Three Essays on Tariff and Non-Tariff Barriers to Trade and U.S. Market Access to China

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ABSTRACT

International trade encourages innovation, boosts development, reduces poverty, creates new markets, enhances competitiveness, improves product quality, and expands the consumer choice set. This dissertation is composed of three papers examining barriers to agricultural trade. The first two papers examine the impact of tariff and non-tariff barriers to agricultural trade while the third paper investigates China's domestic agricultural and international trade policies in order to promote U.S. market access in China.

The first paper investigates how trade liberalization expands the range of products available for import and consumption. A multinomial logit framework of unordered export categories is developed: no trade margin, disappearing margin, intensive margin, and extensive margin. The findings of this paper suggest exporters gain from tariff reductions because they can establish new product relationships with the U.S. and enhance their U.S., and potentially global, supply chains. In addition, if consumers value variety in consumption, the extensive product margin results can be viewed as a positive welfare gain for U.S. agri-food consumers.

The second paper focuses on non-tariff measures (NTM), which have significant implications for agricultural trade and food marketing. This paper focuses on maximum residue limits (MRLs) for pesticides and their trade restricting nature on U.S. fresh fruit and vegetable trade under the Trans-Atlantic Trade and Investment Partnership (T-TIP) and the Trans-Pacific Partnership (TPP). Specifically, this research develops a bilateral index to measure the stringency of destination market tolerances for pesticide residues relative to those faced in the United States. Using a Heckman two-step model, the results shed considerable light on existing regulatory heterogeneity, which has important implications for policy to focus on increasing compatibility of NTMs across trading nations.

The third paper examines China's evolving agricultural and trade policies and discusses the potential impact on U.S. exports to China. China's agricultural imports, and policies affecting those agricultural products, have important implications for the U.S. as the leading export supplier to the Chinese market. China's price support programs, aimed at improving food security and Chinese farmers' incomes, increased domestic prices. This created a gap between domestic and international prices that led to excessive Chinese stockpiles. In response, China implemented respective target prices for cotton and soybeans, eliminated the price support for corn, and continues to introduce new policies.

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General Audience Abstract

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Contents

1. Introduction

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The first paper, entitled "Tariff Changes and the Margins of Trade: A Case Study of U.S. Agri-Food Imports," investigates how trade liberalization expands the range of products available for import and consumption. Recent contributions to the theoretical and empirical trade literature underscore the channels by which exporting occurs, either through increasing the intensity of existing trade flows or by establishing new trade relationships. However, less is known about the extent to which trade liberalization influences the likelihood of trade along these channels. This paper develops a multinomial logit model to assess how tariff changes on agri-food imports affect the probability that country-commodity pairs will enter, exit, or maintain a presence in the U.S. agri-food import market. Using detailed bilateral tariff and trade data between 1996 and 2006, the results suggest that while U.S. tariff reductions provide a small but statistically significant increase on the probability of maintaining existing trade relationships, the magnitude of the impact on new exports is twice as large as both the impact on continuously traded goods and disappearing products. The results have important policy implications regarding the channels by which imports change in conjunction with changes in U.S. agri-food import tariffs.

The second paper, entitled "Hidden Trade Costs? Maximum Residue Limits and US Exports to Trans-Atlantic and Trans-Pacific Trading Partners," focuses on non-tariff measures (NTM), such as sanitary and phytosanitary measures (SPS), which have significant implications for agricultural trade and food marketing. SPS measures are not new, but their significance in international agri-food trade continues to grow. Despite recent data collection efforts, the current literature has not led to a consensus regarding the impact of SPS measures on trade nor has it led to a prescribed framework for how to address SPS policy reforms in multilateral and bilateral trade negotiations. This paper focuses on a specific type of SPS measure that features prominently in the current mega-regional trade negotiations (TPP and T-TIP), namely food safety standards in the form of maximum residue limits. First, the paper constructs a comprehensive database of country-and-product specific MRLs for global fresh fruit and vegetable trade and develops a novel bilateral stringency index to quantify the degree of MRL regulatory heterogeneity between trading nations for the years 2013 and 2014. Second, a formal econometric model is developed to investigate the trade restricting nature of these measures. The results suggest that for any given fresh fruit or vegetable product, importer MRL standards that are marginally stricter than exporter MRLs can impart significant reductions in bilateral trade. However, when MRL policies are roughly equivalent, as is the case between the US and some of its TPP trading partners, the actual restrictiveness of this SPS policy diminishes dramatically. The results have important implications for the current mega-regional negotiations (TPP and T-TIP).

The third paper, entitled "China's Agricultural Domestic and Trade Policies since WTO Accession--Impact on U.S. Agricultural Commodity Exports," reviews China's agricultural policies, and discusses the potential impact on U.S. exports to China. From the U.S. perspective, China is one of the top markets for U.S. agricultural exports. From China's perspective, the U.S. is China's top supplier of its agricultural imports. From China's policy perspective, its long-term goals are to enhance food security and increase farmers' incomes. To accomplish these goals, the Chinese government implemented agricultural and trade policies that steadily increased domestic support. China's policymakers intervened in the market by not only providing support prices, but also steadily increasing support prices. This intervention led to price disparities between domestic and international prices in agricultural commodity markets. Both this and China's openness to the world market demonstrated after joining the WTO in 2001 resulted in a dramatic increase in imports of certain agricultural commodities and an accumulation of excessive stockpiles of domestically produced agricultural commodities. Most recently, the Chinese government strived to reduce its large stockpiles, especially for cotton and corn, and narrow the price gap between China's domestic and international markets by changing its agricultural policies, particularly price support policies for cotton, soybeans, and corn. A new target price policy replaced the price support and temporary reserve programs for cotton to decrease production and reduce stockpiles. A new target price policy was also implemented for soybeans to increase soybean production. The Chinese government recently announced a pilot program to eliminate the corn price support policy to reduce production and stockpiles. This new pilot corn price policy resulted in lower domistic corn prices which impacted the global agricultural market, including the United States, by temporarily reducing China's imports of corn substitutes.

2. Tariff Changes and the Margins of Trade: A Case Study of U.S. Agri-Food Imports

2.1. Introduction

Recent advances in the empirical and theoretical trade literature emphasize the role of firm-level productivity differences to explain bilateral trade patterns along the intensive and extensive margins (Melitz, 2003; Helpman, Melitz, and Rubinstein, 2008; Chaney, 2008; Bernard et al., 2009). Melitz's (2003) framework shows that only the most productive firms are able to enter export markets. Reductions in trade costs, either from lower tariffs or transportation costs, will therefore encourage firms that are currently exporting to expand their export sales (i.e., the intensive margin) and induce new firms to select into export markets (i.e., the extensive margin). Chaney (2008) shows succinctly that the degree of competition among products influences the intensive margin through its effect on variable trade costs, while the extensive margin depends more on the fixed costs of exporting and firm heterogeneity. Absent firm-level data, Helpman, Melitz, and Rubinstein (2008) consider how the decision to export is affected by trade costs at the country level using zero trade flow records. Bernard et al. (2009) find that short-term (long-term) variations in imports and exports (e.g., one-year intervals) are explained by changes in the intensive (extensive) margin.

In addition to new firms entering export markets (extensive partner margin), firms that are currently exporting may expand the number of products/varieties (extensive product margin) exported. Bernard, Redding, and Schott (2011) extends the Melitz model to multi-product and multi-destination firms and find that trade liberalization can induce firms to expand into export markets by adding new products using U.S. manufacturing data and incorporating evidence from the Canada-U.S. Free Trade Agreement (CUSTA). Hummels and Klenow (2005) examined cross-country differences in exported varieties defined at the six-digit level of the harmonized system (HS) and find that the extensive product margin accounts for 60% of the trade of larger economies. For U.S. trade, Broda and Weinstein (2006) estimate that 30% of the growth of imports over 1972–2001 occurred in product varieties that previously did not exist.

Other studies have reviewed the effects of Free Trade Agreements (FTAs) on the extensive margin of firm- and product-level trade (Molina, Bussolo, and Iacovone, 2010; Kehoe and Ruhl, 2013). Molina, Bussolo, and Iacovone (2010) find that FTAs exert a positive effect on the number of new exporters and new products at the firm level within the Dominican Republic-Central American Free Trade Agreement (CAFTA-DR). Kehoe and Ruhl (2013) introduce a "least-traded goods" effect after implementation of the North American Free Trade Agreement (NAFTA), whereby goods that were not exported in the past or experienced trade below a certain threshold are still potential exports along the extensive margin. Their results point to the fact that—with no significant changes in NAFTA's trade policy—trade flows along the extensive margin are negligible. However, Iacovone and Javorcik Iacovone and Javorcik (2008) provide evidence that Mexican firms increased the number of goods exported after the implementation of NAFTA in 1994, and Debaere and Mostashari (2010) find that U.S. tariff changes on industrial product imports have a small but statistically significant effect on the extensive product margin of U.S. imports.

This article assesses the extent to which trade liberalization vis-à-vis tariff changes affects the probability of entering, exiting, or maintaining a presence in the U.S. agri-food import market. Unlike previous studies, this study develops a multinomial framework to study three mutually exclusive margins of agri-food imports—existing, new, and disappearing margins of bilateral trade. More specifically, the purpose of this article is threefold. First, following

Helpman, Melitz, and Rubinstein (2008) we develop a theoretical logit model at the country-product level to explain the margins of U.S. agri-food imports. Second, we develop a detailed database that matches U.S. agri-food tariff changes to corresponding bilateral imports between 1996 and 2006 along with several robustness checks on these two years. Finally, we extend the probit model developed in Helpman, Melitz, and Rubinstein (2008) to a multinomial logit setting of unordered categories of agri-food exporting status.

It should be noted that while the model in Helpman, Melitz, and Rubinstein (2008) is a two-stage heterogeneous firms model predicting entry into exporting and then the intensity of export flows at the country level using zeros in the trade flow matrix, in this paper we do not attempt to explain how tariff changes may influence the second-stage intensity of exports via a gravity-like equation. Rather, our purpose is to derive and extend the first-stage selection equation to a multinomial framework of four categories of export status: (i) goods that have the potential to be traded but remain non-traded; (ii) disappearing goods trade; (iii) new goods trade (extensive margin); and (iv) continuously traded goods (intensive margin).

Our work contributes to the new-new trade literature understanding welfare applications from aggregate productivity changes, variety changes, and heterogeneous firms. In traditional theory, trade and welfare gains come from specialization through comparative advantage or factor endowments, whereas in new trade theory the trade and welfare gains arise from a combination of economies of scale and the expansion of more varieties available to consumers. The new-new trade theory with heterogeneous firms (Melitz, 2003) identifies aggregate productivity growth as an additional source of welfare gain. This productivity growth is due to the reallocation of resources from exiting low-productivity firms to expanding or entering high-productivity firms into export markets. Thus, the selection and market share shifting to more productive firms are important features of new-new trade theory that were not predicted in the old and even the new trade theory based on monopolistic competition (Krugman, 1979).

Additional welfare gains in a heterogeneous firms setup are possible if trade liberalization increases product market competition, which leads to lower mark-ups of price over marginal cost. Consequently, both falling mark-ups and rising average productivity play a role in declining prices and rising real incomes (Bernard et al., 2007; Redding, 2010; Melitz and Redding, 2014, 2013; Baldwin and Ravetti, 2014). Although we do not exploit firm-level transaction data in this article, the results reflect the underlying dynamics of firms based on Melitz (2003) and the selection equation in Helpman, Melitz, and Rubinstein (2008), where we observe new products along the extensive margin of trade and disappearing products resulting from tariff changes.

We find consistent evidence that agri-food tariff liberalization enhances the entry of country-product export pairs into the U.S. market. Extending the analysis to a multinomial setting, we find that more restrictive trade policies increase the probability of disappearing goods, decrease the probability of shipping new goods (extensive margin), and have a negligible effect on the intensive margin or continuously traded goods. The results have important policy implications regarding the channels by which imports change in conjunction with changes in tariffs.

2.2. U.S. Agri-Food Imports

The value of U.S. imports of agricultural and food products doubled from $39.5 billion in 1996 to almost $80 billion in 2006. Figure 2.1 decomposes the growth of imports into existing (intensive margin, henceforth IM), newly traded extensive-margin goods (henceforth EM), and disappearing goods between the two time periods. [1] Existing goods, or the IM, are defined as the

[1] We choose 1996–2006 because this period coincides with the implementation of market access commitments agreed to during the Uruguay Round Agreement on Agriculture (URAA) negotiations and the formal establishment

set of country-product observations that had non-zero trade with the United States in 1996 and 2006, whereas newly traded goods, or the EM, are defined as those country-product pairs that did not trade with the United States in 1996 but did trade in 2006. Finally, disappearing goods are defined as the set of country-product observations that had positive trade with the United States in 1996 but not in 2006.[2]

Perhaps not surprising, figure 2.1 illustrates that the majority of U.S. agri-food import growth is the result of increased trade with existing partner-product relationships that were active in 1996. Relative to the total U.S. agri-food import growth of $40.5 billion ($79.9 - $39.5) between 1996 and 2006, increased trade along the IM of $36.7 billion ($73.8 - $37.4) represents almost 91% ($36.7/$40.5) of this growth. Smaller, new country-product relationships (EM) increased by roughly $6.1 billion, contributing nearly 10% to U.S. agri-food import growth. Approximately 6%, or $2.4 billion, of existing trade in 1996 was absent from the market in 2006 (disappearing trade). This interesting result is consistent with Besedeš and Prusa (2006), who find a considerable amount of churning in trade relationships as exporters test the U.S. market but later fail. Thus, while the expansion of existing trade relationships continues to dominate the growth of U.S. agri-food imports, the formation of new partner-product relationships represents an increasingly important trend.

While instructive, decomposing agri-food trade along each margin at the aggregate level masks a number of important trends at the country-product level. For example, Canada and Mexico, which are part of NAFTA (1994), have historically supplied nearly 50% of U.S. agri-

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of the World Trade Organization (WTO) in 1995. Since 1996, the United States has also negotiated a number of Free Trade Agreements (FTAs), which often contain some upfront tariff eliminations and some phase-in periods for sensitive products. We consider other time periods in the empirical analysis as robustness checks.

[2] Extensive margin and disappearing goods trade can also be found by subtracting existing goods trade from the total value of trade in 2006 and the value of existing goods trade from the total in 1996, respectively.

food imports. More recently, however, new country-product export growth has emerged from China, Brazil, Chile, Australia, Indonesia, New Zealand, Colombia, and the EU-15 countries (treated as a single country). Whereas figure 2.1 decomposed the IM and EM across all partners and products, table 2.1 breaks down the intensive and extensive product margins for a given country as well as the share of products that have been subject to a change in the ad valorem equivalent duty and the median duty change between 1996 and 2006.[3]

On an absolute basis, the EU-15, Canada, and Mexico experienced the highest export growth to the U.S. market of $7.8, $7.7, and $6.1 billion worth of agri-food product exports, respectively. However, these three countries differ in terms of the channels by which this import growth has occurred. Canada's profile consists of over $1.3 billion in new goods, which accounted for over 17% of its export growth to the U.S. market. Mexican and EU-15 export growth, on the other hand, was more concentrated in existing goods, which grew by $5.7 and $7.5 billion, respectively, comprising over 90% of both countries' total export growth. Conversely, while Brazil's export growth along the extensive margin of $1.1 billion is second only to Canada on an absolute scale, the contribution of the extensive margin for Brazil is 57.2% as a share of its total export growth—one of the highest EM growth rates among all countries in our sample. Similarly, China also experienced a significant contribution of newly traded goods at $387 million, or 11.4% of its total agri-food export growth. For Chile, Australia, the EU-15, and low- and high-income countries as a group, U.S. import growth is more concentrated along the existing goods' channels.

In the remaining columns of table 2.1, we report the number of Harmonized System (HS) products traded, the share of overall and newly traded products that experienced tariff reductions, and the median average tariff change. Tariff changes between 1996 and 2006 occurred for

[3] Details on the calculation of tariff changes between 1996 and 2006 are discussed in the data section.

several reasons. First, since the United States is a member of the World Trade Organization (WTO), any exporting partner that is also a WTO member will benefit from a reduction in tariffs resulting from U.S. market access commitments implemented under the Uruguay Round Agreement on Agriculture (URAA) that was phased in over a six-year period for developed economies.[4]

Second, tariff reductions can occur because of the implementation of FTAs. The United States has established FTAs with twenty countries, notably with Canada and Mexico (NAFTA) in 1994, the Dominican Republic (CAFTA-DR) in 2006, Chile and Morocco in 2004, and Australia in 2005. These agreements have resulted in most agricultural products facing duty-free access in the United States. Remaining, sensitive agricultural tariffs on sugar, dairy, rice, peanuts, and tobacco products are scheduled to be liberalized over a transitional period extending up to twenty years in some cases (Johnson, 2009; Adcock and Rosson, 2004; U.S. Chamber of Commerce, International Affairs, 2015).

Third, for some products and countries, tariff changes resulting from the formation of FTAs may not force a reduction in applied tariffs because some agricultural products already entered the U.S. duty free under preferential arrangements such as the Generalized System of Preferences (GSP) for developing countries, initiated in 2001; the African Growth and Opportunity Act (AGOA), initiated in 2000; the Caribbean Basin Initiative (CBI), initiated in 1984; and the Andean Trade Preference Act (ATPA), initiated in 1991 (Paggi et al., 137; Hornbeck, 2012).

[4] However, it is important to note that URAA tariff reduction commitments were from bound rates, which can be much higher than applied rates on some products creating large gaps between the two tariff rates. Thus, the agreed overall average tariff cut of 36% for agricultural products would only change applied tariffs if the gap between bound and applied rates was less than the required percentage tariff cut.

Columns 7–11 of table 2.1 illustrate the total number of agri-food products exported at the six-digit level of the Harmonized System (HS) for each individual country and the total number of country-commodity pair exports to the U.S. market in the case of the EU-15 and low- and high-income groups.[5] Also reported is the share of all products and newly traded goods that experienced tariff reductions between 1996 and 2006 as well as the median reduction in the ad valorem equivalent (AVE) tariff rate. Perhaps due to the signing of an FTA with the United States, Australia stands out as the country with the largest shares of all and newly traded products experiencing a tariff reduction between 1996 and 2006, at 40% and nearly 10% , respectively. Canada exported the largest number of HS-6 digit agri-food lines to the United States, at 650 products and, like Australia, enjoyed tariff reductions on a relatively large share of products (38.9%). However, tariff reductions on newly traded goods originating in Canada were the lowest of all countries at around 2% and with a median tariff reduction on new goods of 1.5%. Brazil experienced the smallest share of products with tariff reductions at 15.5% but realized the largest median tariff reduction for all goods (along with Australia) at 2.8%, the second largest share of new goods facing a tariff reduction (6.9%) behind Australia, and tied for the largest median tariff reduction on new goods (along with Chile) at 5.3%. The U.S. tariff data also indicate that while the median reductions in AVE tariffs are relatively modest in magnitude (ranging from a low of 1% on Canadian goods to a high of 7.9% for new goods from low-income countries), the overall tariff distribution is skewed left, implying that the U.S. agri-food market has become more open, on average, and exporting countries have enjoyed a decrease in AVEs more often than an increase.

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[5] As described in more detail in the data section, each unit of observation in the empirical analysis is a country-commodity pair.

Thus, the data seem to suggest that the new goods margin of trade is influenced not only by tariff liberalization but also by the magnitude by which tariffs are reduced. China, Brazil, and Chile all enjoyed relatively larger median tariff reductions on the new goods margin of trade compared to traditional export sources such as Canada and Mexico. However, the preceding analysis did not control for other factors affecting the probability of exporting along each margin. The next section develops a formal model of selection into exporting.

2.3. Theoretical and Empirical Model

To identify the impact of trade liberalization on the probability of exporting, a framework similar to HMR (2008) is developed. While the model is based on firm-level heterogeneity, as HMR (2008) note: "the features of marginal exporters can be identified from the variation in the characteristics of the destination countries" (p. 4). Further, unlike HMR who use aggregate export flows, we employ product level trade data.

On the demand side, the world economy consists of *R* countries producing and consuming a continuum of agri-food commodities. A constant elasticity of substitution (CES) sub-utility function represents consumer preferences in each country *r* for agri-food commodity *k*. A representative consumer in country *r* maximizes:

(1) $$u_{rk} = \left[\int_{\omega \in B_{rk}} (x_{rk(\omega)})^{\frac{\sigma_k - 1}{\sigma_k}} \, d\omega\right]^{\frac{\sigma_k}{\sigma_k - 1}}$$

subject to:

(2) $$\int_{\omega \in B_{rk}} p_{rk(\omega)} x_{rk(\omega)} \, d\omega = Y_{rk}$$

where B_{rk} is the set of consumable varieties available in country *r*, and $x_{rk(\omega)}$ is the quantity of variety ω in commodity *k* consumed in country *r*, σ_k is the elasticity of substitution across varieties of commodity *k*, $p_{rk(\omega)}$ is the price of variety ω in commodity *k* in country *r*, and Y_{rk} is the optimal expenditure allocated for consumption in country r. To ease notation we suppress time period subscripts.

Solving this utility maximization problem and substituting the budget constraint equation (2) in the first order condition gives country r's demand for each variety:

(3) $$x_{rk(\omega)} = \frac{[p_{rk(\omega)}]^{-\sigma_k} Y_{rk}}{\int_{\omega \in B_{rk}} (p_{rk(\omega)})^{1-\sigma_k} \, d\omega}.$$

The denominator in equation (3) is the ideal CES price index defined as follows:

(4) $$PI_{rk} = \left[\int_{\omega \in B_{rk}} (p_{rk(\omega)})^{1-\sigma_k} \, d\omega\right]^{\frac{1}{1-\sigma_k}}.$$

Thus, country r's demand for each variety ω in commodity k is,

(5) $$x_{rk(\omega)} = \frac{[p_{rk(\omega)}]^{-\sigma_k} Y_{rk}}{(PI_{rk})^{1-\sigma_k}}$$

On the supply side, firms are assumed to have a country- and firm-specific component of unit costs, c_{rk} and a_{rk}, respectively. a_{rk} represents the number of the country's inputs used by the firms per unit of output and c_{rk} measures the cost of this combination of inputs. Unit costs are country specific representing differences in factor inputs across countries, whereas $1/a_{rk}$ represents productivity differences across firms within a country with less productive firms holding higher values of a_{rk}. Following Melitz (2003) and HMR (2008), we assume the distribution of a_{rk} across firms can be described by a product-specific cumulative distribution function G_k (a_{rk}), which is symmetric across all countries with support $[a_{rk,L}, a_{rk,H}]$, $a_{rk,H} > a_{rk,L} > 0$.

Home production and distribution incur only production costs (Melitz 2003). However, when firms in origin country (o)[6] engage in export sales in the destination country (d), two

[6] Note that hereafter o denotes for an origin country, and d denotes for a destination country.

additional costs must be incurred. First, sector level fixed costs (f_{odk}), define the costs associated with establishing a trade relationship such as information, institutions, paper work, product compliance, etc., and are destination specific but independent of firm productivity. Second, variable costs (τ_{odk}), which are also commodity- and destination-specific, define the costs associated with shipment quantities such as transportation costs, tariffs, and other surcharges, which are assumed to be of the "iceberg" form such that in order to have one unit from country *o* shipped to country d, τ_{odk} will be greater than one.

The supply side is characterized by monopolistic competition whereby firms have symmetric cost functions but are asymmetric with respect to productivity. Firms in country *o* maximize profits by charging the standard markup pricing rule $p_{ok}(a_{ok}) = c_{ok}a_{ok}/\alpha_k$, where $1/\alpha_k = \sigma_k/(\sigma_k - 1)$, $\sigma_k > 1$. Thus, if firms in country *o* export to destination country *d*, consumers in country *d* (foreign country) pay the delivered price,

(6) $$p_{dk}(a_{ok}) = \tau_{odk}\, c_{ok}a_{ok}/\alpha_k,$$

while producers in country *o* realize sector *k* profits of:

(7) $$\pi_{odk}(a_{ok}) = (\tau_{odk}\, c_{ok}a_{ok}/\alpha_k) * \ x_{dk} - [(\tau_{odk}c_{ok}a_{ok})\, x_{dk} + c_{ok}f_{odk}].$$

Simplifying the profit function in (7) using equations (5) and (6) we have:

(8) $$\pi_{odk}(a_{ok}) = (1 - \alpha_k) \left(\frac{\tau_{odk}c_{ok}}{\alpha_k PI_{dk}}\right)^{1-\sigma_k} Y_{dk}(a_{ok})^{1-\sigma_k} - \ f_{odk.}$$

The profit function in equation (8) has a few of important properties. First, since domestic market sales do not require payment of fixed costs ($f_{ook} = 0$), countries' internal trade (where $\tau_{ook} = 1$) earn positive profits. Second, country-pair (*od*) export sales by firms in the origin country depend on their own productivity (a_{ok}) in relation to a destination specific cutoff value $\pi_{odk}(\bar{a}_{ok}) = 0$. Therefore if $a_{ok} \leq \bar{a}_{ok}$ then exporting from *o* to *d* is profitable because a firm in the origin country *o* can cover both fixed and variable costs and will have positive sales from exporting commodity *k* to destination country *d*. This leads to an important conclusion raised by HMR (2008) whereby only a fraction $G(\bar{a}_{ok})$ of country *o's* firms will find it profitable to export to destination market *d*. When firms produce differentiated products, only a subset of products (B_d) will be available to destination market consumers compared to the set of products in sector *k* that are produced and traded globally. Third, equation (8) allows for the explicit possibility of zero trade, disappearing trade, and extensive and intensive margin trade because of fixed and variable trade cvost components. For example, if the least productive firms have a coefficient a_{ok} that is below the lower support of $G(a_{ok})$ ($a_{ok} \leq a_L$) then no firms will find it profitable to export. Conversely, if all firms have technical coefficients above the upper support of $G(a_{ok})$ ($a_{ok} \geq a_H$) then all firms in country *o* will find it profitable to export.

With this in mind, we can define a latent variable (Z_{odk}) for the most productive firms using the lower "cutoff" value of $a_{ok,L}$ in country *o* and product *k* (see also Debaere and Mostahsari 2010):

(9) $$Z_{odk}(a_{ok,L}) = \frac{(1-\alpha_k)\left(\frac{\tau_{odk}c_{ok}}{\alpha_k PI_{dk}}\right)^{1-\sigma_k} Y_{dk}(a_{ok,L})^{1-\sigma_k}}{f_{odk}}.$$

Thus, equation (9) is defined as the ratio of variable export profits to the fixed costs (common across all exporters) of exporting such that positive profits exist if $Z_{odk}(a_{ok,L}) > 1$. Because of the interplay of variable and fixed costs along with our interest in how tariff changes impact the four margins of trade in a multinomial setting, equation (9) forms the basis for our empirical model.

Following HMR (2008) and firms' selection into export markets, the fixed costs of trade are assumed to be stochastic:

(10) $$f_{odk} = \exp(\gamma_k \varphi_{od} - e_{odk}),$$

where, the measure of country-pair specific fixed costs is defined as φ_{od} and e_{odk} is the random component. With one importer in our sample (i.e., the US) and because we assume fixed costs of exporting are constant across countries for a given destination market but not necessarily across products, we capture these by specifying a comprehensive set of goods-specific fixed effects. The variable component of trade costs in equation (9) is specified as:

(11) $$(1-\sigma_k)\, ln\, \tau_{odk} = -\mu_{k,1}\, d_{od} - \mu_{k,2}\, t_{odk} - \mu_{k,3} v_{od} + u_{okd},$$

where d_{od} is the natural logarithm of the distance between country *o* and country *d*, t_{odk} is the AVE tariff rate applied by destination country *d* on the origin country *o* for commodity *k*, ν_{od} denotes other variable costs between *o* and *d*, and u_{okd} denotes the random component of variable trade costs.[7]

Substituting equations (10) and (11) into the latent variable equation (9) yields:

(12) $$z_{odk}(a_{ok}) = \beta_k + \beta_{ok} + \beta_{dk} - \mu_{k,1}\, d_{od} - \mu_{k,2}\, t_{odk} - \mu_{k,3} v_{od} - \gamma_k \varphi_{od} + \eta_{odk}$$

where, β_{ok} is an origin-commodity fixed effect absorbing $(1-\sigma_k)\ln(c_{ok})$ and $(1-\sigma_k)\ln(a_{ok,L})$, β_{dk} is a destination-commodity fixed effect capturing $(\sigma_k - 1)\ln(PI_{dk})$ and $\ln(Y_{dk})$, and β_k is a commodity-specific fixed effect absorbing not only the remaining terms in equation (9) ($\ln(1-\alpha_k) - (1-\sigma_k)\ln \alpha_k$) but also the sector specific fixed costs of trading with a single importing country (US), and η_{odk} is a random error term of $e_{odk} + u_{okd}$.

Equation (12) is estimated for the year 2006 conditional on observed policy changes that may (or may not) have taken place relative to the base year 1996. Thus, the estimation framework is based on a comparison of two points in time (Debaere and Mostashari 2010), with

[7] Note that in equation (11) since the elasticity of substitution is greater than one, $\sigma_k > 1$, we specify the variables with negative signs.

1996 serving as our reference year and 2006 the counterfactual year. Within this framework, four (unordered) export outcomes are possible:

1) *No trade margin*: country *o* did not export product *k* to the US in either time period

2) *Disappearing margin*: country *o* exported product *k* in 1996 but not in 2006

3) *Intensive margin*: country *o* exported product *k* in both 1996 and 2006

4) *Extensive margin*: country *o* exported product *k* in 2006 but not in 1996

Outcome 1 is straightforward and is our benchmark category defined as the "no trade" margin. Category 2 is defined as "disappearing goods" since exporters had positive shipments in the initial year but zero trade in the end year. Category 3 is referred to as "continuous" or the intensive margin trade. Finally, outcome 4 is defined as the "new goods" or trade along the extensive margin. Our analysis is focused in particular on outcomes two through four conditional on tariff rate changes in the US agri-food import market. That is, we wish to evaluate the extent to which variable trade costs vis à vis tariff changes influence the probability of disappearing exports, maintaining a presence in the market, or establishing a new trade relationship with the United States.

Letting T_{ok} be an indicator variable equalling 1 when country *o* exports product *k* to the US, and 0 otherwise, and noting the unordered categorical nature of these four trading outcomes, a multinomial logistic model (MNL) is an appropriate empirical tool. Thus, the probability of observing any one of the four possible exporting categories (c) conditional on tariff rate changes and other explanatory variables collapsed into $x'\beta$ is specified as follows:

(13) $$F[T_{ok} = c] = F_{ok,c} = \frac{\exp(x'_{ok,c}\beta_c)}{\sum_{n=1}^{4} \exp(x'_{ok,n}\beta_{ok})}$$

where $0 < F_{odk,c} < 1$, and c = 1, …, 4 categorical outcomes, $F\left(Z_{odk,c}\right) = \Pr(Y_{odk} = c \mid x'\beta)$, and the main explanatory variables in $x'\beta$ are defined as follows:

- Tariff Changes (Δt_{ok}) defined as the 2006 AVE tariff minus the 1996 AVE tariff
- Log Distance (D_{od}) defined as the natural logarithm of the distance between origin country (*o*) and the United States.
- GDP Growth defined as the change in natural logarithm of origin country GDP in 2006 minus the natural logarithm of the origin country's GDP in 1996.
- Exports Status ($status_{ok,1996}$) defined as a binary variable equal to one if exporting country *o* had positive exports of product *k* to the US in the base year (1996), and zero otherwise

Several other specification and estimation issues need to be addressed in a multinomial logit framework. First, we assume each exporting status is unique and has a singular value, allowing us to assign an ordinal number to each outcome with the independent variables held constant across each exporting category. Thus, for each independent variable the MNL estimates a set of *c*-1 coefficients where *c* denotes the number of exporting categories. The MNL model assumes independence across choices, also known as the Independence of Irrelevant Alternatives (IIA). Therefore, the relative probability of observing a categorical outcome is unaffected if we add another outcome or drop one of the existing outcomes (Kennedy, 1998). In our sample of US import data, we do not expect the IIA assumption to be an issue because we attempt to include all possible categories of exporting. However, testing the IIA hypothesis as suggested by MacFadden et al. (1976) and Small and Hsiao (1985) (Long and Freese, 2006) indicates the IIA assumption has not been violated. Further, in the empirical analysis we conduct a specification that drops one of the categorical outcomes and the estimation results are consistent, which is supportive of the IIA assumption.

Second, we also conducted two additional tests that are suggested for a Multinomial Logit Model (Long and Freese, 2006). First to examine the validity of the independent variables we used the Likelihood Ratio test, which showed that all explanatory variables are significant in the model. Second, we conducted a Wald test to check whether we can combine outcome categories. Both tests confirm the independent variables are significantly different between each pair of categorical outcomes.

Third, a recent article by Santos-Silva and Tenreyro (2015) provides an important critique of the HMR (2008) selection into exporting equation. Their critique rests on the assumption about the distribution of the error term in the first-stage probit equation where normality is always a maintained assumption. However, in this paper we focus on the first stage selection equation in a logit-based framework where normality is not a maintained assumption. We note however, that both models yield similar results. We report the results along with robust standard errors in estimation to partially mitigate heteroscedasticity issues raised in Santos-Silva and Tenreyro (2015).

Fourth, there may be some concern about the endogeneity of tariffs. It is widely established in the econometrics literature that the endogeneity of explanatory variables in non-linear categorical dependent variables is difficult to handle. As Wooldridge (2014) notes, methods where fitted values obtained in first-stage regressions are plugged in for endogenous explanatory variables in a second stage equation are generally inconsistent for both the parameters and marginal effects. Thus, to the best of our knowledge in a multinomial logit setting there are few methodological advances to handle instrumental variables (IV). As a (partial) solution to this problem, however, most of the tariff variation in US agri-food imports is cross-sectional in nature (i.e., tariffs vary considerably more across countries and products than over time for a given country-product pair) and thus sector specific fixed effects can capture unobserved factors that may otherwise be in the error term but potentially correlated with tariffs (Debaere and Mostashari 2010).

Fifth, we estimate the multinomial logit model in equation (13) with commodity-specific intercept shifters. Because the US is the only importing country in our sample, sector-specific dummy variables are common to all exporting countries and thus can absorb the influence of US domestic production and supply availability as well as changes in demand or tastes and preferences for specific products.[8] However, as a robustness check we discuss briefly the results from adding an additional variable to the model measuring changes in import expenditure shares for each HS6-digit product in an HS2-digit industry. We also present a more demanding specification that includes grouped exporter-by-commodity fixed effects to control for changes in preferences for goods that are differentiated by country of origin.

Finally, while the focus of this article is to determine the degree to which tariff changes explain existing, disappearing, and newly trade goods, non-tariff measures (NTMs) such as sanitary and phyto-sanitary (SPS) measures or technical barriers to trade (TBT) could also impact the various margins of US agri-food imports. Because of recognized NTM data limitations precluding a comprehensive assessment of NTMs (see Grant, Peterson and Ramniceanu 2015), to address this issue we adopt two approaches. First, to the extent that SPS and TBT measures are time-invariant, we can control for their influence through the use of commodity-specific fixed effects which will help control for those agri-food sectors which tend to be plagued by animal disease, plant health and food safety related non-tariff issues.

[8] While changes in US domestic production levels can impact import quantity demanded, retrieving production data that matches the detailed HS6-digit trade data was not feasible as discussed in the data section.

Second, with the exception of a some well-known pest-specific SPS issues between the US and its trading partners related to plant health (Japanese apple dispute; Argentine lemons) a relatively large share of SPS trade disruptions since 1995 are because of animal disease related issues (i.e., foot and mouth disease (FMD), Bovine Spongiform Encephalopathy, Blue Tongue, Avian Influenza (AI), Porcine Epidemic Diarrhea (PED) virus, Schmallenberg virus, etc.) (see Grant and Arita Forthcoming 2016). Thus, to determine whether our tariff change coefficients are sensitive to animal disease-related SPS measures, we discuss in the results section an additional multinomial logit scenario where all six-digit product lines in the Harmonized System (HS6) representing beef, pork, poultry, and dairy product codes are dropped from estimation.

2.4. Data

Bilateral U.S. agri-food import data over the period of 1996–2008 are collected from the U.S. International Trade Commission (USITC) at the 6-digit level of the Harmonized System (HS). Agri-food products are classified according to the World Trade Organization's (WTO) Multilateral Trade Negotiating (MTN) categories and include products from two-digit chapters 01–24 (excluding Chapter 03 – Fish and seafood products) as well as select codes in higher chapters, such as cotton (Chapters 51–53).[9]

As described in the previous section, we use GDP data from the World Bank Development Indicators (in U.S. dollars) and the United Nations National Accounts as a measure of origin country economic size and level of development.[10] While GDP data are available for a

[9] WTO's MTN categories can be found here (p. 24): https://www.wto.org/english/tratop_e/tariffs_e/tariff_profiles_2006_ e/tariff_profiles_2006_e.pdf

[10] Production data were initially retrieved from the Food and Agricultural Organization Productions Statistics database (PROD-STAT). However, FAO production codes do not map well to HS6-digit products. Further, FAO production values are incomplete for many countries and time periods due to incomplete data on producer prices. In some cases (i.e., Taiwan), we use GDP data from the Penn World Tables (6.3) to supplement WB and UN data when it is incomplete or missing. WB Development Indicators Data can be accessed (with subscription) at: http://ddp-ext.worldbank.org/ext/DDPQQ/ member.do?method=getMembers&userid=1&queryId=135, and UN

much wider set of countries and time periods, an important shortcoming is that this series does not have a commodity dimension. Thus, in an alternative specification we also control for origin production using country-commodity specific fixed effects where commodities are grouped according to their 4-digit chapter of the harmonized system (b_{ok}) (equations 12 and 13). Bilateral distance between the United States and its partner countries is retrieved from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) geo-distance dataset (Mayer and Zignago, 2006).[11]

Bilateral tariffs at the HS6-digit level are computed using the comprehensive customs import values contained in the USITC's Tariff and Trade Data web.[12] The customs data available are the Free on Board (FOB) customs value of shipments; the Cost, Insurance and Freight (CIF) value; the dutiable value of imports; the values of the duties collected; and the CIF charges to export a particular product from a given country to the U.S. market. One of the key advantages of using customs values is that they report the value of duties collected for the year (independent of transport, insurance, and freight costs), making it possible to calculate a true measure of the AVE. This is important given the paucity of reliable tariff data over our timeframe (2006 relative to 1996) and the pervasive use of specific, seasonal, and compound tariffs in U.S. agri-food imports.

To provide some context, cucumber imports (fresh or chilled) face a tariff of $0.0042/kg if imported during between December 1 and the last day of February in the following year,

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GDP data can be retrieved at: http://unstats.un.org/ unsd/snaama/dnllist.asp. Penn World Tables can be accessed at the Center for International Comparisons at the University of Pennsylvania's website: http://pwt.econ.upenn.edu/

[11] CEPII is a Paris-based independent European research institute on the international economy. CEPII's research program and datasets can be accessed at www.cepii.com. CEPII uses the great circle formula to calculate the geographic distance between countries, referenced by latitudes and longitudes of the largest urban agglomerations in terms of population.

[12] Available at: https://dataweb.usitc.gov/

compared to a \$0.0056/kg tariff if imported in any other month.[13] Tariffs on fresh or chilled grapes (HS 080610) are (i) tariff-free between April 1 and June 30, (ii) levied as a specific tariff of \$1.13/m^3 between February 15 and March 31, and (iii) levied at \$1.80/m^3 at any other time of the year. U.S. tariffs on mushrooms (HS 070951) are applied as a compound policy with combinations of specific and ad valorem rates consisting of 0.08/kg plus 20% for non-preferential countries and duty free for most free trade agreement partners with the exception of Korea (\$0.017/kg + 4%), Oman (\$0.026/kg + 6%), and Australia (\$0.033/kg + 7.6%). Conversely, tariffs on non-preferential asparagus imports are purely ad valorem, with the United States applying a 5% duty on imports entering between September 15 and November 15 and a 21.3% duty on imports entering in any other month.

A limitation of the USITC customs values is that the calculation of the AVE tariff is limited to products with non-zero import values. If Argentine grapes were exported in 1996 but disappeared in 2006 (category 2), then calculation of the AVE tariff change absent data on duties collected in 2006 is not feasible. Similarly, missing tariff data also occur for extensive margin trade (category 4) in the initial year (1996) and the no trade margin (category 1) in both years (1996 and 2006).

To overcome this issue we develop a two-step approach. First, we search for any two data points with observable tariff information between the beginning and ending years in our sample (1996 and 2006). When trade occurs in at least two or more years between 1996 and 2006 for a given country-HS6 commodity pair, tariff changes are computed as the difference between the last and first year that trade occurs. Second, we replace the missing observations of tariff changes

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[13] Other provisions include zero duties on most (but not all) products for countries with preferential trading programs with the United States, including Bahrain, Canada, Mexico, Australia, Peru, Columbia, Morocco, Korea, and Oman.

with zero when there is potential for trade.[14] That is, if an exporting country has the potential to export commodity k but there are no observations to calculate an AVE tariff change, we assume there is no change in tariff for that country-product pair. However, because of the sensitivity of this assumption, we also report estimation results that do not include observations when missing tariff changes are replaced with zeros.

Table 2.2 reports summary statistics for U.S. tariff changes defined as the ending year (2006) tariff minus the beginning year (1996) tariff and other variables used in the model. There were 5,039 AVE tariff reductions that occurred at the 6-digit HS country-commodity level over 1996– 2006, 2,573 tariff increases, and 11,571 observations where the AVE tariff remained unchanged. Thus, nearly 40% of country-commodity pairs experienced a different ad valorem tariff equivalent in 2006 compared to 1996, and 66% of this share (5,039) were in the form of tariff reductions. Important examples of tariff liberalization in our sample include raspberries from Turkey, cherries from China, grape wines from Belgium, sunflower seeds/oil from Turkey, cocoa powder from the United Kingdom, olives and fresh cheese from Brazil, and grape juice and margarine from Argentina. These products experienced the highest absolute reduction in the AVE between 1996 and 2006, and some of these products experienced relatively high growth rates along the extensive margin. For example, Argentinian grape juice comprises 3.6% of the share of all newly traded goods on a value basis.

2.5. Results

The econometric results are organized in two sections. Section one presents the results from estimating a logit model conditional on tariff changes to understand better the intensive and extensive margins of U.S. agri-food imports.

[14] In our sample, if an origin country o exports a commodity k at least once over ten years, we consider country o to have the potential to trade commodity k.

Section two estimates the extended multinomial logit model (equation 13) with all four unordered potential categories of exporting as well as the aforementioned scenario that drops the no-trade category because of data limitations and replaces the benchmark category with the more stable continuously traded product category. Finally, it is problematic to refer to the continuously traded category as the intensive margin because initially we do not distinguish whether continuous trade was higher or lower in 2006 compared to 1996. In the final scenario we attempt to shed light on this point by splitting the continuously traded category into two outcomes: (i) continuously traded goods where the level of trade was higher in 2006 compared to 1996 (higher trade intensity) and (ii) continuously traded goods where the level of trade was lower in 2006 compared to 1996.

In both sections we examine the robustness of our findings to alternative beginning and ending year periods and our assumption regarding missing AVE tariff values. All regressions include grouped country and/or commodity dummy variables.[15]

2.5.1. Logit Model of Exporting Status

We begin by investigating the effect of tariff changes on the probability of exporting. Columns (1)–(3) of table 2.3 report the marginal effects along with robust standard errors in parentheses. The marginal effects of the difference in the log of exporters' GDP are statistically significant with the correct sign, as expected. A higher percentage growth in GDP of exporting countries leads to the higher probability of exporting by 0.08 using our preferred specifications in columns 2 and 3 (table 2.3). The marginal effect of the logarithm of distance has the correct negative sign and is statistically significant. As expected, distance—as a proxy for shipping costs—decreases the probability of exporting. The indicator variable Status has the largest positive and statistically

[15] Grouped commodity and country dummies are based on the frequencies with which they are exported to the United States at the HS4-digit level.

significant impact on the probability of exporting agri-food products to the U.S. market. This demonstrates that if good k was exported by country o in 1996, the probability of exporting the same product in 2006 increases by approximately 0.40 (columns 1–3).

For each scenario in table 2.3, the marginal effects of U.S. agri-food tariff changes are reported separately for the intensive and extensive margins by interacting the AVE tariff change variable with the status variable. Two interesting results emerge. First, tariff reductions increase the probability of exporting along both the intensive (Status= 1) and extensive (Status= 0) margins.[16] Put another way, a one-unit increase in AVE tariffs reduces the likelihood of exporting by 0.163 to 0.187 for newly traded products (i.e., varieties that were traded in 2006 but not in 1996) and by 0.086 to 0.099 for continuously traded products (i.e., varieties that were traded in both 1996 and 2006). Second, while the marginal effects conditional on each exporting status are statistically significant, their magnitudes are quite different. For newly traded goods, the magnitude of the marginal effect on the probability of exporting is twice as large as continuously traded products. Thus, tariff reforms appear to have a significant positive effect on the probability of exporting, but the effects are more pronounced for newly traded products.

Even though the initial results are encouraging, it could be argued that the estimates may be sensitive to the selection of the beginning (1996) and ending year (2006) from which to define continuously and newly traded goods (columns 4 and 5). Further, it is also of interest to see whether the results vary systematically with exporters' development status (columns 6 and 7). The results for the extensive margin of exports are robust and statistically significant for each begin-and-end year combination and level of exporter development. Moreover, for the alternate begin and/or end year combinations, the extensive margin marginal effects are nearly 1.5 times

[16] Because the tariff change variable is defined as the 2006 tariff minus the 1996 tariff a reduction in tariffs over this time period yields a negative tariff change. If more negative tariff changes (a smaller number) are associated with a higher likelihood of exporting, we therefore expect the coefficient on tariff changes to be negative.

larger than the 1996/2006 sample. While the marginal effects of tariff changes have the correct sign for continuously traded goods (Status= 1), they are statistically significant only in the case of exports from high-income economies, which matches our earlier description based on table 2.2. In summary, it appears that U.S. agri-food trade liberalization in the form of tariff changes has more of an effect on whether a country trades at all than on whether a country continues to trade.

2.5.2. Results of Multinomial Logit Model (MNL)

While the logit framework was useful in determining how tariff changes affect the intensive and extensive margins of U.S. agri-food imports, it did not consider two other margins of trade: the disappearing and no-trade margins. Conceptually, an increase in tariffs or tariffs that witnessed no change but remain at high levels could lead to products disappearing from or never entering the U.S. agri-food market. In this subsection we discuss the results from estimation of a multinomial logit model with four unordered export categories: Category 1 – no trade margin; Category 2 – disappearing margin; Category 3 – new goods margin; and Category 4 – continuously traded margin. For identification purposes, category 1 defines the base outcome.

Columns (1)–(3) of table 2.4 present the marginal effects of the three categories of exporting. Similar to the previous results, distance and GDP growth are generally of the correct sign and statistically significant. For example, higher GDP growth of exporting countries between 1996 and 2006 is associated with a significantly lower probability of disappearing goods (category 2) and higher probability of new (category 3) and continuously traded (category 4) goods (although the results are more fragile with respect to income growth in the latter category). While distance is statistically significant, it has the expected sign only for continuous trade along the intensive margin (category 4) (columns 1–3). For the disappearing (new goods) margin, a one-unit increase in distance between the United States and its trading partners results in a lower (higher) probability of disappearing (new) products. While somewhat counterintuitive, this result likely reflects the fact that U.S. trade with its North American neighbors, Canada and Mexico, occurs predominantly along the intensive margin and has been stable for many years. The positive and statistically significant marginal effect of distance on the extensive margin is likely because new goods trade is coming from more distant trading partners.[17]

The results for tariff changes are more illuminating. First, the marginal effects for the disappearing margin are positive and significant suggesting that more restrictive tariffs (i.e., tariff changes that are less negative or more positive) increase the probability of export failures. More specifically, a one-unit increase in the tariff change between 1996 and 2006 decreases the probability of disappearing goods by roughly 0.04 percentage points (columns 1–3). Second, tariff changes continue to exert a relatively large and statistically significant positive impact on the extensive margin. Here, a one-unit increase in the AVE tariff change between 1996 and 2006 decreases the probability of exporting new goods by 0.10 (columns 1–3) to 0.12 (columns 4–5) depending on the specification (table 2.4). Third, tariff reductions also seem to influence the likelihood of maintaining a presence in the market (intensive margin), although the magnitudes of the marginal effects for this category are about half those of category 3 (the extensive margin).

In columns 4 and 5 of table 2.4, we examine the robustness of our results to the chosen beginning and end year of our sample period. In column 4 we change both the beginning year and ending year (1998–2008) and column 5 changes only the end year (1996–2008). These

[17]A few studies have focused on the distance effect on the extensive and intensive margin of trade. For instance, Lin and Sim (2012) provide some evidence of increasing (decreasing) extensive (intensive) margins at longer (shorter) distances. Further evidence of this is also provided in Cheong, Kwak, and Tang (2016). The negative marginal effect for the disappearing margin is more challenging to explain but could reflect the fact that more distant trading partners export fewer products because of higher shipping costs and thus have fewer product turnovers (see also Besedeš and Prusa, 2006).

changes produce consistent results although the marginal effect of tariff changes are not statistically significant for disappearing goods and marginally significant for continuously traded goods (1996–2008). For extensive margin trade, on the other hand, the results are robust and consistently point to the fact that tariff changes appear to be an important explanation for the growth of new agri-food import varieties.

An important point is that our intensive margin category of continuously traded products does not establish whether tariff changes lead to higher or lower levels of continuous trade in 2006 compared to 1996. In column 6 of table 2.4, we shed light on the way in which tariff changes impact the level of continuously traded products by splitting the intensive margin category into two outcomes—one in which continuous trade was lower in 2006 compared to 1996 (outcome 4, Trade 96 > Trade 06) and one in which continuous trade was higher (outcome 5, Trade 96 < Trade 06). The results are robust. Not only do tariff reductions increase the probability of higher intensive margin agri-food exports in 2006 by 0.089 percentage points (outcome 5), the tariff change coefficient has the opposite sign for lower intensive margin exports (outcome 4), suggesting that higher tariffs in 2006 compared to 1996 increase the probability of lower export values by 0.064 percentage points.

Further, the absolute values of the magnitude of the coefficients for higher and lower intensive margin categories are not equal. The tariff change coefficient (-0.89) on the probability of higher intensive margin exports is nearly 1.5 times larger in absolute value than the lower intensive margin category (0.64). Thus, tariff reductions appear to have a bigger impact in absolute terms on the probability of having higher exports of continuously traded products than tariff increases do on the probability of having lower exports. Finally, the magnitude of the tariff change coefficient for lower intensive margin exports is consistent in magnitude and significance with disappearing products (0.064 versus 0.040, respectively). That is, higher tariffs in 2006 compared to 1996 increase the likelihood of lower levels of intensive margin exports by roughly the same extent as products disappearing from the market altogether.

2.5.3. Removing the No-Trade Category

As a final check on the sensitivity of our results, we revisit our assumption of inserting zero tariff changes when data on AVE tariffs were missing in the USITC database. In this scenario we eliminate category 1, the “no trade” margin since this category accounts for nearly all missing AVE tariff data and replace it with category 4, continuously traded goods, which now serves as the benchmark outcome. Because the intensive margin category is the most stable and has the most complete and reliable tariff data, this modification should increase estimation efficiency. The results are contained in table 2.5.

Perhaps the most interesting feature of this scenario is that the marginal effects for disappearing and extensive margin trade are all of the correct sign and statistically significant. Further, on an absolute basis the magnitudes of the probability of disappearing and new goods trade are nearly identical and complement each other (0.090 and 0.119, respectively). Thus, while U.S. tariff liberalization increases the probability of exporting along the extensive margin, it simultaneously decreases the probability of disappearing goods by roughly an equal magnitude (0.068 to 0.096) (table 2.5).

Finally, we also estimated two additional specifications while not reported. First, the marginal effects of new, disappearing, and continuously traded products could be picking up SPS and/or TBT regulatory barriers as opposed to tariff changes because of the prevalence of non-tariff SPS measures affecting agri-food trade. The extent to which our results are biased, however, depends on the degree to which SPS and TBT measures are correlated with tariff changes, for which the evidence is tenuous (see Kee, Nicita, and Olarreaga, 2009; Beverelli, Neumüller, and Teh, 2014). Moreover, the lack of high-quality NTM data with consistent time and country coverage (1996–2006) precludes explicit controls in the model.

However, in an attempt to determine whether our tariff change coefficients are impacted by SPS- and TBT-related measures, we re-estimated the multinomial logit model by dropping all HS6-digit beef, pork, poultry, and dairy live and processed animal product codes (HS2-digit chapters 01, 02, and 04). As discussed in the model section, dropping these product codes was driven by the overwhelming prevalence of animal disease related SPS concerns over our sample period (Grant and Arita, 2016).[18] The estimation results with grouped commodity and country fixed effects on this sub-sample of the data produced robust and consistent results. Tariff reductions increase the likelihood of new goods (coeff. = 0.09) and continuously traded goods (coeff. = 0.07) and reduced the likelihood of disappearing trade (coeff. = 0.15). The latter result for disappearing products was only marginally significant, suggesting that the full sample—including animal products—for this category may be driven to some extent by NTMs.

Second, the model includes controls for changing U.S. tastes and preferences between 1996 and 2006. For example, U.S. olive oil imports have grown more than threefold since 1996: from $200 million to over $700 million in 2006. However, with one importer (the United States), changes in the representative consumers' tastes and preferences are partially controlled for by commodity-specific fixed effects. In addition, if products are differentiated by country of origin, then specifications that include grouped commodity-by-country fixed effects will mitigate some of this concern. However, to address this comment more directly, we estimated a multinomial

[18] There are other prominent SPS-related concerns about plant-based and other products such as apples (Japan), lemons (Argentina), and avocados (Mexico) and TBT-related concerns about labelling and certification of Genetically Modified Organisms (GMOs). However, some of these—particularly GMOs—affect U.S. agri-food exports, whereas this study focuses on U.S. agri-food imports.

logit model inclusive of import expenditure shares. First, we calculated the import share of each exporter-by-HS6-digit product in each HS2-digit industry chapter for both 1996 and 2006. Second, we took the difference of the import shares over the two points in time and added this variable to the model to control for products that witnessed significant import growth (or decline).

Adding this variable changed the results very little. The probability of new goods extensive margin trade increases and the probability of disappearing goods decreases for each one-unit increase in the difference of the import expenditure share. Further, the sign and significance of our tariff change policy variable changed very little, with the addition of import expenditure shares with a coefficient of 0.09 (p-value = 0.01) and 0.03 (p-value = 0.33) for new and disappearing goods, respectively.

2.6. Conclusions

This article investigated an important question concerning international agri-food trade: how do trade policies in the form of tariff changes affect the probability of continuous, disappearing, and newly traded U.S. agri-food imports? Recent contributions to the theoretical and empirical trade literature emphasize firm-level productivity differences and the intensive and extensive margins of trade—the so called new-new trade theory (Melitz, 2003; Chaney, 2008; Helpman, Melitz, and Rubinstein, 2008). While these studies have pushed the frontier of international economics research, relatively few studies have examined how explicit trade policies impact the likelihood of trade along each margin (see Beverelli, Neumüller, and Teh, 2014, for an application of trade facilitation on the margins of trade). We extended the empirical literature by developing a multinomial logit framework to assess how detailed product-line tariff changes on U.S. agri-food imports affect the probability that country-commodity pairs will enter, exit, or maintain a presence in the U.S. import market.

The empirical results provide robust evidence that agri-food tariff liberalization enhances the entry of country-product export pairs into the U.S. agri-food market. Extending the analysis to a multinomial setting, our most important findings are as follows. First, the marginal impact of tariff reductions on new exports is two times greater than the impact on continuously traded goods, suggesting that the extensive or new goods trade margin is more sensitive to changes in trade policy than that of established products already in the market. The larger impact of tariff changes on new exports compared to existing exports indicates product variety (and availability) gains, which are an important source of consumer welfare (Broda and Weinstein, 2006; Feenstra and Kee, 2007; Bernard, Redding, and Schott, 2011). Second, by directly linking detailed country-product variation in tariff changes, we found that trade liberalization increases the product variety set vis-à-vis a higher likelihood of extensive margin trade while simultaneously reducing the probability of disappearing varieties. Thus, our findings likely reflect the underlying dynamics of heterogeneous firms, where we observe new products traded along the extensive margin, and simultaneously a lower probability of disappearing products in the wake of U.S. tariff reductions. While the Melitz (2003) model is based on firm-level data, our disaggregated country-level data, with explicit records denoting zero trade flows for specific agri-food products, suggests selection effects into (and out of) agri-food exporting along the lines of Helpman, Melitz, and Rubinstein (2008).

The policy implications of this article are threefold. First, exporters gain from tariff reductions in that they can establish new product relationships with the United States and enhance their U.S. and potentially their global supply chains. For developing countries with interests in exporting agricultural products, tariff reductions lead to enhanced market access opportunities and a reduced likelihood of disappearing products, leading to a more reliable and sustainable source of export revenues. Second, in terms of product variety and availability, consumers gain access to consistent food supplies year-round, lower prices of new and existing imported products when tariffs are reduced, and reduced probabilities of disappearing product varieties. Third, if consumers value variety in consumption as Broda and Weinstein (2006) have found, then on net we view our results as a positive welfare gain for U.S. agri-food consumers.

Finally, while we restricted our attention to the impact of tariff changes on the margins of U.S. agri-food imports, other policy instruments, such as NTMs, are likely to have a significant impact on the way in which export growth occurs. Although difficult in terms of data needs, we view the impact of NTMs on the margins of trade as a fruitful area of future research.

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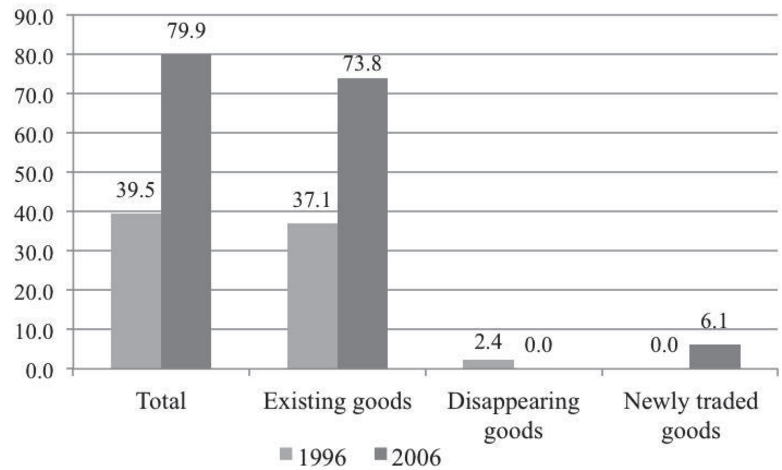
Figures

Figure 2.1. Decomposition of U.S. Agricultural and Food Imports ($bil.), 1996 vs. 2006



Source: U.S. International Trade Commission (USITC) at the six-digit level of the Harmonized System (HS), available at https://dataweb.usitc.gov/.

Tables

Table 2.1. Growth of Intensive and Extensive Margins across Agri-Food Exporters to United States in 2006 Compared to 1996

Exporter	Total Import Growth ($ Mil.)	Continuous Traded ($ Mil.)	Newly Traded ($ Mil.)	Share of Newly Traded Goods	Disappearing Goods ($ Mil.)	No. of HS6 Products Exported	Share of Existing Products with Tariff Reduction	Median AVE Tariff Reduction	Share of New Goods with Tariff Reduction	Median AVE Tariff Reduction for New Goods
Canada	7,695	7,068	1,325	17.2%	698	650	38.9%	1.0%	2.2%	1.5%
Mexico	6,115	5,714	510	8.3%	109	494	25.5%	3.2%	2.8%	1.4%
China	3,381	3,016	387	11.4%	22	467	34.0%	1.9%	6.6%	2.3%
Brazil	1,965	902	1,123	57.2%	59	291	15.5%	2.8%	6.9%	5.3%
Chile	1,689	1,651	114	6.7%	76	264	29.9%	2.6%	6.4%	5.3%
Australia	1,751	1,707	56	3.2%	11	293	40.3%	2.8%	9.6%	4.9%
EU-15	7,838	7,544	726	9.3%	432	3,334	35.2%	1.9%	5.7%	3.5%
Low-Income	3,599	3,201	569	15.8%	171	3,122	12.8%	4.1%	3.8%	7.9%
High-Income	36,760	33,466	5,517	15.0%	2,223	12,813	25.4%	2.0%	5.0%	4.9%

Notes: Low- and high-income countries are classified according to the World Bank's list of high- and low-income economies. AVE denotes the ad valorem equivalent tariff duty inclusive of specific tariffs and other taxes/fees collected at the border but exclusive of transport margins. AVE tariff data are collected from the U.S. international Trade Commission's dutiable values (see http://dataweb.usitc.gov/)

Table 2.2. Summary Statistics by Exporting Category

	Trade Category			
Variable	***Category 1: No-Trade Margin***	***Category 2: Disappearing Margin***	***Category 3: Intensive Margin***	***Category 4: Extensive Margin***
Log Distance				
Mean	8.89	8.81	8.88	8.73
Stdev	0.51	0.64	0.54	0.78
Min	6.31	6.31	6.31	6.31
Max	9.69	9.69	9.69	9.69
TARIFF CHANGE ($t^{2006} - t^{1996}$)				
Mean	-0.003	-0.001	-0.012	-0.005
Stdev	0.073	0.119	0.110	0.094
Min	-2.556	-1.000	-1.857	-1.009
Max	2.320	2.623	0.674	1.250
GDP GROWTH ($t^{2006} - t^{1996}$)				
Mean ($ Bil.)	$138	$197	$198	$299
Stdev ($ Bil.)	$278	$333	$357	$427
Min ($ Bil.)	-$349	-$349	-$349	-$349
Max ($ Bil.)	$1,857	$1,857	$1,857	$1,857
N (per trade category)	9,144	1,990	3,401	4,648

Notes: Category 1 is defined as U.S agri-food imports with zero trade in both 1996 and 2006. Category 2 is defined as US agri-food imports with positive trade in 1996 but zero trade in 2006. Category 3 is the set of US agri-food imports with positive trade in 1996 and 2006. Category 4 is the set of US agri-food imports with zero trade in 1996 and positive trade in 2006.
Source: Authors calculations from USITC trade data

Table 2.3. Logit Model Results of US Agricultural and Food Product Imports, 1996-2006

	Full Sample					Sub-Sample	
						High Income Countries	*Low Income Countries*
Estimation Method		*Logit model Marginal Effect*		*Logit model Marginal Effect*		*Logit model Marginal Effect*	
	1	2	3	4	5	6	7
Fixed Effects[a]	*Grouped commodity*	*Grouped country*	*Group commodity and country*	*Grouped commodity and country*		*Grouped commodity and country*	
Initial Year	*1996*	*1996*	*1996*	*1998*	*1996*	*1996*	*1996*
End Year	*2006*	*2006*	*2006*	*2008*	*2008*	*2006*	*2006*
Variable							
Status	0.428***	0.401***	0.391***	0.396***	0.382***	0.423***	0.430***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.000)	(0.000)
ΔTariff (Status = 0)	-0.187***	-0.175***	-0.163***	-0.237***	-0.214***	-0.180***	-0.194**
	(0.048)	(0.048)	(0.047)	(0.053)	(0.047)	(0.001)	(0.041)
ΔTariff (Status = 1)	-0.099*	-0.086	-0.090*	-0.049	-0.07	-0.096*	-0.115
	(0.055)	(0.056)	(0.057)	(0.055)	(0.059)	(0.100)	(0.514)
Log Dist	-0.024***	-0.012**	-0.017***	-0.025***	-0.016***	-0.026***	0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.000)	(0.802)
Δ Log GDP	0.016*	0.081***	0.078***	0.045***	0.059***	0.011	0.053**
	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.337)	(0.015)
N	19,183	19,183	19,183	19,545	19,183	14,662	4,521
Pseudo-R^2	0.139	0.147	0.155	0.153	0.146	0.138	0.126
LR	3588.4	3836.1	4029.4	4052.9	3801.7	2784.1	737.5
Pr > Chi^2	0	0	0	0	0	0	0

Notes: *Status* is an indicator variable equal to one if exporter o exported product k in 2006, and zero otherwise, *ΔTariff* denotes 2006 tariff minus 1996 tariff, *Log Dist* denotes the natural logarithm of distance, and *Difference in Log GDP* denotes the 2006 exporter GDP minus the exporter's 1996 GDP.One, two and three asterisks denote significance at the 10%, 5%, and 1% levels, respectively. Robust standard errors are in parentheses

[a] Fixed Effects Included: Grouped commodity at hs4/ Grouped Countries (based on the number of times a particular country and commodity trades with the US).

Table 2.4. Multinomial Logit Results of US Agricultural and Food Products, 1996-2006

	Alter fixed effects			Change begin/end year		Modified intensive margins
Estimation Method	*Multinomial Logit model: Base outcome = category 1 (No trade margin)*					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Grouped commodity	*Grouped countries*	*Group commodity /group countries*	*Grouped commodity /grouped countries*		*Group commodity /group countries*
Initial Year	*1996*	*1996*	*1996*	*1998*	*1996*	*1996*
End Year	*2006*	*2006*	*2006*	*2008*	*2008*	*2006*
Variable	***2. Disappearing Goods***					
ΔTariff	0.040*	0.038*	0.040*	0.015	0.014	0.040*
	(0.025)	(0.024)	(0.025)	(0.027)	(0.026)	(0.025)
Log Dist	-0.015***	-0.016***	-0.016***	-0.004	-0.015***	-0.015***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Δ Log GDP	-0.046***	-0.040***	-0.040***	-0.024***	-0.039***	-0.046***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
	3. Extensive Margins					
ΔTariff	-0.107***	-0.104***	-0.103***	-0.121***	-0.126***	-0.110***
	(0.030)	(0.030)	(0.029)	(0.031)	(0.029)	(0.030)
Log Dist	0.016***	0.018***	0.016***	0.009*	0.020***	0.016***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Δ Log GDP	0.051***	0.059***	0.058***	0.043***	0.056***	0.058***
	(0.008)	(0.009)	(0.009)	(0.008)	(0.007)	(0.008)
	4. Intensive Margins					***Trade 96 > Trade 06***[a]
ΔTariff	-0.051*	-0.030	-0.025	-0.027	-0.043	0.064***
	(0.034)	(0.032)	(0.031)	(0.033)	(0.031)	(0.018)
Log Dist	-0.078***	-0.059***	-0.063***	-0.056***	-0.063***	-0.017***
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)
Δ Log GDP	-0.098***	0.009***	0.007	-0.015*	-0.023***	-0.026***
	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.006)
	5. Intensive Margins					***Trade 96 < Trade 06***[a]
ΔTariff	-	-	-	-	-	-0.089***
						(0.027)
Log Dist	-	-	-	-	-	-0.054***
						(0.004)
Δ Log GDP	-	-	-	-	-	0.033
						(0.009)
N	19,183	19,183	19,183	19,545	19,183	19,183
Pseudo-R^2	0.014	0.040	0.049	0.044	0.049	0.045
LR	676	1900	2300	2132	2317	2366
Pr > Chi^2	0.000	0.000	0.000	0.000	0.000	0

Notes: *ΔTariff* denotes 2006 tariff minus 1996 tariff, *Log Dist* denotes the natural logarithm of distance, and *Δ Log GDP* denotes the 2006 exporter GDP minus the exporter's 1996 GDP. One, two and three asterisks denote significance at the 10%, 5%, and 1% levels, respectively. Robust standard errors are in parentheses

Fixed Effects Included: Grouped commodity at hs4 and Grouped Countries (based on the number of times a particular country and commodity trades with the US).

[a] *Trade 96 > Trade 06* (*Trade 96 < Trade 06*) refers to intensive margin outcome when exports by region *o* of commodity *k* are less (more) in 2006 compared to 1996.

Table 2.5. Modified Multinomial Logit Results of US Agricultural and Food Products, 1996-2006

	Alter fixed effects			Change begin and/or end year	
Estimation Method	*Multinomial Logit model Marginal Effect*			*Multinomial Logit model Marginal Effect*	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
	Grouped commodity	*Grouped countries*	*Group commodity /group countries*	*Grouped commodity /grouped countries*	
Initial Year	*1996*	*1996*	*1996*	*1998*	*1996*
End Year	*2006*	*2006*	*2006*	*2008*	*2008*
Variable	*Marginal Effect*				
2 Disappearing Goods					
Tariff Change	0.096**	0.089**	0.095**	0.068*	0.090**
	(0.040)	(0.039)	(0.041)	(0.041)	(0.043)
Log Distance	0.001	-0.008	-0.005	0.011*	-0.004
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Difference in Log GDP	-0.054***	-0.083***	-0.081***	-0.046***	-0.070***
	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
3 Extensive Margins					
Tariff Change	-0.090**	-0.101**	-0.108***	-0.113***	-0.119***
	(0.046)	(0.046)	(0.046)	(0.047)	(0.047)
Log Distance	0.073***	0.066***	0.067***	0.044***	0.070***
	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)
Difference in Log GDP	0.161***	0.094***	0.095***	0.083***	0.113***
	(0.014)	(0.015)	(0.015)	(0.014)	(0.013)
4 Base Outcome: Intensive Margins					
N	9,957	9,957	9,957	10,119	9,923
Pseudo-R^2	0.014	0.032	0.037	0.035	0.040
LR	295.5	661.9	764.5	747.9	833.8
Pr > Chi^2	0.000	0.000	0.000	0.000	0.000

Notes: Category 4 – continuous or intensive margin trade - serves as the base outcome and the no trade category is omitted from estimation. *ΔTariff* denotes 2006 tariff minus 1996 tariff, *Log Dist* denotes the natural logarithm of distance, and *Δ Log GDP* denotes the 2006 exporter GDP minus the exporter's 1996 GDP. One, two and three asterisks denote significance at the 10%, 5%, and 1% levels, respectively. Robust standard errors are in parentheses

[a] Fixed Effects Included: Grouped commodity at hs4/ Grouped Countries (based on the number of times a particular country and commodity trades with the US).

3. Hidden Trade Costs? Maximum Residue Limits and US Exports to Trans-Atlantic and Trans-Pacific Trading Partners

3.1. Introduction

We have witnessed a significant shift in the focus of agricultural trade policy concerns from border related costs such as tariffs, quotas, and exports subsidies that dominated much of the research and policy agenda in the lead up to the historic Uruguay Round Agreement on Agriculture (URAA), to non-tariff measures (NTMs) and a plethora of "behind the border" policies in the form of regulatory measures and product standards. While tariffs remain high on a handful of agricultural sectors and tariff-rate quotas guarantee at least some access in certain markets, most agricultural economists agree that new 21st century obstacles to trade are more obscure in nature and have the potential to be more trade distorting (Beghin, Maertens and Swinnen 2015; Josling, Roberts, and Orden 2004; OECD 2005; WTO 2012). As Baldwin (1999) noted more than a decade ago: "…the lowering of tariffs has, in effect, been like draining a swamp. The lower water level has revealed all the snags and stumps of non-tariff barriers that still have to be cleared away" (p. 237).[19]

Broadly defined, NTMs are policy measures, other than ordinary customs tariffs, that can potentially have an economic effect on international trade in goods, changing quantities traded, or prices or both (UNCTAD 2010). Among the potential list of NTMs affecting agricultural and food trade, Sanitary and Phytosanitary (SPS) measures feature prominently. First, SPS measures are pervasive in agri-food trade 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

[19] Baldwin was not the only prominent Economist to highlight the increasing prevalence of NTMs. Lawrence (1996) noted that "… once tariffs are removed, complex problems remain because of differing regulatory policies among nations" (pg. 7) and Preeg (1998) concludes that: "…as border restrictions [tariffs] are reduced or eliminated, other policies become relatively more important in influencing trade flows and thus need to be assimilated in the trade relationship" (p. 50).

measures permits countries to adopt their own set of standards provided these measures are based on a risk assessment, not discriminatory between countries with similar conditions, and are minimally trade distorting to prevent the disingenuous use of these measures as instruments of disguised protectionism (Josling, Roberts and Orden, 2004). Third, SPS and TBT measures are the most frequently encountered NTMs according to data collected from official sources such as the United Nations Conference on Trade and Development's (UNCTAD) Trade Analysis and Information System (TRAINS) and the WTO's new Integrated Intelligence Portal (I-TIP). They are also considered among the most relevant impediments to exports, according to a small sample of NTM business surveys conducted by the World Bank.

A major impediment to research progress on NTMs in agri-food trade is the difficulty in constructing NTM datasets suitable for empirical analyses because of the many different forms NTMs can be applied, when and how each measure is imposed, and on which country/commodity pairs. Although there is no complete global inventory of public and private NTM measures, multi-country and multi-institutional efforts to define, classify and categorize NTMs and their role in international trade have been undertaken the most recent being the UNCATD (2015) report culminating several years of effort by an expert committee termed the Multi-Agency Support Team (MAST). Despite these efforts, quantification of NTMs and in particular, those that represent significant obstacles to trade including case-studies and full-scale inventory approaches, has not lead to a consensus about the impact of NTMs on trade nor has it led to a prescribed framework of how to address NTM policy reforms in multilateral and bilateral negotiations. Difficulties arise because of the enormous amount of data collection that is required to obtain accurate empirical results that reflect economic outcomes and because of the wide range of channels by which NTMs can impact agricultural trade, commercial transactions, and even the ability of firms to establish new trading relationships.

The evidence to date has been mixed (see Li and Beghin 2013; Beghin, Maertens and Swinnen 2015; WTO 2012) and oftentimes the proverbial water has become muddied as more obscure measures are identified. While new information and improved NTM classification systems has increased our understanding of the nature of these measures it has simultaneously revealed a large and diverse universe of applicable measures whether justified or not. In principle, the United Nations Conference on Trade and Development (UNCTAD) maintains and periodically updates its Trade Analysis and Information System (TRAINS) database that covers well over 100 types of NTMs affecting agricultural and non-agricultural trade. However, the applicability of the TRAINS database has been subject to criticism for several reasons (Disdier, Fontagne and Mimouni 2008; Peterson et al. 2013; Grant et al., 2015). First, even if an NTM is notified in the TRAINs database very little information exists describing the type of measure affecting trade. Second, TRAINS does not contain a bilateral country-pair dimension which means researchers must assume that if an import measure is notified it applies to all exporters. Third, unlike agricultural tariffs for which WTO Members are required to notify rates and any changes in applicable duties, NTMs are not subject to such comprehensive reporting requirements. Further, the use of NTMs changes over time as new types of measures appear when new ingredients or supplements are registered for use or cost saving input technologies such as new pesticides becomes available.

While many SPS regulations are in place to protect animal and plant health from imported pests and disease, a particular type of SPS regulations known as Maximum Residue Limits (MRLs) or tolerances, are designed to safeguard human health. MRLs describe the maximum legal level of concentration of pesticides or feed additives that a country is willing to accept in or on the surfaces of food products. Although MRLs have become a key regulatory measure to limit human exposure to chemicals and veterinary drug residue, overly restrictive tolerances or limits set by importing countries that deviate significantly from international standards or those maintained by exporting countries may provide incremental reductions in human health and environmental hazards but will almost certainly increase compliance costs for foreign and domestic producers, consumer prices of food products in importing countries, and in some cases may shut off trade as products get rejected at the border (Xiong and Beghin, 2012a).

In the March 2014 *Report on SPS Measures* (USTR 2014), the Office of the US Trade Representative highlighted a number of discriminatory SPS measures affecting US fruit and vegetable (FV) and animal product trade. A common theme in this report was the concern of overly burdensome maximum residue limits (MRLs), particularly regarding pesticides and aflatoxins in tree nuts and restrictions or bans concerning biotechnology, ractopamine, trichinosis, bovine spongiform encephalopathy (BSE), avian influenza (AI) and certain veterinary drugs imposed on US exports of animal products. Perhaps not surprisingly, many of the country-product examples of SPS restrictions listed in the report lie in Asia and Europe – two continents that are part of the large mega-regional trade deals with the US.

While broad-based approaches to quantify the effect of NTMs on trade are useful for developing a “big picture”, simply put, NTMs include a very diverse array of policies that can have heterogeneous impacts on trade (Beghin, Maertens and Swinnen 2015). Given persistent difficulties in constructing suitable NTM datasets, this article adopts a targeted approach investigating a specific type of SPS regulation in a particular product class of US trade, namely maximum residue limits affecting fresh fruits and vegetable (FV) exports. More specifically, the purpose of this article is first to construct a novel dataset of MRLs. Second, we develop a bilateral stringency index of MRL heterogeneity between trading partners. Following Li and Beghin’s (2013) index work, we modify their index, which is designed to evaluate the stringency of members' MRLs with respect to the international standard, to incorporate an explicit bilateral dimension. The decision to export and the intensity of exports with a given bilateral partner likely depend more on the stringency of MRL standards in the importing nation as opposed to the international standard. Third, we disaggregate the stringency index into three common classes of chemicals – herbicide, fungicide and insecticide. Therefore, our indices vary not only by product and/or country but potentially by type of chemical. Fourth, we empirically develop a formal econometric model to access the trade restricting nature of these measures. Further, a Heckman approach is applied to explore whether exporting nations facing stringent MRL policies in destination markets actually export at all. We develop a bilateral trade flow equation to test the degree to which MRLs reduce both the probability and intensity of trade.[20] Finally, we use the bilateral stringency indices and the empirical model to shed light on key regulatory differences between the US and its main trading partners in the Trans-Pacific and Trans-Atlantic trade negotiations.

3.2. MRL Policy Setting

While the SPS Agreement allows WTO Members to adopt their own set of regulations, it encourages countries to apply internationally accepted science-based standards established by the Codex Alimentarius Commission (henceforth CAC or Codex).[21] The Codex Committee on Pesticide Residues (CCPR) is the primary body responsible for establishing MRLs for pesticide residues. While the CCPR's responsibility is to establish MRLs for pesticides in specific food items or in groups of food, the Joint Food and Agricultural Organization (FAO)/World Health Organization (WHO) Meeting on Pesticide

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[20] The extensive margin describes as the emergence of new trade flows (i.e. the probability of having strictly positive trade flows), and the intensive margin introduces as the value of these positive flows (Besedeš and Prusa, 2011).

[21] The Codex Alimentarius Commission (CAC) "develops harmonized international food standards to protect health of consumers and ensure fair practices in food trade" (http://www.fao.org/fao-who-codexalimentarius/en/).

Residues (JMPR) is responsible for reviewing the appropriate toxicology and residue field data, conducting dietary risk assessments, and recommending specific MRLs to the CCPR. Thus, human health risk assessments must be conducted to ensure food safety before a Codex MRL can be established (Epstein, 2013; Madden, 2014; WHO 2009).

The CCPR follows a three-step process to establish a Codex MRL. First, a member country nominates a chemical/commodity to the CCPR. Second, the JMPR reviews the data provided for this chemical/commodity. Finally, according to the WHO (2009), the establishment of the MRL will be considered by the CCPR, if the JMPR's review confirms that there are no issues or concerns. Although the CAC sets the MRLs for most agricultural and livestock products, WTO members are not legally bound to adopt such standards and there is no means to enforce equivalency with the international standard. As such, MRLs vary widely across countries as discussed shortly because of differences in residue definitions, usage patterns, formulations used in the residue field experiments that may differ from pesticide use in actual production settings, and in the procedures used to determine MRL levels (Madden, 2014). In such circumstances, countries can adopt standards that differ from Codex as long as they are science-based, non-discriminatory, and minimally trade-distorting (Beghin, 2014).

Thus, no official harmonized level of MRL exists globally (Achterbosch et al., 2009; Drogue and DeMaria, 2010; Van der Meulen and van der Velde, 2004). For example, the European Union (EU) and the United States (US) have established different MRLs for the chemical Methidathion - a widely used organophosphate insecticide used in the production of oranges and other citrus fruits. Because the insecticide can be toxic to humans, avian species, and honeybees, the EU's harmonized SPS policy sets a more stringent residue limit of 0.02 parts per million (ppm), compared to the US which establishes a less stringent standard of four ppm. For comparison, the CAC international standard for Methidalthion in oranges is two ppm.[22]

In the US, the Environmental Protection Agency (EPA) is responsible for establishing residue limits on pesticides that have been registered and approved for use (e.g., have been determined with “reasonable certainty” not to pose a harmful threat to human or environment health). In setting the tolerance, the EPA considers: the toxicity of the pesticide and its break-down products, how much of the pesticide is applied and the frequency of application; and how much of the pesticide (i.e., the residue) remains in or on the surfaces of food by the time it is prepared for retail markets. Pesticide manufacturers, or registrants, are required to submit a variety of scientific trials that identify possible harmful effects the chemical could have on humans (its toxicity), and the amount of the chemical (or breakdown products) likely to remain in or on the surface of food. This information is then used in the EPA’s risk assessment and determination of the tolerance. Once an EPA tolerance is established, the limit applies both to domestically produced and imported products. In addition, established MRLs can be updated if new information regarding toxicity or residue data warrants a revision to the existing tolerance (EPA website, 2014).

In the EU, MRLs apply to 315 fresh and processed agricultural products. In cases where pesticides have not been registered, the EU maintains a default MRL of 0.01 mg/kg. The EU’s standard setting MRL process first involves estimating residue levels in or on a crop when the pesticides are applied under the Good Agricultural Practice (GAP). Second, the total daily intake of the specific pesticide is estimated using consumer intake models and the established residue level. Third, an acceptable daily intake (ADI) is established using information based on toxicological tests. Sensitive groups of consumers such as children are considered in order to determine a safe ADI limit as well as a second limit referred to as the

[22] It should be noted that international and country-specific MRL standards for a given chemical differ depending on the product. For example, the CAC international MRL standard for pears and table grapes is 1 ppm compared to 0.1 ppm for onions and tomatoes and 0.01 ppm for Macadamia nuts. In the empirical exercise, we develop an index to measure dissimilarities in two trading partners MRL standards for a given product.

Acute Reference Dose[23] (ARFD). Once these intake limits are computed, the European Commission (EC) establishes a new MRL or revises the existing MRL based on the condition that the daily consumer intake of residues is less than the ADI. For crops and chemicals produced and used outside of the EU, MRLs are established upon request of the exporting country (EC website, 2014; Smolka, 2006).

3.3. Previous NTM and MRL Work

A growing body of empirical literature has emerged exploring the relationship between NTMs and international trade. Because of data limitations, most empirical investigations of NTMs employ either broad-based inventory approaches which attempt to cover the widest possible scope of notified NTMs, or focus on a single case-study where better information is available for a specific type of measure. Swann et al. (1996) found that non-tariff standards generally promoted trade in the United Kingdom (UK). Their results initially challenged the predominant view that standards restrict trade. Subsequent studies have often found negative effects of NTMs on trade. Examining the trade impacts of country specific and bilaterally shared standards in 12 OECD countries and 471 industries over the period 1985-1995, Moenius (2004) finds a negative effect of national standards on trade in non-manufacturing sectors. Using frequency and converge ratios for 61 product groups, including some agri-food commodities, Fontagné, Mimouni and Pasteels (2005) find that SPS and TBT measures have a negative impact on agri-food trade but not necessarily on trade in industrial products. Disdier, Fontagne, and Mimouni (2008) use notification frequencies on NTMs and the *ad valorem* tariff-equivalents estimated by Kee, Nicita and Olarreaga (2008) to estimate broad-based impacts of NTM regulations on agri-food trade. They find that NTMs have a negative influence on trade in cut flowers, processed food products (e.g.

[23] ARFD is the pesticide dose that can be consumed during one day (short time), without considerable health hazard (Smolka, 2006).

beverages) and meat, but a strong positive influence on trade in cereals, wool and albuminoids/starch.

Jayasinghe, Beghin and Moschini (2009) depart from broad-based inventory approaches and focus on a particular product – US corn seed exports. Making use of the EXCERPT database, the authors use a count variable to determine the number of SPS measures affecting corn seed exports and find that trade is decreasing in the number of foreign SPS/TBT standards required. Similarly, Peterson et al. (2013) and Grant et al. (2015) focus on phyto-sanitary treatments (i.e., Methyl Bromide, Cold and refrigeration treatments, etc.) impacting US fresh fruit and vegetable trade. Both studies find that SPS measures tend to reduce US trade initially. However, an innovation in their study is that exporters can overcome the fixed costs of establishing treatment facilities once exporters accumulate product treatment experience in the global market place such that the negative phyto-sanitary trade effect vanishes.

Equally important broad-based and case-study approaches have been conducted in the context of standards and residue limits related to food safety. In terms of broad-based approaches, an important empirical assessment of the trade effects of NTM regulatory heterogeneity was accomplished in the NTM-IMPACT project (see Orden, Beghin and Henry 2012 for a summary). An aggregate data set of regulations and standards measured on a comparable basis for the EU and nine of its trade partners were assembled by collaborators at twelve institutions. The vast array of NTMs covered by the project are technically complex and difficult to evaluate, aggregate, and quantify. Winchester et al. (2012) articulated these challenges and described the procedures followed to develop a comprehensive snapshot of EU regulatory heterogeneity in 2008-09 including measures for import requirements concerning food safety, animal and plant health, labeling, traceability, conformity assessment and certification requirements. Indices of the heterogeneity of trade regulation (HIT) were computed in each of these areas. Concluding evidence from this project indicates that regulatory differences in NTMs negatively impact EU trade.

Case-study approaches have offered a number of additional insights. Otsuki et al. (2001) finds a negative effect of the EU's aflatoxin standard on African groundnut exports. Moving from the CAC standard established by the FAO and the WHO to the more stringent European Commission standard decreases African exports of cereals, dried fruits, and nuts to Europe by $670 million. Xiong and Beghin (2012a) recently overturned the estimated effect in Otsuki et al. (2001), by considering possible demand enhancing effects of SPS regulations. However, other case-studies addressing many of the econometric criticisms raised in Xiong and Beghin (2012a) tend to corroborate the significant negative effects of MRL stringency. Examples include Wilson and Otsuki (2004) for MRLs on chlorpyrifos in banana exports; Wilson, et al. (2003) on the effect of residue limit standards on tetracycline in beef exports; Chen, et al. (2008) on food safety standards impacting China's exports of vegetables, fish and aquatic products; Drogué and DeMaria (2012) on MRLs affecting apples and pears; and Disdier and Marette (2010) on antibiotics impacting crustaceans exports.

While the focus of these studies tends to be narrower in terms of commodity coverage, the results tend to show more stringent maximum residue limits and food safety standards negatively impact trade, particularly for developing nations. Comparing the stringency of MRLs between trade partners is complicated because there are often numerous residue limits that apply to any given product.[24] First, some of the aforementioned studies tend to compare an importers MRL policy with the Codex established international standard without paying much attention to regulatory differences between origin and destination countries. Even if an importer's MRL policy is more stringent than the international standard

[24] For example, the US has established tolerances for 131 chemicals for apples. However, the same number of registered tolerances is not identical across countries. For apples, the number of established tolerances for chemicals varies from 45 in China, 79 in Canada, to 112 in Japan. This compares to 68 MRLs registered by Codex.

there are cases where an exporter's MRL policy may be the most restrictive. If exporting firms face a more stringent domestic MRL policy than either the international or importer's standard, it is not likely that the importer's MRL policy could be considered overly trade distorting even if the importer's MRL policy is more stringent than the international standard. Second, a drawback with case-study approaches that focus on one chemical class such as Aflatoxins is that if other MRLs are operating, the empirical analysis may overstate the impacts of the targeted Aflatoxin MRL.

An alternative approach is to consider a targeted stringency index that captures and summarizes the full spectrum of a country's MRL standard for a given product. Such an approach has several advantages. First, the index is bilateral in the sense that we can pay attention to hidden trade obstacles facing exporters in the proposed mega-regional agricultural negotiations. Second, the index can be computed on a product-by-product basis (i.e., apples, pears, grapes, lettuce, etc.) for each exporting partner thereby capturing only those chemicals registered for use for a given product. Finally, the index is targeted at a specific type of SPS policy – namely MRLs. An important drawback in the construction of indices in studies such as Winchester et al. (2012) and the NTM-Impact project for the EU is that the index assigns equal weight to all types of NTMs covered regardless of the importance and/or intensity of their use in the underlying production process excluding MRLs (Winchester et al., 2012; Li and Beghin, 2013; Achterbosch et al., 2009; Burnquist et al., 2011; Drogue and DeMaria, 2012; Ferro et al., 2013; Foletti and Shingal, 2014a and b). Indeed, Winchester et al. (2012) argue that the general nature of the index makes it difficult to determine the importance of individual (or groups of) NTMs for a given product and country pair. The authors state further that it is difficult to know without expert evaluation which standards matter and which do not for a given product and country pair.

3.4. Indices of Regulatory Heterogeneity

Constructing a measure encapsulating the degree of regulatory MRL heterogeneity remains an open empirical issue. Achterbosch et al. (2009) constructed stringency levels of MRLs affecting Chile's exports of fruits to the EU over the period of 1996-2007 using averages of the actual difference in MRLs for each pesticide divided by the sum of the limits for the two trading partners. Foletti and Shingal (2014a) build on Achterbosch et al.'s (2009) framework by separate the stringency index into two measures – one when the exporter maintains a stricter limit and the second when the importer maintains a stricter limit – with the goal of testing the claim that regulatory heterogeneity always creates compliance costs for countries no matter where this heterogeneity comes from. Drogue and DeMaria (2012) compute the respective distance between each country's MRL standards by subtracting the Pearson's coefficient correlation from one, which gives an index with domain [0, 2]. When the index value is close to zero (two), the two trading partners have the same (dissimilar) MRL standards. However, a major shortcoming of the Pearson index is that it does not provide information about which trading partner (importer or exporter) has the stricter MRL. For reasons discussed previously, we believe such information is crucial to the question of whether differences in MRLs represent barriers or catalysts to trade.

Winchester et al. (2012) develop directional [25] and non-directional heterogeneity indices of trade regulation (DHIT and HIT respectively), as defined by Rau et al. (2010), based on the Gower index of (dis)similarity (Gower 1971). The standards investigated, however, include import requirements concerning food safety, animal and plant health, labeling, traceability, conformity assessment, process requirements and certification requirements. Thus, the number of measures involved in the computation of the HIT is very large, and they weight all NTMs equally in their index, arguing that using all of the

[25] Only for MRL index, but for other standards there is a lack of additional knowledge to determine the direction of stringency.

information is a better alternative than focusing on just a few NTMs, which is equivalent to putting a weight of zero on all but those few. Indices over a large number of NTMs; however, makes it difficult to determine which measures are responsible for trade disruptions and the direction of stringency (can not determine which one of the importer or exporter has more stringent standard).

With this in mind, the starting point in our analysis is a modification of Li and Beghin's (2013) non-linear exponential index [26] that takes into account the dissimilarity of MRL policies between country-pairs rather than between a destination's standard relative to the international Codex limit. Formally, the bilateral stringency index (*BSI*) between origin region *o* and destination region *d* for the *c* classes of chemicals used in the production of product *k* is defined as follows:

$$(1) \qquad BSI_{codk} = \left(\frac{1}{N_{ck}}\right) \sum_{p \in N_{ck}} exp\left(\frac{MRL_{opk} - MRL_{dpk}}{MRL_{opk}}\right)$$

where N_{ck} is the number of chemicals in chemical class *c* used in the production of commodity *k*, MRL_{opk} is the maximum residue limit for the p^{th} chemical in class *c* for commodity *k* in region *o* and MRL_{dpk} is the maximum residue limit for the p^{th} chemical in class *c* for commodity *k* in region *d.* As we mentioned above, one of the limitation of previous studies in this line of work is they often employ an aggregate measure of stringency or dissimilarity over all chemicals. However, this index makes it difficult to determine which measures are responsible for trade disruptions. To address this concern, we disaggregate the BSI index of MRL stringency into separate indices for different chemicals. Thus, we consider three broad classes of pesticides - herbicides, insecticides, and fungicides – to identify whether MRL policy dissimilarities between the destination and origin regions vary systematically across different classes of chemicals (*c*).

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[26] In their study, Li and Beghin (2013) explicitly provide the properties of the non-linear exponential stringency index (p. 59 and 60).

The advantages of the exponential function are that it maps heterogeneous *BSI* differences onto the range zero (exp($-\infty$)) and 2.72 (exp(1)) and penalizes larger MRL differences between *o* and *d* relatively more. For example, if the destination region has a much stricter MRL for chemical *p* in class *c* (i.e., 0.1 ppm) compared with the origin region (i.e., 5 ppm), reflecting a heterogeneous regulatory situation, then the ratio of MRLs will approach a value of unity and the BSI function will approach its upper limit of *exp*(1) = 2.72. Conversely, if the origin region has a much stricter MRL for chemical *p* in class *c* compared to the destination region, then the ratio of MRLs will be negative and in the limit the exponential function will approach zero, reflecting the fact that the destination region MRL is not likely to represent a "barrier" to trade because exporting firms are already required to meet a more stringent domestic tolerance. Finally, if the origin and destination regions have the same MRL for chemical *p* in class *c*, then the ratio equals zero and the BSI is *exp*(0) = 1, reflecting an equivalent or harmonized SPS situation.

As described shortly, the *BSI* is calculated for all countries with established MRL standards and the requirement that the chemical is used in production based on data provided by the USDA/NASS surveys of pesticide use for 26 fruits and 25 vegetable crops across producers in the United States. All else constant, stricter MRLs in the destination country relative to the origin country are expected to have a negative impact on trade. The extent to which trade falls for incremental increases in the *BSI*, however, is clearly an open empirical question.

3.5. Empirical Approach

In order to quantify the extent to which MRL policy dissimilarities reduce fruit and vegetable trade between trading partners, a product-level model of bilateral trade is developed based on the work of Anderson and van Wincoop (2003), Baldwin and Taglioni (2006), Peterson et al. (2013) and Grant et al. (2015) and augmented to focus not only on the overall impact of all trading partners, but in particular on U.S. exports to the EU and TPP markets. The model assumes all varieties of commodity *k* are differentiated by origin region *o* and consumer preferences in destination region *d* for commodity *k* are weakly separable, which can be described by a CES utility function of the following form:

$$(2) \qquad u_{dk} = \left(\sum_{o=1}^{R} \delta_{odk}^{\frac{1}{\sigma_k}} q_{odk}^{\frac{\sigma_k - 1}{\sigma_k}} \right)^{\frac{\sigma_k}{\sigma_k - 1}}$$

where δ_{odk} denotes a preference parameter for commodity *k* exported by region *o* to region *d*. *R* represents the total number of regions. q_{odk} is the quantity of commodity *k* exported by origin region *o* and consumed in destination region *d*. The elasticity of substitution between all varieties of commodity *k* is described by σ_k. Time period subscripts are suppressed as discussed further below due to the limited time-series nature of the MRL data.

A representative consumer in region *d* maximizes its utility (2) conditional on her budget constraint. The following describes the consumers' expenditure function allocated to consumption of commodity *k* in region *d* from region *o*:

$$(3) \qquad V_{odk} = p_{odk} q_{odk},$$

Solving this utility maximization problem and substituting the budget constraint equation (3) in the first order condition gives consumer demand for quantity of commodity *k* in region *d* from region *o*. In equation (3) p_{odk} is consumer price for commodity *k* in region *d* from region *o*, which is linked to producer price for commodity *k* in region *o* through the price linkage equation:

$$(4) \qquad p_{odk} = t_{odk} p_{p\_ok},$$

where t_{odk} defines the trade costs of exporting commodity *k* from region *o* into region *d* and p_{p_ok} denotes producer prices in region *o*. Substituting the optimal quantity along with equation (4) in equation (3) yields the following expenditure function for commodity *k* in region *d* from region *o*:

(5) $$V_{odk} = \frac{\delta_{odk}\left(t_{odk}p_{\boldsymbol{p}\_ok}\right)^{1-\sigma_k} E_{dk}}{PI_{dk}^{1-\sigma_k}},$$

where E_{dk} is commodity *k* specific in region *d*'s expenditure and the denominator in equation (5) is the CES price index (PI_{dk}) defined as follows:

(6) $$PI_{dk} = \left(\sum_{r=1}^{R}\delta_{rdk}p_{rdk}^{1-\sigma_k}\right)^{\frac{1}{1-\sigma_k}}.$$

Equation (5) shows region *o*'s sales to each destination market that is a function of economic size (E_{dk}), origin prices relative to the overall price index (p_{p_ok} and PI_{ok}), bilateral trade costs and preferences (δ_{odk}). This expenditure function (equation 5) defines the elements of gravity model developed in Anderson and van Wincoop (2003) and Baldwin and Taglioni (2006). Therefore, summation of consumer expenditures across destination markets, including *o*'s market evaluated at the producer price in region *o*, will give the total sales of commodity *k* that is produced in region *o*. Assuming market clearing condition for commodity *k*, the total quantity of commodity *k* produced in region *o* (Y_{ok}) will equal to the quantity demanded in domestic market (*oo*), as well as the quantity demanded across destination markets (*od*).

(7) $$Y_{ok} = \underset{d=1}{\overset{R}{\square}} V_{odk} = \underset{d=1}{\overset{R}{\square}} \frac{\delta_{odk}\left(t_{odk}p_{\boldsymbol{p}\_ok}\right)^{1-\sigma_k} E_{dk}}{PI_{dk}^{1-\sigma_k}}$$

Using equation (7), we can solve for $p_{p\_ok}^{1-\sigma_k}$ and substitute the result into equation (5) as suggested by Anderson and van Wincoop (2003). The expenditure function in equation (8) incorporates an explicit commodity dimension developed by Peterson et al. (2013) and Grant et al. (2015), which was a modification of Baldwin and Taglioni's (2006) expenditure function.

(8) $$V_{odk} = \frac{\delta_{odk}t_{odk}^{1-\sigma_k}Y_{ok}E_{dk}}{\left(\sum_{d=1}^{R}\frac{\delta_{odk}t_{odk}^{1-\sigma_k}E_{dk}}{PI_{dk}^{1-\sigma_k}}\right)PI_{dk}^{1-\sigma_k}} = \frac{\delta_{odk}t_{odk}^{1-\sigma_k}Y_{ok}E_{dk}}{\Omega_{ok}PI_{dk}^{1-\sigma_k}}.$$

Similar to Grant et al. (2015), trade costs in equation (8) are a multiplicative function of transportation margins, and consist of several factors to transport *k* from producers in region *o* to consumers in region *d*. To capture the extent to which bilateral MRL stringency impacts trade costs, we employ this index as a proxy for trade costs, along with geographical distance and an indicator of free trade agreements. In equation (9), we initially assume trade costs are variable; however, later in this section we examine the extent to which BSI impacts the probability of exporting. Thus, we will consider bilateral MRL stringency, not only as variable cost of trade, but also as the fixed cost of trade, where firms require to cover fixed cost in order to start a new relationship.

$$t_{odk}^{1-\sigma_k} = dist_{od}^{\delta_1} \exp\left(RTA_{od}\right) \underline{\subseteq}_{c} BSI_{odk}^{\theta_c} z_{odk}^{\theta_0} \tag{9}$$

where, $dist_{od}$ is the geographical distance between regions *o* and *d*, RTA_{od} is an indicator of free trade agreements, BSI_{odk} is the bilateral stringency index defined in previous section (equation 1) and recalling that we define $c = 3$ classes of pesticide MRL categories (herbicides, insecticides, and fungicides), and z_{odk} are other potentially unobserved determinants of trade costs.

Finally, to re-write equation (8) in the format of the product line gravity model, some further modifications are necessary. First, the CES utility function is homothetic, so an increase in E_{dk} yields a proportional increase in V_{odk}, holding all other variables constant. Second, in equation (8) E_{dk} is not directly observable and there is a long history of encountering difficulties estimating trade models because most of the variables involved are not directly observable. However, the expenditure for commodity *k* in region *d* is a function of income and the price indices for each commodity. Third, the price indices, Ω_{odk} and PI_{dk}, are also not directly observable. Previous empirical studies such as Peterson et al. (2013), Grant et al. (2015) and many other studies assume expenditure (E_{dk}) is a function of total income per capita (GDP) and employ GDP in their models, and also use production quantities as a proxy for production value (Y_{ok}). Furthermore, these studies use time varying country-specific fixed effects for unobservable price indices as suggested by Baldwin and Taglioni (2006), Anderson and van Wincoop (2003), Feenstra (2004) and many others. In this study, since MRL data availability limits our analysis to two years of data, we adopt an alternative approach, which captures expenditure, production value and price indices using time-invariant country and commodity-specific fixed effects (*o*, *d* and *k*) as consistent alternatives. These dummy variables control for production levels in the exporting country, expenditure in importing countries and the unobserved price indices.

The final alteration is the issue of zero trade flows. Santos-Silva and Tenreyro (2006), Pham and Martin (2008), Helpman, et al. (2008) and Jayasinghe, et al. (2009) show that omitting zero trade flows leads to biased estimates due to sample selection issues, particularly if the reason for the existence of zero trade is correlated with right-hand side variables such as MRL policies. One approach to incorporate zero trade flows is the Poisson pseudo-maximum likelihood (PPML) estimation framework as discussed in Santos-Silva and Tenreyro (2006). Substituting equation (1) into (9), and then equation (9) into equation (7), along with E_{dk} and Y_{ok} yields our baseline model of product line trade flows:

$$X_{odk} = \exp\left(\pi_o + \pi_d + \pi_k + \sum_c \theta_c BSI_{codk} + \lambda_1 \ln Dist_{od} + \lambda_2 RTA_{od} + \sum_c \theta_{c_{US-EU}} BSI_{codk} I_{US-EU} + \sum_c \theta_{c_{US-TPP}} BSI_{codk} I_{US-TPP} \right) \varepsilon_{odk} \quad (10)$$

where X_{odk} is the export value of bilateral fresh fruit and vegetable trade between *o* and *d*, and $I_{US\text{-}EU}$ and $I_{US\text{-}TPP}$ are indicator variables equal to one if *o* is the US and *d* belongs to the EU or TPP countries, respectively. By including these terms, we allow the EU and TPP MRL policies with respect to US exports to have potentially different trade impacts. π_o, π_d and π_k are exporter, importer and commodity fixed effects, and ε_{odkt} is the multiplicative error term.

While the Poisson model controls for zero trade flows and sample selection bias, based on the nature of our data, a zero trade observation may indicate a more restrictive MRL policy imposed by a destination country. In particular, an important consideration of MRL policies is whether exporting nations facing stringent MRL policies in destination markets actually export at all. While estimating the Poisson model on two sets of data, first on positive export data and then on positive and zero export data, provides some information, whether omitting zeros lead to significantly different BSI results, Helpman, et al. (2008) offer an intuitive approach. Helpman, et al. (2008) develop a model of selection into exporting, which considers the fixed costs firms need to cover in order to export commodity *k* from region *o* to region *d*. Based on Melitz's (2003) firm heterogeneity framework, only the most productive firms are able to enter export markets. Furthermore, Crivelli and Groeschl (2016) explain different SPS measures can have heterogeneous effects on trade, particularly the costs of trade, including fixed and variable costs. The Helpman, et al. (2008) model developed from Heckman (1979) enables us to distinguish the effect of MRL policy on the extensive (i.e., probability of exporting) and intensive (intensity of exports) margins of trade. Other studies in this line, Crivelli and Groeschl (2016), Disdier and Marette (2010), Jayasinghe, Beghin and Moschini (2010), and Xiong and Beghin (2012) examine the impact of different SPS measures on the extensive and intensive margins of trade.[27]

Thus, the final objective of the empirical modeling is whether exporting nations facing stringent MRL policies in destination markets actually export at all. To do so, we investigate the impact of regulatory stringency of MRL standards on both the probability and level of trade, while controlling for sample selection issues. To that end, a two-stage Heckman model is developed to distinguish the impact of MRL policy on the probability of

[27] While Crivelli and Groeschl (2016) in their study use a broader measure (concern over SPS measures reported to the WTO by exporter at HS4 product line), the three other studies focus on a specific measure. Disdier and Marette (2010) use country specific MRLs; Jayasinghe, Beghin and Moschini (2010) apply SPS regulations using export certification; and Xiong and Beghin (2012) use aflatoxin contaminants.

exporting and the intensity of exports. Heckman's (1979) model retain the log-linear transformation of the model and treats zero trade flows as censored observations. The model includes both a selection and outcome equation as follows:

$$(11) \qquad Y^*_{odk} = \pi_o + \pi_d + \pi_k + \sum_c \theta_c BSI_{codk} + \delta_1 \ln Dist_{od} + \delta_2 RTA_{od} + \delta_3 Lang_{od} + \mu_{odk}$$

$$(12) \qquad \ln X^*_{odk} = \pi_o + \pi_d + \pi_k + \sum_c \theta_c BSI_{codk} + \delta_1 \ln Dist_{od} + \delta_2 RTA_{od} + \varepsilon_{odk}$$

where Y^*_{odk} is a latent variable predicting whether or not bilateral trade between *o* and *d* is observed and ln (X^*_{odk}) is the natural logarithm of the intensity of bilateral trade. Y^*_{odk} and lnX^*_{odk} are not observable in the selection and outcome equations, respectively, but we do observe $Y_{odk} = 1$ if $Y^*_{odk} > 0$ and $Y_{odk} = 0$ if $Y^*_{odk} \leq 0$ and $lnX_{odk} = lnX^*_{odk}$ if $Y^*_{odk} > 0$ and lnX_{odk} is not observed if $Y^*_{odk} \leq 0$. The model can be estimated by a two-step procedure suggested by Heckman (1979) or the one-step maximum likelihood estimation where the selection and outcome equation are estimated simultaneously. The two-step procedure first estimates the bivariate selection equation using a Probit model and generates the standard inverse of the Mills ratio,[28] which is subsequently included as an additional regressor in the outcome equation.

The advantage of the Heckman model is that it can effectively estimate both the extensive and intensive margins of trade by explicitly modeling zero trade flows. That is, it allows us to determine if stringent MRL policies impact the probability of exporting, the intensity of exports, or both. In this model an appropriate exclusion restriction is often required[29], Helpman, et al. (2008) use regulation costs and common religion as exclusion restriction variables. Crivelli and Groeschl (2016) also include common religion as an excluded variable, while other studies in this line employ an excluded variable based on the

[28] The inverse Mills ratio is the ratio of the probability density function (PDF) over the cumulative distribution function (CDF) (Cameron and Trivedi, 2010).
[29] While Cameron and Trivedi (2010) note that the system is theoretically just-identified through the non-linearity of the inverse mills ratio, for practical purposes, they suggest the model requires an exclusion restriction in the selection equation.

availability of data, such as common language, colonial ties, and time.[30] Disdier and Marette (2010) include common language in their selection equation. In this article, we include common language, $Lang_{od}$, as an exclusion restriction because common language may help to facilitate understanding of destination market information on rules and regulations of MRL standards and may help expedite product compliance issues.

3.6. Data Description

Information on MRLs during 2013 and 2014 are obtained from the global MRL database maintained by the Foreign Agricultural Service (FAS) (see mrldatabase.com). Since the global MRL database is frequently updated and without archives, we extracted the MRL data first in December 2013 and then again in December 2014. The established MRL data for each fruit and vegetable by each individual country including CODEX standards were retrieved. The total number of pesticides with established MRLs reported in the global MRL database is 256 chemicals. However, not all pesticides with established MRLs are approved for use. Therefore, we have retrieved data from the National Agricultural Statistics Service (NASS) producer surveys that report 162 chemicals used in fruit and vegetable production. NASS develops surveys to determine on-farm chemical use and pest management information for agricultural commodities. Each chemical's biological name is then matched with the chemical identifier reported in the global MRL database.

Once the list of active chemicals is created, it is then merged with the global MRL data, leaving us with a three-dimensional database of MRLs that varies by country, commodity, and the pesticide chemical name. Our product sample includes 51 fruit and vegetable products (FVs) (see appendix table A) at the 6-digit level of harmonized system for 85 countries with reported MRL tolerances for 162 pesticides used in production over the sample period 2013 and 2014. The raw unbalanced dataset has 678,252 observations

[30] Xiong and Beghin (2012) include a colonial tie dummy variable as exclusion restriction in their model, while Jayasinghe and Beghin (2010) employ a set of time dummy variable in their selection equation.

[31]consisting of a year, country, commodity and pesticide dimension. However, around 42% of observations are missing because an MRL is not registered for use in a given country or an established MRL has not been registered. While some countries maintain default values (e.g. the EU introduces a default value of 0.01 ppm) if no MRL is reported, replacing these missing values with default values does not add much information to our sample (35% of the observations are still missing).

Reported MRLs can be divided into six categories – Codex standards, European Union standards, United States standards, Gulf Cooperation Council (GCC) standards, other countries with their own standards, and countries deferring to exporting countries' standards. Among the 88 countries listed in Table 3.1 for which we collected MRL information, 27 countries adopt the Codex standard for all products and 31 countries set their own standards. Sixteen countries defer to the EU's standard, seven countries use their trading partners' (exporting countries) standards, four countries adopt the GCC standards, and Mexico defers to the US standards. With the exception of Peru (Codex deferral) and Mexico (US deferral), all of the Trans-Pacific Partnership (TPP) and T-TIP members (Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, United States and Vietnam and the EU) set their own MRL standards. Importantly as discussed previously and shown in Table 3.2, some countries establish a default MRL, which can be used if a specific MRL is not reported, a pesticide has not been registered for use, or is in the process of being registered for use. The default values demonstrate the most stringent residue concentration that is permitted.[32]

Table 3.3 provides a comparison of the MRL data for countries that set their own standards relative to the international standard (Codex) and the United States. It also presents for each country the Codex-based stringency index scores defined in Li and Beghin (2013).

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[31] There are 336,510 and 341,742 observations in 2013 and 2014, respectively.
[32] Further information available at www.MRLdatabase.com.

Column (1) (Table 3.3) illustrates the share of each country's MRLs that are stricter (i.e., a tighter limit) than Codex. Relative to the international standard, Brazil's MRL standards appear to be the most stringent among all countries in Table 3.3 with 61 percent of its standards being set at stricter limits than those advocated by Codex. Column (2) presents similar results but instead of the Codex we compare MRL stringencies to the United States. Here, Russia appears to set the most restrictive tolerances with 68 percent of established MRLs being more stringent than the corresponding values set by the United States.[33] Following Russia, Brazil, Turkey, Iceland and Norway with 64 percent and the EU with 63 set their MRLs more stringent than the United States.

Columns (3) and (4) summarizes the degree of MRL policy dissimilarity as measured by the bilateral stringency index (BSI) relative to Codex. Interestingly, our Codex-based BSI calculation reveals that Thailand, Malaysia, Saudi Arabia, Canada, India, Singapore, South Africa, China, the US, New Zealand, Japan [34] and the GCC all have BSI values less than one indicating a less stringent MRL policy compared to Codex. Conversely, the remaining countries from Brazil to Brunei have Codex-based BSI levels above unity indicating a more stringent level of MRL policy. Also of interest are the Codex-based BSI's for EU and TPP countries. Among TPP countries, Chile and Australia have the highest MRL stringency index levels at 1.07 and 1.05, respectively which indicates only a slightly more restrictive MRL policy compared to Codex, whereas many other TPP members including Japan and New Zealand have indices that are much less stringent than Codex and the United States. On the other hand, with an MRL index of 1.25 the EU ranks eighth in terms of its MRL stringency compared to Codex. It should be noted that, the result of MRL index for EU are the same as the results of MRL index in the Li and Beghin's paper. The final two columns in Table 3.3

[33] While Russia reports a limited number of established MRLs, those established MRLs have the most stringent values compared to the US standards.

[34] Our Codex-based BSI for Japan in this paper is less stringent than the one Li and Beghin's reported, while the index without including default are similar. It should be noted that, the range of products and the year in our paper are different compared to the Li and Beghin's study.

report the number of established and non-established MRLs in our database. As shown, the US has the highest number of established MRLs (14,311), while Indonesia has the lowest number of established MRLs (384).

Also of interest is the fact that MRL tolerances differ widely across products for the same chemical. For instance, Acetamiprid is an odorless neonicotinoid insecticide, which controls for sucking insects on some fruits such as citrus, pome, and grapes and leafy vegetables. Codex has established 12 different tolerances for this chemical depending on the fruit or vegetable product being traded. However, the EU, Japan and the US set 19, 15 and 14 unique values for this chemical, respectively, and their values are consistent with Codex ranging from 0.01 to around 5 ppm (with the exception of 15 ppm for the United States). While it is conceivable that biological and production factors necessitate 19 different tolerance levels for a given pesticide (as in the EU), it could also be the case that countries are creating MRL policy flexibility similar to the way in which countries set different tariff rates for the same product depending on the country of origin. At the other extreme, more generic pesticides such as 2,4-D have a much lower range of Codex tolerances across products ranging from a low of two ppm to a high of ten ppm (and the only other unique tolerances are two and five ppm). Similar ranges exist for 2,4-D MRLs in the EU, Japan and the US.

One of the objectives of this study is to disaggregate the stringency index into separate indices over the class of commonly used pesticides in agriculture, which may provide more accurate stringency measures. As we mentioned previously, to determine which measures are responsible for trade disruptions, we disaggregate the BSI index of MRL stringency into separate indices for different chemicals. Pesticides applicable for fruits and vegetables can be divided into several classes of chemicals - herbicide, insecticide and fungicide. Each of them has different characteristics in type and different amounts of resistance in fruits and vegetables. Therefore, we add another dimension to our dataset, which is the type of chemical. Each chemical is mapped to each class of chemical. Our dataset consists of 63 insecticides, 45 herbicides, 42 fungicides, and 12 “other.” If a type of chemical does not belong to one of the three classes of chemicals we call it “other.”[35] It should be noted that, the “other” category is ignored because the number of active chemical in this category were negligible.

Finally, annual bilateral trade of fresh fruits and vegetable products are merged with the constructed MRL database. The bilateral annual export flows of FVs between trading partners are obtained from the United Nations Commodity Trade Statistics Database at 6-digit level of harmonized system. Geographical distance is taken from the *Centre d’Etudes Prospectives et d’Informations Internationales* (CEPII) geo-distance dataset (Mayer and Zignago 2006).[36] Information on Regional Trade Agreements (RTAs) data is obtained from Grant (2013) and De Sousa (2012). Table 3.4 presents the summary statistics for the variables in our econometric model. Our sample contains 95 exporters and importers[37], 51 fruit and vegetable products over a two year sample period. The final sample includes 257,647 observations, of which 65% observations are zero trade flows.[38]

3.7. Results

The results are organized as follows. In section one we present qualitative illustrations of the MRL bilateral stringency index across countries, products and classes of chemicals

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[35] Rodenticides, molluscicides, nematicides, plant growth regulators and acaricides

[36] CEPII is an independent European research institute on the international economy stationed in Paris, France. CEPII’s research program and datasets can be accessed at www.cepii.com. CEPII uses the great circle formula to calculate the geographic distance between countries, referenced by latitudes and longitudes of the largest urban agglomerations in terms of population.

[37] The number of countries is extended to 95 from the original numbers, which were 85. In particular, we kept those EU members who have fruits and vegetables trade flow but did not report MRLs in the global MRL database. The missing MRL values are replaced with the MRLs reported by EU. EU harmonized its MRL system since 2008.

[38] In order to explore if a country has the potential to export a given commodity, we assume if an exporter did not export a given commodity at least 3 times over a period of 10 years (2004-2014), we consider that the exporter does not have the potential to export a given commodity. We make this assumption because retrieving data at 6-digit level of FVs from Food and Agricultural Organization (FAO) is not feasible.

focusing our attention on the EU and TPP markets. While these results illustrate basic trends and bilateral stringency levels across countries and products, they do not establish a more casual link between MRL policy dissimilarities and trade. Section two presents the formal econometric results to test and quantify the extent to which regulatory heterogeneity in MRL policies disrupt bilateral trade in fresh fruits and vegetables.

3.7.1. Bilateral Stringency Index

Table 3.5 presents the simple and trade-weighted averages of the BSI overall and across four different classes of pesticides. Columns (1) and (2) illustrate the simple and trade-weighted averages across partner countries assuming the US is the exporting nation.[39]

Among the countries listed in Table 3.5, Iceland, Norway, Switzerland, the EU, Russia, Turkey, Brazil and the United Arab Emirates have the highest stringency index based on simple averages of the BSI. These countries have a stringency index above 1.5, which shows a potentially high level hidden trade costs in the form of strict food safety tolerances. Iceland has the highest trade weighted BSI against the United States. Commodities with high stringency indices between the US and Norway include brussels sprouts, cauliflower, broccoli, spinach, avocado and leeks with stringency levels between 1.91 and 2.01. The top imported commodities such as apples and grapes have more moderate stringency levels of 1.45 and 1.29, respectively, but still above one indicating the US firms faces greater MRL stringency for exports compared to serving the domestic market. Russian's imports of melons and cherries from the US, for example, have BSIs of 2.17 and 1.92, respectively. The BSIs for the rest of the countries listed in Table 3.5 show moderate stringency levels between one and 1.5. It is also worth mentioning that major importers of US FVs such as Canada, Mexico and Japan have the least stringent MRLs on average.

[39] Recall the BSI is not symmetric and thus the direction of trade flow matters.

Table 3.5 also displays BSIs for many of the Trans Pacific Partnership (TPP) countries. Among TPP countries, Chile and Australia have higher equally weighted stringency level of BSIs of approximately 1.29. However, Chile's trade weighted BSI is much higher than its unweighted BSI, suggesting that commodities sourced from the US with greater values of imports tend to have stricter MRL tolerances. Conversely, for the EU, the trade-weighted BSI is lower than the equally weighted BSI, indicating that US export intensity is higher in less stringent MRL product categories.

Columns (3) through (8) of Table 3.5 also report the stringency level of tolerances for different classes of chemicals. Turkey's BSI for herbicides and fungicides has the highest stringency indices above two, while it has a moderate level of stringency for insecticides on average. In order to simplify these results, Figure 3.1 plots the average trade-weighted bilateral stringency indices for different classes of chemicals, where the vertical axis shows the average stringency level when the US is the exporting country. Again, Brazil, the EU, Iceland, Norway and Russia rank the highest (> 1.5) in stringency among all US trading partners for the insecticides index. Switzerland has an insecticide index around 1.5 and the remaining countries have moderate levels below 1.5 for insecticides. A broader range of countries/regions, including some in the TPP and T-TIP, have herbicide BSIs above 1.5, including Chile, the EU, Indonesia, Norway, Peru, Saudi Arabia, Switzerland, Turkey and Vietnam. BSI-insecticides and BSI-herbicides for China and Japan, and the BSI-fungicides for New Zealand are the only countries with indices below one. It is also apparent that BSI-fungicides generally have a stricter stringency index compared to other classes of chemicals. While the highest level of stringency belongs to BSI-herbicide for Turkey, the BSI-fungicides are consistently close to or above 1.5.

Figure 3.2 displays a distribution plot (boxplot) of the range of the BSIs across commodities within a given country and is useful to decipher the variability of MRL policies for select destination countries. The figure shows that although China has a relatively less stringent MRL policy overall, it has the highest variation among the three pesticide indices compared to other countries (the exception being fungicides for Indonesia). On the other hand, Canada, Japan, Australia and Korea have a much narrower MRL policy span.

Table 3.6 and Figure 3.3 both illustrate average and the variability, respectively, of BSI levels across commodities. Table 3.6 illustrates that vegetables have stricter BSI levels using both equally and trade weighted averages across US trading partners. Specifically, brussels sprouts, broccoli, cauliflower, avocados and celery are five commodities facing the most restrictive MRL tolerances globally. Among fresh fruits and vegetables, apples, leaf lettuce, strawberries and grapes rank the highest among US exports in 2013 and 2014, but on average face moderate stringency levels ranging between 1.14 (grapes) to 1.32 (strawberries). In figure 3.3 fresh tomato exports face the smallest range and lowest level of MRL tolerances for each pesticide class and commodity. For cherries, broccoli, leaf lettuce and onions, however, not only the level but also the variability of MRLs is relatively high.

Given the sensitive nature of NTMs and food safety issues in the T-TIP and TPP negotiations, we next analyze the BSI indices with respect to these markets to assess current regulatory heterogeneity faced by US exporters (Figures 3.4 and 3.5). For TPP markets (Figure 3.4), our results indicate that eight commodities (grapefruits, lemons and limes, oranges, leaf lettuce, tomatoes, pears and quinces, apples, peaches and nectarines) out of 48 commodities with significant exports rank in the top 20 *least* stringent indices to TPP countries in 2013 and 2014. Apples, which ranked 17 out of the 20 of the least stringent MRL tolerances, is the top export of US fruits and vegetables to TPP countries. Here the BSIs are close to one which illustrates that TPP MRLs are closer to equivalent with the US compared to those faced in the EU (figure 3.5). The top fruit and vegetable exports to the EU are grapefruit, apples, grapes, onions, raspberries and blackberries, strawberries, and cherries.

According to our results, three commodities (apples, grapes, and mushrooms and truffles) rank in the top 10 least stringent indices to the EU in 2013 and 2014. On the other hand, avocados and cauliflower rank among the most stringent MRL commodities exported to the EU. Comparing the EU and TPP markets indicates that the stringency levels for the EU are much stricter than those in TPP markets, with values frequently exceeding 1.5 for certain commodities and pesticide classes in the former, compared to values much closer to unity in the latter.

Figure 3.6 also plots the variations of BSI indices for each chemical class for the EU and TPP markets. The boxplot of the EU indices shows stricter indices and wider dispersion compared to TPP markets, particularly among fungicides indicating room for negotiations that would be subject for committee for scenario investigation over MRLs in this class of pesticides. In addition, we conducted a non-parametric two-sample Wilcoxon rank-sum test to test whether differences between the indices across the EU and TPP markets are significantly different. The equality of the BSI indices was easily rejected.

Finally, Table 3.7 simplifies the analysis further by categorizing commodities into bin ranges: less than one, between one and 1.5, and greater than 1.5.[40] Interestingly, the majority of BSIs for TPP markets fall into the middle category, with a smaller but still significant number of commodities – 15, 11 and 5 for insecticides, herbicides and fungicides, respectively – exhibiting BSIs less than one. This underscores the important point that for most fruit and vegetable products, TPP countries have roughly similar BSIs to those of the US. In the EU, the majority of BSIs fall into the last category - greater than 1.5 – indicating a more stringent MRL policy environment and the potential for MRL harmonization in the trade negotiations.

[40] Note that, some fruits and/or vegetables do not have BSI indices across all the classes of chemicals. Therefore, the total numbers of commodities across different classes of chemicals for the EU and/or TPP markets are not equal.

3.7.2. Econometrics Results

The econometric estimates reported here shed light on the degree to which differences in MRL regulatory stringencies affect bilateral exports of fruits and vegetables between trading partners. In the results part we discuss the following. First, we discuss aggregate BSI impacts on trade flows. Second, we discuss the results by augmenting the model with indicators for US exports to TPP and T-TIP markets and the interaction of these with the BSI. In the third section, we distinguish between the different classes of chemicals to determine if the negative and significant trade flow effects of the aggregate BSI results are systematically driven by a particular class of chemicals. Finally, we examine the effects of MRL policy dissimilarities on the probability of exporting and the intensity of exports using a Heckman model. In all regressions, importer, exporter and commodity fixed effects are included and standard errors are clustered by country-pairs.

3.7.2.1. OLS, Poisson and Negative binomial Model

Table 3.8 considers the aggregate BSI effects across all countries and between the US-EU and US-TPP. The results for geographical distance and belonging to a mutual regional trade agreement are of the correct sign and statistically significant across all specifications. In terms of MRL policy, the BSI showcases a negative and statistically significant sign across all model specifications in columns (1)-(6) suggesting that higher BSIs – indicative of a more stringent tolerance in the destination compared to the origin market – significantly reduces bilateral fresh fruit and vegetable exports. Thus, overall, the impact of MRL tolerances is trade impeding because it likely requires more careful production, testing and compliance costs to serve international markets with stricter food safety guidelines. The economic interpretation is similar to a semi-elasticity since the dependent variable is in logs while the BSI is a levels index. A stricter BSI equivalent to an increase in the BSI by 0.1 at the mean (the BSI mean equals to 1.039, which is about 10.39% increase) reduces fruit and vegetable exports by 7% in the OLS model (column 1) and 8.8% in the Poisson model (Column 2).

However, these results are across all countries and products in the database. As well will see, when we introduce individual controls for US exports to the EU and TPP markets in the OLS model (column 4), the results paint an asymmetric picture of MRL trade impacts. Here, the BSI coefficient is more negative and statistically significant for US exports to the EU, but has a positive and statistically significant interaction coefficient for US trade with TPP partners.[41] The result of F-test for the difference between the estimated coefficients also confirms that the US-EU and US-TPP coefficients are statistically different (p-value = 0.00). Quantitatively, the estimates imply that stricter bilateral stringencies of MRLs (by 0.1 at mean) declines US export of fruits and vegetables to the EU members by a striking 23.6% in OLS model (column 4). Thus, the effect of stricter MRLs is quite elastic with respect to its effect on US-EU trade. To examine which countries, among TPP countries are driving the fact that the TPP BSI coefficient is much less strict than EU BSI for US exports, we estimate the model with two different data samples (Table 3.12). First, we exclude Canada and Mexico from the TPP sample, interestingly the TPP BSI for US export coefficient (0.88) magnitude increases (nothing else change) and indicates more lax effect of MRL policies on exports of fruits and vegetables from the US to TPP market, excluding Canada and Mexico. Furthermore, if we only exclude Canada from the TPP market data, the parameter estimated increases even more (1.19). These estimation results for these two new sets of data show, most TPP countries, excluding Canada are driving the fact that the TPP BSI coefficient is much less strict than EU BSI for US exports.

In addition to the baseline estimations, we also allow the BSI effect to vary over

[41] The mean BSI index for EU and TPP markets are 1.59 and 1.12, respectively.

fungicides, herbicides and insecticides (table 3.9).[42] In a similar format to table 3.4 columns (1)-(3) report the results of chemical class-specific BSIs across all trading partners, while columns (4)-(6) distinguish between US-EU and US-TPP markets. The results are robust. With the exception of fungicides in the Poisson model, more restrictive MRL policies tend to impose negative and statistically significant trade distortions (Columns 1-3). In columns (4)-(6), the impact of BSIs for different classes of chemicals on the US-EU and the US-TPP markets are more sensitive and fragile given the lower number of observations in these categories making identification more challenging. However, some interesting findings emerge. First, the mostly negative BSI effects reported in columns (4)-(6) turns out to be driven almost entirely by fungicides and insecticides for the US-EU and insecticides in particular for the US-TPP markets. The results have important policy implications because they suggest specific chemical classes on which trade negotiators can focus attention. Second, herbicide indices of MRL stringency appear to enhance US exports. Because the BSIs measure the stringency of MRL heterogeneity for the US-TPP markets, the results for herbicides suggest that tighter restriction boost trade, and the potential demand enhancing impact of MRL policy with respect to herbicide MRLs.

3.7.2.2. Intensive and Extensive Margins of Trade

We now turn to the results of the Heckman model, which is presented in 3.10. Similar to the previous section, we first discuss aggregate BSI impact on the probability of exporting and the intensity of exports. Second, we discuss the results of aggregate BSI impact on the US exports to EU and TPP markets based on the augmented model. Third, the results of chemical class-specific BSIs across all trading partners are presented. Finally, we report and discuss the results of the dis-aggregate BSIs based on the different classes of chemicals for US exports to EU and TPP markets. In all regressions, importer, exporter and commodity

[42] The last category of chemical class "Other" are dropped from regression estimations because a small number of observations belonging to this category.

fixed effects are included and standard errors are clustered by country-pairs. Furthermore, through all specifications, we include common language as the exclusion restriction in the selection model. We also use common religion as exclusion restriction[43] and the results are robust (Table 3.12).

The results in Table 3.10, columns (1) and (2) suggest that MRL stringency reduces the probability of market entry by -0.03 (selection equation, where the marginal effect [44] of MRL stringency is -0.03) as well as decreases the intensity of exports by -0.51. Thus, MRL policies likely impart significant fixed and variable trade costs of exporting, judging by the negative and significant extensive and intensive margin results. Columns (3) and (5) distinguish the impact of MRL stringency on the probability of exporting and the intensity of export between US-EU and US-TPP markets. While MRL policy indicates a negative impact on the decision to export between US-EU and US-TPP (the marginal effect for the estimated parameter of MRL policy for US export to EU is negative and statistically significant (-0.12), but not statistically significant for US export to TPP markets), the impact of MRL tolerances between US-EU and US-TPP markets is opposite. MRL policy plays an impeding role on the intensity of US exports to EU (-1.15), while this impact is trade enhancing with respect to the US exports to TPP markets (1.06 and statistically significant). Previous studies in this line also find interesting results. Similar to the former result for US-EU, Jayasinghe, Beghin and Moschini (2010) also find a negative and statistically significant impact of MRLs on the probability and volume of US export demand for corn seeds. However, similar to the latter result for US-TPP markets, Disdier and Marette (2010) find while the impact of MRLs on extensive margin is negative but insignificant, it negatively and significantly affects the

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[43] Common religion may also strongly affect the export decision; however, once the new trade relation has been created, it may not impact the amount of trade. Data on common religion across country pairs are collected from Elhanan Helpman's homepage. In their study, Helpman et al. (2008) calculate the index of common religion between trading partners as (% Protestants in region *o* × % Protestants in region *d*) + (% Catholics in region *o* × % Catholics in region *d*) + (% Muslims in region *o* × % Muslims in region *d*).

[44] Since the selection equation is a probit model, we also estimate the marginal effects of the parameter estimated in the selection equation.

intensive margin of imported crustaceans. Furthermore, Crivelli and Groeschl's (2016) find interesting and similar results for their study of the impact of SPS measures on the extensive and intensive margin of trade. Their results (similar to us with respect to the US export to TPP markets) show SPS measures have a negative and significant impact on the market entry, which increase fixed costs of trade. However, SPS standards have positive and significant impact on the intensity of trade. In particular, those exporters who overcome the fixed costs of trade indicate the safety of their products to consumers, and consequently their standards have a positive impact on the intensive of trade.

Additionally, columns (5) and (6) report the results of chemical class-specific BSIs across all trading partners. The results show MRL policy has a negative impact across all chemical classification at both margins of trade. Lastly, columns (7) and (8) report the results of chemical class-specific BSIs while distinguishing MRL policy effects between US-EU and US-TPP markets. While the results are more sensitive and fragile because of the low number of observations in these categories, overall our findings are mostly consistent to our previous specifications. Where for those parameter estimated that are statistically significant, MRL policy has a negative effect on the extensive and intensive margins of trade for US-EU, while negative effect on the extensive margin of trade but positive effect on the intensive margin of trade for US-TPP markets. The coefficients on the gravity control variables are consistent with existing gravity estimates through all specifications. The geographical distance between two trade partners has negative impact on bilateral trades on both the probability of exporting and the volume of trade, while having RTAs fosters exports of fruits and vegetables between trade partners at both margins of trade. Common language reduces the fixed costs of trade and positively affects the probability of exporting.[45]

[45] The results are consistent when we include common religion as the exclusion restriction in the model.

3.8. Conclusions

In this article we focus on a specific type of SPS measures that are prominently featured in the current mega-regional trade negotiations, namely food safety standards in the form of maximum residue limits. This paper introduce the bilateral stringency index to assess how regulatory heterogeneity (and convergence) for pesticide tolerances used in the production process of fresh fruits and vegetables impacts trade between the US and its partner countries in the aggregate and in the proposed mega-regional trade deals. We develop the aggregated bilateral stringency index based on different classes of chemicals, which provides further insight as to the types of pesticides that influence trade flows. In particular, previous studies in this line of work often employ an aggregate measure of stringency or dissimilarity over all chemicals with established MRLs relative to the international standard, whereas we develop a bilateral stringency measure based the fact that it likely matters more to exporters what the MRL policy is in the destination market as opposed to what tolerance level is advocated by Codex.

Second, we construct a new database on international fruit and vegetable exports matched to maximum residue limits for each country in 2013 and 2014. The results of the country-level index indicate that Brazil, Iceland, Norway, Switzerland, Turkey, and the EU rank among the most stringent among all US trading partners, Canada and China, two of the top markets for US exports of fruits and vegetables show moderate stringency levels, while Japan is consistently among the least restrictive MRL partners in our database. At product level, brussels sprouts, avocadoes and celery rank among the highest MRL stringent commodities whereas the top US fruit exports consisting of apples, grapes, oranges, cherries and strawberries, have a moderate stringency index. Further, the results clearly indicate that there is a significant gap in regulations regarding maximum residue limits among several major US foreign markets for fruits and vegetables, particularly EU and TPP. For instance, the BSI-insecticide for apples is stricter than BSI-herbicide and BSI-fungicide between the US and the EU, while there is virtually no difference among the three classes of chemical indices for apple trade between the US and TPP markets. The stringency index results also provide a snapshot of regulatory heterogeneity between the US and its important export markets in the EU and TPP countries. Overall, the bilateral stringency indices suggest much stricter regulations for the EU compared to TPP markets for both fruits and vegetables and across different classes of chemicals, suggesting that trade negotiators will likely want to emphasize the dissimilarity of MRL tolerances in the T-TIP negotiations. Thus, the results of this study provide important policy implications as the negotiations between the US and TPP and T-TIP countries progress. It should be noted that while recently the US has formally withdrawn from TPP, the results of this research is useful for any bilateral trade agreement between the US and TPP countries individually (i.e., Japan).

Using the bilateral stringency indices, we also empirically develop a formal econometric model to understand the trade restricting nature of these measures for fruits and vegetables. More importantly, our augmented trade model has the characteristic to distinguish the impact of MRL policy on exports across all potential exporters and between the US as an exporter and its main trading partners in the Trans-Pacific and Trans-Atlantic trade negotiations. We contribute to the analysis of SPS measures by estimating the impact of bilateral MRL stringency using several specification models. Our findings shed light on the impact of MRL stringency on exports for fruits and vegetables across all trading partners, which impedes trade; it likely requires more careful production, testing and compliance costs to serve international markets with stricter food safety guidelines. However, when we introduce individual controls for US exports to the EU and TPP markets, the results paint a contrasting picture of MRL effects on US exports. The results suggest MRL policy impedes US exports to EU, while it enhances trade with respect to the US exports to TPP markets. The latter result is suggestive of the potentially demand enhancing of MRL policy. Therefore, it is important to take into account the preference of consumer in term of food safety.

Additionally, we also allow the BSI effect to vary over different classes of chemicals, fungicides, herbicides and insecticides. Our findings show the most negative BSI effect turns out to be caused almost entirely by fungicides and insecticides for the US-EU and insecticides for the US-TPP markets. This result is particularly interesting for trade negotiators – it may enable them to focus attention on specific chemical classes. Furthermore, herbicide indices of MRL stringency appear to enhance US exports to TPP markets. This suggests stricter MRL policy of the US may serve as a demand enhancing effect on the US exports to TPP markets, and tighter restriction boost trade.

Lastly, an important consideration of MRL policies is whether exporting nations facing stringent MRL policies in destination markets actually export at all. Therefore, we point out the impact of MRL policy on a market entry barrier to all potential exporters, while decomposing exports into extensive and intensive margins of trade. Our results suggest that MRL stringency decreases both the probability of exports as well as the intensity of exports across all trading partners. Thus, MRL policies likely impart significant fixed and variable trade costs of exporting judging by the negative and significant extensive and intensive margin results. Hence, MRL policy constitutes a market entry barrier to all exporters.

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Figures

Figure 3.1. The BSI indices at country level for different class of chemical- trade weighted (assuming the US as origin country)

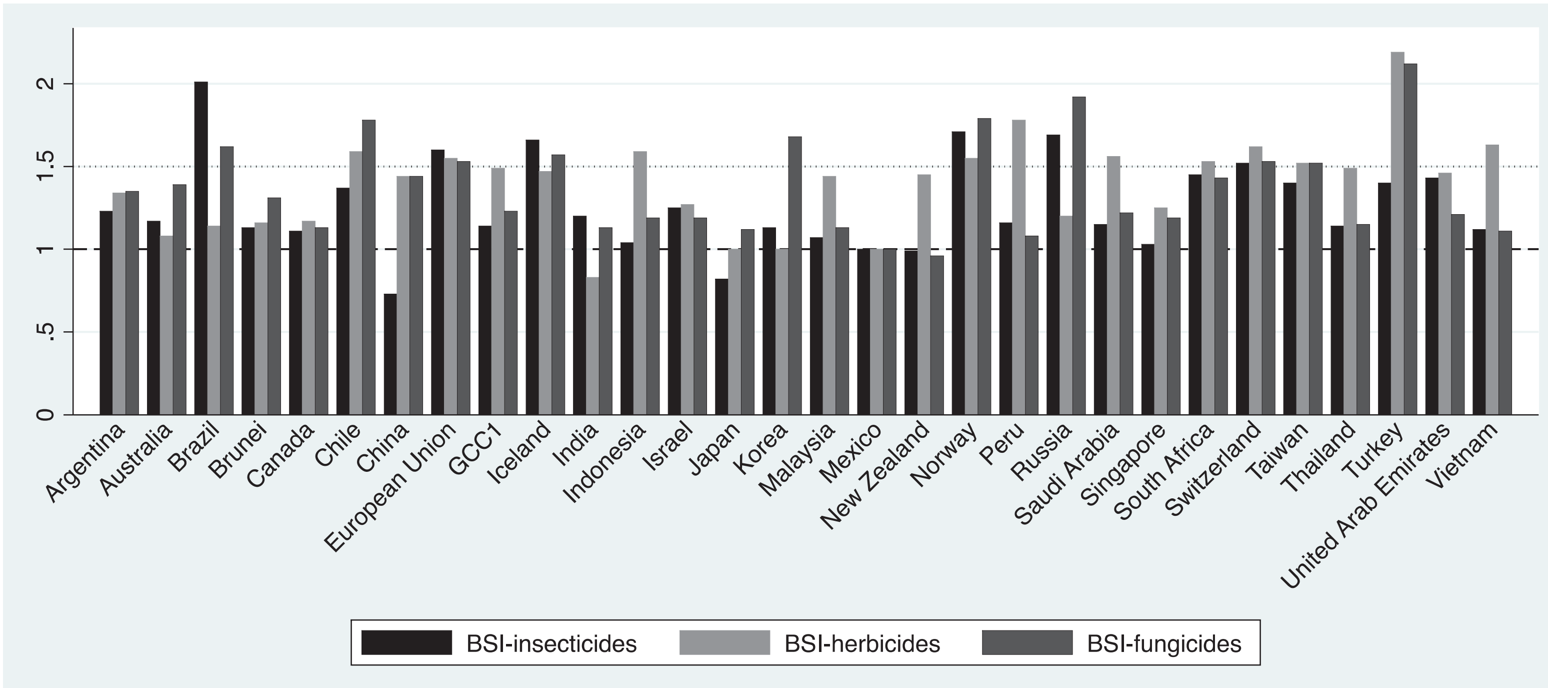


Figure 3.2. The box plot BSI indices at country level for insecticides, herbicides and fungicides

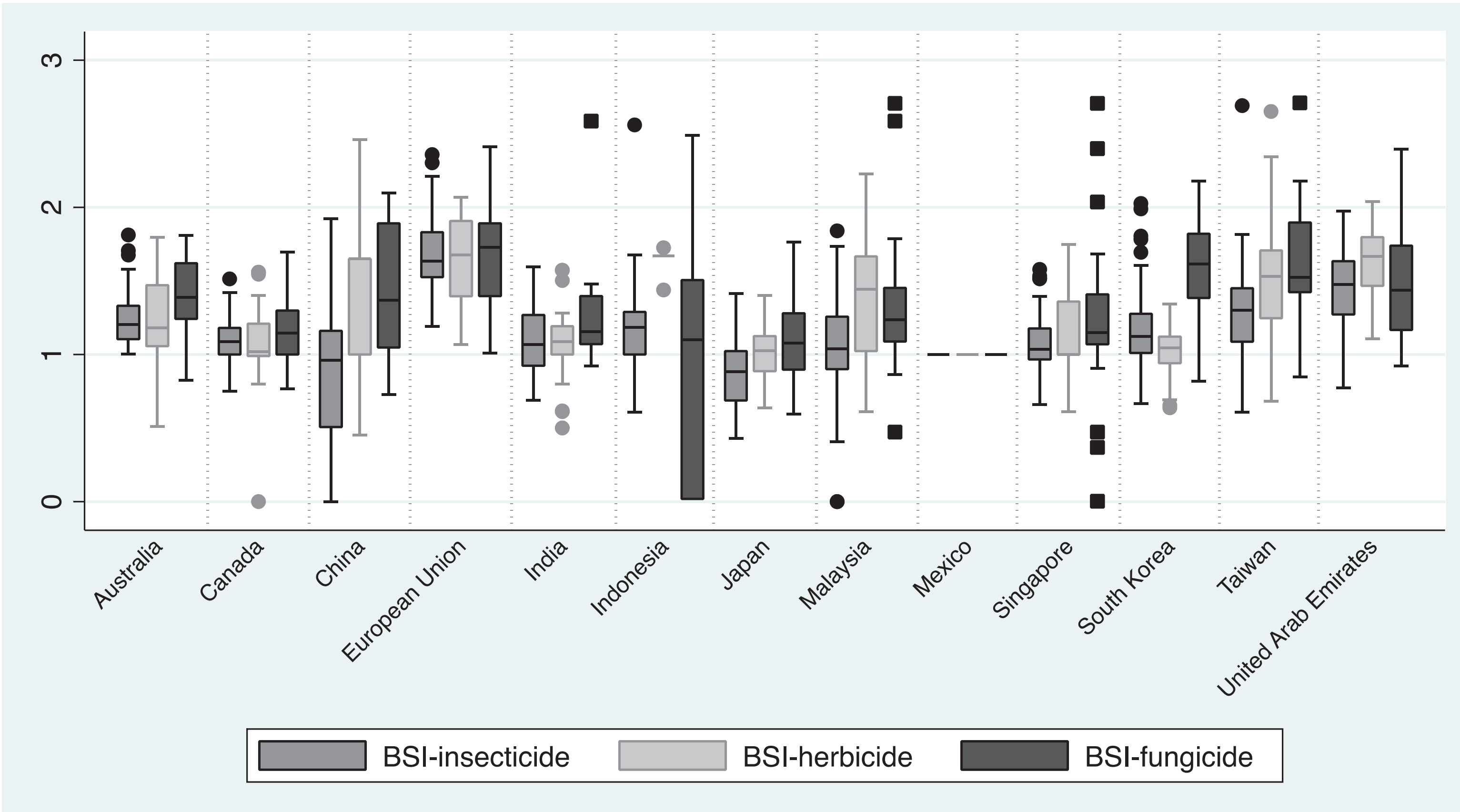


Figure 3.3. The box plot BSI indices at commodity level for different class of chemical insecticides, herbicides and fungicides

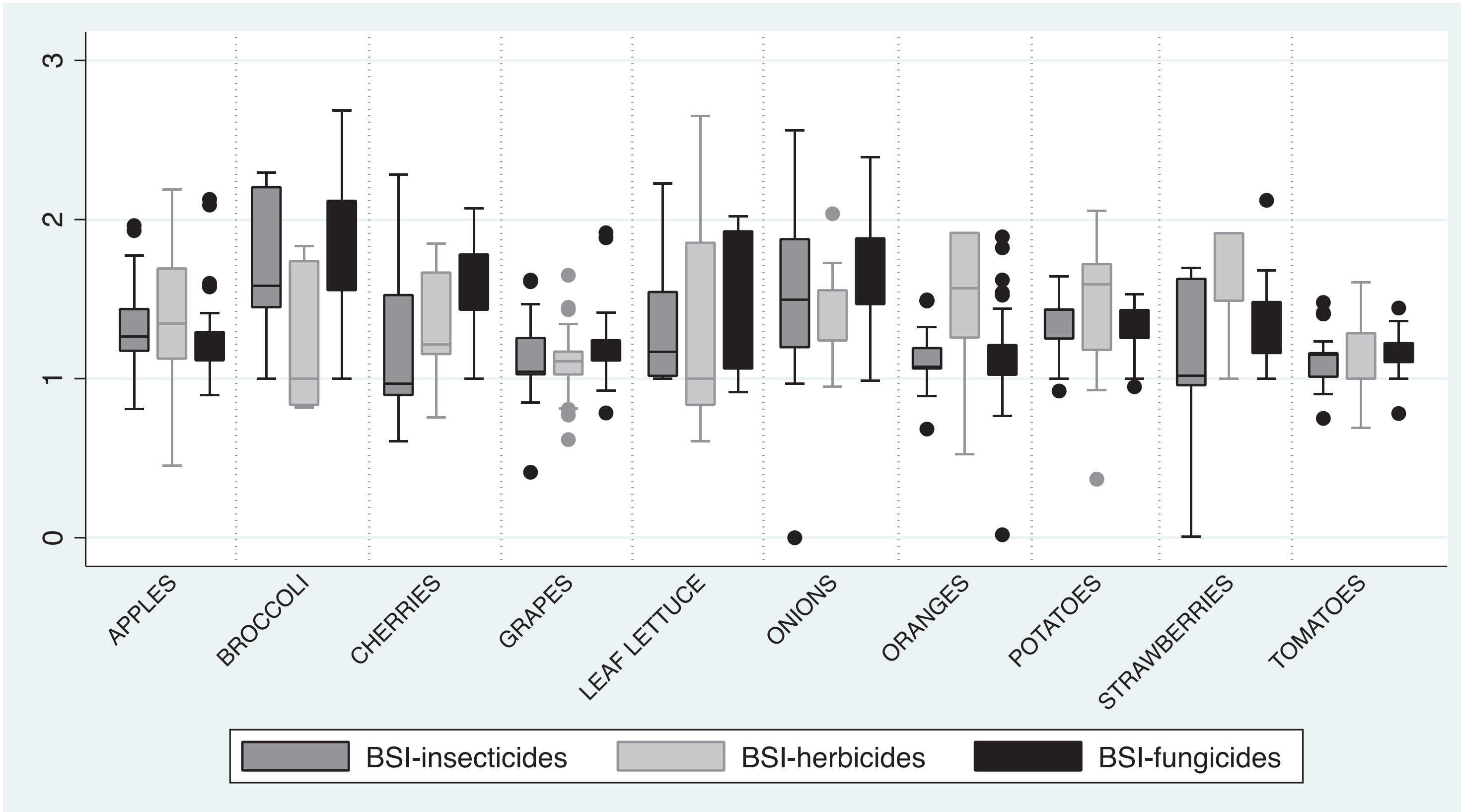


Figure 3.4. TPP Stringency Indices for Top US Exports – Trade Weighted

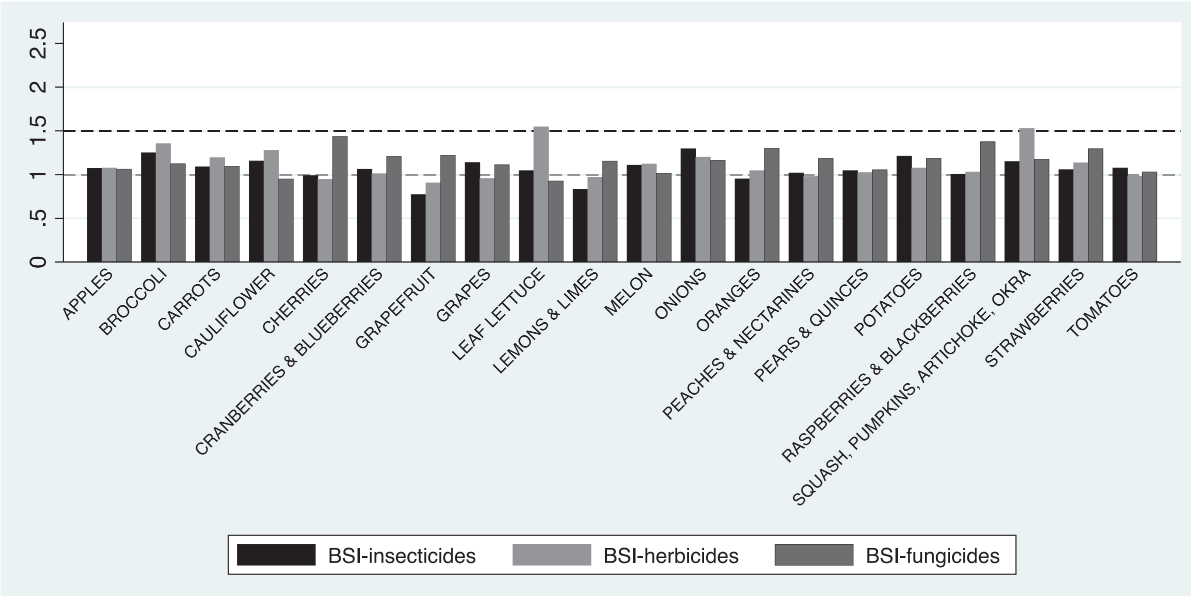


Figure 3.5. EU Stringency Indices for Top US Exports – Trade Weighted

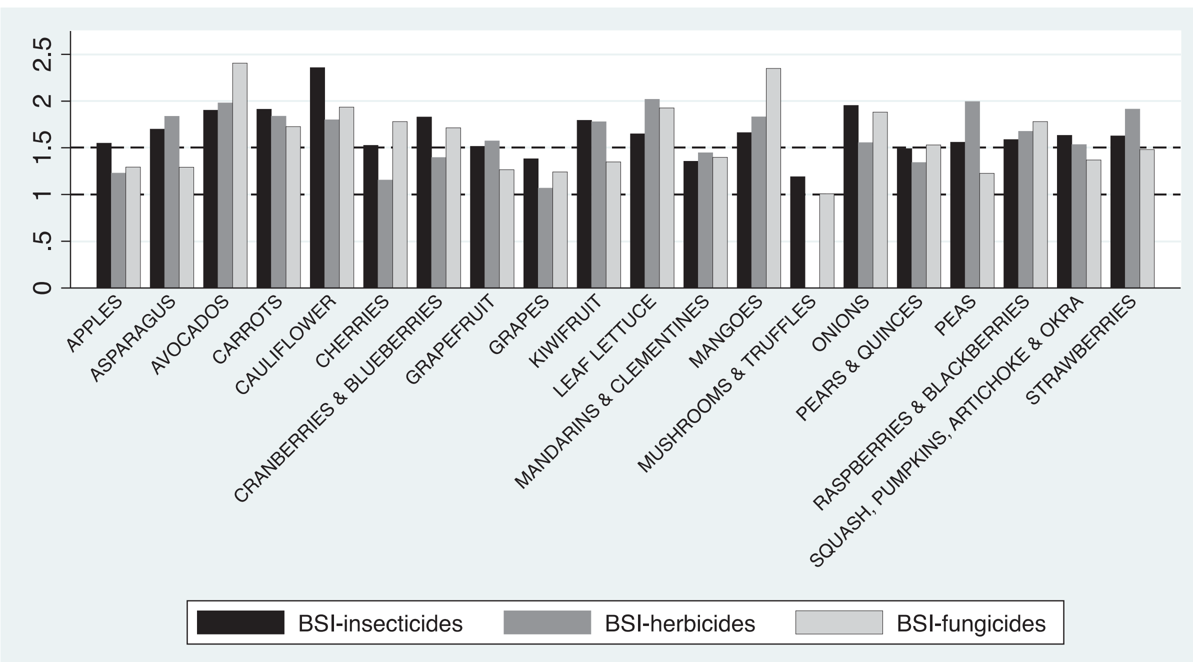
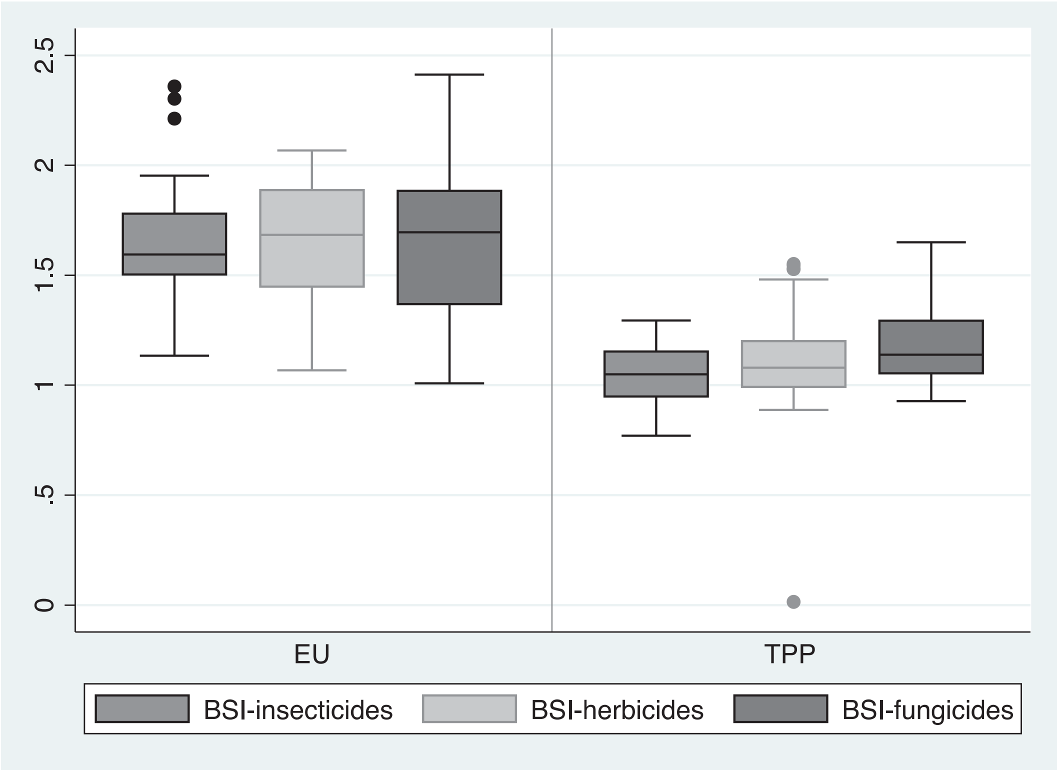


Figure 3.6. The box plot BSI indices for different classes of chemicals across the EU and TPP markets – Trade Weighted



Tables

Table 3.1. List of Countries that report pesticides MRL standards

	List of countries				Notes
Codex	Algeria	Costa Rica	Kenya	Philippines	Some countries may defer to the US or the EU if there is no Codex MRL
	Angola	Dominican Republic	Lebanon	Trinidad and Tobago	
	Bahamas	Ecuador	Morocco	Tunisia	
	Bangladesh	El Salvador	Netherlands Antilles	United Arab Emirates	
	Barbados	Guatemala	Nicaragua	Venezuela	
	Bermuda	Hong Kong	Pakistan	Honduras	
	Cambodia	Jamaica	Panama		
	Colombia	Jordan	Peru		
European Union	Belgium	French Pacific Islands	Ireland	Portugal	
	Denmark	French West Indies	Italy	Spain	
	Finland	Germany	Netherlands	Sweden	
	France	Greece	Poland	United Kingdom	
Exporting countries	Albania	Antigua and Barbuda	Cayman Islands	Haiti	
	Nevis	Sri Lanka	St. Lucia		
Gulf Cooperation Council	Bahrain	Kuwait	Oman	Qatar	
	Saudi Arabia				
Own standards	Argentina	China	Israel	South Africa	Some countries may defer to Codex if there is no own standard
	Australia	Cuba	Japan	South Korea	
	Brazil	Egypt	Malaysia	Switzerland	
	Brunei	Iceland	New Zealand	Taiwan	
	Canada	India	Norway	Thailand	
	Chile	Indonesia	Russia	Turkey	
	Customs Union of Belarus, Kazakhstan, and Russia		Singapore	Vietnam	
United States	Mexico				

Source: MRLdatabase.com, December 2013 and 2014

Table 3.2. Default MRL in parts per million (ppm)

Default MRL in parts per million (ppm)	Country
0.01 ppm	Japan
0.01 ppm	Norway
0.01 ppm	EU
0.01 ppm	Iceland
0.1 ppm	Canada
A default MRL of 0.01 ppm applies when no GCC, Codex, US or EU MRL is established.	Saudi Arabia
Codex MRL	Brazil
Codex MRL	Chile
Codex MRL	India
Codex MRL	Israel
Codex MRL	Thailand
Codex MRLs	Cuba
Codex MRLs	Singapore
Codex MRLs	Vietnam
Codex MRL + 0.01 ppm	Argentina
Codex MRLs + 0.01 ppm	Malaysia
EU MRL regulations + 0.01 ppm	Turkey
EU MRLs	United Arab Emirates (UAE)
Least restrictive value between MRLs established in their national regulation (0.1 ppm default included) and MRLs established by Codex.	New Zealand
Less restrictive value established in the EU and Codex regulations + 0.01 ppm	South Africa
US MRLs + EU MRLs	Dominican Republic
When there is a conflict between the two regulations, MRLs established by the Customs Union take precedence.	Russia

Source: MRLdatabase.com, December 2013, 2014

Table 3.3. Comparing MRL patterns across countries with Codex and US MRLs, and their level of protectionism (International science-based Codex)

Region	More stringent than Codex %	More stringent than US %	Level of protectionism (international science base codex)	Level of protectionism (international science base codex) with default value	Number of established MRLs	Number of non-established MRLs
Brazil	61	64	1.52	1.12	2,065	12,246
Turkey	51	64	1.43	1.39	1,454	12,857
Russia	53	68	1.39	1.57	904	13,407
Switzerland	42	62	1.35	1.35	9,167	5,144
Iceland	35	64	1.29	1.44	10,361	3,950
Norway	35	64	1.29	1.44	10,361	3,950
Taiwan	45	55	1.28	1.28	6,271	8,040
European Union	32	63	1.25	1.40	10,513	3,798
Israel	20	54	1.19	1.19	5,247	9,064
United Arab Emirates	0	60	1.13	1.13	10,871	3,440
South Korea	34	45	1.10	1.10	7,852	6,459
Argentina	10	51	1.09	1.31	4,530	9,781
Chile	8	46	1.07	1.07	5,511	8,800
Australia	38	51	1.05	1.05	5,191	9,120
Indonesia	5	47	1.02	1.02	384	13,927
Vietnam	5	46	1.02	1.02	4,242	10,069
Brunei	8	43	1.01	1.01	4,856	9,455
Thailand	1	45	1.00	1.00	3,927	10,384
Malaysia	3	44	0.99	1.21	4,168	10,143
Saudi Arabia	1	43	0.98	0.98	4,033	10,278
Canada	37	19	0.97	1.28	5,242	9,069
India	2	40	0.96	0.96	4,425	9,886
Singapore	5	40	0.94	0.94	4,514	9,797
South Africa	0	57	0.91	1.00	10,956	3,355
China	21	43	0.89	0.89	827	13,484
United States	30	0	0.88	0.88	14,311	0
New Zealand	0	35	0.87	0.94	4,704	9,607
Japan	17	32	0.73	0.93	9,146	5,165
Gulf Cooperation Council[1]	12	26	0.64	0.64	398	13,913

Note: Codex numbers of established MRLs are 3,839 and non-established MRLs are 10,472.

[1] Gulf Cooperation Council consists of Bahrain, Kuwait, Oman, Qatar, and Saudi Arabia

Table 3.4. Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Trade flow	$796,281	$11.6 mil.	$0.000	$1660.0 mil.
Log Distance	8.587	1.000	4.394	9.894
RTA	0.372	0.483	0.000	1.000
BSI	1.039	0.317	0.000	2.715
BSI-Fungicides	1.040	0.340	0.000	2.717
BSI-Herbicides	1.051	0.402	0.000	2.711
BSI-Insecticides	1.045	0.367	0.000	2.715

Note: Number of observation equal to 257,647.

Table 3.5. The BSI indices at Country Level for different class of chemical (assuming the US as origin country)

Region	BSI		BSI-insecticides		BSI-herbicides		BSI-fungicides	
	Equally weighted	Trade weighted	Equally weighted	Trade weighted	Equally weighted	Trade weighted	Equally weighted	Trade weighted
Iceland	1.679	1.587	1.696	1.660	1.652	1.473	1.702	1.573
Norway	1.673	1.680	1.691	1.710	1.648	1.551	1.711	1.793
Switzerland	1.620	1.518	1.627	1.519	1.484	1.620	1.727	1.528
European Union	1.620	1.567	1.630	1.591	1.635	1.547	1.616	1.521
Russia	1.596	1.559	1.677	1.690	1.388	1.196	1.795	1.920
Turkey	1.570	1.403	1.486	1.399	2.207	2.190	2.018	2.125
Brazil	1.551	1.657	1.557	2.006	1.302	1.141	1.867	1.620
United Arab Emirates	1.507	1.377	1.468	1.428	1.624	1.460	1.490	1.206
South Africa	1.459	1.466	1.403	1.453	1.578	1.533	1.512	1.434
Taiwan	1.426	1.456	1.329	1.397	1.522	1.521	1.635	1.523
Israel	1.360	1.288	1.330	1.251	1.279	1.268	1.652	1.188
Chile	1.288	1.460	1.252	1.366	1.379	1.592	1.344	1.784
Australia	1.277	1.181	1.251	1.174	1.258	1.080	1.405	1.393
Argentina	1.263	1.290	1.166	1.227	1.204	1.338	1.293	1.346
Indonesia	1.252	1.087	1.238	1.037	1.646	1.592	0.939	1.189
South Korea	1.251	1.204	1.200	1.126	1.029	1.004	1.576	1.679
Thailand	1.243	1.201	1.147	1.137	1.594	1.491	1.296	1.153
Saudi Arabia	1.232	1.207	1.142	1.147	1.413	1.558	1.309	1.218
Brunei	1.192	1.206	1.139	1.129	1.130	1.162	1.329	1.312
Vietnam	1.168	1.174	1.037	1.119	1.760	1.626	1.144	1.114
Peru	1.165	1.191	1.048	1.163	1.688	1.776	1.182	1.085
India	1.151	1.157	1.106	1.202	1.060	0.834	1.247	1.130
Singapore	1.144	1.112	1.078	1.033	1.166	1.250	1.239	1.186
Malaysia	1.142	1.131	1.044	1.074	1.401	1.444	1.308	1.125
GCC[1]	1.117	1.131	1.122	1.127	1.057	1.225	1.309	1.228
Canada	1.115	1.121	1.080	1.107	1.080	1.165	1.155	1.129
New Zealand	1.084	1.063	0.964	0.989	1.467	1.454	1.090	0.962
China	1.066	1.054	0.892	0.726	1.428	1.437	1.415	1.443
Mexico	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Japan	0.952	0.922	0.872	0.817	1.008	0.999	1.120	1.120

[1] GCC: Gulf Cooperation Council

Table 3.6. The BSI indices at commodity level for different class of chemical (assuming the US as origin country)

Commodity	BSI		BSI-insecticides		BSI-herbicides		BSI-fungicides	
	Equally weighted	Trade weighted	Equally weighted	Trade weighted	Equally weighted	Trade weighted	Equally weighted	Trade weighted
BRUSSELS SPROUTS	1.618	1.204	1.629	1.215	1.254	1.286	1.682	1.136
BROCCOLI	1.607	1.273	1.655	1.295	1.216	1.330	1.702	1.191
CAULIFLOWER	1.566	1.181	1.642	1.231	1.209	1.257	1.479	1.029
AVOCADOS	1.557	1.300	1.221	1.116	1.723	1.443	2.224	1.706
CELERY	1.557	1.308	1.661	1.333	1.134	1.440	1.400	1.253
MANGOES	1.533	1.750	1.251	1.566	1.769	1.818	2.013	2.253
CARROTS	1.482	1.187	1.590	1.165	1.101	1.221	1.368	1.147
PINEAPPLES	1.478	1.353	1.458	1.341	1.438	0.814	1.994	1.619
ONIONS	1.477	1.306	1.498	1.360	1.323	1.300	1.571	1.301
LEEKS	1.417	1.225	1.512	1.073	1.419	1.098	1.401	1.321
PAPAYAS	1.405	1.088	1.122	0.776	1.762	1.485	1.631	1.597
ASPARAGUS	1.404	1.205	1.338	1.114	1.392	1.318	1.407	1.162
HEAD LETTUCE	1.381	1.196	1.377	1.243	1.177	1.409	1.502	1.122
SPINACH	1.371	1.026	1.363	1.020	1.198	1.010	1.566	1.099
POTATOES	1.344	1.202	1.333	1.231	1.431	1.133	1.324	1.204
EGGPLANTS	1.337	1.023	1.261	1.040	1.196	1.105	1.510	0.961
STRAWBERRIES	1.320	1.187	1.216	1.083	1.558	1.192	1.302	1.300
PEPPERS	1.317	1.225	1.279	1.183	1.228	1.499	1.355	1.108
LEAF LETTUCE	1.296	1.042	1.269	1.060	1.280	1.540	1.415	0.962
FRESH BEANS	1.286	1.169	1.243	1.154	1.595	1.210	1.233	1.164
SQUASH, PUMPKINS ARTICHOKE &	1.279	1.210	1.310	1.178	1.208	1.494	1.286	1.190
BANANAS	1.275	1.309	1.060	0.993	1.551	1.829	1.349	1.332
CUCUMBERS	1.272	1.158	1.335	1.212	1.170	1.140	1.144	1.095
PEAS	1.262	1.182	1.209	1.243	1.677	1.141	1.062	1.111
RASPBERRIES & BLACKBERRIES	1.262	1.205	1.068	1.047	1.624	1.121	1.467	1.406
KIWIFRUIT	1.256	1.223	1.089	1.187	1.748	1.239	1.214	1.416
CHERRIES	1.251	1.161	1.131	1.020	1.354	1.141	1.510	1.461
APPLES	1.248	1.139	1.288	1.161	1.373	1.217	1.191	1.110
MELON	1.231	1.100	1.325	1.126	1.162	1.125	1.027	1.016
PEARS & QUINCES	1.228	1.130	1.209	1.136	1.652	1.201	1.228	1.136
PEACHES & NECTARINES	1.228	1.183	1.192	1.137	1.425	1.174	1.328	1.258
GRAPEFRUIT	1.223	1.103	1.181	1.043	1.593	1.159	1.106	1.238
CRANBERRIES & BLUEBERRIES	1.220	1.140	1.144	1.099	1.520	1.094	1.288	1.240
GARLIC	1.212	1.249	1.058	1.220	1.004	0.995	1.387	1.346
LEMONS & LIMES	1.204	0.953	1.138	0.871	1.661	1.137	1.152	1.126
PLUMS & SLOES	1.199	1.107	1.046	0.935	1.434	1.330	1.566	1.404
ORANGES	1.193	1.052	1.151	0.985	1.561	1.149	1.115	1.292
APRICOTS	1.190	1.137	1.105	0.933	1.340	1.044	1.388	1.389
MANDARINS & CLEMENTINES	1.168	0.959	1.105	0.925	1.497	1.018	1.152	1.023
TOMATOES	1.168	1.049	1.157	1.078	1.123	0.984	1.184	1.037
GRAPES	1.144	1.105	1.121	1.025	1.102	1.116	1.159	1.142
DATES	1.140	1.039	1.140	1.039	-	-	-	-

FIGS	1.079	1.004	1.043	1.003	1.459	0.908	-	-
LEGUMES EXC PEAS BEANS	1.068	1.009	1.080	1.051	1.222	1.086	0.971	0.955
MUSHROOMS & TRUFFLES	0.875	0.868	0.878	0.818			1.002	1.001

Table 3.7. The stringency level across products for TPP markets and the European Union

		BSI<1	1<BSI<1.5	1.5<BSI
	BSI-insecticides	15	33	0
TPP	BSI-herbicides	11	31	4
	BSI-fungicides	5	38	3
	BSI-insecticides	-	12	36
EU	BSI-herbicides	-	13	33
	BSI-fungicides	-	18	28

Table 3.8. Bilateral Stringency Indices Impacts on Exports of Fruits and Vegetables

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method	**OLS**	**Poisson**	**Negative Binomial**	**OLS**	**Poisson**	**Negative Binomial**
Fixed Effects Included						
BSI	-0.70***	-0.88***	-0.44***	-0.68***	-0.86***	-0.41***
	(0.03)	(0.15)	(0.08)	(0.03)	(0.15)	(0.08)
$BSI_{US\text{-}EU}$				-2.36***	-1.38***	-1.58***
				(0.08)	(0.14)	(0.09)
$BSI_{US\text{-}TPP}$				0.70***	-0.15	0.39***
				(0.11)	(0.2)	(0.11)
Log Distance	-1.69***	-0.99***	-1.34***	-1.70***	-1.00***	-1.36***
	(0.01)	(0.03)	(0.02)	(0.01)	(0.03)	(0.02)
RTA	0.99***	1.07***	0.80***	0.93***	0.98***	0.73***
	(0.02)	(0.1)	(0.05)	(0.02)	(0.1)	(0.05)
Observations	257,647	257,647	257,647	257,647	257,647	257,647
(pseudo) R^2	0.527	0.572	0.308	0.529	0.598	0.309

Note: The dependent variable is the log of one plus the value of exports in column (1) and (3) and the level of exports in column (2) and (5). The dependent variable in column (3) and (6) are scaled by million. Robust standard errors are in parentheses. One, two and three asterisks denote significance at the 10%, 5% and 1% levels, respectively. Fixed effects included importer, exporter & commodity.

Table 3.9. Bilateral Stringency Indices Impacts on Exports of Fruits and Vegetables

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method	**OLS**	**Poisson**	**Negative Binomial**	**OLS**	**Poisson**	**Negative Binomial**
Fixed Effects Included						
BSI-Fungicides	-0.27***	0.002	-0.34***	-0.25***	-0.04	-0.32***
	(0.04)	(0.14)	(0.08)	(0.04)	(0.14)	(0.08)
BSI-Herbicides	-0.39***	-0.47***	-0.34***	-0.38***	-0.51***	-0.31***
	(0.03)	(0.09)	(0.06)	(0.03)	(0.1)	(0.06)
BSI-Insecticides	-0.51***	-1.05***	-0.68***	-0.49***	-0.95***	-0.65***
	(0.04)	(0.18)	(0.08)	(0.04)	(0.18)	(0.08)
BSI-Fungicides $_{US-EU}$				-0.54	-0.33	-0.87**
				(0.44)	(0.91)	(0.38)
BSI-Herbicides $_{US-EU}$				-0.26	0.55	0.84*
				(0.48)	(0.73)	(0.5)
BSI-Insecticides $_{US-EU}$				-1.70***	-1.51	-1.46***
				(0.62)	(0.93)	(0.53)
BSI-Fungicides $_{US-TPP}$				-0.07	0.54	0.5
				(0.39)	(0.33)	(0.33)
BSI-Herbicides $_{US-TPP}$				0.75***	1.14***	-0.32
				(0.28)	(0.3)	(0.26)
BSI-Insecticides $_{US-TPP}$				-0.11	-1.61***	0.29
				(0.43)	(0.38)	(0.4)
Log Distance	-1.71***	-1.00***	-1.37***	-1.71***	-1.02***	-1.39***
	(0.01)	(0.04)	(0.02)	(0.01)	(0.04)	(0.03)
RTA	0.93***	1.08***	0.84***	0.86***	0.97***	0.75***
	(0.03)	(0.1)	(0.05)	(0.03)	(0.11)	(0.05)
Observations	207,258	207,258	207,258	207,258	207,258	207,258
(pseudo) R^2	0.542	0.614	0.312	0.544	0.592	0.313

Note: The dependent variable is the log of one plus the value of exports in column (1) and (3) and the level of exports in column (2) and (5). The dependent variable in column (3) and (6) are scaled by million. Robust standard errors are in parentheses. One, two and three asterisks denote significance at the 10%, 5% and 1% levels, respectively. Fixed effects included importer, exporter & commodity.

Table 3.10. Bilateral Stringency Indices Impacts on Exports of Fruits and Vegetables

Estimation Method	Heckman Selection Model							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Selection Pr(exp_{odk} >0	*Outcome Equation*	*Selection Equation*	*Outcome Equation*	*Selection Equation*	*Outcome Equation*	*Selection Equation*	*Outcome Equation*
BSI	-0.17***	-0.51***	-0.17***	-0.49***				
	(0.02)	(0.05)	(0.02)	(0.05)				
BSI $_{US-EU}$			-0.78***	-1.15***				
			(0.04)	(0.07)				
BSI $_{US-TPP}$			-0.02	1.06***				
			(0.06)	(0.11)				
BSI-Fungicides					-0.09***	-0.32***	-0.09***	-0.28***
					(0.02)	(0.06)	(0.02)	(0.06)
BSI-Herbicides					-0.11***	-0.23***	-0.11***	-0.21***
					(0.01)	(0.04)	(0.01)	(0.04)
BSI-Insecticides					-0.09***	-0.50***	-0.09***	-0.46***
					(0.02)	(0.07)	(0.02)	(0.07)
BSI-Fungicides $_{US-EU}$							-0.26	-0.05
							(0.23)	(0.37)
BSI-Herbicides $_{US-EU}$							-0.03	0.16
							(0.19)	(0.39)
BSI-Insecticides $_{US-EU}$							-0.46**	-1.30***
							(0.22)	(0.5)
BSI-Fungicides $_{US-TPP}$							-0.34***	-0.21
							(0.09)	(0.34)
BSI-Herbicides $_{US-TPP}$							0.21**	0.58**
							(0.07)	(0.25)
BSI-Insecticides $_{US-TPP}$							0.08	0.68*
							(0.11)	(0.37)
Log Distance	-0.71***	-1.23***	-0.71***	-1.26***	-0.73***	-1.26***	-0.73***	-1.30***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
RTA	0.29***	0.62***	0.29***	0.52***	0.25***	0.69***	0.25***	0.57***
	(0.01)	(0.04)	(0.01)	(0.04)	(0.01)	(0.04)	(0.01)	(0.04)
Common Language	0.31***		0.31***		0.29***		0.29***	
	(0.01)		(0.01)		(0.02)		(0.02)	
Observations	257,647		257,647		207,258		207,258	
Estimated rho	0.093***		0.109***		0.096***		0.129***	
	(0.009)		(0.009)		(0.010)		(0.009)	
Estimated lambda	0.275***		0.325***		0.284***		0.383***	
	(0.028)		(0.027)		(0.030)		(0.028)	

Note: Robust standard errors are in parentheses. One, two and three asterisks denote significance at the 10%, 5% and 1% levels, respectively. Fixed effects included importer, exporter & commodity. Common Language is the exclusion restriction variable in the model.

Table 3.11. Bilateral Stringency Indices Impacts on Exports of Fruits and Vegetables

Estimation Method	Heckman Selection Model							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Selection Equation	*Outcome Equation*	*Selection Equation*	*Outcome Equation*	*Selection Equation*	*Outcome Equation*	*Selection Equation*	*Outcome Equation*
BSI	-0.15***	-0.49***	-0.15***	-0.47***				
	(0.01)	(0.05)	(0.02)	(0.05)				
BSI $_{US\text{-}EU}$			-0.78***	-1.14***				
			(0.04)	(0.08)				
BSI $_{US\text{-}TPP}$			-0.14**	1.09***				
			(0.05)	(0.11)				
BSI-Fungicides					-0.08***	-0.32***	-0.08***	-0.28***
					(0.02)	(0.06)	(0.02)	(0.06)
BSI-Herbicides					-0.11***	-0.23***	-0.11***	-0.20***
					(0.01)	(0.04)	(0.01)	(0.04)
BSI-Insecticides					-0.08***	-0.47***	-0.08***	-0.44***
					(0.02)	(0.07)	(0.02)	(0.07)
BSI-Fungicides $_{US\text{-}EU}$							-0.33	-0.07
							(0.23)	(0.40)
BSI-Herbicides $_{US\text{-}EU}$							-0.08	0.40
							(0.02)	(0.42)
BSI-Insecticides $_{US\text{-}EU}$							-0.39*	-1.57***
							(0.23)	(0.56)
BSI-Fungicides $_{US\text{-}TPP}$							-0.37***	-0.27
							(0.09)	(0.34)
BSI-Herbicides $_{US\text{-}TPP}$							0.15**	0.59**
							(0.06)	(0.25)
BSI-Insecticides $_{US\text{-}TPP}$							0.03	0.67*
							(0.09)	(0.37)
Log Distance	-0.72***	-1.27***	-0.72***	-1.31***	-0.75***	-1.31***	-0.75***	-1.29***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
RTA	0.29***	0.62***	0.28***	0.53***	0.25***	0.69***	0.25***	0.59***
	(0.01)	(0.04)	(0.01)	(0.04)	(0.01)	(0.04)	(0.01)	(0.04)
Common Religion	0.34***		0.33***		0.31***		0.31***	
	(0.02)		(0.02)		(0.02)		(0.02)	
Observations	238,670		238,670		190,279		190,279	
Estimated rho	0.121***		0.135***		0.127***		0.144***	
	(0.010)		(0.010)		(0.010)		(0.010)	
Estimated lambda	0.362***		0.404***		0.381***		0.431***	
	(0.032)		(0.031)		(0.034)		(0.032)	

Note: Robust standard errors are in parentheses. One, two and three asterisks denote significance at the 10%, 5% and 1% levels, respectively. Fixed effects included importer, exporter & commodity. Common Language is the exclusion restriction variable in the model.

Table 3.12. Bilateral Stringency Indices—Subsample TPP markets

	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method	**OLS**	**Poisson**	**OLS**	**Poisson**	**OLS**	**Poisson**
Fixed Effects Included						
BSI	-0.68***	-0.86***	-0.68***	-0.87***	-0.68***	-0.87***
	(0.03)	(0.15)	(0.03)	(0.15)	(0.032)	(0.15)
BSI $_{\text{US-EU}}$	-2.36***	-1.38***	-2.36***	-1.16***	-2.29***	-1.04***
	(0.08)	(0.14)	(0.08)	(0.15)	(0.08)	(0.15)
BSI $_{\text{US-TPP}}$	0.70***	-0.15				
	(0.11)	(0.2)				
BSI $_{\text{US-TPP (excluding Canada and Mexico)}}$			0.88***	0.97***		
			(0.12)	(0.19)		
BSI $_{\text{US-TPP (excluding Canada)}}$					1.19***	1.35***
					(0.11)	(0.17)
Observations	257,647	257,647	257,647	257,647	257,647	257,647
(pseudo) R^2	0.529	0.598	0.529	0.599	0.528	0.601

Note: The dependent variable is the log of one plus the value of exports in column (1) and (3) and the level of exports in column (2) and (5). The dependent variable in column (3) and (6) are scaled by million. Robust standard errors are in parentheses. One, two and three asterisks denote significance at the 10%, 5% and 1% levels, respectively. Fixed effects included importer, exporter & commodity.

Appendix

Table A. List of commodities

Fruits	Vegetables
APPLES	ASPARAGUS
APRICOTS	BROCCOLI
AVOCADOS	BRUSSELS SPROUTS
BANANAS	CARROTS
CHERRIES	CAULIFLOWER
CITRUS NES	CELERY
CRANBERRIES & BLUEBERRIES	CUCUMBERS
CURRANTS	EGGPLANTS
DATES	FRESH BEANS
FIGS	GARLIC
GRAPEFRUIT	GLOBE ARTICHOKES
GRAPES	HEAD LETTUCE
KIWIFRUIT	LEAF LETTUCE
LEMONS & LIMES	LEEKS
MANDARINS & CLEMENTINES	LEGUMES EXC PEAS BEANS
MANGOES	MUSHROOMS & TRUFFLES
MELON	ONIONS
ORANGES	PEAS
PAPAYAS	PEPPERS
PEACHES & NECTARINES	POTATOES
PEARS & QUINCES	RADISHES ETC
PINEAPPLES	SPINACH
PLUMS & SLOES	SQUASH, PUMPKINS, ARTICHOKES & OKRA
RASPBERRIES & BLACKBERRIES	TOMATOES
STRAWBERRIES	WITLOOF CHICORY
WATERMELONS	

4. China’s Agricultural Domestic and Trade Policies since WTO Accession--Impact on U.S. Agricultural Commodity Exports

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4.1. Introduction

In November 2015, Cheng Guoqiang, a Bureau Secretary General of the Development Research Center, the State Council of China in Beijing said

> “We don’t have to produce major grains all by ourselves for two reasons. First, the environmental carrying capacity is limited in China. Second, it is not necessary to produce all grains from the perspective of food security” (*China Agricultural News*, 2015).

In recent years, the Chinese government implemented agricultural policies that steadily increased domestic support to raise farmers’ income and promote the country’s long-term food security goals (Zhong and Zhu, 2017). China’s policymakers intervened in its agricultural commodity markets by increasing support prices and allocating numerous subsidies to farmers. This intervention led to a price wedge between China’s domestic and international markets, increased production, and resulted in an excessive accumulation of stocks for supported commodities as well as high feed prices for China’s livestock industry (Zhong, 2015; Anderson-Sprecher and Bugang, 2015; Hejazi and Marchant, 2017). At the same time, the production cost of major agricultural commodities, particularly input costs, rose rapidly in China (Zhong, 2015). Thus, China’s policymakers have been at a crossroads regarding commodity policies as the Chinese government has come to realization that the continuation of its support prices for agricultural commodities are more likely to cause greater price distortions and send distorted signals to both the domestic and international markets.

These issues matter for both Chinese policymakers and foreign markets because China is one of the major importers of agricultural commodities in the world (Marchant, 2017). While China accounts for almost 19% of the world's population, it has only 11% of its arable land (World Bank, 2016).[46] Additionally "moderate to severe soil degradation affects more than 40% of China's arable land, exacerbated by overuse of fertilizer, intensive grazing and the reliance on biomass for rural energy" (Campbell, 2016). Therefore, China has great potential to be a destination market for agricultural exports with land abundant regions in the world (Coleman, Fry and Boughner, 2002). In 2001, China became a member of the World Trade Organization (WTO) and significantly opened up its markets,[47] resulting in a dramatic increase of agricultural imports (Gale, 2013). China's influence on global agricultural markets has grown over the years and is now more likely to grow rapidly (Hansen et al., 2017). Thus, China's policy changes are more likely to significantly impact world agricultural commodity markets, especially the U.S., as China's number one supplier of agricultural commodities (Gale, Hansen and Jewison, 2015).

While China's agricultural trade policies play an important role in its imports, policies vary depending on the commodity and self-sufficiency targets (Gale, Hansen and Jewison, 2015). However, these trade policies may be non-transparent to China's trading partners. For example, the tariff rates quota system is set to create a transparent trade channel compared to pre-WTO internal quota and licensing systems. However, the Chinese government uses this system to regulate and control the level of imports into China (Hansen, 2015; Gale, Hansen and Jewison, 2015). These issues particularly create uncertainty and greater risks for exporting agricultural commodities to China.

Given this uncertainty and risk, the main objective of this research is to document and review China's agricultural domestic and trade policies post-WTO accession. In this research we

[46] World Bank population data is updated for the year 2015, but last updated data for arable land is 2013.
[47] Because of reducing its tariffs and eliminating absolute import quotas (Colby, Diao and Tuan, 2001).

sought to answer the question on why China and its agricultural policies are important for U.S. agricultural exports. This research contributes to recent literature by collecting, reviewing, and analyzing policies from many sources with a focus on China's evolving agricultural policies and discussing the potential impact on U.S. exports to China. Additionally, it provides U.S. agribusiness exporters with updated and better knowledge to evaluate potential risks and opportunities associated with diverse agricultural and trade policies in China.

The rest of this paper is organized as follows: first, China's growing demand for major agricultural commodities from the U.S. is explored. Second, China's agricultural and development goals are reviewed, and following that, China's agricultural and trade policies to achieve its goals are discussed. Fourth, China's recent or new challenges as a result of current policies are examined, followed by introducing China's evolving agricultural policies. Finally, potential impacts of China's policies on U.S. agricultural commodity exports to China are identified.

4.2. Overview of U.S. Agricultural Exports to China

Before accession into the WTO, the value of China's agricultural imports were relatively low. However, in recent decades, China's place in the world market has vastly grown and is currently the leading agricultural importing country worldwide (Hansen et al., 2017; Gale, Hansen and Jewison, 2015). China's total agricultural imports rapidly increased from below $15 billion in 2001 to above $115 billion in 2015 (UN Comtrade).[48] China's top suppliers of agricultural imports, including the U.S., Brazil, Australia, Canada, New Zealand and Argentina, are countries with abundant land resources (Gale, Hansen and Jewison, 2015). China's limited arable land and large population (or available per capita arable land) create potential export opportunities for countries with abundant land and water resources.

[48] In this paper the value of imports and exports are nominal values.

U.S. exports of agricultural products to China rose rapidly from below $2.5 billion in 2001 to above $23 billion in 2015. Even though in 2015 China's import of agricultural products from the U.S. decreased by 16% compared to 2014, the U.S. remains China's leading supplier (Figure 4.1). In 2008, China was the fourth top destination for U.S. agricultural exports. Between 2012-14 and again in 2016, China surpassed Canada to become the leading market for U.S. agricultural exports, figure 4.2 (Hansen et al., 2017; Gale, Hansen and Jewison, 2015). China's dramatic upward trend of import flows should be treated with caution in the future, given China's recent economic downturn (*Economist's View*, May 2016).

[Insert Figures 4.1 and 4.2 Here]

Figure 4.3 shows U.S. agricultural exports to China by commodity between 2001 and 2015 (excluding cattle hides). The U.S. share of China's imports for *oilseeds*, *cereal grains*, *cotton* and *meat* were 33%, 30%, 11% and 8%, respectively (UN Comtrade, 2016). S*oybeans*, the top U.S. agricultural commodity exported to China, accounts for nearly all of U.S. oilseed exports and captures the largest share of China's imports from the United States. U.S. *cereal grain* exports, which include *wheat*, *rice*, *corn* and *sorghum*, increased, particularly since 2011, because of dramatic increases in exports of *sorghum* as feed substitutes in response to China's high domestic *corn* price. It should be noted that while China has import restrictions on *corn*, it does not have any import restrictions for sorghum. The U.S. exports of *cotton* surged in 2012 in response to the high domestic cotton price. Thus, China's high domestic price for *cotton* created an export opportunity for U.S. *cotton* exports in the short run. The U.S. export share of *meat* declined drastically, from 40% in 2011 to 17% in 2014 and finally to 8% in 2015. This decline occurred for a variety of reasons such as food safety and antidumping issues (Xie and Marchant, 2015).[49]

[49] U.S. poultry exports fell in 2010 following an antidumping action against U.S. poultry by China. Furthermore, China banned all poultry imports from the U.S. in January 2015 because of avian influenza outbreaks, even though the illness was discovered only in specific regions of the U.S. (Xie and Marchant, 2015). U.S. beef imports have been banned since 2003 due to bovine spongiform encephalopathy (USTR-SPS report, 2012).

[Insert Figure 4.3 Here]

In recent years, U.S. exports of *distillers' dried grains* (*DDGs*) and *sorghum* as feed substitutes increased dramatically (Figure 4.4) in response to China's high domestic *corn* price.

Furthermore, China's *corn* imports are limited due to import restriction, e.g. Tariff Rate Qoutas (TRQs). In contrast, there are no import restrictions on feed substitutes. The U.S. *DDG* exports to China increased by six million metric tons (mmt) between 2009-2015. Similarly, U.S. *sorghum* exports increased by 8.8 mmt between 2013-2015. Prior to China's high *corn* prices, there were virtually no imports of feed substitutes (Anderson-Sprecher and Ji, 2016). In December 2010, China started and imposed a 5% anti-dumping (AD) duty against the *DDGs* exported from the United States (Legos and Junyang, 2012). Thus, this has dropped U.S. exports of *DDGs* to China in 2011 and has been extended until June 2012. However, the U.S. recovered from this anti-dumping case since its DDG exports significantly increased in 2012 and afterwards. Recently, China again imposed a 33% anti-dumping (AD) duty against the *DDGs* exported from the United States to limit their imports (Anderson-Sprecher and Ji, 2016).

[Insert Figure 4.4 Here]

While the above section provided a historical view of U.S-China agricultural exports from a U.S. export perspective, the next section discusses the Chinese government's agricultural and development goals.

4.3. China's Agricultural and Development Goals

The major policy objective of China has always centered on increasing grain capacity to sustain 95% self-sufficiency, which is emphasized in China's Five Year Plans and its No. 1 documents (OECD, 2011 and 2013). The definition of self-sufficiency changed toward the end of 2013 and Chinese policymakers relaxed their food security goal to maintain absolute food security in staple grains -- *rice* and *wheat* -- and allow moderate grain imports for animal feed -- *corn* (OECD, 2015; Anderson-Sprecher and Junyang, 2014).

Increasing China's rural income growth is another top priority of the Chinese government to ensure an improvement of farmers' incomes (Tuan, Zhong and Ke, 2004). These goals are considered as major factors that contribute to China's political stability and are critical or pivotal when formulating and implementing the country's agricultural and trade policies (Zhong, 2015). To fulfill these goals, the Chinese government implemented various agricultural and trade policies since its WTO accession in 2001. These policies are discussed below.

4.4. China's Agricultural Domestic and Trade Policies Post-WTO Accession

Focusing on agricultural domestic policies to maintain grain self-sufficiency and rural income growth, the Chinese government has encouraged farmers to increase production using agricultural commodity subsidies[50] and price support programs. With regard to China's trade policy for agricultural products a hybrid market approach was adopted post-WTO accession in 2001. China's trade reforms after joining the WTO include shifting from a planned trade regime to one based on tariffs, limiting the role of state trading enterprises, and moving toward a more market-driven economy (OECD, 2005). Combined with its WTO commitment, China has adopted a more open trade regime, which significantly reduced import tariffs (Hansen, Tuan and Somwaru, 2011). However, like other countries Chinese policymakers have also kept in place key policy instruments, such as tariff variations and tariff rate quotas (TRQs), to protect its agricultural domestic market (Lohmar et al., 2009). These key policy instruments are discussed below.

4.4.1. Major Agricultural Commodity Subsidies

Since 2004, China's agricultural policy embarked on a new course to increase production and

[50] For example, direct payments, improved seeds and agricultural machinery purchases.

promote food security. The Chinese government began to allocate subsidies to *rice* farmers. Over time, the amount of subsides increased and expanded to other types of subsidies and additional commodities (Gale, 2013; Meng, 2012). At the starting point in 2004, subsidies were allocated nationwide (Gale, Lohmar and Tuan, 2005) in terms of *direct payments*, *improved seeds* and *agricultural machinery purchases* for *rice*, *wheat*, *corn* and *soybeans* and eventually expanded to *cotton* and *rapeseed*.

Focusing on agricultural domestic policies to maintain grain self-sufficiency and rural income growth, the Chinese government encouraged farmers to increase production by allocating *direct payments* to farmers (Huang, Wang, and Rozelle, 2013). Allocating *improved seeds subsidies* to farmers encouraged adoption of new crop varieties with increased yields. *Agricultural machinery purchase* subsidies were distributed to farmers to indirectly reduce production costs (Zhong, Chen and Zhu, 2016). Gradually in 2006, *comprehensive* or *general-input subsidies* and *transfer payments* were also introduced. *Comprehensive input subsidies* include *fertilizers, pesticides, plastic films* and *diesel* and were introduced to compensate the increase in input prices (Zhong, Chen and Zhu, 2016). *Transfer payments* were first distributed to grain counties and in 2008 expanded to *oilseed* and *pork* counties. In 2008, an *insurance subsidy* was introduced and the Chinese government distributed *insurance subsidies* to support farmers to cover some of farmers' losses from the consequences of a natural disaster (Zhong, Chen and Zhu, 2016). In 2009, the Chinese Ministry of Agriculture and the Chinese Ministry of Finance expanded the *improved seed subsidies* for *rice*, *wheat*, *corn* and *cotton* to cover the entire available arable land and include *soybean* acreage in the regions of Liaoning, Jilin, Heilongjiang and Inner Mongolia (Bermouna and Li, 2014).

[Insert Figure 4.5 Here]

Figure 4.5 depicts China's expenditures on major agricultural subsidy programs between

2004 and 2014. Overall, the total support by the Central Government increased from less than $2 billion in 2004 to $20 billion in 2009 and to greater than $30 billion in 2013 (county transfer payments are excluded). However, the total support stopped growing and slightly decreased in 2014 (Gale, 2015). **Since implementation in 2004, the overall growth in subsidy payments to Chinese farmers reflects a strategy of continuously increasing annual subsidies.**

Beginning in 2015, the Chinese government introduced a new agricultural support policy that combined three former subsidies (1) *high quality seeds or varieties*, (2) *direct payments* and (3) *comprehensive input subsidies*. This new combined policy was named "agricultural support and protection subsidies" and also referred to as "3 in 1" policy (seed, input and production subsidy). Pilot programs for this new policy have been implemented for selected provinces including Anhui, Shandong, Hunan, Sichuan, and Zhejiang (major grain-producing provinces). [51] The goal for introducing this new policy was to protect land productivity,[52] increase farm size, use subsidies in a more efficient way, and support production of moderate-scale operations (Tuan, 2015; WTO, 2016).

As developed countries[53] reduced farm subsidies for agriculture, China, as a developing country, spends more on subsidies (*The Economist*, May 2015). According to the 2017 OECD database, the amount of China's domestic support doubled between 2009 and 2015.[54] China's domestic support continues to increase, while the allocated domestic support to

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[51] Source: Gale et al., 2005.

[52] Scarce land and abundant labor encourage the Chinese farmers to maximize land productivity by intensively using labor and variable inputs particularly fertilizers (OECD, 2007). While the rapid increase of fertilizer in China may have helped to increase land production capacity the overwhelmingly usage of fertilizer and pesticide input use has caused a steady decline in total factor productivity (Wong, 1987).

[53] In OECD countries, average spending on farm subsidies dropped from 1.6% to 0.9% of GDP between 1995-97 and 2010-12 (*The Economist*, May 2015).

[54] OECD reports the producer subsidy equivalents (PSEs), which measure the value of agricultural subsidies as a percentage of the value of production at the farm level, including output and input price policies as well as direct payments (OECD, 2017).

farmers have already reached its WTO limits on the Amber Box [55] (according to the Clever and Xinping report in 2015). The Amber Box subsidies are limited because the WTO under the agricultural commitments restricts this type of subsides to 8.5 percent of the value of production. Therefore, China has recently explored other methods like decoupled payments or other allowable agricultural support under the WTO regulations (under Green Box measures) to support farmers' incomes (Clever and Xinping, 2015; OECD, 2013). Most recently, the U.S. has raised its concern to the WTO regarding China's domestic support because China's support already used up its Amber Box payment levels. In particular, the U.S. has brought a trade enforcement action to the WTO, claiming China's government provided excessive support in the form of domestic support for the production of *rice, wheat* and *corn* (USDA, 2016). In the press release related to the complaint, the U.S. makes the argument that the Chinese government's excessive support levels have distorted Chinese domestic prices, undercut American farmers (negative economic effect on the U.S. exports of *rice*, *wheat*, and *corn*), and China failed to meet its commitment to the WTO (USDA, 2016). A dispute panel was established by the WTO for this complaint on January 2017, and recently, the WTO dispute panel has been composed (Orden et al., 2017).

4.4.2. Domestic Price Support, Temporary Reserve Programs and Consequences

4.4.2.1. Domestic Price Support Program

Starting in 2004, China shifted from taxing agriculture to exploring ways to directly assist farmers by providing production subsidies as part of China's price support program[56] (Gale 2013). The primary tool used to encourage production of targeted crops was a *minimum purchase price* for commodities produced in major producing regions in China. This policy has been applied to *rice* and *wheat* since 2004 and expanded to include *soybeans, rapeseed*

[55] Domestic subsidy measures impact production directly and fall into the Amber Box. Based on WTO commitments these types of support must be reduced to a certain pre-determined level for the WTO (WTO website).

[56] China's government gradually eliminated the agriculture tax paid to the government by farmers, and finally the centuries-old agricultural tax was completely eliminated in all provinces in 2006.

and *corn* in 2008 (Gale 2013). Policies for *rice* and *wheat* staple grains are explicitly introduced as a *minimum procurement price policy* through which the government guarantees to purchase *rice* and *wheat* if the market price is lower than the support price (OECD, 2011). The Chinese National Development and Reform Commission along with the Ministry of Agriculture determine minimum prices for *rice* and *wheat* each year to support farmers in major producing areas (FAO, 2012). The prices vary based on different types of grain and are set for a varying time period after harvest (Zhong, Chen and Zhu, 2016). Beginning in 2004, the minimum prices were set below the world market prices. However, domestic prices have increased annually through 2015 above the world price levels (Figure 4.6).

When the grain market price falls below the minimum, farmers sell their commodities to state enterprises at the minimum purchase price. The three main state enterprises are SINOGRAIN (China Grain Reserves Corporation), COFCO (China National Cereals, Oils, and Foodstuffs Corporation), and CGLC (China Grain and Logistics Corporation).[57] These corporations intervene in the purchase of grains and support Chinese farmers' incomes (FAO, 2012). In order to maintain a sufficient amount of supply in the market when the price is high, weekly auctions are held by the Chinese government to release grain procured under the minimum price program. The Chinese government has increased minimum prices to protect Chinese producers from rising input costs and the appreciation of the yuan (OECD 2013). From 2008 to 2015, percentage increases in the price support were 96% to 111% for different types (long grain, medium and short grains) of *rice*, 71% for *wheat*, 68% for *corn*, 30% for *rapeseed*, 49% for *soybeans*, and 8% for *cotton* [58] (Figure 6; Gale, 2013).

[Insert Figure 4.6 Here]

4.4.2.2. Temporary Reserve Program

The temporary reserve program was introduced by the Chinese government under a system of

[57] Since March 2013, CGLC merged and operates as a subsidiary of COFCO limited (Bloomberg, June 2016).
[58] Cumulative increases in price support for cotton was between 2011-2015.

ad hoc temporary buying and storaging programs for *corn*, *rapeseed*, *soybeans*, *pork* and *sugar cane* in 2008 (Tuan, 2015), and in 2011 for *cotton* (OECD, 2011). For example, Chinese authorities purchased large volumes of these commodities to support farmers when international prices fell sharply, especially in early 2009 during the global economic crisis (FAO, 2012; Gale, 2013). The intent of the reserve program was to allow the Chinese government to use stockpiles and consequently reduce imports (Gale, 2013; OECD, 2013). However, both increases in the production levels and imports have left the government with excessive stockpiles of many agricultural commodities, which increased costs of stockholding. Thus, **in 2013, the public stockholding cost for various commodities reached $8.8 billion** (OECD, 2015).

The temporary reserve program for frozen *pork* aims to not only support producers but to stabilize the market for consumers' welfare and to control inflation (Zhong, Chen and Zhu, 2016). In 2009, the government set a price monitoring system for *pork* based on the ratio of the *pork* to *corn* price to ensure a stable *pork* supply to the market and to protect Chinese farmers' income. Under this policy, when the price ratio is low, the Chinese Government subsidizes *pork* meat processors in order to stockpile frozen *pork meat*, and later when the price ratio is high they can sell frozen *pork meat* onto the market (Rabobank, 2012).

Figure 4.7 shows the trend of China's stocks of major agricultural commodities since joining the WTO in 2001. Stocks of *corn*, *cotton* and *wheat* have dramatically increased since 2010. China is currently evolving its price support policies (e.g., target price for *cotton* and *soybeans*) to mitigate its excessive stock levels and to reduce stock additions.

[Insert Figure 4.7 Here]

Based on Anderson-Sprecher et al. reports in 2015, by the end of the 2014/15 marketing year, China held 59% of global *cotton* stocks. China attempted to manage its reserve *cotton* while selling stocks and limiting extra import quotas (Anderson-Sprecher et al., 2015). Even though

China applied policy instruments to reduce production and limit imports, large *cotton* stocks continue, which amounts to 61% of the world's total stocks by the end of 2015/16 (Anderson-Sprecher et al., 2015). Due to China's record *corn* production, *corn* stocks have reached a record high. The data from supply and utilization tables (figure 7) reports ending stocks for *corn* of 100 million metric tons (PS&D USDA-FAS FAS, 2016). However, the actual levels of corn stockpiles are even greater (China Daily, 2016).

Ren Zhengxiao, head of the State Administration of Grain, in the China Daily (2016) reported that "the *corn* stockpile is expected to reach 200 million metric tons by April," which is equal to the total amount of *corn* that China consumes in a year (Wei, January 2016). Through auction, the Chinese government has not been successful in selling the excessive *corn* stockpiles because of the high domestic prices and inconsistency in the quality of *corn* stocks (Anderson-Sprecher et al., 2015).

Chinese agricultural stockpiles reached a record high in 2015. The annual growth rate of domestic grain production was lower than 3%, while the annual growth rate of grain stocks exceeded 8% (*China Agricultural News*, 2015). The State Grain Administration published a notice on its official site about the acquisition and safe-storage of autumn grains in 2015, since grain stocks reached a new record high. The amount of stockpiled grain in storage facilities was unprecedented with very limited remaining storage capacity (*China Agricultural News*, 2015).

4.4.2.3. Consequences of Current Policies

4.4.2.3.1. Price Gap

China continuously increased the support price for key agricultural commodities to achieve its long-term food security goal and raise farmers' incomes. However, the price support and reserve programs have distorted China's agricultural markets. Most Chinese agricultural commodity market prices exceeded the world commodity price, which created a strong incentive to import (Clever and Xinping, 2015). Figure 4.8 compares the *wheat* price in China to the U.S. price, as well as *corn*, *rice*, *soybeans* and *cotton* prices between 2001 and 2015. It illustrates that while U.S. and international prices fell sharply in 2009, China's *wheat*, *corn*, *rice*, *soybeans* and *cotton* prices followed an upward trend (Gale, 2015).

[Insert Figure 4.8 Here]

4.4.2.3.2. Stock Accumulation

The "price support and reserve programs have distorted China's agricultural markets and created inefficiencies in the distribution of the country's production resources" (Zhong, Chen and Zhu 2016, p 10). Since the time of implementation, the price support level for most Chinese agricultural commodities increased despite falling international prices between 2012 and 2015 (Clever and Xinping, 2015). Chinese authorities have purchased large volumes of domestic commodities at support prices. This left the government with excessive stockpiles (Clever and Xinping, 2015). Furthermore, low international prices have created a strong incentive for China to import (Clever and Xinping, 2015). Thus, imports increased for the same commodities that the Chinese government purchased under the temporary reserve program. In other words, China's imports increased (imports added to the domestic market) simultaneously with an increase in stock accumulation (production stored and taken out of the domestic market). Consequently, the oversupply of agricultural commodities has caused a growing financial burden on the Chinese government.

4.4.2.3.3. Environmental Concern

While China's grain production doubled between 1978 and 2013, the usage of fertilizer input (based on nitrogen equivalent) increased by more than seven-fold (Zhong, Chen and Zhu, 2016). **In 2013, the usage of fertilizer in China's crop production was three times the average usage of fertilizer in the world** (Figure 4.9). This application of fertilizer has raised great environmental concerns.

[Insert Figure 4.9 Here]

Chinese policymakers are aware of these negative environmental impacts. In response, Chinese officials emphasized sustainable food production in their recent Five Year Plan and their No. 1 Document (Anderson-Sprecher and Bugang, 2015). As previously mentioned, Chinese policymakers modified the definition of food security to sustain self-sufficiency in only *wheat* and *rice* and allow the increase imports of feed grains, particularly *corn*. Furthermore, they are considering strategies to enhance food productivity by reducing the use of inputs instead of increasing the levels of outputs (Zhong, Chen and Zhu, 2016).

In sum, China's new policies have built large stocks (especially for *cotton* and *corn*, figure 4.7), created a financial burden, resulted in excessive usage of fertilizer, and finally domestic prices have become much higher than import prices. These have become new challenges for Chinese policymakers.

Since 2015, the minimum prices have remained at the same level as in 2014 for *rice* and *wheat* (OCED, 2015), and China is now debating how to reform its price support program to reduce price interventions and balance its stockpiles of agricultural commodities (Gale, 2016). Thus, the Chinese support price policy is evolving and will be discussed in the section titled evolving policies to resolve the challenges. The rest of this section focuses on **China's trade policy** instruments.

4.4.3. China's trade policies -- Tariffs

As a result of WTO accession, China's averaged applied tariffs for agricultural products dropped from 23.1% in 2001 to 18.2% in 2002. This rate fell even more to 15.3% in 2005, which was in line with its WTO commitments. The tariff ranges varied from 0% to 121.6% in 2001 and this upper bound (121.6%) declined to 65% in 2005 (OECD, 2005) and has remained at this level through 2016 (WTO, 2016). China's *grain* and *oilseeds tariffs* dropped from 51.9% during 2001 to 11% in 2005.

For balancing domestic supply and demand, tariff rates are occasionally adjusted. The average applied tariff remained the same during 2005-2010 and in 2011 declined slightly by 0.2% (OECD, 2011). In 2011-2013, the government reduced import tariffs for certain agricultural imports to contain inflation: *agricultural machinery*, *fertilizers*, *animal feed*, *infant formula*, and *frozen seafood* (OECD, 2013).

In 2014, the average applied tariff dropped from 15.1% to 14.8% and maintained this rate in 2015 (WTO, 2016). Even though the average applied agricultural tariff fell since WTO accession (table 4.1), tariffs for *rice, wheat*, *cotton*, *sugar* and *tobacco* did not. The Chinese government considers *rice*, *wheat*, *cotton* and *sugar* as its most important agricultural commodities and *tobacco* as a significantly sensitive commodity (OECD, 2015).

[Insert Table 4.1 Here]

China presumably applied higher tariffs to agricultural commodities that are of national importance to safeguard production. For example, the highest tariffs are applied to *cereals* and *preparations* (23.3%), *sugar* (30.9%), *cotton* (22.0%) and *tobacco* (21.8%), while other products, such as *fruits*, *vegetables*, and *animal products*, have applied tariffs below average because of their comparative advantage in production (these commodities are labour-intensive farm products[59]) (WTO, 2016; Huang and Rozelle, 2002). *Soybeans*, with a high level of imports, have tariff rates equal to 10.5%, which is one of China's lowest tariff protections (WTO, 2016).

Reviewing China's agricultural tariffs reveals that China applies low tariffs for commodities in which it has a high comparative advantage (with the exception of *soybeans*), while China applies high tariffs for commodities of national importance (WTO, 2016). Based on the 2006 WTO report, these varied levels of tariffs may display a potential source of price distortion,

[59] With the largest population in the world, China has limited arable land, but an abundance of labor to produce labor-intensive agricultural commodities.

which seems to stem from China's food security goal through sufficient domestic supply (WTO, 2006).

4.4.4. China's trade policies -- Tariff Rate Quotas

China retained the tariff rate quota (TRQ) system for a set of agricultural products and fertilizers (55 tariff lines at the 8-digit level of the harmonized system in 2005) (WTO, 2006).[60] TRQs restrict the quantity of imports in order to support Chinese farmers' incomes. *Wheat, rice, corn, soybean oil, rapeseed oil, palm oil, sugar*, *cotton* and *wool* are subject to TRQs. In 2006, TRQs were eliminated for *soybean oil*, *palm oil* and *rapeseed oil,* and only tariffs (see above; not TRQs) are applicable for these commodities. Therefore 47 tariff lines at the 8-digit level of the harmonized system were subject to TRQs in 2006 and afterward (WTO, 2009).

The ad valorem rates are considered for both in-quota and out-of-quota tariff rates (WTO, 2016). [61] The in-quota tariffs are around 1% and the out-of-quota tariffs are significantly higher and are mostly equal to bound rates (Table 4.2 depicts the TRQs for *grains* and *cotton*). *Cotton* imports have always exceeded the specified in-quota level (quota fill rate) since the time of implementation (in-quota imports for *cotton* is 0.894 million tonnes per year) (OECD, 2015; WTO, 2016). Based on the 2015 OECD report, a sliding duty is applied for above quota imports (OECD, 2015). Sugar imports have also exceeded its quota fill rate (in-quota imports for *sugar* is 1.945 million tonnes per year) (WTO, 2016). The quota fill rates for the rest of the commodities are low (OECD, 2016). While these fill rates for *wheat,*

[60] "The 55 tariff lines are included in HS Chapters 10 (*wheat* and *meslin*, *corn*, *rice*), 11 (cereal flour other than *wheat* and *meslin*, *cereal groats*), 15 (*soybean oil*, *palm oil*, *rape colza*, *mustard oil*), 17 (*cane* or *beet sugar*), 3 (*mineral chemical fertilizers*) and 51 (*wool* and *waste of wool*). Although *fertilizer* is not an agricultural product under the WTO definition, it is included in this section because of its importance as an input. Upon accession, China replaced quantitative import restrictions on *sugar*, *cotton*, and three types of *fertilizers* (DAP, NPK, and urea) by TRQs" (WTO document WT/ACC/CHN/49, 1 October 2001).

[61] Except the out-of-quota rate for a type of *cotton*, which is subject to a sliding duty, which depends on the price of *cotton*; however, it cannot exceed 40% (more detail refers to WTO reports 2016).

corn and *rice* increased recently, they did not exceed the boundary for the in-quota rate (OECD, 2015).

[Insert Table 4.2 Here]

China's National Development and Reform Commission (NDRC) manage the quota system for *grains* and *cotton*, and the Ministry of Commerce (MOFCOM) are responsible for the remaining commodities. The NDRC and MOFCOM administrate and publish the announcement for TRQ levels and also determine how much of import quotas are allocated to state trading enterprises.

While limiting the influence of state trading enterprises (STEs), which was one of the gradual liberalization goals of China's foreign trade regime, the Chinese government allows STEs to control imports of key agricultural commodities. The state trading enterprises influence key agricultural imports to ensure a stable supply of these commodities. STEs control the import of grains (including *corn*, *rice*, and *wheat*), *sugar*, *tobacco*, *cotton* and *chemical fertilizers* and they are responsible to set import prices, which are based on the c.i.f. (cost, insurance and freight) prices, plus tariffs and other charges. The share of imports under TRQs allocated to STEs is relatively high. STEs have the authorization to import 90% of the *wheat* quota, 70%, 60%, 50% and 33% of the *sugar, corn, rice*, and *cotton* quotas, respectively (Anderson-Sprecher et al., 2015; WTO, 2012). The remaining imports under TRQs are allocated to private enterprises (Hansen, Tuan and Somwaru, 2011; Anderson-Sprecher et al., 2015).

4.4.5. China's trade policies -- Free Trade Agreements (FTAs)

As of December 2015, 15 preferential trade agreements were signed by the Chinese government (WTO, 2016). Concurrently, 12 *Trans-Pacific Partnership* (TPP) countries[62] – including the U.S. – signed a trade agreement; however, China was not involved. It should be

[62] The 12 countries include US, Japan, Malaysia, Vietnam, Singapore, Brunei, Australia, New Zealand, Canada, Mexico, Chile and Peru.

noted that seven out of twelve TPP countries have already signed FTAs with China. As of January 2017, the U.S. formally withdrew from TPP.

China continues to expand free trade agreements (FTA) to diversify its agricultural suppliers beyond the *U.S.* and *South America*. The *Asia-Pacific Trade Agreement* (APTA) is a FTA among developing countries in the Asia-Pacific region as a preferential trading agreement in 2009. China is further extending its FTA with other countries and as a result has signed a number of *bilateral FTAs* with *Chile* (in force since 2006), *Pakistan* (2007), *New Zealand* (2008), *Singapore* (2008), *Peru* (2009) and *Costa Rica* (2011) (OECD, 2011).

In January 2010, the *China-ASEAN Free Trade* Area (CAFTA) was implemented, which is among China and *Brunei*, *Indonesia*, *Malaysia*, the *Philippines*, *Singapore* and *Thailand*. China also offered unilateral preferential tariffs on certain products to the least developed countries in 2013 (WTO, 2012; OECD, 2015). In mid-2014, the bilateral trade agreements between China and *Switzerland* and *Iceland*, respectively, were implemented (Ministry of Commerce, 2015; OECD, 2015). The *China-Australia FTA*, ChAFTA, was concluded and announced in November 2014 (OECD, 2015). China also signed a FTA with *South Korea* in June 2015 and agreed to implement it on December 2015 (Qing, 2015).

4.5. Evolving Policies to Resolve China's Challenges

To recap, the key challenges identified from the above sections include (1) high Chinese domestic prices relative to international prices, (2) growing Chinese stockpiles along with (3) the sustainability of agricultural development. China continuously increased its support price for key agricultural commodities in an effort to achieve its long-term food security goal and raise farmers' incomes. But the support price and reserve programs distorted China's agricultural markets and, as previously mentioned, created inefficiencies in the allocation of the country's natural resources (Zhong, Chen and Zhu, 2016).

4.5.1. Elimination of price supports for all commodities except rice and wheat

The major challenges confronting Chinese policymakers currently are how to increase farmers' income and improve food security without distorting domestic market prices and accumulating massive stockpiles. To do so, in the 13th Five Year Plan, the Chinese government announced a market oriented price formation system (Zhong, Chen and Zhu, 2016), and began abandoning its price support program for major agricultural commodities, except *rice* and *wheat*. *Rice* and *wheat* are the two food grains that the Chinese government continues to purchase at its minimum support price. However, this price policy will **no longer be based on <u>continuously increasing</u> minimum prices each year**. Thus, the minimum support price will not be used as a tool for <u>increasing</u> farmers' income (Clever and Xinping, 2016b). It should be noted that, the price support may decline relative to the declining world prices but the rate of farmers' income protection may increase. The Chinese government introduced pilot programs in selected provinces that have changed the support price policy into a target price for *cotton* and *soybeans* and terminated the support price for c*orn*, discussed below.

4.5.2. Target Price for Cotton and Soybeans - Pilot Program

In the 2014/15 marketing year, Chinese policymakers introduced a target price policy pilot program for *cotton* and *soybeans*, which replaced the support price and temporary reserve programs. Under this policy if the target prices are above market prices, the Chinese government allocates a *direct subsidy* to farmers, based on the difference between the target and market prices. Unlike the prior price support/temporary reserve programs, stocks will not be accumulated since the governement no longer purchases the supported commodities.

4.5.2.1. Cotton

The Chinese government introduced the target price policy for *cotton* to reduce large stockpiles, which accumulated because of the support price embodied in the temporary reserve programs. Specifically, high domestic *cotton* prices encouraged farmers to produce more, while the surplus was purchased by the Chinese governemnt and went to stocks. Simultaneously, low international prices increased *cotton* imports even though the Chinese government had imposed limits on the amount of imports using TRQs.

The *target price* began in the marking year 2014/15 and covers *cotton* in only Xinjiang Autonomous Region, the key *cotton* production area in China (Clever and W. Xinping, 2015). If the market price for *cotton* falls below the target price the Chinese government will *distribute direct subsidies* to farmers (OECD, 2015; Zhong, Chen and Zhu, 2016). The payment mechanism is based on the 90% of funds allocated to producers on the basis of certified production sold and 10% allocated to the southern part of Xinjiang to be paid on the basis of certified planted area (OECD, 2017).

In 2014/15, the target price for *cotton* was $3,220.00 (19,800 Yuan) per ton and this price was reduced in the 2015/16 to $3,081.00 (19,100 Yuan) per ton (Figure 4.10). Therefore *cotton* profits and production were effectively reduced in 2015/16 as a result of the lower target price in the previous marketing year. The target price for *cotton* continued to decline in the following marketing year 2016/17 to $2,906.00 (18,600 Yuan) per ton (Clever and Xinping, 2016a). While the target price for *cotton* declined since the time of implementation, it is still higher than the international price for *cotton* (17,147.47 and 13,238.50 Yuan per ton in 2014 and 2015, respectively).

According to Clever and Xinping report (2016a), this new pilot policy was successful for *cotton* in the first two years of its implementation "in terms of contribution to a market oriented *cotton* price formulation mechanism, a stable *cotton* acreage and a reasonable income for farmers" as well as "in facilitating the restructuring of the *cotton* industry and increasing the efficiency of the government" direct subsidy allocated to the target price policy for *cotton* (Clever and Xinping, 2016a p.17). Based on the 2017 OECD report, the target price will maintain until 2020 (OECD, 2017).

[Insert Figure 4.10 Here]

4.5.2.2. Soybeans

Unlike *cotton*, where the motivation behind the target price was to reduce stockpiles, for *soybeans*, the pilot target price program was to encourage production. It began in the marketing year 2014/15 and covers *soybeans* in four Northeast provinces of Heilongiang,[63] Jilin, Liaoning and Inner Mongolia (Clever and Xinping, 2015). Similar to *cotton* under this policy, if market price for *soybeans* falls below the target price, a *direct subsidy* is allocated to farmers based on the difference between the target and market prices and the area of production (Clever and Xinping, 2014; OECD, 2015; Zhong, Chen and Zhu, 2016). However, *soybean* farmers are still struggling to boost yields and production levels. Based on the Clever and Xinping report (2016b), *soybean* yield remains constant due to the lack of accessing enhanced seed technology (Clever and Xinping, 2016b).

In the marketing year 2015/16, this new pilot policy encouraged farmers to increase soybean production; however, this impact was negligible. Similarly, it seems there was no change in *soybean* production in the marketing year 2016-17, but the Chinese government continues this new pilot price policy for the marketing year 2016-17 (Anderson-Sprecher and Ji, 2016). In 2014-15, the target price for *soybeans* was $770.50 (4,800 Yuan) per ton (Figure 4.11 and Anderson-Sprecher et al., 2015). This target price has not changed since the time of implementation (Anderson-Sprecher and Ji, 2016). In comparison with the international price for *soybeans*, the Chinese target price for *soybeans* is higher than the international price for soybeans (3,864 and 3,097 Yuan per ton in 2014 and 2015, respectively).

[Insert Figure 4.11 Here]

Since the implementation of the target price policy, the target price for *cotton* has been

[63] Heilongiang is the largest soybean-producing province in China.

reduced, while the target price for *soybeans* has been constant.

4.5.3. Stockpiles and Ending the Support Price for Corn - Pilot Program

Toward the end of March 2016, Liu Xiannan, Director of the Economy and Trade Office of China's NDRC, publicized an end to the price support policy for *corn*. The Chinese government introduced a new mechanism of market purchase for *corn* and ended the temporary reserve program in the Northeastern provinces and Inner Mongolia (Clever and Xinping, 2016b). The main reasons for ending the floor price for *corn* include China's excessive stocks of *corn*, environmental concerns and unsustainable farming practice with excessive use of fertilizer (Clever and Xinping, 2016b). China experienced *corn* surpluses for consecutive years with growing stockpiles (refer to figure 4.7). Some *corn* stocks have deteriorated and cannot be sold (Clever and Xinping, 2016b).

As a result of announcing the elimination of the *corn* support price policy, China's *corn* price fell, which affected the value of *corn* stocks. The price of *corn* fell sharply from RMB1,586 in January, 2016 to RMB 1,497 at the end of March, 2016 (Clever and Xinping, 2016b). For China's *corn* stockpiles, this decline led to a paper loss of over $10 billion and even larger total costs when considering the cost of storing *corn* and the *corn* stocks that were already molded (Clever and Xinping, 2016b). The Chinese government on the other hand encouraged increased *corn* consumption in industrial uses, such as processing and ethanol production (Gale et al., 2009).

4.6. China's Policies: Impacts on U.S. Agricultural Commodity Exports

China continuously reformed its agricultural policies (described above) to achieve its development and agricultural goals. However, its agricultural "policies have played a significant role in promoting U.S. agricultural exports with varying degrees for different commodities" since WTO accession (Gale 2013, p. 33). These policy changes have important implications for U.S. agribusiness exporters because China is one of the top destinations for

U.S. agricultural exports (figure 4.2). The following section exemplifies the impact of China's agricultural policies on U.S. agricultural exports with an example of China's policies for *corn* over time.

4.6.1. Changes in China's corn support price since WTO accession and impacts on feed substitute markets

As described above, beginning in 2008 China's continuously increased the support price for *corn* creating a price gap, where China's domestic *corn* price far exceeded the world *corn* price (figure 4.8). Due to import restrictions (imposing TRQs), China's *corn* imports were limited. In contrast, there were no import restrictions on animal feed substitutes for *corn*. This resulted in a significant increase in world and U.S. exports of feed substitutes to China, e.g., *sorghum*, *DDGs* and *barley*.

However, with the recent pilot program to eliminate China's Northeastern *corn* support price, both China's domestic and the global market are impacted. Many farmers in China have profited from producing *corn* because of its high domestic price. With this new policy China's domestic *corn* price falls and producing *corn* will not be as profitable for Chinese farmers (Clever and Xinping, 2016b). The export level of feed substitutes such as *sorghum*, *barley* and *DDGs*, rapidly increased since 2012 because of China's high domestic *corn* price. More recently (2016), the declining domestic *corn* price is expected to decrease feed substitute imports. *Sorghum* and *barley* imports fell by 33% and 29% in the marketing year 2015/16, respectively (Clever and Xinping, 2016b). Further, based on the Clever and Xinping report (2016b), *sorghum* and *barley* imports are predicted to fall by 26% and 14% in the marketing year 2016/17, respectively (Figure 4.12).

[Insert Figure 4.12 Here]

This policy change will impact U.S. *sorghum* exports (Wang and Malaga, 2016). The U.S. exported 90% of its *sorghum* to China in 2014/15 (Clever and Xinping, 2016b; Wang and

Malaga, 2016). Similarly, this new policy to eliminate China's *corn* support price (a free market *corn* price) may impact U.S. *DDG* exports to China, which rapidly increased during recent years (figure 4.4).[64] In the short-term, this new policy reduces the export of U.S. and world feed substitutes to China due to the release of existing *corn* stock reserves. In the long-run, when *corn* stockpiles reach a certain level, it is expected that domestic demand and supply for *corn* will determine China's domestic *corn* price and imports of feed substitutes (Zhong, Chen and Zhu, 2016).

The review of these policy changes points out how China's agricultural policies play a role in U.S. agricultural exports to China (Marchant, 2017). China's evolving agricultural policies should be closely and timely monitored by the U.S. government and U.S. agribusiness exporters (Gale, 2015). In sum, China's agricultural imports are increasing; however, as Zhong (2016) described several factors might influence U.S. exports to China, including (1) "the periodically political difficulties" and (2) "disputes on non-farm trade" between the two countries as well as (3) "China's changing priority in overall development."

4.7. Summary and Conclusions

In this research we sought to answer the question on why China and its agricultural policies are important for U.S. agricultural exports. From the U.S. perspective, China is one of the top markets for U.S. agricultural exports, and in fact between 2012-14 and again in 2016, China surpassed Canada to become our top market. U.S. agricultural exports to China rose rapidly from below $2.5 billion in 2001 to above $25 billion in 2016. From China's perspective, the U.S. is China's top supplier of its agricultural imports. Even though in 2015 China's import of agricultural products from the U.S. decreased compared to the previous year, the U.S. remains the leading supplier among China's major importing countries.

[64] It should be noted that figure 4 reports data based on the calendar year; however, figure 14 reports data based on the marketing year.

From China's policy perspective, the Chinese government implemented agricultural and trade policies that steadily increased domestic support to raise farmers' income and promote its long-term food security goals. To accomplish these goals, China's policymakers intervened in the market by not only providing support prices but also steadily increasing support prices. This intervention led to price disparities between domestic and international prices in agricultural commodity markets. Both this and China's openness to the world market demonstrated after joining the WTO in 2001 resulted in a dramatic increase in imports of certain agricultural commodities and an accumulation of large stockpiles of domestically produced agricultural commodities.

Most recently, Chinese policymakers have strived to reduce China's large stockpiles, especially for *cotton* and *corn*, and to narrow the price gap between China's domestic and international markets. In order to achieve these goals, Chinese policymakers changed its agricultural policies, particularly support price policies for *cotton*, *soybeans* and *corn*. A new target price policy replaced the support price and temporary reserve programs for *cotton* in the Xinjiang Autonomous Region to decrease production and *cotton* stockpiles. This new pilot policy for *soybeans* is implemented in the four Northeast provinces to increase soybean production. Furthermore, the Chinese government recently announced a pilot program to eliminate the support price policy for *corn* in the Northeastern provinces and Inner Mongolia to reduce *corn* production and *corn* stockpiles. Implementing this new pilot *corn* price policy impacted the global agricultural market along with the United States. The recently lower domestic *corn* price reduced China's imports of *corn* substitutes, *sorghum* and *DDGs*, which were dramatically increased especially from the U.S. in the last few years due to high domestic *corn* prices in China (figures 4.4 and 4.12).

Despite China's evolving agricultural policies, which are temporarily reducing import of agricultural commodities and the recent economic downturn, China's increase and expansion of imports may be inevitable in the long-run (Hejazi and Marchant, 2017). In summary, China has one-fifth of the world’s population along with one-tenth of the world’s arable land. Therefore China is not likely to avoid its dependence on the global market (World Bank, 2016), including the U.S., either through trade or foreign direct investment.

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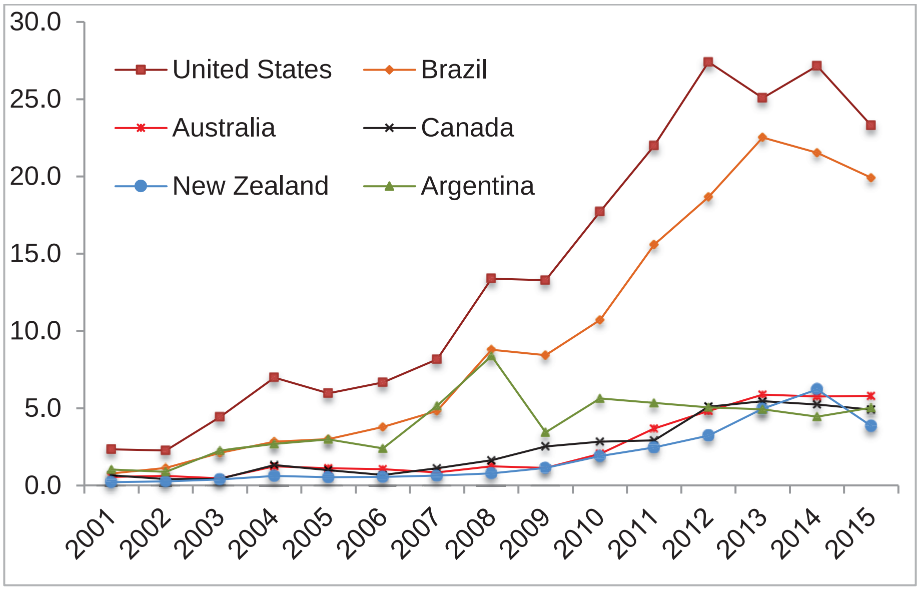
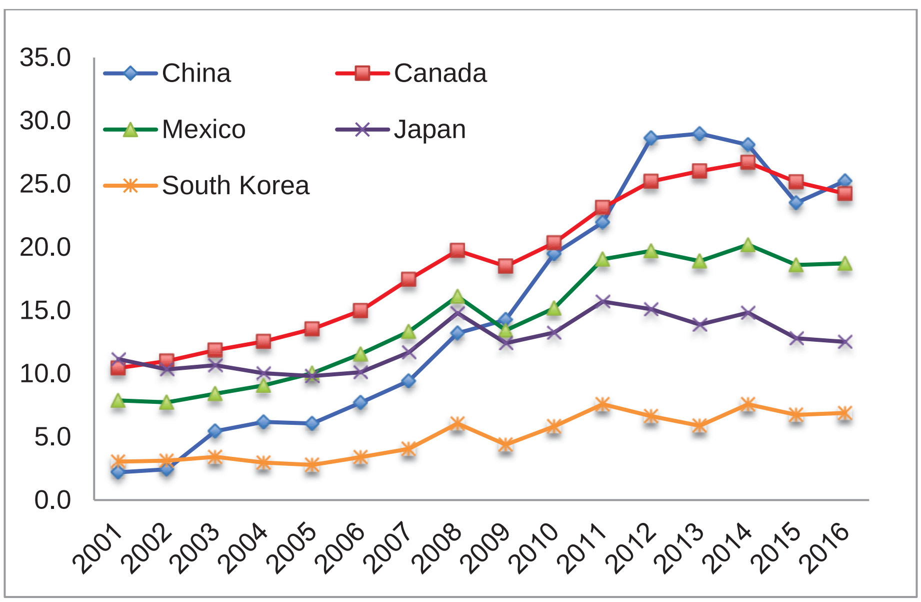
Figures

Figure 4.1: China's agricultural imports by source countries, 2001-2015 ($ Billion)



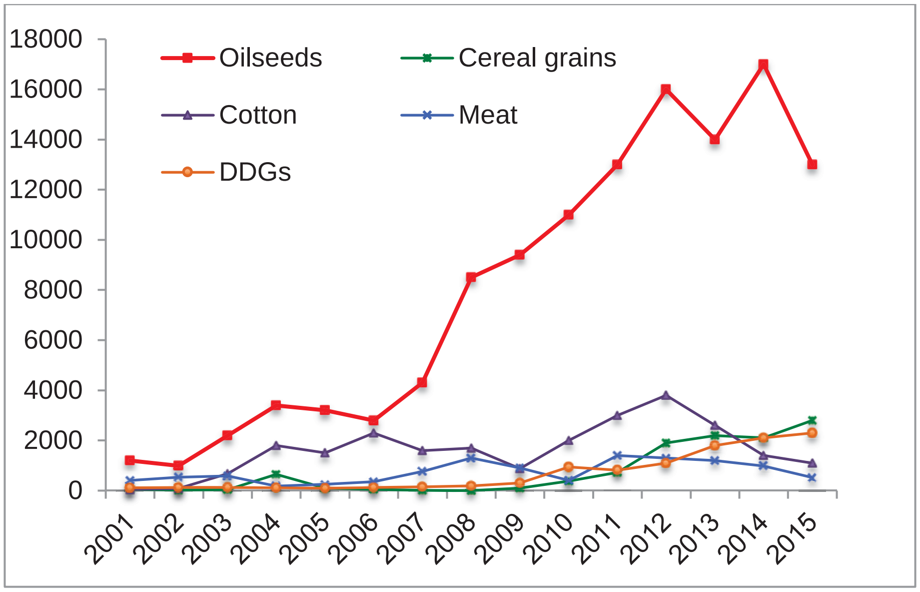
Source: Figure generated from UN Comtrade data.
Note: China's import data include products from two-digit chapters 01 through 24 as well as select codes in higher chapters such as cotton.

Figure 4.2: U.S. agricultural exports by destination countries, 2001-2016 ($ Billion)



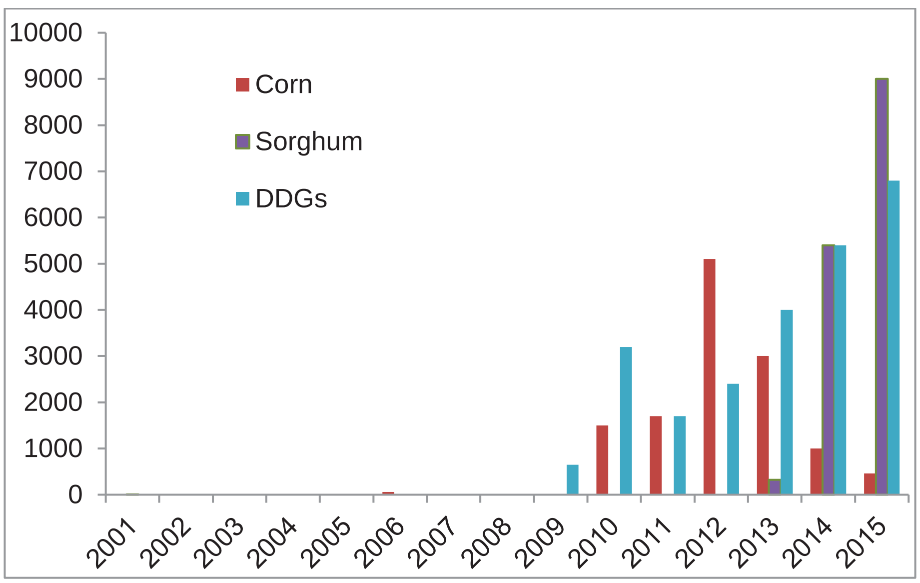
Source: Figure generated from USDA, Forign Agricultural Service data, 2017.

Figure 4.3: U.S. agricultural exports to China by commodity (excluding cattle hides), 2001-2015 ($ Million)



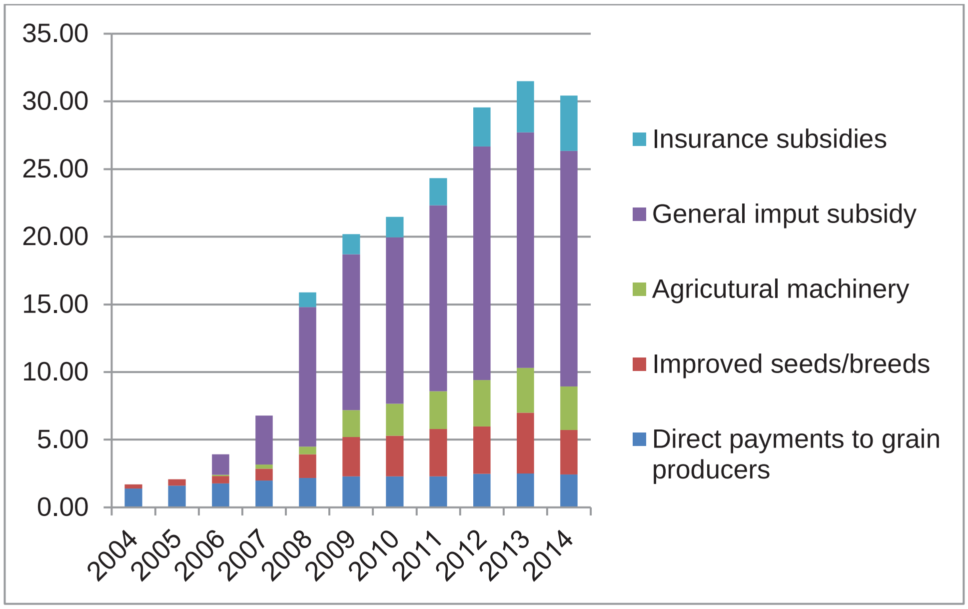
Source: Figure generated from UN Comtrade data.

Figure 4.4: U.S. animal feed exports to China, corn, sorghum and distillers' dried grains (DDGs), 2001-2015 (1000 MT)



Source: Figure generated from UN Comtrade data.

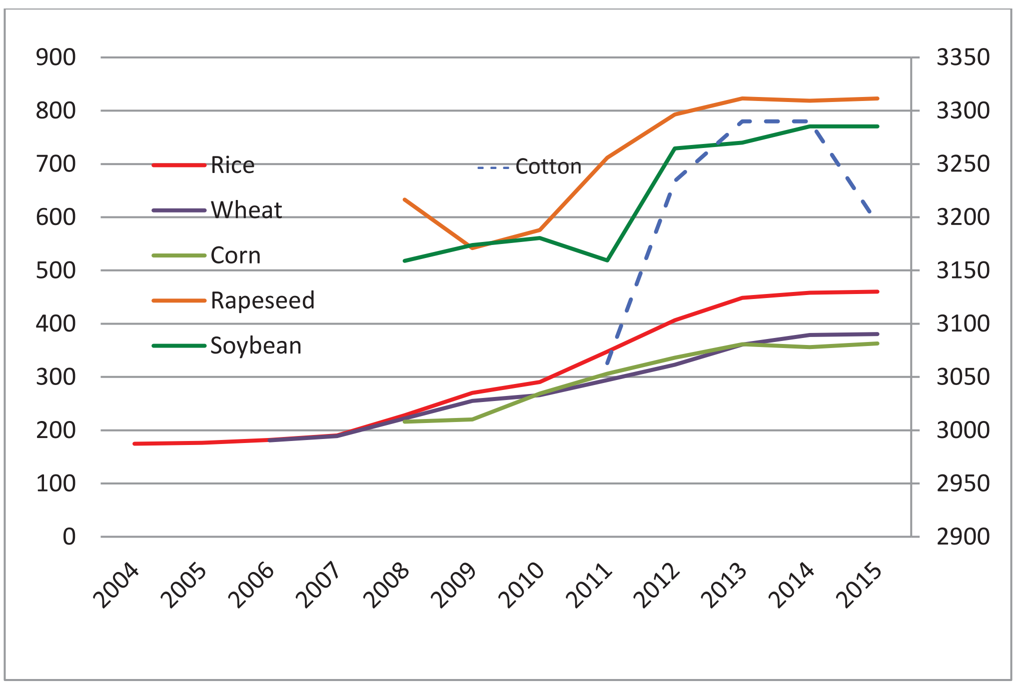
Figure 4.5. China's major agricultural subsidies: expenditures 2004-14 ($ Billion)



Source: Figure generated from Tuan 2015

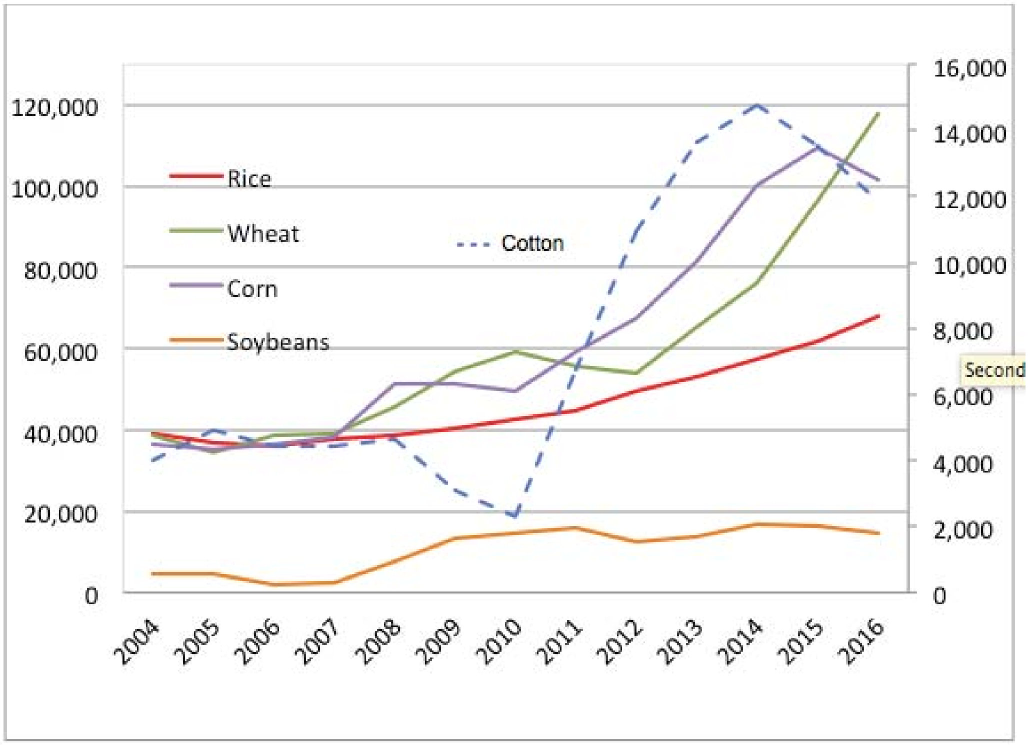
Note: County transfer payments are not reported in figure 5.

Figure 4.6. China's support prices, 2004-2015 ($ per metric ton; support price for cotton is shown on the right axis due to different scale)



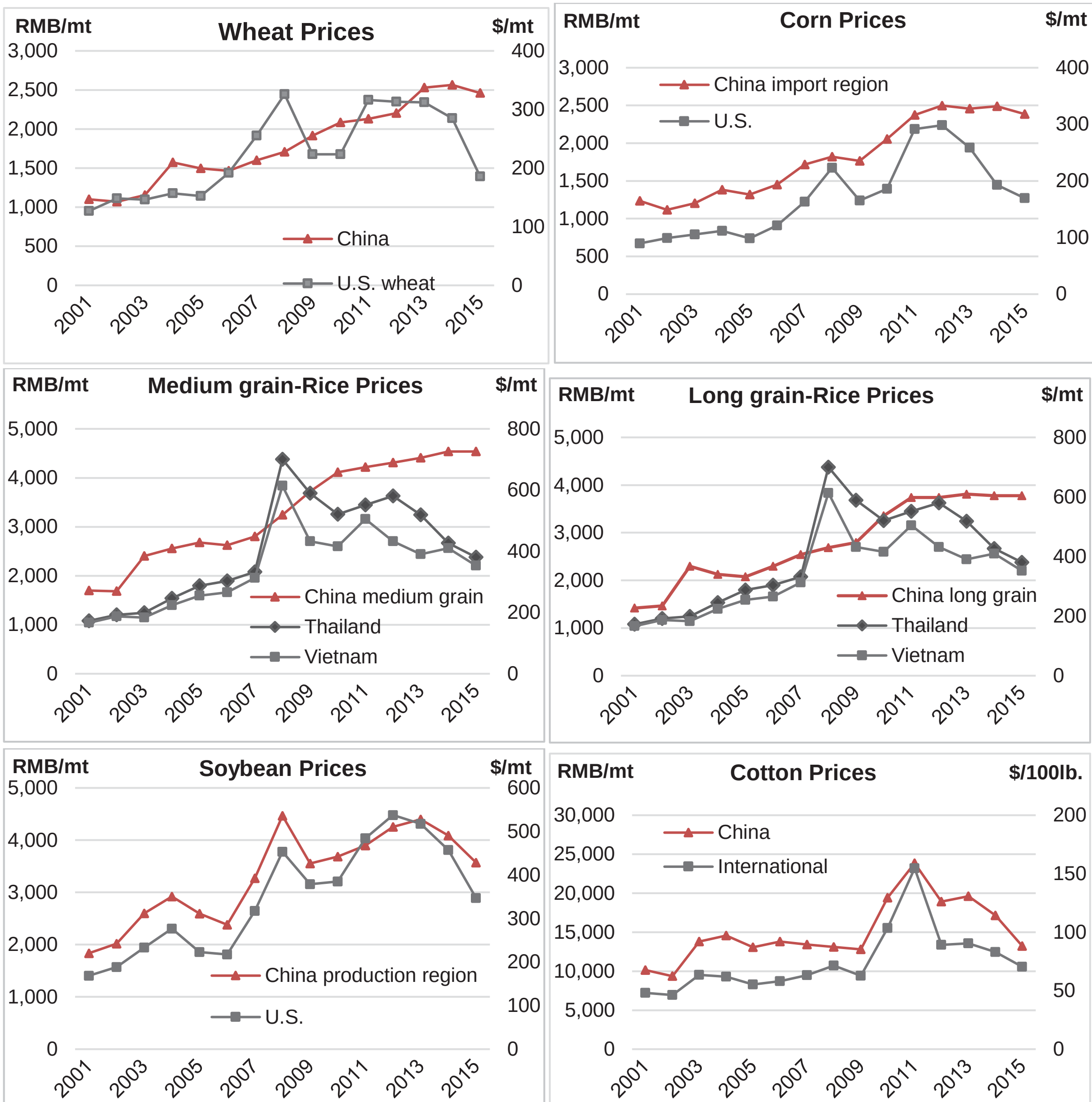
Source: Figure generated from USDA calculations, ERS using announcements by China National Development and Reform Commission (Gale, 2013); 2011-2015 data were collected from various USDA-GAIN reports.

Figure 4.7. China's stockpiles of major agricultural commodities, marketing year from October 2004 to September 2016



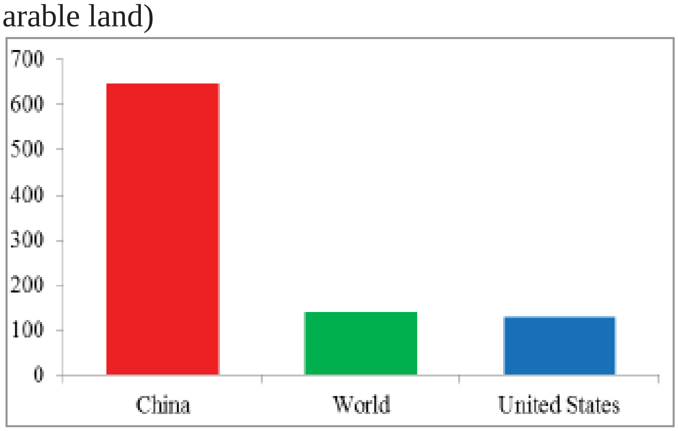
Source: Figure generated from USDA-FAS, Market and Trade Data, Production, Supply and Distribution (PSD), Year 2014 refers to 2014/2015, 10/2014-09/2015.
Note: left axis: 1000 MT and *cotton* is shown on the right axis 1000 bales (480 lb.).

Figure 4.8. China's domestic and international prices of wheat, corn, rice and soybeans ($ per metric ton) and cotton (U.S. cents per lb.).



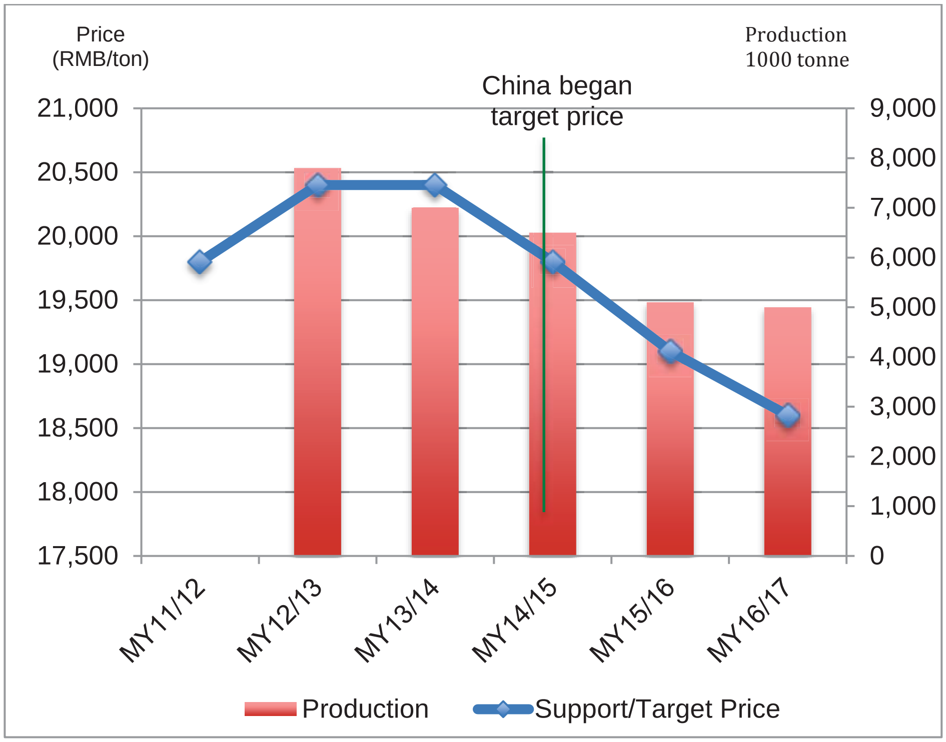
Source: ERS analysis of data from China National Grain and Oils Information Center and USDA, 2015

Figure 4.9. Fertilizer use in China, the United States and the world (Kilograms per hectare of arable land)



Source: World Bank Development Indicators; Anderson-Sprecher and Bugang, 2015.

Figure 4.10. China's cotton support policy evolution and cotton production

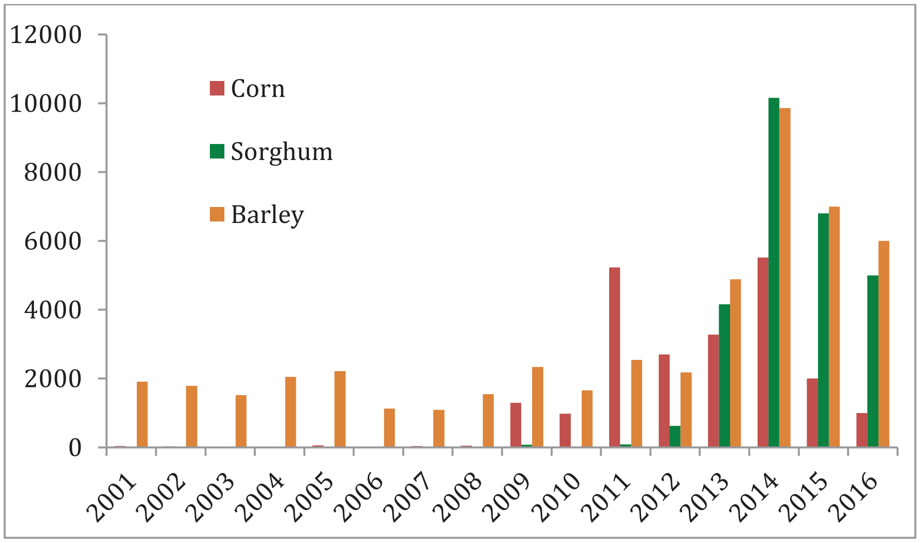


Source: Figure generated from FAS/Beijing Estimates/Forecast (Clever and Xinping 2016a).
Note: MY11/12 to MY13/14 is government support price; MY14/15 to MY16/17 is "target price" for Xinjiang only. Left axis: Price (RMB/ton) and right axis: Production (1000 tons).

Figure 4.11. China's soybean support/target price and production average wholesale soybean price (RMB/ton)

Source: Figure generated from State Grain Administration (Clever and Xinping, 2016b) and OECD 2017.

Figure 4.12: China's total sorghum, barley and corn imports from the world, marketing year from October to September 2001/2016 (1000 MT)



Source: Figure generated from USDA-FAS, Market and Trade Data, PSD, Year 2014 refers to 2014/2015, 10/2014-09/2015.

Tables

Table 4.1. Average applied tariffs for agricultural products

Year	**2001**	**2005**	**2015**
Average applied tariffs	23.1%	15.3%	14.8%

Source: OECD, 2005; WTO, 2016

Table 4.2. Tariff Rate Quotas for selected commodities (2013-14)

Commodities	TRQ (Metric Tons)	Private Share	State Enterprise Share	Tariff rate within TRQ	Tariff rate out of TRO
Wheat	9,636,000	10%	90%	1%	65%
Corn	7,200,000	40%	60%	1%	65%
Rice (short and long grain)	5,320,000	50%	50%	1%	65%
Cotton	894,000,000	67%	33%	1%	40%

Source: WTO, 2016; Anderson-Sprecher et al., 2015

5. Conclusions

This dissertation focused on examining barriers to agricultural trade. The first paper investigated an important question concerning international agri-food trade: how do trade policies in the form of tariff changes affect the probability of continuous, disappearing, and newly traded U.S. agri-food imports? The second paper focused on a specific type of SPS measures that are prominently featured in the current mega-regional trade negotiations (TPP and T-TIP), namely food safety standards in the form of maximum residue limits. The third paper sought to answer the question on why China and its agricultural policies are important for U.S. agricultural exports.

The first paper extends the empirical literature related to the firm-level productivity differences and the intensive and extensive margins of trade by developing a multinomial logit framework to assess how detailed product-line tariff changes on U.S. agri-food imports affect the probability that country-commodity pairs will enter, exit, or maintain a presence in the U.S. import market. The empirical results suggest that exporters gain from tariff reductions in that they can establish new product relationships with the U.S. and enhance their U.S., and potentially their global, supply chains. For developing countries with interests in exporting agricultural products, tariff reductions lead to enhanced market access opportunities and a reduced likelihood of disappearing products, leading to a more reliable and sustainable source of export revenues. Moreover, in terms of product variety and availability, consumers gain access to consistent food supplies year-round, lower prices of new and existing imported products when tariffs are reduced, and reduced probabilities of disappearing product varieties. Furthermore, if consumers value variety in consumption, then net results are a positive welfare gain for U.S. agri-food consumers.

The second paper introduces the bilateral stringency index to assess how regulatory heterogeneity (and convergence) for pesticide tolerances used in the production process of fresh fruits and vegetables impacts trade between the US and its partner countries in the aggregate and in the proposed mega-regional trade deals (TPP and T-TIP). This paper developed the aggregated bilateral stringency index based on different classes of chemicals, which provides further insight as to the types of pesticides that influence trade flows. The stringency index results also provide a snapshot of regulatory heterogeneity between the US and its important export markets in the EU and TPP countries. Overall, the bilateral stringency indices suggest much stricter regulations for the EU compared to TPP markets for both fruit and vegetables and across different classes of chemicals, suggesting that trade negotiators will likely want to emphasize the dissimilarity of MRL tolerances in the T-TIP negotiations. Thus, the results of this study provide important policy implications as the negotiations between the US and TPP and T-TIP countries progress. It should be noted that while recently the US has formally withdrawn from TPP, the results of this research are useful for any bilateral trade agreement between the US and TPP countries individually (i.e., Japan). Using the bilateral stringency indices, this paper contributes to the analysis of SPS measures by estimating the impact of bilateral MRL stringency using several specification models. The findings shed light on the impact of MRL stringency on exports for fruit and vegetables across all trading partners, which impedes trade; it likely requires more careful production, testing and compliance costs to serve international markets with stricter food safety guidelines. The results painted a contrasting picture of MRL effects on US exports. The results suggest MRL policy impedes US exports to the EU, while it enhances trade with respect to US exports to TPP markets.

The third paper reviewed China’s evolving agricultural and trade policies, and discussed the potential impact on U.S. exports to China. From the U.S. perspective, China is one of the top markets for U.S. agricultural exports. From China's perspective, the U.S. is China's top supplier of its agricultural imports. From China's policy perspective, its long-term goals are to enhance food security and increase farmers' incomes. To accomplish these goals, the Chinese government implemented agricultural and trade policies that steadily increased domestic support. China's policymakers intervened in the market by not only providing support prices, but also steadily increasing support prices. This intervention led to price disparities between domestic and international prices in agricultural commodity markets. Both this and China's openness to the world market demonstrated after joining the WTO in 2001 resulted in a dramatic increase in imports of certain agricultural commodities and an accumulation of large stockpiles of domestically produced agricultural commodities. Most recently, the Chinese government strived to reduce its large stockpiles, especially for cotton and corn, and narrow the price gap between China's domestic and international markets by changing its agricultural policies, particularly price support policies for cotton, soybeans, and corn. A new target price policy replaced the price support and temporary reserve programs for cotton to decrease production and reduce stockpiles. A new target price policy was also implemented for soybeans to increase soybean production. The Chinese government recently announced a pilot program to eliminate the corn price support policy to reduce production and stockpiles. This new pilot corn price policy impacted the global agricultural market, including the United States, by reducing China's imports of corn substitutes. Despite China's evolving agricultural policies, which are reducing imports of some agricultural commodities, and the recent economic downturn, China's increase and expansion of imports may be inevitable in the long-run. In closing, China has one-fifth of the world's population along with one-tenth of the world's arable land. Therefore China is not likely to avoid its dependence on the global market, including the U.S., either through trade or foreign direct investment.