")){
                return true;
           }
      else  return false;
    }
//**********************************************************************
*****
    private void extractFruitRegs(String pageTxt){
        Matcher matcher1;
        Matcher matcher2;
        Pattern pattern1 = Pattern.compile("(FRUIT|FRUITS|RAISINS|FRESH
FRUIT|DRIED FRUIT|DRIED GRAPES|(PLANTS AND PLANT PARTS)|(PLANTS, PARTS
EXCEPT FOR SEEDS)|(ALL PLANT PARTS)|(FRUIT (FROM|(AND
(USED|CONT))))|(TABLE GRAPES)|([A-Z ,]*INCLUDING FRUIT[A-Z ,]*))[A-Z ,]* -
---plant part----");
        Pattern pattern2 = Pattern.compile("Horizontal Rule");

        matcher1 = pattern1.matcher(pageTxt);
        matcher2 = pattern2.matcher(pageTxt);
        //MyFileWriter writer = new MyFileWriter();

          if(matcher1.find()){
            matcher2.find(matcher1.end());
            plantPartText = pageTxt.substring(matcher1.start(),
matcher2.end());
            //System.out.println(country+" | "+commodity+" | "+year+" |
"+month+" | FRUIT SECTION | "+matcher1.group());
        }
        else
        {
              noFruitSection=true;
            //System.out.println(country+" | "+commodity+" | "+year+" |
"+month+" | NO FRUIT SECTION:\n "+pageTxt);
        }



        /*for(int i=0;i<strArray.length;i++){
        Pattern pattern = Pattern.compile("(FRUIT|FRUITS|RAISINS|FRESH
FRUIT|DRIED FRUIT|DRIED GRAPES|(PLANTS AND PLANT PARTS)|(PLANTS, PARTS
EXCEPT FOR SEEDS)|(ALL PLANT PARTS)|(FRUIT (FROM|(AND
(USED|CONT))))|(TABLE GRAPES)|([A-Z ,]*INCLUDING FRUIT[A-Z ,]*))[A-Z ,]* -
---plant part----");
        Matcher matcher = pattern.matcher(strArray[i]);
        if(matcher.find()){
            canCopy=true;}
```

```
        if(strArray[i].trim().matches("^Horizontal Rule$"))
            canCopy=false;
        if(canCopy==true && !strArray[i].matches("^$"))
                plantPartText += strArray[i]+'\n';
        }
        if(plantPartText.isEmpty())
            noFruitSection=true;*/


    }
//*****************************************************************************
******
    public String getRegulations(){
        String results = "";

         if(originList.size()>0){
             for (int i=0;i<originList.size();i++){
                 results +=
country+"|"+commodity+"|"+year+"|"+month+"|"+originList.get(i).getOrigin()
;
                 for(int j=0;j<originList.get(i).getRegsListSize();j++){
                     results +=
"|"+originList.get(i).getRegulation(j).getRegulationStatus();
                 }
                 results += "\n";
             }
         }
         else{
            results+=country+"|"+commodity+"|"+year+"|"+month+"|ALL
STATES";
            for(int i=0;i<regsList.size();i++){
                results += "|"+regsList.get(i).getRegulationStatus();
            }
         }
        return results;

    }
//*****************************************************************************
******
    public String getPests(){
   String result = "";
        if(originList.size()>0){
                for (int i=0;i<originList.size();i++){
                   result +=
country+"|"+commodity+"|"+year+"|"+month+"|"+originList.get(i).getOrigin()
;
                for(int j=0;j<originList.get(i).getPestsListSize();j++){
                    result +=
"|"+originList.get(i).getPest(j).getRegulationStatus();
                }
                   result += "\n";
              }
            }
        else{
```

```
                result+=country+"|"+commodity+"|"+year+"|"+month+"|ALL
STATES";
                for (int i=0;i<pestsList.size();i++)
                    result += "|"+pestsList.get(i).getRegulationStatus();
            }
   return result;
    }
//*********************************************************************
******
    public void printRawText(){
        System.out.println(plantPartText);
    }
//*********************************************************************
******
    public String getTreatmentQuantities(){

        Pattern pattern = Pattern.compile("[0-9]+[\\.0-9]*");
        Matcher matcher = pattern.matcher(plantPartText);

                while(matcher.find())
                {
                     treatmentQuantities += matcher.group()+"|";
                }

        return treatmentQuantities;
    }
//*********************************************************************
******
    public String getStates(){

        String allStates="";

        if(noFruitSection){
        for(int i=0;i<states.size();i++){
        Pattern pattern = Pattern.compile(states.get(i).getRegex());
        Matcher matcher = pattern.matcher(pageText.toUpperCase());
        if(matcher.find()){
            allStates += country +"|"+commodity+"|"+year+"|"+month +"|NO
FRUIT SECTION|"+states.get(i).getAbbreviation()+"|file://localhost/" +
pageURL +"\r\n";
             }
            }
        }
        else{
        for(int i=0;i<states.size();i++){
        Pattern pattern = Pattern.compile(states.get(i).getRegex());
        Matcher matcher = pattern.matcher(plantPartText);
        if(matcher.find()){
            allStates += country +"|"+commodity+"|"+year+"|"+month
+"|FRUIT SECTION|"+states.get(i).getAbbreviation()+"|file://localhost/" +
pageURL +"\r\n";
             }
            }
           }
```

```
        return allStates;
    }
//**********************************************************************
******
    public String getCommonPests(){
        String results="";
if(noFruitSection){
        for(int i=0;i<pestsList.size();i++){
        Pattern pattern = Pattern.compile(pestsList.get(i).getRegex());
        Matcher matcher = pattern.matcher(pageText.toUpperCase());
        if(matcher.find()){
            results += country +"|"+commodity+"|"+year+"|"+month +"|NO
FRUIT SECTION|"+pestsList.get(i).getCommonName()+"|file://localhost/" +
pageURL + "\r\n";
                }
            }
        }
 else{
        for(int i=0;i<pestsList.size();i++){
        Pattern pattern = Pattern.compile(pestsList.get(i).getRegex());
        Matcher matcher = pattern.matcher(plantPartText.toUpperCase());
        if(matcher.find()){
            results += country +"|"+commodity+"|"+year+"|"+month +"|FRUIT
SECTION|"+pestsList.get(i).getCommonName()+"|file://localhost/" + pageURL
+ "\r\n";
                }
            }
        }

        return results;
    }
//**********************************************************************
******
    public void extractOriginReqs(){
    /*
     * Looks for instances of FROM or From at the start of line and
extracts up
     * to the next FROM or From or Horizontal Rule
     */
     String from="";
     String text="";
     ArrayList <RegexVector> combinedVectorList = new
ArrayList<RegexVector>();
     RegexVector horizontalRule = new RegexVector();

    // Pattern pattern = Pattern.compile("(\\n|\\r\\n)F(ROM|rom)");
    // Matcher matcher = pattern.matcher(plantPartText);
   // while(matcher.find()){
   //     combinedVectorList.add(new
RegexVector(matcher.start(),matcher.end(),matcher.group(),false,true));
        //System.out.println(matcher.group());
  //  }
    Pattern pattern3 = Pattern.compile("F(ROM|rom).+----sub part");
    Matcher matcher3 = pattern3.matcher(plantPartText);
```

```
    while(matcher3.find()){
        combinedVectorList.add(new
RegexVector(matcher3.start(),matcher3.end(),matcher3.group(),false,true));
    }

    Pattern pattern2 = Pattern.compile("Horizontal Rule");
    Matcher matcher2 = pattern2.matcher(plantPartText);
    if(matcher2.find()){
        horizontalRule=new
RegexVector(matcher2.start(),matcher2.end(),matcher2.group(),false,true);
    }
     //for(int i=0;i<matcherList2.size();i++)

//System.out.println(plantPartText.substring(matcherList2.get(i).getStart(
),matcherList2.get(i).getEnd()+30));
     /*if(combinedVectorList.size()>1)
        while(flag){
            flag=false;
            for(int k=0;k<combinedVectorList.size()-1;k++){
                //sort the combined vector list

if(combinedVectorList.get(k).getStart()>combinedVectorList.get(k+1).getSta
rt()){
                    temp = combinedVectorList.get(k);
                    combinedVectorList.set(k,
combinedVectorList.get(k+1));
                    combinedVectorList.set(k+1, temp);
                    flag=true;
                }
            }
        }*/
     if(!combinedVectorList.isEmpty()){
         for (int i=0;i<combinedVectorList.size();i++){
             //from =
plantPartText.substring(combinedVectorList.get(i).getStart(),
plantPartText.indexOf("\n", combinedVectorList.get(i).getEnd())).trim();
             from = combinedVectorList.get(i).getGroup();
           try{
             text =
plantPartText.substring(combinedVectorList.get(i).getStart(),
combinedVectorList.get(i+1).getStart()).trim();
           }
           catch(Exception e){
              // e.printStackTrace();
             text =
plantPartText.substring(combinedVectorList.get(i).getStart(),
horizontalRule.getEnd()).trim();
           }
             originList.add(new OriginOrHostRawText(from,text,false));
             //System.out.println(text);
         }
     }
  }
```

```
//***********************************************************************
******
    public String printResults(){
        String result="";
        if(originList.isEmpty()){
            result += country +"|"+commodity+"|"+year+"|"+month+"|ALL
STATES AND ALL HOSTS";
            for(int a=0;a<regsList.size();a++)
                     result += "|"+regsList.get(a).getRegulationStatus();
            for(int b=0;b<pestsList.size();b++)
                     result += "|"+pestsList.get(b).getRegulationStatus();

            result+="\n";
        }
        else{
            for(int i =0;i<originList.size();i++){
                for(int m=0;m<originList.get(i).getOriginListSize();m++){
               result += country
+"|"+commodity+"|"+year+"|"+month+"|"+originList.get(i).getOrigin(m);

                for(int j=0;j<originList.get(i).getRegsListSize();j++)
                    result +=
"|"+originList.get(i).getRegulation(j).getRegulationStatus();

                for(int k=0;k<originList.get(i).getPestsListSize();k++)
                    result += "|"+
originList.get(i).getPest(k).getRegulationStatus();

               result += "\n";

                }
            }
        }
        return result;
    }
}


package spsregulations;

import java.util.ArrayList;

/**
 *
 * @author Radu Ramniceanu
 */

public class CountriesBreakdownList {
    private ArrayList <String> AFR; //Inter African Union from 1999 to
2009
    private ArrayList <String> EUN; //European Union
    private ArrayList <String> KEN; //Kenia from 199905 to 200404.
Separate after that.
    private ArrayList <String> SUN; //The Former Soviet Republics
```

```
public CountriesBreakdownList(){
    AFR = new ArrayList<String>();
    EUN = new ArrayList<String>();
    KEN = new ArrayList<String>();
    SUN = new ArrayList<String>();

    AFR.add("AGO");
    AFR.add("BEN");
    AFR.add("BBWA");
    AFR.add("BFA");
    AFR.add("BDI");
    AFR.add("CMR");
    AFR.add("CAF/RCA");
    AFR.add("TCD");
    AFR.add("COG");
    AFR.add("COD/ZAR");
    AFR.add("CIV");
    AFR.add("GNQ");
    AFR.add("GAB");
    AFR.add("GMB");
    AFR.add("GHA");
    AFR.add("GIN");
    AFR.add("GNB");
    AFR.add("LSO");
    AFR.add("LBR");
    AFR.add("MLI");
    AFR.add("MRT");
    AFR.add("MOZ");
    AFR.add("NER");
    AFR.add("RWA");
    AFR.add("SEN");
    AFR.add("SLE");
    AFR.add("SOM");
    AFR.add("SWZ");
    AFR.add("TGO");
    AFR.add("ZWE");

    EUN.add("AUT");//1999 to 2009
    EUN.add("BEL");//1999 to 2009
    EUN.add("BGR");
    EUN.add("CYP");
    EUN.add("CZE");
    EUN.add("DNK");//1999 to 2009
    EUN.add("EST");
    EUN.add("FIN");//1999 to 2009
    EUN.add("FRA");//1999 to 2009
    EUN.add("DEU");//1999 to 2009
    EUN.add("GRC");//1999 to 2009
    EUN.add("HUN");
    EUN.add("IRL");//1999 to 2009
    EUN.add("ITA");//1999 to 2009
    EUN.add("LVA");
```

```
        EUN.add("LTU");
        EUN.add("LUX");//1999 to 2009
        EUN.add("MLT");
        EUN.add("MCO");
        EUN.add("NLD");//1999 to 2009
        EUN.add("POL");
        EUN.add("PRT");//1999 to 2009
        EUN.add("ROU");
        EUN.add("SMR");
        EUN.add("SVK");
        EUN.add("SVN");
        EUN.add("ESP");//1999 to 2009
        EUN.add("SWE");//1999 to 2009
        EUN.add("GBR");//1999 to 2009
        EUN.add("VAT");
        KEN.add("KEN");
        KEN.add("TZA");
        KEN.add("UGA");
        SUN.add("ARM");
        SUN.add("AZE");
        SUN.add("BLR");
        SUN.add("EST");// 1999 to 2001
        SUN.add("GEO");
        SUN.add("KAZ");
        SUN.add("KGZ");// 1999 to 2008
        SUN.add("LVA");// 1999 to 2000
        SUN.add("LTU");// 1999 to 2000
        SUN.add("MDA");
        SUN.add("RUS");
        SUN.add("TJK");
        SUN.add("TKM");
        SUN.add("UKR");
        SUN.add("UZB");
    }

    public int getSUNsize(){
        return SUN.size();
    }
    public int getKENsize(){
        return KEN.size();
    }
    public int getEUNsize(){
        return EUN.size();
    }
    public int getAFRsize(){
        return AFR.size();
    }
    public String getSUNiso(int index){
        return SUN.get(index);
    }
    public String getKENiso(int index){
        return KEN.get(index);
    }
    public String getEUNiso(int index){
```

```
        return EUN.get(index);
    }
    public String getAFRiso(int index){
        return AFR.get(index);
    }

}


package spsregulations;

import java.util.regex.Pattern;
import java.util.regex.Matcher;

/**
 *
 * @author Radu Ramniceanu
 */

public class DateExtractor {

    private Pattern datePattern = Pattern.compile("\b([0-9]{1,2}/[0-
9]{2}/[0-
9][4])\b|\b((J(anuary|u(ne|ly))|February|Ma(rch|y)|A(pril|ugust)|(((Sept|N
ov|Dec)em)|Octo)ber) [0-9]{1,2}, [1-9]{4})\b");
    private Matcher dateMatcher;
    private String lastUpdated;

    public DateExtractor(){
    }

    public String ExtractLastUpdatedDate(String text){
        dateMatcher.reset();
        dateMatcher = datePattern.matcher(text);

        if(dateMatcher.find())
            return dateMatcher.group();
        else
            return "Last Updated date not found!";
    }

}


package spsregulations;

import org.htmlparser.*;
import java.io.*;
import org.htmlparser.util .*;
import org.htmlparser.filters.TagNameFilter;
import org.htmlparser.tags.LinkTag;
import org.htmlparser.tags.TitleTag;
import java.util.regex.Pattern;
import java.util.regex.Matcher;
```

```
/**
 *
 * @author Radu Ramniceanu
 */

public class HTMLreader {

    //get year, month, alpha-3 country code and CMDMENU.html from Main
class
    //find the four commodities and send to HTMLParser class
public static void GetCommodityData(String year,String month,String
countrycode,String countryPath,BufferedWriter writer,BufferedWriter
errorwriter)
{

    //cmdmenuPath will be used to initialize a Parser object.
    Parser commenu;
    Parser catmenu;
    NodeList cmdlist = new NodeList();
    NodeList tempcmdlist = new NodeList();
    NodeList catlist = new NodeList();
    NodeList tempcatlist = new NodeList();
    LinkTag cmdtag= new LinkTag();
    LinkTag cattag= new LinkTag();
    TitleTag catTitle = new TitleTag();
    //String
commodityRegEx="^((PRUNUS(?=(\\s(AVIUM|CERASUS|SP))|$))|(FRAGARIA(?=(\\s(A
NANASSA|CHILOENSIS|X|SP))|$))|.*VITIS.*|.*VITACEAE.*)$";
    String
commodityRegEx="(PRUNUS(?=(\\s(AVIUM|CERASUS|SP))|$))|(FRAGARIA(?=(\\s(ANA
NASSA|CHILOENSIS|X|SP))|$))|.*VITIS.*|.*VITACEAE.*";
    Pattern commodityPattern = Pattern.compile(commodityRegEx);
    String cherryRegEx =
"^PRUNUS\\s(AVIUM|CERASUS|MACROPHYLLA|ASPLENIIFOLIA|SP|SPP)$";
    String strawberryRegEx = "(^FRAGARIA\\s)|(.*ANANASSA.*)";
    String grapesRegEx =
"(^VITIS\\s(VINIFERA|SP$|SPP$|SP|SPP)$)|^VITACEAE.*";
    String categoryRegEx="(\\s|.*)(PROHIBITED|RESTRICTED|UNRESTRICTED).*";
    Commodity comEx;
    AllCommodities allComm;
    Category catEx;
    String commodityText;
    String categoryText;
    String cmdMenuTitle="";
    String catMenuTitle="";
    SimpleNodeIterator cmdNodeIterator = null;
    SimpleNodeIterator catNodeIterator = null;

    try{
        commenu=new Parser(countryPath+"\\"+"CMDMENU.HTM");
        //commenu.setEncoding("ISO-8859-1");
```

```
        tempcmdlist=commenu.parse(null);
        cmdlist = tempcmdlist.extractAllNodesThatMatch(new
TagNameFilter("A"),true);
        cmdNodeIterator=cmdlist.elements();
        //commenu.reset();
        MyVisitor visitor = new MyVisitor();
        //commenu.visitAllNodesWith(visitor);
        tempcmdlist.visitAllNodesWith(visitor);
        cmdMenuTitle=visitor.getMenuTitle();
            }
    catch(Exception ex){
        //if CMDMENU.HTM does not exist create an instance of comEx with a
        //NotPrepared code
        //noPrep = new NotPrepared(countryPath,year,month,countrycode);
       // System.out.println(countrycode+"|"+"No
CMDMENU"+"|"+year+"|"+month + "|"+ex.toString());
        try{
        errorwriter.write(countrycode+"|"+"No CMDMENU"+"|"+year+"|"+month
+ "|"+ex.toString());
        errorwriter.newLine();
        }
        catch(IOException ioe){
            ioe.printStackTrace();
        }

    }
        /*If CMDMENU does not contain individual commodities then all
         *commodities receive the same treatment.
         */
        if(cmdMenuTitle.toUpperCase().trim().matches(".* ALL
COMMODITIES$")){
                allComm = new
AllCommodities(countryPath+"\\"+"CMDMENU.HTM",year,month,countrycode);
                //System.out.println(countrycode + "|All Commodities
CMDMENU"+"|"+year+"|"+month+"|"+allComm.GetLastUpdated()+"|"+countryPath+"
\\"+"CMDMENU.HTM");
                try{
                    writer.write(countrycode + "|All Commodities
CMDMENU"+"|"+year+"|"+month+"|"+allComm.GetLastUpdated()+"|"+countryPath+"
\\"+"CMDMENU.HTM");
                    writer.newLine();
                }
                catch(IOException ioe){
                    ioe.printStackTrace();
                }
            }
        else if(cmdMenuTitle.toLowerCase().trim().matches(".* complete
list$")){

                /*
                 * If CMDMENU.HTM contains a list of commodities, then we
will find the
                 * four relevant commodities and extract the text
information.
```

```
            */
        while(cmdNodeIterator.hasMoreNodes()){

            cmdtag = (LinkTag) cmdNodeIterator.nextNode();
            Matcher commodityMatcher =
commodityPattern.matcher(cmdtag.getLinkText().trim());

            //if(cmdtag.getLinkText().trim().matches(commodityRegEx)){
            if(commodityMatcher.find()){
                comEx = new Commodity(cmdtag.getLinkText(),
cmdtag.extractLink(),year,month,countrycode);
                //
System.out.println(countrycode+"|"+cmdtag.getLinkText().trim()+"|"+year+"|
"+month+"|"+comEx.GetLastUpdatedDate()+"|"+cmdtag.extractLink());
                try{

writer.write(countrycode+"|"+cmdtag.getLinkText().trim()+"|"+year+"|"+mont
h+"|"+comEx.GetLastUpdatedDate()+"|"+cmdtag.extractLink());
                    writer.newLine();
                }
                catch(IOException ioe){
                    ioe.printStackTrace();
                }
            }
        }
    }
    else if(cmdMenuTitle.toUpperCase().trim().matches(".* SPECIAL
COUNTRY POLICIES$")){
        //System.out.println(countrycode+"|"+"Special Country
Policies|"+year+"|"+month);
        try{
            writer.write(countrycode+"|"+"Special Country
Policies|"+year+"|"+month);
            writer.newLine();
        }
        catch(IOException ioe){
            ioe.printStackTrace();
        }
    }
  /* try{
    catmenu=new Parser(countryPath+"\\"+"CATMENU.HTM");
    tempcatlist=catmenu.parse(null);
    catlist=tempcatlist.extractAllNodesThatMatch(new
TagNameFilter("A"),true);
    catNodeIterator=catlist.elements();
    MyVisitor visitor = new MyVisitor();
    tempcatlist.visitAllNodesWith(visitor);

   if(visitor.getMenuTitle().toUpperCase().trim().matches(".*ALL
COMMODITIES$"))
    {
          //System.out.println(countrycode+"|"+"All Commodities
CATMENU"+"|"+year+"|"+month+"|"+visitor.getLastUpdated()+"|"+countryPath+"
\\"+"CATMENU.HTM");
```

```
            catEx = new Category("All
Commodities",countryPath+"\\"+"CATMENU.HTM",year,month,countrycode);
                try{
                    writer.write(countrycode + "|All Commodities
CATMENU|"+year+"|"+month+"|"+catEx.GetLastUpdated()+"|"+countryPath+"\\"+"
CATMENU.HTM");
                    writer.newLine();
                }
                catch(IOException ioe){
                    ioe.printStackTrace();
                }
        }
       else
        while (catNodeIterator.hasMoreNodes()){
            cattag = (LinkTag) catNodeIterator.nextNode();

            if(cattag.getLinkText().matches(categoryRegEx)){
                catEx = new Category(cattag.getLinkText(),
cattag.extractLink(),year,month,countrycode);

//System.out.println(countrycode+"|"+cattag.getLinkText().trim()+"|"+year+
"|"+month+"|"+catEx.GetLastUpdatedDate()+"|"+cattag.extractLink());
                   try{

writer.write(countrycode+"|"+cattag.getLinkText().trim()+"|"+year+"|"+mont
h+"|"+catEx.GetLastUpdated()+"|"+cattag.extractLink());
                       writer.newLine();
                   }
                   catch(IOException ioe){
                       ioe.printStackTrace();
                   }

            }
        }

    }
    catch(Exception ex){
        //System.out.println(countrycode+"|"+"No
CATMENU"+"|"+year+"|"+month+"|"+ex.toString());
        try{
        errorwriter.write(countrycode+"|"+"No CATMENU"+"|"+year+"|"+month
+ "|"+ex.toString());
        errorwriter.newLine();
        }
        catch(IOException ioe){
            ioe.printStackTrace();
        }
    }*/
  }
public static void PrintAllCommodities(String year,String month,String
countrycode,String countryPath,BufferedWriter writer,BufferedWriter
errorwriter){
        Parser commenu;
    NodeList cmdlist = new NodeList();
```

```
    NodeList tempcmdlist = new NodeList();
    boolean hasCMDMENU=true;

    LinkTag cmdtag= new LinkTag();


    //String commodityRegEx="\nPRUNUS AVIUM.*|.*CERASUS.*|\nPRUNUS
MACROPHYLLA.*|.*ASPLENIIFOLIA.*|\nPRUNUS
SPP.*|\nVITIS.*|.*VINIFERA.*|\nFRAGARIA.*|\nVITACEAE.*";

    SimpleNodeIterator cmdNodeIterator = null;

        try{
        commenu=new Parser(countryPath+"\\"+"CMDMENU.HTM");
        tempcmdlist=commenu.parse(null);
        cmdlist = tempcmdlist.extractAllNodesThatMatch(new
TagNameFilter("A"),true);
        cmdNodeIterator=cmdlist.elements();
        MyVisitor visitor = new MyVisitor();
        tempcmdlist.visitAllNodesWith(visitor);
            }
    catch(Exception ex){
            hasCMDMENU=false;
        }
            if(hasCMDMENU==true){
           while(cmdNodeIterator.hasMoreNodes()){

               cmdtag = (LinkTag) cmdNodeIterator.nextNode();

                   try{

writer.write(countrycode+"|"+year+"|"+month+"|"+cmdtag.getLinkText().trim(
));
                       writer.newLine();
                   }
                   catch(IOException ioe){
                       try{

errorwriter.write(countrycode+"|"+year+"|"+month+"|"+ioe.getMessage());
                       errorwriter.newLine();}
                       catch(IOException
ioe2){System.out.println(ioe2.toString());}
                       ioe.printStackTrace();
                   }

            }
}
    }
}


package spsregulations;
```

```
import java.io.BufferedReader;
import java.io.FileReader;
import java.io.*;

/*
 *
 * @author Radu Ramniceanu
 */

public class Main {

    public static void main(String[] args) {

File myDir = new File("C:/minorleague.ceris.purdue.edu/archive");

      if( myDir.exists() && myDir.isDirectory())
        {
            //create a list of files
            File[] root = myDir.listFiles();
            for(int i=0; i < root.length; i++)
             {
               if (root[i].isDirectory()&&
root[i].getAbsolutePath().matches(".*2009.*"))
               //if (root[i].isDirectory())
                {
                    //get year and month
                    String temp=root[i].toString();
                    String year=root[i].getName().substring(0, 4);
                    String month=root[i].getName().substring(4, 6);
                    File dir=new File(root[i].toString());
                    File[] yearfolder=dir.listFiles();

                    for(int j=0;j<yearfolder.length;j++)
                    {



                        if (yearfolder[j].isDirectory())
                        {


System.out.println(yearfolder[j].getName()+"|"+year+"|"+month);
                            if(yearfolder[j].getName().length()==3)
                            {

                            //If name of folder contains 3 letters this is
a country folder
                            //get the year and month from yearfolder
                            //get alpha-3 country code from yearfolder
                            //get CMDMENU.html from specific country
folder.
                            //send year, month, alpha-3 country code and
country path to htmlreader class
                            try{
```

```
                                BufferedWriter errorout=new
BufferedWriter(new FileWriter("exceptions.txt", true));
                                BufferedWriter out=new BufferedWriter(new
FileWriter("commodities.txt", true));

HTMLreader.GetCommodityData(year,month,yearfolder[j].getName(),yearfolder[
j].getCanonicalPath(),out,errorout);
                                out.flush();
                                errorout.flush();
                                out.close();
                                errorout.close();
                            }
                            catch(Exception
ex){System.out.println("Main.java: "+ex);
                            ex.printStackTrace();}
                            }

                            else if(yearfolder[j].getName().length()!=3)
                            {
                                //This is a folder but may not be a
country.
                                //Output error message.
                                //System.out.println("Main.java:
"+yearfolder[j].getName()+" is not a country folder!");
                            }

                        }
                    }

                }
            }
        }*/
/*********************************************************************
****/

      // This piece of code reads creates commodity objects from a last
modified
         // file on the D drive.
        //System.out.println("Country|Commodity|Year|Month|Origin|MB|Hot
Water|Forced Air|Irradiation|Vapor Heat|Cold Treatment|Fumigation plus
Refrigeration|Freezing|SO2CO2|IP|AD|Workplan|Guidelines|Prohibited|Urestri
cted|Sample Shipment");
      /*try{
            String line="start";
            String[] temp=null;
            String[] path=null;
            Commodity allCom;
            Commodity   comm;
        BufferedReader reader = new BufferedReader(new
FileReader("D:/Commodities_Modified Dates 1999 to 2009.txt"));

        while(line != null)
        {
            line = reader.readLine();
```

```
            if(line!=null){
            temp = line.trim().split("\\|");
            }

            if(temp[1].equalsIgnoreCase("All Commodities CMDMENU")){
                allCom = new
Commodity(temp[1],temp[6],temp[3],temp[4],temp[0]);
                //allCom.printPage();
                //System.out.print(allCom.getCommonPests());
                //System.out.print(allCom.getStates());
                //System.out.println(allCom.getRegulations());
                //System.out.println(allCom.getPests());
                System.out.println(allCom.printResults());


            }
            else{
                path = temp[6].split("//localhost/");
                comm = new
Commodity(temp[1],path[1],temp[3],temp[4],temp[0]);
                //System.out.print(comm.getStates());
                //System.out.println(comm.getPests());
                //System.out.print(comm.getCommonPests());
                //System.out.println(comm.getRegulations());
                System.out.println(comm.printResults());
            }
        }
        reader.close();
        }
        catch(Exception fnfe){
            fnfe.printStackTrace();
        }
*************************************************************************
***/

        //This piece of code creates Category objects from last modified
        //file on the D drive
    try{
            String line="start";
            String[] temp=null;
            String[] path=null;
            Category   cat;
        BufferedReader reader = new BufferedReader(new
FileReader("D:/Categories_Modified Dates 1999 to 2009.txt"));

        while(line != null)
        {
            line = reader.readLine();
            if(line!=null){
            temp = line.trim().split("\\|");
            }

            if(temp[1].equalsIgnoreCase("All Commodities CATMENU")){
```

```
                 cat = new
Category(temp[1],temp[5],temp[2],temp[3],temp[0]);
                //System.out.println(allCom.print);
               //System.out.print(cat.getStates());
                // System.out.print(cat.getPests());
                 //System.out.println(cat.getResults());
                // System.out.print(cat.getPestsRestriction());
                // System.out.print(cat.getThereAreNo());
                 System.out.println(cat.printResults());

            }
            else{
                path = temp[5].split("//localhost/");
                cat = new
Category(temp[1],path[1],temp[2],temp[3],temp[0]);
                //System.out.print(cat.getStates());
                //System.out.println(cat.getResults());
                //System.out.println(cat.getLinkToRestrictedPage());
                //System.out.print(cat.getPestsRestriction());
               // System.out.print(cat.getPests());
                //System.out.print(cat.getThereAreNo());
                System.out.println(cat.printResults());

            }
        }

        }
        catch(Exception fnfe){
            fnfe.printStackTrace();
        }
    }
}


package spsregulations;

import java.io.*;

/**
 *
 * @author Radu Ramniceanu
 */
public class MyFileWriter {

    public MyFileWriter(){}

    public void WriteError(String str){
        try{
            BufferedWriter writeout=new BufferedWriter(new
FileWriter("exceptions.txt", true));
            writeout.append(str);
            writeout.close();
        }
        catch(IOException ioe){
```

```
            ioe.printStackTrace();
        }

    }
    public void WriteOut(String str){
                try{
            BufferedWriter writeout=new BufferedWriter(new
FileWriter("ALL_COMMODITIES_CMDMENU.txt", true));
            writeout.append(str);
            writeout.close();
        }
        catch(IOException ioe){
            ioe.printStackTrace();
        }

    }

}


package spsregulations;

 import org.htmlparser.Tag;
 import org.htmlparser.Text;
 import org.htmlparser.visitors.NodeVisitor;
 import org.htmlparser.Node;
 import org.htmlparser.tags.BoldTag;
 import org.htmlparser.nodes.TextNode;
 import org.htmlparser.util.NodeTreeWalker;
 import org.htmlparser.tags.BulletList;
 import org.htmlparser.tags.Bullet;

/**
 *
 * @author Radu Ramniceanu
 */

public class MyVisitor extends NodeVisitor
 {
     String menuTitle="";
     String pageAsText="";
     String lastUpdated="";
     String tempDate="";


     public MyVisitor ()
     {
     }

    @Override
     public void visitTag (Tag tag)
     {
      if (tag.getTagName().equalsIgnoreCase("TITLE"))
            menuTitle=tag.toPlainTextString().replace('\n', ' ');
```

```
      if (tag.getTagName().equalsIgnoreCase("HR"))
          pageAsText += "\nHorizontal Rule\n";
      if (tag.getTagName().equalsIgnoreCase("P"))
          pageAsText += '\n';
      if(tag.getTagName().equalsIgnoreCase("I")){
          Node temp = tag.getFirstChild();
    //introduce the § sign before and after each bold or italic emphasized
    //words which will most likely be pests of concern
          if(temp instanceof BoldTag){
              Node temp2 = temp.getFirstChild();
              temp2.setText("§"+temp2.getText().replace('\n', ' ')+"§");
          }
          if(temp instanceof TextNode){
              temp.setText("§"+temp.getText().replace('\n', ' ')+"§");
          }
      }
      /*if(tag instanceof BulletList){
          NodeTreeWalker myWalker = new NodeTreeWalker((Node)tag,false);
          Node tempNode = tag;
          String
ulListLevel="\n&&&&&&&&&&"+myWalker.getCurrentNodeDepth()+"&&&&&&&&&&\n";
          do{
            if (tempNode instanceof Bullet){

tempNode.getFirstChild().setText(ulListLevel+"||||||||||"+myWalker.getCurr
entNodeDepth()+"||||||||||\n"+tempNode.getFirstChild().getText());
                //System.out.println(tempNode.toPlainTextString().trim());
                }
            else if(tempNode instanceof BulletList){

ulListLevel="&&&&&&&&&&"+myWalker.getCurrentNodeDepth()+"&&&&&&&&&&\n";
                }
            tempNode = myWalker.nextNode();
          }while(myWalker.hasMoreNodes());
      }*/
     }

    @Override
     public void visitStringNode (Text string)
     {
        if(!string.getText().matches("\\n \\n") ||
!string.getText().matches("\\n"))
        pageAsText += string.getText();
         //System.out.println(pageAsText);

         if(string.getText().trim().matches("^LAST UPDATED.*"))
             lastUpdated=string.getText().trim();
     }

    public String getMenuTitle()
    {
        return menuTitle;
    }
    public String getPageAsText()
```

```
    {
        return pageAsText;
    }
    public boolean wasUpdated(){
        boolean test = false;
        if(lastUpdated.isEmpty())
            test=true;

        return test;
    }
    public String getLastUpdated(){
        String year, month, day;
        String[] strArray;


if(lastUpdated.matches(".*(J(anuary|u(ne|ly))|February|Ma(rch|y)|A(pril|ug
ust)|(((Sept|Nov|Dec)em)|Octo)ber).*")){
                 if(lastUpdated.matches(".*January.*"))
                    month="01";
                 else if(lastUpdated.matches(".*February.*"))
                    month="02";
                 else if(lastUpdated.matches(".*March.*"))
                    month="03";
                 else if(lastUpdated.matches(".*April.*"))
                    month="04";
                 else if(lastUpdated.matches(".*May.*"))
                    month="05";
                 else if(lastUpdated.matches(".*June.*"))
                    month="06";
                 else if(lastUpdated.matches(".*July.*"))
                    month="07";
                 else if(lastUpdated.matches(".*August.*"))
                    month="08";
                 else if(lastUpdated.matches(".*September.*"))
                    month="09";
                 else if(lastUpdated.matches(".*October.*"))
                    month="10";
                  else if(lastUpdated.matches(".*November.*"))
                    month="11";
                  else if(lastUpdated.matches(".*December.*"))
                    month="12";
                  else
                      month="undefined";

                strArray = lastUpdated.split(" ");
                day =
strArray[3].substring(0,strArray[3].lastIndexOf(","));
                if(day.length()==1)
                    day = "0"+day;
                year = strArray[4];

                tempDate=year+month+day;

        }
```

```
        else{
            strArray = lastUpdated.substring(lastUpdated.lastIndexOf("
")).trim().split("/");
            tempDate =strArray[2]+strArray[0]+strArray[1];
        }

        return tempDate;
    }
 }


package spsregulations;

import java.util.regex.Pattern;
import java.util.regex.Matcher;
import java.util.ArrayList;

/**
 *
 * @author Radu Ramniceanu
 */
public class OriginOrHostRawText {
    private String originOrHost;
    private String rawtext;
    private boolean isHost;
    private boolean fromRegulatedArea;
    private boolean fromNonRegulatedArea;
    private RegulationsList regsList;
    private PestsList pestList;
    private boolean foundCherry;
    private boolean foundGrape;
    private boolean foundStrawberry;
    private ArrayList<String> originList;
    private ArrayList<String> hostList;
    private ArrayList<String> cmdtPRUstat;

    public OriginOrHostRawText(){

    }
    public OriginOrHostRawText(String from,String text,boolean host){
        originOrHost=from.trim();
        rawtext=text.trim();
        regsList = new RegulationsList();
        pestList = new PestsList();
        isHost = host;
        foundCherry = false;
        foundGrape = false;
        foundStrawberry = false;
        fromRegulatedArea=false;
        fromNonRegulatedArea=false;
        originList = new ArrayList<String>();
        hostList = new ArrayList<String>();
        cmdtPRUstat = new ArrayList<String>();
```

```
        if(!isHost)
            this.cleanOrigin(from);
        else
            this.cleanHost(from);



        for(int i=0;i<regsList.size();i++){
           Pattern pattern1 = Pattern.compile(regsList.get(i).getRegex());
           Matcher matcher1 = pattern1.matcher(rawtext.toUpperCase());
             if(matcher1.find())
               regsList.get(i).setIsRegulated();
            }
        for(int k=0;k<pestList.size();k++){
           Pattern pattern2 = Pattern.compile(pestList.get(k).getRegex());
           Matcher matcher2 = pattern2.matcher(rawtext.toUpperCase());
           if(matcher2.find()){
              pestList.get(k).setIsRegulated();

           }
            }


        if(!isHost&&(fromRegulatedArea||fromNonRegulatedArea)){
            for(int l=0;l<pestList.size();l++){
                for(int m=0;m<pestList.get(l).getNumberOfHosts();m++){
                    if(pestList.get(l).getHosts(m).matches("VITIS"))
                        foundGrape=true;
                    else if(pestList.get(l).getHosts(m).matches("PRUNUS"))
                        foundCherry=true;
                    else
if(pestList.get(l).getHosts(m).matches("FRAGARIA"))
                        foundStrawberry=true;
                }
            }
        }
        if(foundGrape)
            cmdtPRUstat.add("80610");
        if(foundCherry)
            cmdtPRUstat.add("80920");
        if(foundStrawberry)
            cmdtPRUstat.add("81010");

    }
    public int getCmdtPRUstatSize(){
        return cmdtPRUstat.size();
    }
    public String getcmdtPRUstat(int x){
        return cmdtPRUstat.get(x);
    }
    public boolean cmdtPRUstatIsEmpty(){
        return cmdtPRUstat.isEmpty();
    }
    public String getOrigin(){
```

```
        return originOrHost;
    }
    public String getRawText(){
        return rawtext;
    }
    public int getRegsListSize(){
        return regsList.size();
    }
    public int getPestsListSize(){
        return pestList.size();
    }
    public Regulation getRegulation(int x){
        return regsList.get(x);
    }
    public Pest getPest(int x){
        return pestList.get(x);
    }
    public boolean getIsFromRegulatedArea(){
        return fromRegulatedArea;
    }
    public boolean getIsFromNonRegulatedArea(){
        return fromNonRegulatedArea;
    }
    public boolean isHost(){
        return isHost;
    }
    public int getHostListSize(){
        return hostList.size();
    }
    public String getHost(int x){
        return hostList.get(x);
    }
    public String foundGrape(){
        if(foundGrape)
            return "1";
        else
            return "0";
    }
    public String foundCherry(){
        if(foundCherry)
            return "1";
        else
            return "0";
    }
    public String foundStrawberry(){
        if(foundStrawberry)
            return "1";
        else
            return "0";
    }
    public int getOriginListSize(){
        return originList.size();
    }
    public String getOrigin(int index){
```

```
        return originList.get(index);
    }
    private void cleanOrigin(String from){
    StateList states = new StateList();

        Pattern patternr = Pattern.compile("(?<!(NOT|NON)(\\s*|-
))REGULATED");
        Matcher matcherr = patternr.matcher(rawtext.toUpperCase());
        if(matcherr.find())
            fromRegulatedArea=true;

        Pattern patternN = Pattern.compile("(?<=(NOT|NON)(\\s*|-
))REGULATED");
        Matcher matcherN = patternN.matcher(rawtext.toUpperCase());
        if(matcherN.find())
            fromNonRegulatedArea=true;

        for(int i=0;i<states.size();i++){
            Pattern pattern = Pattern.compile(states.get(i).getRegex());
            Matcher matcher = pattern.matcher(from.toUpperCase());
            if(matcher.find()){
                originList.add(states.get(i).getState());
            }
         }
    }
    private void cleanHost(String from){

     //rename host to a single word
     for(int n=0;n<pestList.size();n++){
       Pattern pestPattern = Pattern.compile(pestList.get(n).getRegex());
       Matcher pestMatcher =
pestPattern.matcher(originOrHost.toUpperCase());
       if(pestMatcher.find()){
        hostList.add(pestList.get(n).getCommonName());
       }
     }
     //check to see if this our 3 commodities are named hosts
     Pattern cherryPattern =
Pattern.compile("prunus(\\s(avium|sp|cerasus))|p\\.(\\s(avium|cerasus))");
     Matcher cherryMatcher = cherryPattern.matcher(rawtext.toLowerCase());
     if(cherryMatcher.find())
       foundCherry=true;
      Pattern strawberryPattern =
Pattern.compile("fragaria|strawberr(ies|y)");
      Matcher strawberryMatcher =
strawberryPattern.matcher(rawtext.toLowerCase());
      if(strawberryMatcher.find())
        foundStrawberry=true;
      Pattern grapePattern =
Pattern.compile("vitis(\\ssp|\\svinifera|\\s)|vitaceae|grapes");
      Matcher grapeMatcher = grapePattern.matcher(rawtext.toLowerCase());
      if(grapeMatcher.find())
        foundGrape=true;
```

```
      //if our three commodities are not found. check our list of USDA
hosts
      if(!foundCherry||!foundGrape||!foundStrawberry){
       for(int l=0;l<pestList.size();l++){
         for(int m=0;m<pestList.get(l).getNumberOfHosts();m++){
            if(pestList.get(l).getHosts(m).matches("VITIS"))
               foundGrape=true;
            else if(pestList.get(l).getHosts(m).matches("PRUNUS"))
               foundCherry=true;
            else if(pestList.get(l).getHosts(m).matches("FRAGARIA"))
               foundStrawberry=true;
           }
         }
       }
    }
}


package spsregulations;

/**
 *
 * @author Radu Ramniceanu
 */

public class Pest {

    private String scientificName;
    private String commonName;
    private String regex;
    private String[] hosts;
    private boolean isRegulated;

    public Pest(String host,String str){
        String[] temp = str.split("\\|");
        regex=str;
        commonName = temp[2];
        scientificName = temp[3];
        hosts = host.split("\\|");
        isRegulated=false;
    }

    public String getScientificName(){
        return scientificName;
    }

    public String getCommonName(){
        return commonName;
    }

    public String getRegex(){
        return regex;
    }
    public String getHosts(int x){
```

```
        return hosts[x];
    }
    public int getNumberOfHosts(){
        return hosts.length;
    }
    public boolean getIsRegulated(){
        return isRegulated;
    }
    public String getRegulationStatus(){
        if(isRegulated)
            return "1";
        else
            return "0";
    }
    public void setIsRegulated(){
        isRegulated=true;
    }
}


package spsregulations;

import java.util.ArrayList;

/**
 *
 * @author Radu Ramniceanu
 */

public class PestsList {
    ArrayList <Pest> pestList;

    public PestsList(){

        Pest mexicanff = new
Pest("VITIS|PRUNUS|FRAGARIA","ANASTREPHA\\s*LUDENS|MEXICAN\\s*FRUIT\\s*FLY
|MFF|Anastrepha ludens");
        Pest orientalffly = new
Pest("VITIS|PRUNUS|FRAGARIA","BACTROCERA\\s*DORSALIS|ORIENTAL\\s*FRUIT\\s*
FLY|OFF|Bactrocera dorsalis|DACUS\\s*DORSALIS");
        Pest medfly = new
Pest("VITIS|PRUNUS|FRAGARIA","CERATITIS\\s*CAPITATA|MEDITERRANEAN\\s*FRUIT
\\s*FLY|MEDFLY|Ceratitis capitata");
        //Pest lbam = new
Pest("EPIPHYAS\\s*POSTVITTANA|LIGHT\\s*BROWN\\s*APPLE\\s*MOTH|LBAM|Epiphya
s postvittana");
        Pest codlingmoth = new
Pest("VITIS|PRUNUS","CYDIA\\s*POMONELLA|CODLING\\s*MOTH|CodlingMoth|Cydia
pomonella");
        Pest stemnematode = new
Pest("VITIS|FRAGARIA","DITYLENCHUS\\s*DIPSACI|STEM\\s*NEMATODE|StemNematod
e|Ditylenchus dipsaci");
```

```
        Pest pinkhibmealybug = new
Pest("VITIS","MACONELLICOCCUS\\s*HIRSUTUS|PINK\\s*HIBISCUS\\s*MEALYBUG|PHM
|Maconellicoccus hirsutus");
        Pest applemaggot = new
Pest("PRUNUS","RHAGOLETIS\\s*POMONELLA|APPLE\\s*MAGGOT|AppleMaggot|Rhagole
tis Pomonella");
        Pest pacificspidermite = new
Pest("VITIS|PRUNUS|FRAGARIA","TETRANYCHUS\\s*PACIFICUS|PACIFIC\\s*SPIDER\\
s*MITE|PSM|Tetranychus pacificus");


        pestList = new ArrayList<Pest>();
        pestList.add(medfly);
        //pestList.add(lbam);
        pestList.add(orientalffly);
        pestList.add(applemaggot);
        pestList.add(pacificspidermite);
        pestList.add(pinkhibmealybug);
        pestList.add(stemnematode);
        pestList.add(mexicanff);
        pestList.add(codlingmoth);


    }

    public int size(){
        return pestList.size();
    }
    public Pest get(int index){
        return pestList.get(index);
    }

}


package spsregulations;

import java.util.ArrayList;

/**
 *
 * @author Radu Ramniceanu
 */

public class RegexVector {
    private int start;
    private int end;
    private String group;
    private boolean isHost;
    private boolean isFrom;
    private ArrayList<RegexVector> child;

    public RegexVector(){
```

```java
    }
    public RegexVector(int x,int y, String g,boolean host,boolean from){
        start = x;
        end = y;
        group = g;
        isHost = host;
        isFrom = from;
        child = new ArrayList<RegexVector>();
    }
    public void addChild(RegexVector chld){
        child.add(chld);
    }
    public int getStart(){
        return start;
    }
    public int getEnd(){
        return end;
    }
    public String getGroup(){
        return group;
    }
    public boolean isHost(){
        return isHost;
    }
    public boolean isFrom(){
        return isFrom;
    }

}


package spsregulations;

/**
 *
 * @author Radu Ramniceanu
 */

public class Regulation {

    private boolean isRegulated;
    private String regex;
    private String SPSregName;

    public Regulation(String name, String regexpr){
        isRegulated = false;
        regex=regexpr;
        SPSregName=name;
    }
    public void setIsRegulated(){
        isRegulated=true;
    }
    public void setName(String name){
        SPSregName = name;
```

```
    }
    public void setRegex(String expression){
        regex = expression;
    }
    public String getName(){
        return SPSregName;
    }
    public String getRegex(){
        return regex;
    }
    public boolean getIsRegulated(){
        return isRegulated;
    }
    public String getRegulationStatus(){
        if(isRegulated)
            return "1";
        else
            return "0";
    }
}

package spsregulations;

import java.util.ArrayList;

/**
 *
 * @author Radu Ramniceanu
 */

public class RegulationsList {
    ArrayList <Regulation> regList;

    public RegulationsList(){
        regList = new ArrayList <Regulation>();

        Regulation t101= new
Regulation("t101","METHYL|(\\(MB\\))|\\s+MB\\s+");
        Regulation t102= new
Regulation("t102","((HOT\\s*WATER)|(SOAPY\\s*WATER)|(WATER\\s*TREATMENT))"
);
        Regulation t103= new Regulation("t103","FORCED\\s*AIR");
        Regulation t105= new Regulation("t105","IRRADIA(TION|ATE|ATED)");
        Regulation t106= new Regulation("t106","VAPOR\\s*HEAT");
        Regulation t107= new Regulation("t107","COLD\\s*TREATMENT");
        Regulation t108= new
Regulation("t108","FUMIGATION\\s*(PLUS|AND)\\s*REFRIGERATION");
        Regulation t109= new Regulation("t109","^.*methyl bromideo.*$");
        Regulation t110= new Regulation("t110","FREEZ(E|ING)");
        Regulation ip= new
Regulation("ip","(IMPORT\\s*PERMIT)|\\(IP\\)|\\sIP\\s");
        Regulation ad= new
Regulation("ad","(ADDITIONAL\\s*DECLARATION(S))|\\(AD\\)|\\sAD'S\\s|\\sAD\
\s");
```

```
        Regulation workplan= new Regulation("workplan","WORK\\s*PLAN");
        Regulation guidelines = new
Regulation("guidelines","GUIDELINE(S)");
        Regulation prohibited = new Regulation("prohibited","PROHIBITED");
        Regulation unrestricted = new
Regulation("unrestricted","UNRESTRICTED");
        Regulation t601c1= new Regulation("t601c1","^.*methyl
bromideo.*$");
        Regulation t601c2= new Regulation("t601c2","^.*methyl
bromideo.*$");
        Regulation sample = new Regulation("sample","SUBSAMPLE|SAMPLE");
        Regulation SO2   = new
Regulation("sulphurdioxide","SULPHUR\\s*DIOXIDE|SO2");
        Regulation CO2 = new
Regulation("carbondioxide","CARBON\\s*DIOXIDE|CO2");
        regList.add(t101);
        regList.add(t102);
        regList.add(t103);
        regList.add(t105);
        regList.add(t106);
        regList.add(t107);
        regList.add(t108);
        regList.add(t110);
        regList.add(SO2);
        regList.add(CO2);
        regList.add(ip);
        regList.add(ad);
        regList.add(workplan);
        regList.add(guidelines);
        regList.add(prohibited);
        regList.add(unrestricted);
        regList.add(sample);


    }
  public Regulation get(int index){
        return regList.get(index);
    }
  public int size(){
        return regList.size();
    }
}

package spsregulations;

/**
 *
 * @author Radu Ramniceanu
 */

public class State {

    private String stateName;
    private String stateAbbrev;
```

```
    private String regex;

    public State(String regexpr){
        regex=regexpr;
        String[] temp = regexpr.split("\\|");
        stateName = temp[0];
        stateAbbrev = temp[1].substring(0, 2);
    }

    public String getState(){
        return stateName;
    }

    public String getAbbreviation(){
        return stateAbbrev;
    }
    public String getRegex(){
        return regex;
    }
}

package spsregulations;

import java.util.ArrayList;

/**
 *
 * @author Radu Ramniceanu
 */

public class StateList {
    ArrayList <State> statesList;

    public StateList(){

        State    AL  = new State("ALABAMA|\\s+AL[\\s,]+");
        State    AK  = new State("ALASKA|\\s+AK[\\s,]+");
        State    AZ  = new State("ARIZONA|\\s+AZ[\\s,]+");
        State    AR  = new State("ARKANSAS|\\s+AR[\\s,]+");
        State    CA  = new State("CALIFORNIA|\\s+CA[\\s,]+");
        State    CO  = new State("COLORADO|\\s+CO[\\s,]+");
        State    CT  = new State("CONNECTICUT|\\s+CT[\\s,]+");
        State    DE  = new State("DELAWARE|\\s+DE[\\s,]+");
        State    FL  = new State("FLORIDA|\\s+FL[\\s,]+");
        State    GA  = new State("GEORGIA|\\s+GA[\\s,]+");
        State    HI  = new State("HAWAII|\\s+HI[\\s,]+");
        State    ID  = new State("IDAHO|\\s+ID[\\s,]+");
        State    IL  = new State("ILLINOIS|\\s+IL[\\s,]+");
        //State  IN  = new State("\\s(INDIANA|IN)(\\s|,)");
        State    IA  = new State("IOWA|\\s+IA[\\s,]+");
        State    KS  = new State("KANSAS|\\s+KS[\\s,]+");
        State    KY  = new State("KENTUKY|\\s+KY[\\s,]+");
        State    LA  = new State("LOUISIANA|\\s+LA[\\s,]+");
        State    ME  = new State("MAINE|\\s+ME[\\s,]+");
```

```
        State    MD  = new State("MARYLAND|\\s+MD[\\s,]+");
        State    MA  = new State("MASSACHUSETTS|\\s+MA[\\s,]+");
        State    MI  = new State("MICHIGAN|\\s+MI[\\s,]+");
        State    MN  = new State("MINNESOTA|\\s+MN[\\s,]+");
        State    MS  = new State("MISSISSIPPI|\\s+MS[\\s,]+");
        State    MO  = new State("MISSOURI|\\s+MO[\\s,]+");
        State    MT  = new State("MONTANA|\\s+MT[\\s,]+");
        State    NE  = new State("NEBRASKA|\\s+NE[\\s,]+");
        State    NV  = new State("NEVADA|\\s+NV[\\s,]+");
        State    NH  = new State("NEW\\s*HAMPSHIRE|\\s+NH[\\s,]+");
        State    NJ  = new State("NEW\\s*JERSEY|\\s+NJ[\\s,]+");
        State    NM  = new State("NEW\\s*MEXICO|\\s+NM[\\s,]+");
        State    NY  = new State("NEW\\s*YORK|\\s+NY[\\s,]+");
        State    NC  = new State("NORTH\\s*CAROLINA|\\s+NC[\\s,]+");
        State    ND  = new State("NORTH\\s*DAKOTA|\\s+ND[\\s,]+");
        State    OH  = new State("OHIO|\\s+OH[\\s,]+");
        State    OK  = new State("OKLAHOMA|\\s+OK[\\s,]+");
        State    OR  = new State("OREGON|\\sOR(\\s|\\,)");
        State    PA  = new State("PENNSYLVANIA|\\s+PA[\\s,]+");
        State    RI  = new State("RHODE\\s*ISLAND|\\s+RI[\\s,]+");
        State    SC  = new State("SOUTH\\s*CAROLINA|\\s+SC[\\s,]+");
        State    SD  = new State("SOUTH\\s*DAKOTA|\\s+SD[\\s,]+");
        State    TN  = new State("TENNESSEE|\\s+TN[\\s,]+");
        State    TX  = new State("TEXAS|\\s+TX[\\s,]+");
        State    UT  = new State("UTAH|\\s+UT[\\s,]+");
        State    VT  = new State("VERMONT|\\s+VT[\\s,]+");
        State    VA  = new State("VIRGINIA|\\s+VA[\\s,]+");
        State    WA  = new State("WASHINGTON|\\s+WA[\\s,]+");
        State    WV  = new State("WEST VIRGINIA|\\s+WV[\\s,]+");
        State    WI  = new State("WISCONSIN|\\s+WI[\\s,]+");
        State    WY  = new State("WYOMING|\\s+WY[\\s,]+");
        State    AS  = new State("\\s(AMERICAN SAMOA|ASM)(\\s|,)");
        State    DC  = new
State("DISTRICT\\s*OF\\s*COLUMBIA|\\s+DC[\\s,]+");
        State    FM  = new State("\\s(FEDERATED STATES OF
MICRONESIA|FM)(\\s|,)");
        State    GU  = new State("\\s(GUAM|GU)(\\s|,)");
        State    MH  = new State("\\s(MARSHAL ISLANDS|MH)(\\s|,)");
        State    MP  = new State("\\s(NORTHERN MARIANA
ISLANDS|MP)(\\s|,)");
        State    PW  = new State("\\s(PALAU|PW)(\\s|,)");
        State    PR  = new State("\\s(PUERTO RICO|PR)(\\s|,)");
        State    VI  = new State("\\s(VIRGIN ISLANDS|VI|USVI)(\\s|,)");
        State allOtherStates = new State("ALL\\s*OTHER|\\s+AOS");
        State otherThan = new State("OTHER\\s*THAN|\\s+OTHN");
        State usa = new State("U\\.S\\.A\\.|\\s+USA[\\s,]+");

        statesList = new ArrayList<State>();
        statesList.add(AL);
        statesList.add(AK);
        statesList.add(AZ);
        statesList.add(AR);
        statesList.add(CA);
        statesList.add(CO);
```

```
statesList.add(CT);
statesList.add(DE);
statesList.add(FL);
statesList.add(GA);
statesList.add(HI);
statesList.add(ID);
statesList.add(IL);
statesList.add(IN);
statesList.add(IA);
statesList.add(KS);
statesList.add(KY);
statesList.add(LA);
statesList.add(ME);
statesList.add(MD);
statesList.add(MA);
statesList.add(MI);
statesList.add(MN);
statesList.add(MS);
statesList.add(MO);
statesList.add(MT);
statesList.add(NE);
statesList.add(NV);
statesList.add(NH);
statesList.add(NJ);
statesList.add(NM);
statesList.add(NY);
statesList.add(NC);
statesList.add(ND);
statesList.add(OH);
statesList.add(OK);
statesList.add(OR);
statesList.add(PA);
statesList.add(RI);
statesList.add(SC);
statesList.add(SD);
statesList.add(TN);
statesList.add(TX);
statesList.add(UT);
statesList.add(VT);
statesList.add(VA);
statesList.add(WA);
statesList.add(WV);
statesList.add(WI);
statesList.add(WY);
statesList.add(AS);
statesList.add(DC);
statesList.add(FM);
statesList.add(GU);
statesList.add(MH);
statesList.add(MP);
statesList.add(PW);
statesList.add(PR);
statesList.add(VI);
statesList.add(allOtherStates);
```

```
        statesList.add(otherThan);
        statesList.add(usa);


    }

   public State get(int index){
        return statesList.get(index);
    }
   public int size(){
       return statesList.size();
   }
}
```

Appendix D: Article IV of the PPC

General provisions relating to the organizational arrangements for national plant protection

1. Each contracting party shall make provision, to the best of its ability, for an official national plant protection organization with the main responsibilities set out in this Article.

2. The responsibilities of an official national plant protection organization shall include the following:

a) the issuance of certificates relating to the phytosanitary regulations of the importing contracting party for consignments of plants, plant products and other regulated articles;

b) the surveillance of growing plants, including both areas under cultivation (*inter alia* fields, plantations, nurseries, gardens, greenhouses and laboratories) and wild flora, and of plants and plant products in storage or in transportation, particularly with the object of reporting the occurrence, outbreak and spread of pests, and of controlling those pests, including the reporting referred to under Article VIII paragraph 1(a);

c) the inspection of consignments of plants and plant products moving in international traffic and, where appropriate, the inspection of other regulated articles, particularly with the object of preventing the introduction and/or spread of pests;

d) the disinfestation or disinfection of consignments of plants, plant products and other regulated articles moving in international traffic, to meet phytosanitary requirements;
e) the protection of endangered areas and the designation, maintenance and surveillance of pest free areas and areas of low pest prevalence;

f) the conduct of pest risk analyses;

g) to ensure through appropriate procedures that the phytosanitary security of consignments after certification regarding composition, substitution and reinfestation is maintained prior to export; and

h) training and development of staff.

3. Each contracting party shall make provision, to the best of its ability, for the following:

a) the distribution of information within the territory of the contracting party regarding regulated pests and the means of their prevention and control;

b) research and investigation in the field of plant protection;

c) the issuance of phytosanitary regulations; and

d) the performance of such other functions as may be required for the implementation of this Convention.

4. Each contracting party shall submit a description of its official national plant protection organization and of changes in such organization to the Secretary. A contracting party shall provide a description of its organizational arrangements for plant protection to another contracting party, upon request.