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New Estimates of the Ad-valorem Equivalent of SPS Measures: Evidence from Specific Trade Concerns

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Summary

Countries maintain a large and diverse set of non-tariff measures (NTMs) to safeguard the health of plants, animals and humans. However, policymakers and regulatory bodies often neglect the potential adverse trade effects of non-tariff measures. Despite a large literature investigating the trade flow effects of NTMs, less is known about the extent to which sanitary and phytosanitary (SPS) measures raised trade concerns by exporters reduce exporting countries' agricultural and food trade to importing markets maintaining these measures.

This study utilizes the World Trade Organization's (WTO) SPS specific trade concerns database to identify economically meaningful and potentially consequential SPS measures on members' trade. We develop a product-line structural gravity model to estimate the trade effects of non-tariff SPS measures flagged as concerns by the top 30 agricultural exporting and importing countries covering products in meat, dairy, fruits & vegetables, and cereals & preparations.

Results indicate that trade losses due to SPS measures of concern are significant, both globally and for specific countries, sectors and individual SPS measures. Conservatively, our estimates imply a 68% reduction in agricultural trade during years in which SPS measures of concern were active. Moreover, the estimated *ad-valorem* protection imposed by SPS trade concern measures ranges from a 33% to 106% equivalent tariff, on average. Significant heterogeneity in the estimated AVE of SPS measures exists across countries. Comparing SPS measures maintained by U.S., EU and China on imports, presents a rather stark asymmetric picture, with *ad-valorem* tariff equivalents of U.S. SPS measures estimated at 41%, compared to 76.4% and 130% ad-valorem equivalent protection imposed by SPS measures maintained by the EU and China, respectively.

Finally, we identified six case-study SPS measures of concern to take a closer look at their trade impacts. These included (i) EU Aflatoxin limits on groundnuts and cereals; (ii) EU GMOs policies on cereal grains; (iii) BSE restrictions on beef (various countries); (iv) Japan’s positive list MRL standards; (v) Ractopamine restrictions on pork; and (vi) China’s restrictions on Avian Influenza in poultry. Results indicate that China's restrictions on poultry imports due to Avian Influenza concerns and EU, China, Russia, Taiwan, and Thailand zero tolerance for ractopamine in pork exports are the most prohibitive standards, with AVE tariffs 120.3% and 88.9%, respectively.

Keywords: *Non-Tariff Measures, Sanitary and Phytosanitary Measures, Specific Trade Concerns, Gravity, Ad-valorem Equivalents*

JEL classification: F14, Q17, Q18

I. Introduction

Non-tariff measures (NTMs) are not new, but their prominence in global agricultural trade continues to increase. The United Nations Conference on Trade and Development (UNCTAD 2019) defines NTMs as policy measures other than ordinary customs tariffs that can affect international trade in goods, changing quantities traded, prices, or both. World Trade Organization (WTO) members are permitted to adopt non-tariff regulations under the Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) Agreements in pursuit of social, public, environmental, and other policy objectives. These objectives include ensuring the safety of imported food, the protection of animal and plant health, and the well-being of consumers. SPS and TBT standards are often justified on the grounds that they are necessary to correct market failures that may arise due to the lack of sufficient monitoring and control of the quality, characteristics, and safety of imported agri-food products.

The SPS and TBT agreements obligate Members to notify the WTO when new regulations or standards governing agricultural imports are adopted. Since 1995, WTO Member countries have notified over 24,000 SPS and 35,000 TBT notifications. Grant and Arita (2017) tabulated and summarized notifications of SPS specific trade concerns and found that SPS measures overwhelming account for the largest component of NTMs impacting agri-food trade. The universe of non-tariff notifications, along with survey data and national sources, are collected and analyzed by UNCTAD distinguishing between seven broad categories of non-tariff measures including, but not limited to, SPS, TBT, para-tariffs, price controls, quantity controls, finance measures, etc. (UNCTAD, 2012).

The increasing use of SPS regulations across international borders has stimulated a significant research effort investigating the effects of these measures on international trade ((Deardorff and Stern, 1997; Moenius, 2006; Ferrantino, 2006; Disdier et al., 2008; Hoekman and Nicita, 2011; Kee et al., 2009; Gourdon and Nicita, 2012; Peterson et al., 2013; Arita et al., 2015; Beghin et al., 2015; Grant et al., 2015; Swinnen, 2016; Crivelli and Gröschl, 2016; Cadot and Gourdon, 2016). On the one hand, standards and regulations can enhance trade by increasing consumers' confidence.[1] For example, in economies where consumer awareness of food safety, animal welfare, and plant health is particularly sensitive, SPS measures may increase demand for products that are more stringently regulated (Josling, Roberts, and Orden 2004). On the other hand, regulatory measures can deliberately or unintentionally restrict trade, particularly for developing country exports that may lack monitoring, testing, and certification infrastructure to demonstrate compliance with regulatory requirements. Trade disputes over SPS measures can also occur between highly developed economies, such as between the U.S. and EU, where acceptable risk levels and interpretation of appropriate science differs among policymakers.[2]

[1] Beghin and Xiong (2014) make this argument in the context of maximum residue limits.
[2] For example, Barlow et al. 2015 describe differences between risk assessment and exposure determinations versus hazard-based approaches where even the detection of harmful agents is used to

Disdier et al. (2008) examined the impact of SPS and TBT measures using notification-based data from UNCTAD and find that these measures significantly reduce developing countries' exports to OECD countries, but do not affect trade between OECD members. Kee et al. (2009) use 78 developed and developing countries to estimate trade restrictiveness indices and ad-valorem tariff equivalents (AVEs) of NTMs and found that poor countries not only have more restrictive trade regimes, they also face significant barriers on their exports. Averaging across countries, NTMs were found to almost double the level of trade restrictiveness imposed by tariffs. Gourdon and Nicita (2012) utilize newly collected data from UNCTAD and the World Bank to investigate the use of NTMs in 26 countries and find that the incidence of SPS/TBT measures varies greatly across countries and economic sectors, with a large part of concerns raised by developing countries. Their sample contained measures up to 2011 for approximately 25 countries. Staiger (2012), Beghin et al. (2012), Beghin et al. (2015) and Swinnen (2016), on the other hand, provide a detailed exploration of NTMs and emphasize the complexity involved in determining their economic impacts on trade and welfare in the presence of externalities, political issues and other market imperfections.

Among the NTMs affecting agricultural trade, SPS and TBT measures are the most frequently encountered measures according to data collected by UNCTAD's Trade Analysis and Information System (TRAINS) and the WTO's Integrated Trade Intelligence Portal (I-TIP) (WTO, 2012; Ederington and Ruta, 2016). 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 and International Trade Centre (World Bank, 2008; UNCTAD, 2012). The importance of NTMs in agricultural trade has led to significant research interest in quantifying their impacts. Cadot and Gourdon (2016) and Grant and Arita (2017) note that SPS/TBT measures overwhelmingly account for the largest component of NTM costs in agri-food sectors. Kee et al. (2009) find that average NTM AVEs for agricultural products are three times higher than those for manufactured goods. Hoekman and Nicita (2011) concur the findings in Kee et al. (2009) that agricultural trade is much more restricted than manufactured products, reflecting both higher tariffs and a greater use of NTMs.

Arita et al. (2015) and Arita, Beckman and Mitchell (2017) find significant negative effects of SPS regulations maintained by the European Union (EU) for certain agricultural sectors such as cereals, beef, pork and fruits and vegetables. Peterson et al. (2013) and Grant et al. (2015) find negative effects of SPS measures on U.S. fresh fruit and vegetable trade, but at a diminishing rate as importers and exporters accumulate SPS treatment experience in the global marketplace. Fontagné et al. (2015) use a panel of French firm-level exports to estimate the effect of SPS measures on the intensive and extensive margins of trade and find that SPS measures reduce export participation by 4 percent and exported value by 18 percent. Conversely, Crivelli and Gröschl (2016) find negative effects on the probability of trade occurring but positive impacts of SPS measures on the value of trade (conditional on market entry). Because WTO Members have considerable flexibility on the products (and countries) to which regulations apply, policymakers often neglect to take account of the potential trade effects of these measures (Orden and

formulate regulatory policy.

Roberts 2007).

While existing studies have certainly advanced understanding of the impacts of non-tariff measures on international trade, the effects of SPS measures in agri-food trade are generally not well understood in part because of the sheer number of measures in place making it difficult to sort out the more restrictive and potentially troublesome measures affecting exports from those that serve legitimate objectives to ensure the quality and safety of animal, plant and human health. Figure 1 illustrates the number SPS and TBT measures notified to the WTO since 1995. Cumulatively, over 24,000 SPS and 35,000 TBT measures have been notified. The number of SPS notifications has consistently exceeded 1,000 notified regulations per year since 2006, and exceeded the number of TBT notifications, which cover a much larger set of products beyond agriculture, in 2006, 2007, 2008, 2011, 2014, and 2015.

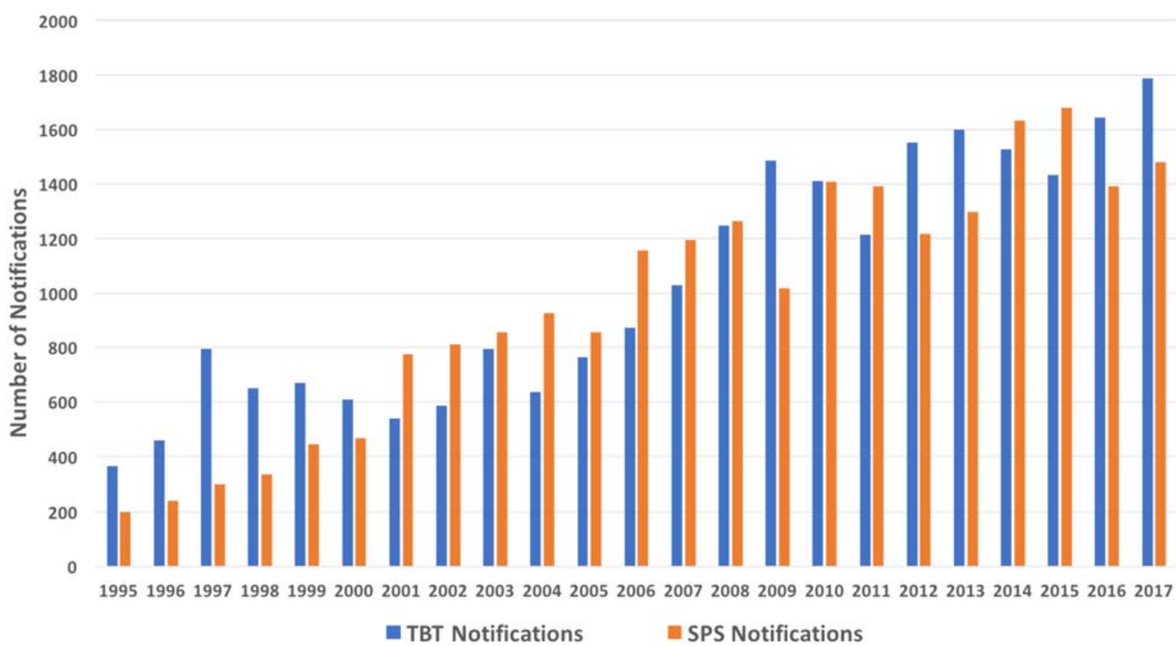

FIGURE 1. TRENDS IN NOTIFICATION OF SPS AND TBT MEASURES TO THE WTO, 1995-2017
Source: Author's calculations from WTO's SPS Information Management System available at http://spsims.wto.org/

A critical challenge in estimating the effects of NTMs is selecting the sample of regulatory standards to evaluate. While collecting and tabulating SPS and TBT notifications illustrated in Figure 1 allows researchers to examine the widest possible scope of measures, such examinations treat all notifications equally. For example, Japan's October 3, 2019 SPS notification (G/SPS/N/JPN/684) that certain plant products need to be accompanied by a phytosanitary certificate is likely far less impactful on trade than China's 2009 emergency notification of restrictions on US swine exports (G/SPS/N/CHN/117) due to H1N1 swine flu concerns, or China's 2015 restrictions on U.S. poultry exports due to Highly Pathogenic Avian Influenza (AI), or the EU Commission's 2010 regulation (Commission Regulation (EU) No. 165/2010) setting maximum limits (ML) on aflatoxin in ready-to-eat peanuts at 2 ug/kg for aflatoxin B1 and 4 ug/kg for total aflatoxin.[3] In the latter case, the EU's ML's are considerably lower than the 10 ug/kg recommended by the Food and Agricultural Organization and World Health Organization (FAO/WHO) Joint Expert Committee on Food Additives (JECFA) and current options under consideration by Codex.

The purpose of this study is to address key challenges in the literature on estimation of the trade effects of SPS measures impacting agricultural trade: how do we identify economically meaningful and potentially consequential SPS measures in order to evaluate and quantify their trade effects? Critical research questions for agricultural policymakers include: (i) By how much do non-tariff SPS measures that have been flagged as specific trade concerns impact members' agricultural trade? (ii) What types of non-tariff SPS measures are responsible for significant agri-food trade shocks? (iii) In which destination markets and product sectors are these measures occurring? (iv) How does agri-food trade respond when resolution of SPS concern measures is achieved?

While case-study approaches have the benefit of signaling out a specific measure (i.e., Peterson et al., 2013; Li and Beghin, 2017), it is difficult to compare across different types of SPS measures. Broad-based approaches are useful for an overall picture (i.e., Disdier et al., 2008; Kee et al., 2009; Gourdon and Nicita, 2012; Beghin et al., 2015; Cadot and Gourdon, 2016), yet it is difficult to distinguish between important and unimportant measures in terms of their trade impacts. Following Grant and Arita (2017), this study adopts a targeted approach. Specifically, this article:

1) Identifies a subset of SPS measures that have been flagged as specific trade concerns (STCs) by agricultural exporting countries in the WTO's SPS committee meetings for SPS measures maintained by importing countries over the 1995-2016 period,
2) Uses the specific trade concerns to identify active country-pair and product trading relationships that may been affected by SPS measures of concern, and estimates their trade impact, and
3) Converts the econometric trade impacts of SPS measures into *ad-valorem* tariff equivalents (AVEs) to provide academic researchers and policy-makers with SPS trade impact estimates for use in computational partial and general equilibrium simulations of bilateral trade negotiations seeking to harmonize regulatory differences.

An important feature of the SPS STCs database is that it provides a bilateral (importer-by-exporter) dimension of trading partners potentially affected product-specific SPS measures. This bilateral dimension is often absent from the broader class of regular WTO notifications of non-tariff measures. SPS specific trade concerns also contains a rich set of underlying information in terms of the frequency with which the concern is raised, the nature of the SPS measure (animal health, plant health or food

[3] For comparison, most countries have set aflatoxin maximum limits of 10-15 ug/kg. Japan's ML is set at 10 ug/kg.

safety), the severity of the measure in terms of the language used to describe the concern by exporting countries, the duration of the SPS concern, and approximate time periods in which resolution of the concern was achieved.

We expand selected SPS specific trade concerns into a country-pair-by-product time series of bilateral trade flows to estimate econometrically and evaluate and rank their trade impacts. In particular, our empirical strategy allows for identification of the trade effects of these measures not only during the period in which SPS trade concerns were active but also after resolution is achieved to shed light on the potential gains available through the multilateral process of the WTO's SPS committee meetings. We produce three trade impact assessments:

1. The trade impact of SPS concern measures globally,
2. A decomposition of trade impacts into global animal, plant and food safety based SPS concern measures, and
3. The trade impact of six specific case-study SPS measures of concern facing the U.S. and other large agricultural exporters.

The reminder of the article is organized as follows. Section 2 describes the sources and summary statistics of SPS specific trade concerns, bilateral trade and other explanatory variables. Section 3 presents the methodology used to estimate the trade effects and AVEs estimates of SPS measures raised as STCs by exporters. Section 4 provides the empirical results. Finally, Section 5 concludes.

II. Data and Descriptive Overview

SPS specific trade concerns identify a set of cross-cutting SPS issues based on measures that have been flagged by exporting countries as trade concerns. In this section we describe trends in SPS specific trade concerns and products and countries included in the bilateral trade database.

II.1 SPS Specific Trade Concerns

Through July, 2019, the WTO’s SPS Committee has recorded 464 specific trade concerns dating back to 1995. These records comprise SPS measures maintained by importers that have been flagged as specific trade concerns by exporters at the WTO's SPS committee meetings.[4] For the purposes of matching specific trade concerns to bilateral trade data, we collected information about these concerns from 1995-2016.

For each concern, the WTO's SPS Information Management System (IMS) reports the exporting country raising or supporting the SPS concern, the importing

[4] The WTO’s “Understanding the WTO Agreement on Sanitary and Phytosanitary Measures,” states that the SPS Agreement established a committee on SPS Measures (The “SPS committee”) to provide a forum for consultations about food safety or animal and plant health measures which affect trade, and to ensure the implementation of the SPS Agreement. See: https://www.wto.org/english/tratop_e/sps_e/spsund_e.htm

country maintaining the measure, the Harmonized System (HS) product code(s) affected (typically at the HS 4-digit level), the first and last date the SPS issue was raised, the number of times the SPS issue was raised, the subject keywords, and the resolution status.

From 1995 through 2016, the WTO's SPS committee recorded 417 specific trade concerns. However, a number of concerns contain missing country and/or product information.[5] After dropping the observations with missing country or product details, trade concerns related to non-food sectors (e.g., wood or cosmetic products)[6], and non-SPS subjects (e.g., technical barriers to trade such as labelling and packaging requirements)[7] the SPS trade concern data set contains 374 concerns.

Figure 2 plots the number of SPS specific trade concerns raised for each of the WTO's SPS subject categories – animal health (AH), plant health (PH), food safety (FS) and other concerns not elsewhere specified (OTH) – and the cumulative number of countries involved in SPS trade concerns from 1995-2016.

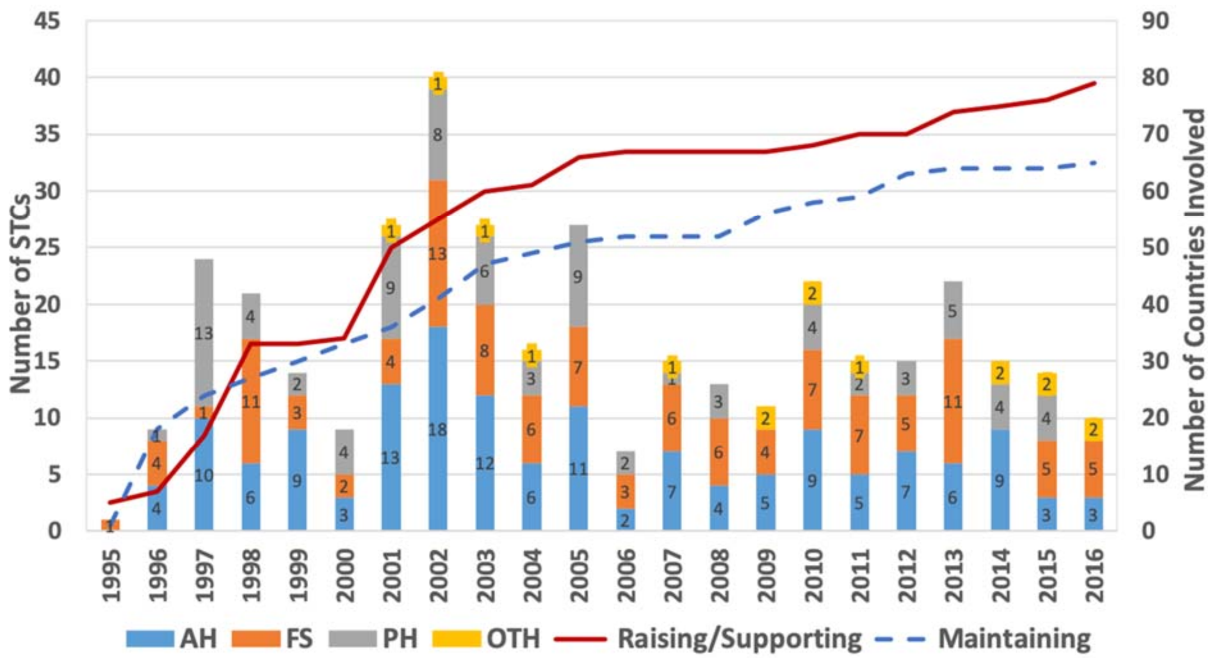

Figure 2: SPS specific trade concerns by year, subject, and countries involved.
Note: AH, PH, FS, and OTH denote, respectively, SPS specific trade concerns related to animal health, plant health, food safety, and other issues. Raising/Supporting (red solid line) and Maintaining (blue dashed line) refer to the cumulative count of countries involved. Source: Authors' calculation.

Animal health concerns comprise 152 STCs (41%) fo SPS concerns, 119 concerns (32%) are related to food safety, 87 (23%) are related to plant health, and the remaining 16 concerns (4%) are related to the other issues such as licensing, certification requirements, and control or inspection procedures. The number of

[5] For example, STCs 7, 26, 190, 235, 384, and others.
[6] For example, STCs 59, 81, 143, and 182.
[7] For example, STCs 13, 214, and 240.

countries participating in SPS specific trade concerns increased rapidly in the 2001-2006 period due, in part, to multiple outbreaks of food safety related animal diseases such as Bovine Spongiform Encephalopathy (BSE), or mad cow disease. The number of SPS specific trade concerns raised has gradually slowed in recent years. An average of 17 SPS specific concerns have been raised annually since 2010. Through 2016, 79 countries raised or supported, and 75 countries maintained at least one SPS trade concern.[8]

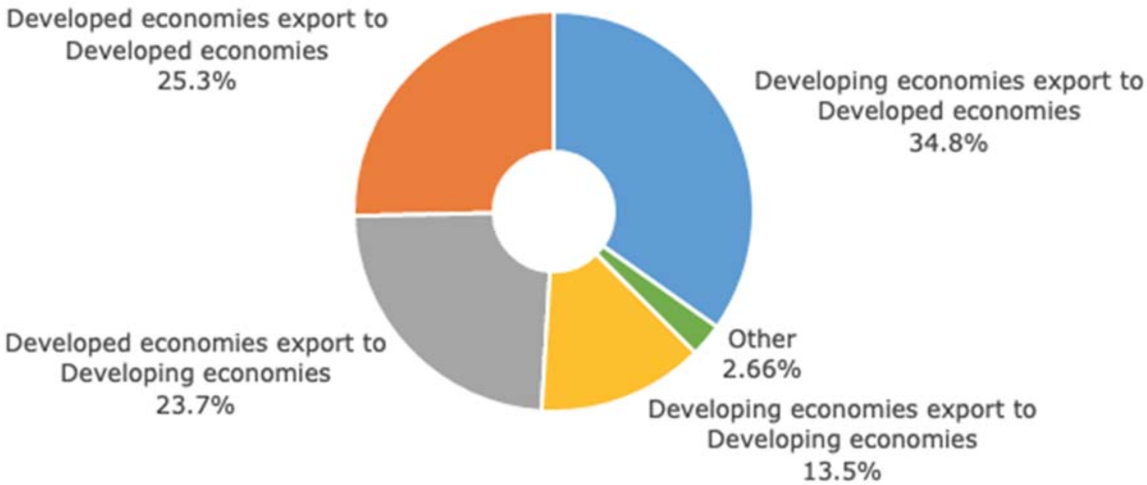

Figure 3. Share of SPS Specific Trade Concerns by Income Levels
Note: The "Other" category includes developed and developing country exports to least developed countries, and least developed country exports to developed and developing countries. Source: Authors' calculation

Figure 3 provides a breakdown of participating countries in SPS specific trade concerns by income status. The majority of SPS trade concerns (97%) are raised, supported, or maintained by high-income developed and middle-income developing countries. STCs that are raised/supported by developing country exporters against the measures maintained by developed country importers make up the largest share, 35%, followed by 25% for STCs raised/supported and maintained among developed countries. 24% of concerns raised or supported by developed countries are against the measures maintained by middle-income developing countries, and 13% of STCs are raised or supported by developing countries against the measures maintained by other developing countries. Least developed countries are not well represented in SPS specific trade concerns.

Using the first and last date SPS trade concerns were raised, we calculate the average number of times SPS trade concerns were subsequently raised and the average duration or length of time each STC continued to be an issue for exporters. The distribution for each of these calculations are plotted in Figure 4. Many SPS trade concerns are raised 1~3 times and are of relatively short duration (1~3 years). For context, the WTO's SPS committee holds three regular meetings each year. However, countries may not raise/support the same STC consecutively in all three meetings of

[8] We treat the European Union (EU 28) as one single country in our data

every year. Thus, the total number of times the STC is raised is not necessarily equal to three times the length of active years.

Nonetheless, there are some extreme cases. First, the highest solid circle above any of the animal health, plant health, food safety and other concern categories is STC 193, an animal health related SPS concern over restrictions on BSE that was subsequently raised 34 times by the EU and U.S. and supported by Canada, Switzerland and Uruguay. Second, STC 238 - a food safety related SPS concern about the EU's regulation of novel foods - was subsequently raised 23 times by Colombia, Ecuador and Peru and supported by another 20 countries. STC 193 related to BSE restrictions on beef lasted nearly 15 years and STC 238 lasted 12 years before exporting countries stopped raising the concern.

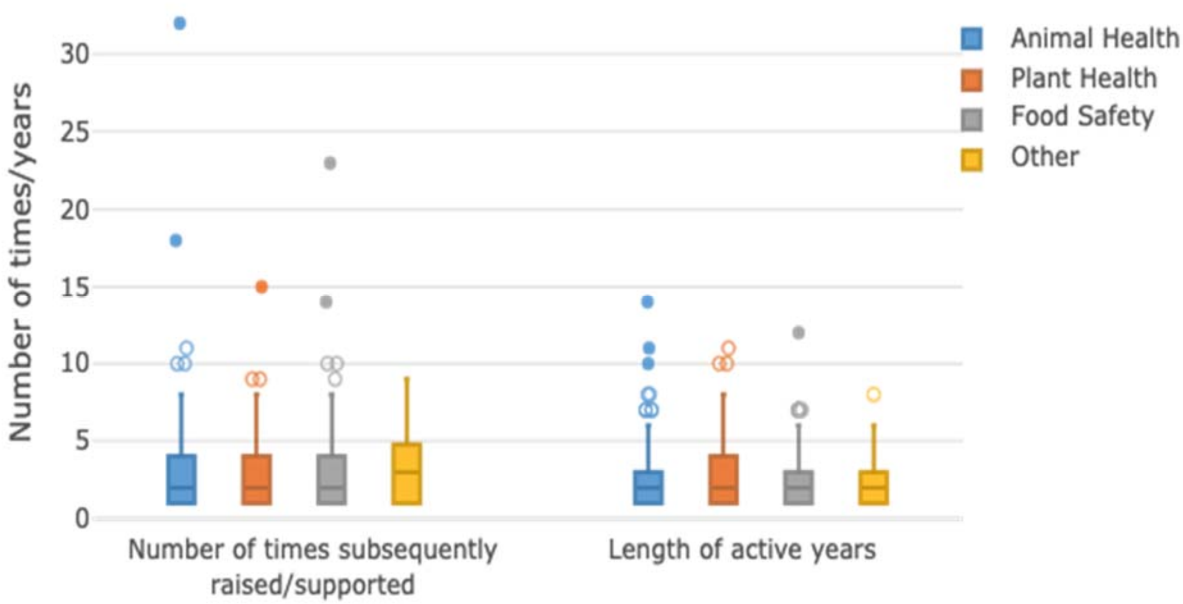

Figure 4: Number of times SPS Trade Concerns are Subsequently Raised and the Duration of Concerns (1995-2016)
Note: Outliers that are more than 3 times the interquartile range (IQR) above the 3rd quantile or below the 1st quantile is represented by a solid circle. Suspected outliers that are more than 1.5 times the IQR but less than 3 times the IQR above the 3rd quantile or below the 1st quantile are represented by an open circle. Source: Authors' calculation.

Figure 5 plots the incidence of SPS specific trade concerns by subject across the WTO's Multilateral Trade Negotiating (MTN) product sectors. Several results are worth noting. First, livestock and meat products (MEAT) is the sector most impacted by SPS trade concern measures with over 500 product incidences. Within the MEAT category, animal health related SPS concerns make up the largest share and are responsible for over 80% of SPS concerns impacted by trade restrictions. Food safety concerns is a distant second with nearly 20% of concerns impacting products in this category. MEAT is followed by Fruits and vegetables (FV) with nearly 420 SPS trade concerns covering products in this sector. Contrary to the livestock and meat sector, fruit and vegetables are impacted by a number of plant health and food safety related SPS trade concerns split roughly equal between the two categories. Cereals and preparations and dairy products follow meat and fruits and vegetables each with roughly 200 SPS trade concerns covering products in these sectors. Sugar and confectionary candy products (SGR) are the least impacted by SPS trade concern measures.

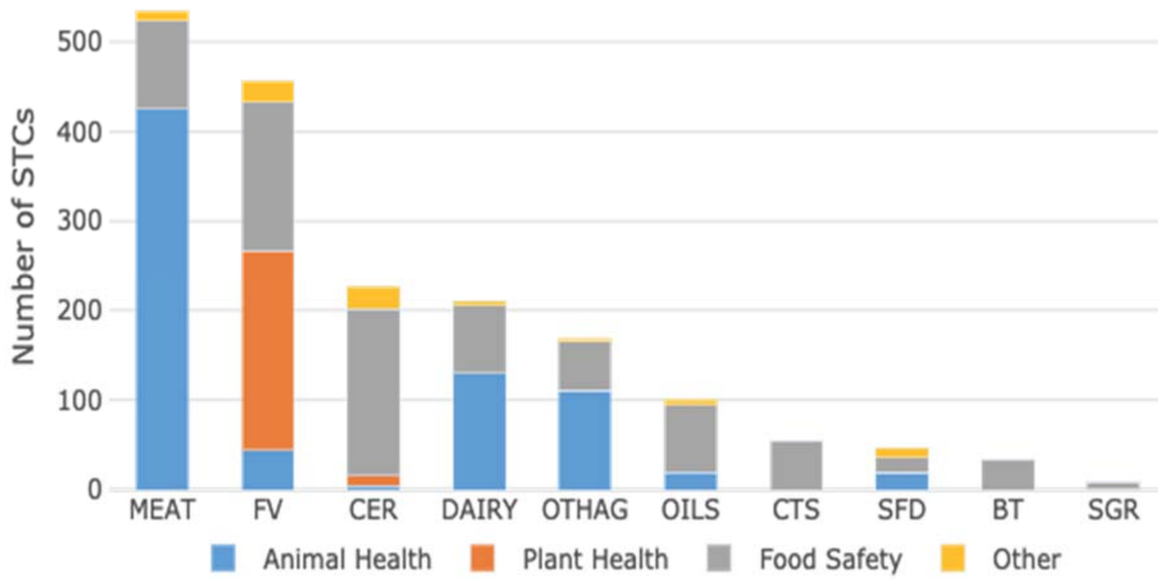

Figure 5. Tabulation of SPS Trade Concerns by Sector and Subject, 1995-2016

Note: MEAT = animal products; FV = fruits & vegetables; DAIRY = dairy products; CER = cereals & preparations; OILS = oilseeds, fats & oils; SFD = fish & fish products; CTS = coffee, tea, mate & spices; BT = beverages & tobacco; SGR = sugars & confectionery products; OTHAG = other agricultural products. Source: Authors' calculation.

To gain further insight with respect to countries and products actively engaged in raising/supporting and maintaining SPS trade concerns Figures 6 and 7 present the top 10 countries raising/supporting and maintaining SPS STCs across each of the WTO's MTN categorization of agricultural products, respectively. Both the U.S. and EU are leading participants in SPS trade concerns with each country raising or supporting 116 and 110 SPS concerns, and maintaining 39 and 81 SPS measures of concern against other exporting countries, respectively. U.S. exporters expressed a considerable number of SPS concerns against BSE, AI (Avian Influenza) and MRL restrictions, which affect meat and fruit & vegetable product exports. For example, in October 2008, the U.S. raised and Canada, Brazil, Costa Rice, Ecuador, and Peru supported a concern on Taiwan's restrictions on the use of Ractopamine – a veterinary drug that increases swine feed efficiency (STC 275). Because a certain fraction of the drug can

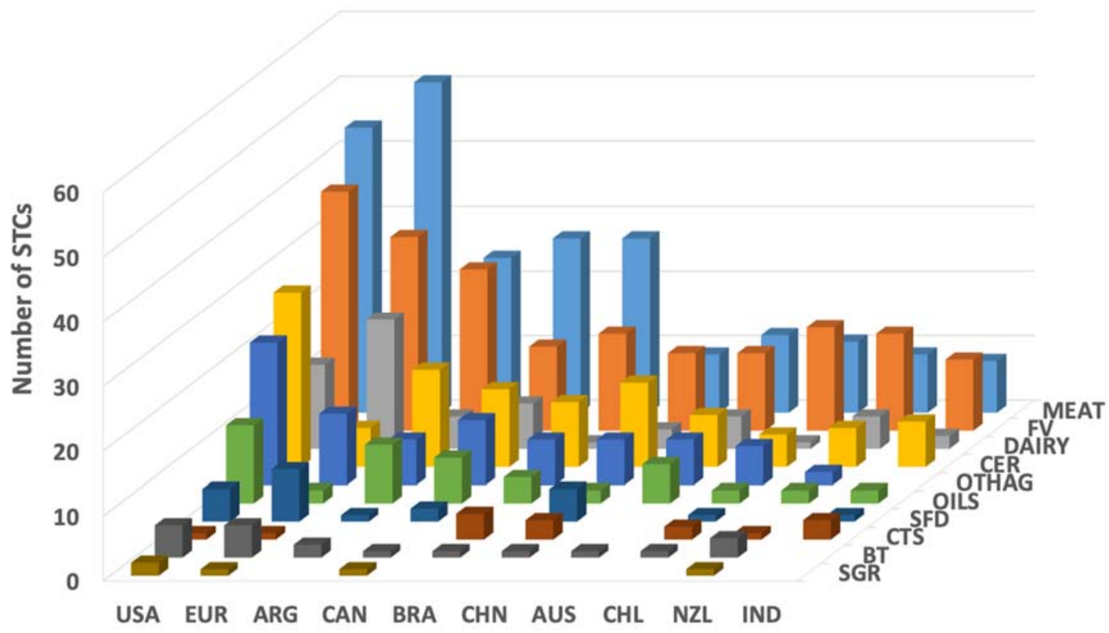

Figure 6. Top 10 Exporters Raising SPS Specific Trade Concern Measures

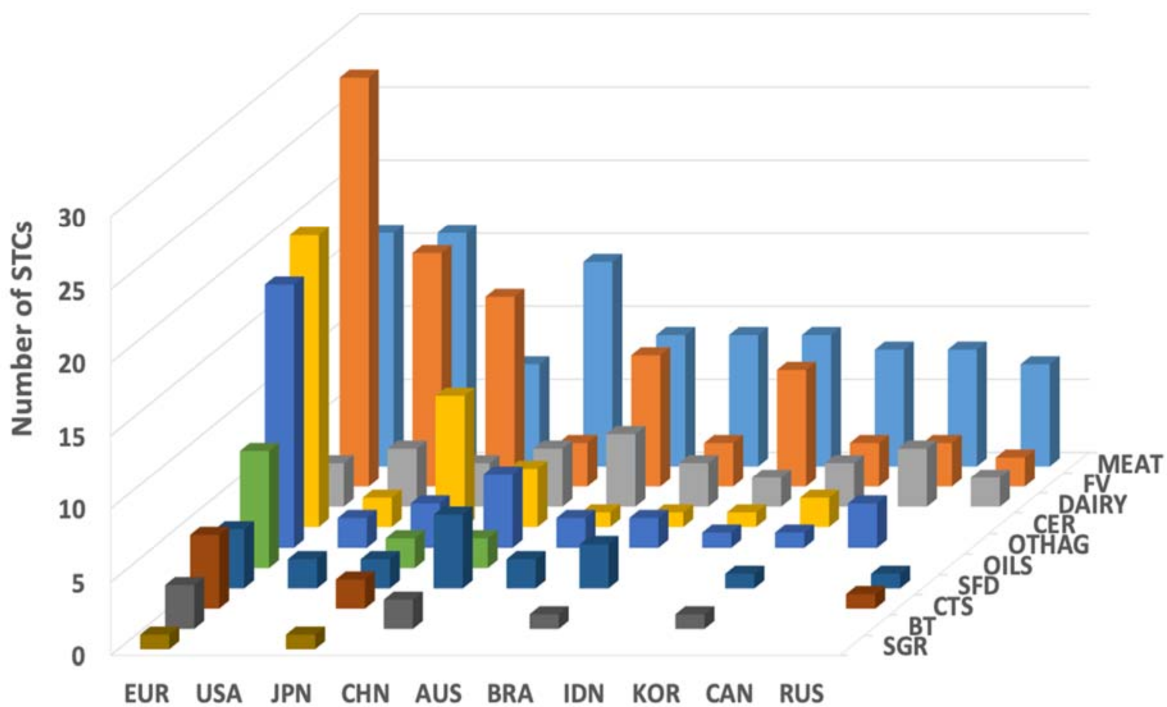

Figure 7. Top 10 Countries Maintaining SPS Specific Trade Concern Measures

Note: MEAT = animal products; FV = fruits & vegetables; DAIRY = dairy products; CER = cereals & preparations; OILS = oilseeds, fats & oils; SFD = fish & fish products; CTS = coffee, tea, mate & spices; BT = beverages & tobacco; SGR = sugars & confectionery products; OTHAG = other agricultural products. Source: Authors' calculation.

remain in processed meat cuts, some countries have argued that small amounts of residue (<10 ppb) are proven safe, while other countries including China, Thailand, Russia, and the EU have prohibited the use of ractopamine even through an international Codex MRL has been in place since 2012.[9] The ractopamine SPS concern has subsequently been raised 5 times and remains unresolved.

Like the U.S., EU exporters have also raised numerous SPS trade concerns against BSE, AI, ASF (African swine fever), and other food additives restrictions. For instance, in June 2004, the EU (and the U.S.) raised concerns about many countries' ban/restrictions on their beef exports due to concern about BSE (STC 193). Since the first confirmed case of BSE in 1986 in the United Kingdom and subsequent BSE outbreaks in the EU and North America (Canada and the U.S.) in the early 2000s, many destination markets ceased importing beef from these countries. Destination markets specifically mentioned in the concern include Australia, Brazil, China, Japan, South Korea, Thailand, Turkey, Ukraine, and Saudi Arabia. After raising the concern over 34 times (the most recent in November 2018), the concern is now considered partially resolved.

Unlike the U.S., however, EU SPS trade measures are more likely to be flagged as concerns by exporters. Related to its hazard-based approach to enact regulatory legislation, EU countries often maintain more stringent SPS standards than international food standards (i.e., FAO/WHO Codex Alimentarius, the World Organization for Animal Health (OIE) and the International Plant Protection Convention (IPPC)). Long-standing issues include the EU's setting of maximum residue limits and restrictions on genetically modified organisms (GMOs). In October 2001, the U.S. first expressed concerns about the EC (European Commission) proposals on genetically modified food and feed, and the traceability and labelling of GMOs. 12 other countries supported U.S. concerns regarding the treatment of GMOs by the EU (see STC 106, 110, 117 and 396). Although the proposed regulations were meant to protect human and animal health, consumers, and the environment, they have been considered *de facto* trade-barriers due to lengthy approval processes. Despite the concern being recorded as resolved with the WTO in 2006, the U.S. again expressed trade concerns in June 2016 regarding further delays in the EU's approval process for soybean biotechnological applications (STC 396). As described later in this report, even though some SPS trade concerns get reported as resolved in the WTO's SPS information management system, this does not guarantee that the importing country has withdrawn or revised its SPS policy such that these measures no longer represent a barrier to trade.

Other developing countries such as Brazil, China and India have also participated more actively in raising/supporting and maintaining SPS trade concerns. Because China has a zero tolerance for the presence of Ractopamine, Salmonella, Listeria Monocytogenes, and other pathogens in imported raw meat and poultry, many countries have expressed concerns about the unwarranted delay or restrictions of their products exported into the Chinese market. For example, STC 246 reported the trade

[9] See also: "U.S. Presses Taiwan on Ractopamine Ban," Food Safety News, February 7, 2012, *available at:* https://www.foodsafetynews.com/2012/02/us-presses-taiwan-on-ractopamine-ban/

concern about China's import restrictions on products of animal origin due to dioxin raised by the EU, and STC 251 discussed SPS trade measures concerning China's zero tolerance for pathogens on raw meat and poultry products raised by the U.S.

Also plotted along the secondary horizontal axes in Figures 6 and 7 are the various MTN product sectors affected by SPS trade concern measures. The top 10 exporting countries raising SPS trade concerns include the U.S., EU, Argentina, Canada, Brazil, China, Australia, Chile, New Zealand and Indonesia. The top 10 importing countries maintaining measures of concern include the EU, U.S., Japan, China, Australia, Brazil, India, South Korea, Canada and Russia. While there is some variation between countries in terms of the product sectors in which SPS trade concern measures are being raised against importing countries applying the measures, or maintained against exporting countries facing these measures, meat (28.6%), fruits and vegetables (21.8%), dairy (13.4%), and cereals and preparations (12.3%) are consistently the most frequently affected product sectors. These four product sectors account for 85% of all SPS specific trade concern measures raised in the WTO's SPS committee meetings. These four product sectors also have a relatively large trade weight in global agri-food trade covering an average of 51% of each of the top 10 exporting and importing countries' agricultural trade.

To conclude this section, Figure 8 takes a closer look at SPS trade concern measures raised or supported by the U.S. and the average duration of concerns across animal health, plant health, food safety and other concern topics. While there is some double counting that goes on due to the fact that some product sectors get wrapped up in multiple SPS concern subject categories, the results suggest that animal health and food safety SPS measures are the largest subject areas of concern impacting U.S. exports. Together these two categories accounted for 82% of all concerns raised or supported by the U.S. The U.S. raised or supported 167 concerns over SPS measures affecting animal health, 156 SPS trade concerns over food safety measures, 45 plant health concerns and just 27 other categories of SPS concerns. With the exception of the Other category, animal health related SPS concerns raised or supported by the U.S. had the longest duration with a mean length of 5 years to resolve and a maximum of almost 15 years in the case of BSE restrictions.

II.2 Bilateral Agricultural Trade Data

After carefully examining the global dataset of SPS specific trade concerns, we found that the top 30 agricultural importers and exporters consistently and actively participate in raising and maintaining SPS measures of concern. Further, we identified four major product sectors - meat, dairy, fruits & vegetables, and cereals & preparations – that represent over 85% of the full sample of SPS trade concern measures. Thus, SPS trade concerns tend to be quite concentrated among 20~30 exporting and importing countries and four product sectors. To ease the computational burden involved in econometric estimation of SPS trade impacts, in what follows we describe a global database of bilateral agricultural trade flows to quantify trade impacts of SPS measures facing the top 30 global agri-food trading countries and four major agricultural product sectors. Appendix Tables A1 anad A2 provide the list of the top 30 countries

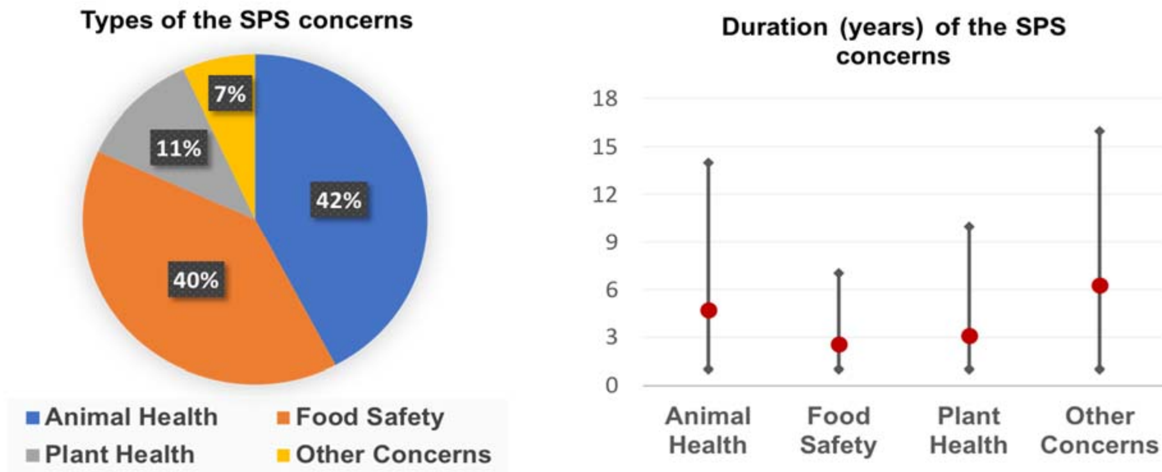

Figure 8. Subject and Duration of SPS Trade Concerns Raised or Supported by the United States, 1995-2016
Source: authors calculations

included in our sample and a mapping of product codes into MTN sectors for which we focused on four (Meat, Dairy, fruits, vegetables and plants, and cereals and preparations).

Data on the value of bilateral agricultural trade flows at the Standard International Trade Classification (SITC, revision 1) 4-digit product level from 1995 to 2016 are collected from the United Nations Commodity Trade Statistics (UN Comtrade) database.[10] We used the SITC product codes for two reasons. First, the SITC classification allows us to use a longer time series of bilateral trade data. While the HS system was first developed in 1988, countries, including many developing countries did not effectively convert their trade statistics to the HS system until the late 1990s. Second, the SITC product codes involve fewer product classifications compared to the HS system. Because we coded each of the 374 SPS specific trade concerns involving the top 30 countries used in our sample individually for each country-pair-by-product, the SITC codes expedited this mapping. A potential drawback of the SITC product codes is that they are less disaggregated compared to the HS6 and HS4 product codes. For example, the four agricultural product sectors considered in this article – meats, dairy, fruits and vegetables, and cereals and preparations – correspond to 86 HS4 (or 303 HS6) product codes compared to 60 SITC product codes.

Appendix Table A2 lists the 10 MTN sectors making up agricultural trade, including the four MTN sectors of interest in this study and their corresponding HS and SITC product codes. We also collected information on bilateral preferential and Most Favored Nation (MFN) average applied tariffs from International Trade Centre-Market Access Map (ITC-MacMap) database.[11] Other economic and trade related variables

[10] Available at: https://comtrade.un.org/
[11] Available at: www.macmap.org

such as the bilateral distance between trading partners, whether two countries speak common language, share a common colonial tie, or land border, and whether they belong to a mutual free trade agreement are collected from the World Bank, and Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).[12] Import demand Elasticities, which as described below help convert the SPS trade impact into ad valorem tariff equivalents, are collected from Soderbery (2015) and Grant et al. (2018) to match the product and country pairs included in the study.

Notably, about a quarter of the SPS trade concerns released by the WTO do not provide explicit HS codes for products affected by SPS concern measures. IN these case, we extracted relevant product codes based on the SPS committee meeting minutes and summary reports which provide detailed summaries of each SPS specific trade concern. We then matched and re-coded the products at the SITC 4-digit level to help determine a broad category of commodities as opposed to a specific category within a product. For example, beef in the SITC product code consists of “Meat of bovine animals, fresh, chilled, frozen, salted” in SITC code 0111 compared to 6 different HS6 codes disaggregating beef into fresh, frozen, carcasses, half carcasses, bone-in or boneless, etc.

When merging the SPS trade concern measures with SITC 4-digit bilateral trade data, two additional items need to be mentioned. First, while more than one-half, 57.4%, of the matched observations were targeted by a single STC, several concern measures overlapped with multiple STCs. Sometimes these concerns were quite different in terms of the type of measure, frequency with which the concern was raised, and/or other characteristics, causing an issue when mapping individual trade concerns to a single country-pair-by-product observation in the global bilateral trade flow database.[13] To address this issue, we merged SPS trade concern measures using the earliest reported concern or the concern with the longest active period. We believe that these are the most troublesome SPS concerns revealed by exporting countries that are likely impacting trade.

Second, we screened the SPS trade concern measures to eliminate those STCs that involved draft measures (i.e., SPS measures that were in the process of undergoing the 60 day comment period before being implemented). For example, STC 288 discussed the concern raised by the EU and supported by Canada, Iceland, Norway and the U.S. on certain draft measures by the Ukraine on a wide range of animals and animal product imports. In March 2010, Ukraine withdrew the measures due to BSE and other prior animal disease issues after consulting with the concerned members and welcomed further developments of its import system in a transparent manner.

[12] Available at: https://databank.worldbank.org and http://www.cepii.fr/CEPII/en

[13] 24.2% of trade observations were targeted by two distinct STCs, and 18.4% by three or more distinct STCs.

Similarly, STC 299 documented the concern raised by China and India and supported by Costa Rica, Jamaica, Mexico, Pakistan and Philippines concerning the U.S. 2009 Food Safety Enhancement Act that proposed several new measures, including required registration of export food companies, follow-up inspections, compulsory third-party certification for high risk imported products and the expansion of the Food and Drug Administration (FDA) authority. This draft regulation was later became law - the Food Safety and Modernization Act - passed by the U.S. Senate in November 2010. However, considering the wide potential product coverage and uncertainty over which product sectors are considered "high risk" or require third party audits, these types of SPS specific trade concern measures were eliminated in this study.

Third, we initially expanded each SPS trade concern measure into a time series using the first and last date when the concern was raised (or the time when the concern was reported as resolved/partially resolved). However, through consultations with the WTO's SPS committee in Geneva in May of 2018, it was learned that countries rarely report when SPS (and TBT) trade concerns are resolved. Moreover, when countries do report trade concerns as resolved, it is often because the WTO secretariat has urged members to report on the status of their trade concerns.[14]

Fourth, an equally important issue is that in synthesizing the minutes attached to each concern it was realized that trade concerns often started well before the issues were first recorded with the WTO's SPS committee. In other cases, concerns were re-raised and continued after the time when they were recorded as resolved or partially resolved, such as the GMO case against the EU. In other cases related to animal disease, SPS restrictions due to AI resurfaced several years later, even after they were reported as resolved or went unreported. Therefore, using the WTO's recorded beginning and ending dates of SPS specific trade concerns is not able to consistently capture the time period of trade interventions leading to possible measurement error and inconsistent modeling outcomes.

To address these issues, we implemented a data-driven approach to the coding of SPS trade concerns in five steps:

(1) Make use of the WTO's SPS trade concern data as an identification signal indicating which exporters are likely facing SPS issues in specific destination markets for each product.

(2) Evaluate the time series bilateral trade flow data for all affected country-pair-by-product combinations (treatment group) during, before, and after the dates suggested in the language of the recorded SPS committee meeting minutes.

[14] Interviews with the WTO's SPS committee in May, 2018 suggest that every few years the committee urges members to update the status of unresolved SPS trade concerns. Our data confirmed this. A large portion of SPS trade concerns were "reported" as resolved/partially resolved in 2004, 2010, 2013, and 2017.

(3) Supplement the information in (1) and (2) with various web-based searches and national sources of SPS specific trade concern measures and consultations with trade policy officials.

(4) Determine the length of time agricultural trade flows were impacted (if any) beyond those recorded in the WTO's SPS committee. If no clear consensus or pattern emerged, SPS trade concerns were coded as recorded based on the language used to describe the situation recorded WTO's SPS committee minutes.

(5) Focus the mapping of SPS trade concern measures on meaningful trade relationships with significant historical trade using a threshold of at least one million dollars of product trade between country-pairs.

This five-step process left us with 202 SPS specific trade concern measures matched to bilateral agricultural trade data from which to conduct a comprehensive empirical analysis. Our data contain 26,348 country-pair-by-product observations affected by SPS trade concern measures over 22 years, and a total of 579,656 observations representing bilateral trade between 30 agricultural importing and exporting countries and 60 SITC product codes in four agricultural sectors (meats, dairy, fruits & vegetables, and cereals & preparations).

Five percent of country-pair-by-product trade are in the treatment group, i.e., experienced at least one SPS trade concern measure. Notably, within the treatment group, 49 percent of SPS trade concerns do not contain a benchmark period, meaning the SPS concern measures had been in place well before being recorded at the WTO, and 19 percent of them do not contain a post-resolution period, meaning SPS concern continues to be unresolved. Table 1 provides summary statistics of the variables in the global agricultural trade flow database used in the empirical analysis.

III. Empirical Methods

Following Peterson, Grant, Roberts and Karov (2013), we specify a structural gravity equation at the product line to estimate the impact of SPS measures that have been revealed as specific SPS trade concerns by exporters. Let V_{odk} denote the value of exports from origin country o to destination country d in product sector k at time t, the gravity equation can be expressed as

$$V_{odkt} = \frac{Y_{okt}E_{dkt}}{\sum_o Y_{okt}}\left(\frac{T_{odkt}}{\Omega_{okt}P_{dkt}}\right)^{1-\sigma} \tag{1}$$

where, Y_{okt} is the value of total production of product k for country o at time t; E_{dkt} is the total expenditure on product k by country d at time t; T_{odkt} contain all trade costs needed to get product k from producers in country o to consumers in country d at time

Table 1: Summary Statistics

	Mean	Std. Dev.	Min	Max
Trade value (million $), V_{odkt}	6.367	56.798	0	5505
Control variables				
Regional trade agreements, RTA_{odt}	0.243	0.429	0	1
Common language, $Comlang_{od}$ (Binary)	0.236	0.425	0	1
Common colony, $Comcol_{od}$ (Binary)	0.098	0.298	0	1
Common border, $Contig_{od}$ (Binary)	0.074	0.261	0	1
Distance (thousand miles), Log($DIST_{od}$)	8.828	0.820	5.371	9.901
Macroeconomic variables				
Importer's GDP (trillion $), Log($GDP_{dt}$)	6.328	1.378	1.845	9.853
Exporter's GDP (trillion $), Log($GDP_{ot}$)	6.406	1.722	1.845	9.853
Average applied tariff, Tar_{odkt}	0.184	0.508	0	26.692
Trade elasticities, σ_{odk}	3.434	1.357	1.100	12.932
SPS specific trade concerns variables				
SPS Trade Concern, Active, $STC_{1,odkt}$	0.025	0.156	0	1
SPS Trade Concern, Post-Resolution, $STC_{2,odkt}$	0.017	0.130	0	1
Animal Health STC, Active, $AH_{1,odkt}$	0.008	0.090	0	1
Animal Health STC, Post-Resolution, $AH_{2,odkt}$	0.005	0.068	0	1
Plant Health STC, Active, $PH_{1,odkt}$	0.005	0.068	0	1
Plant Health STC, Post-Resolution, $PH_{2,odkt}$	0.004	0.061	0	1
Food Safety STC, Active, $FS_{1,odkt}$	0.011	0.104	0	1
Food Safety STC, Post-Resolution, $FS_{2,odkt}$	0.008	0.090	0	1
Other STC, Active, $OTH_{1,odkt}$	0.001	0.037	0	1
Other STC, Post-Resolution, $OTH_{2,odkt}$	0.001	0.027	0	1

Note: The data include 30 countries and 60 SITC product codes over 1995-2016, with a total of 579,656 observations (26,348 country-pair-by-product trade relationships for 22 years).
Source: Authors' calculation.

t; Ω_{okt} and P_{dkt} are the CES price indices used to capture the general equilibrium effects of inward and outward multilateral resistance terms that arise from changes in countries' overall trade resistance or openness at time t.

In the context of agricultural trade, the trade costs are proxied through a multiplicative function of the following factors:

$$T_{odkt} = (1 + Tar_{odkt}) \exp\left[\left(\prod_{s} \theta_s L_{od(s)}\right) RTA_{odt}^{\gamma} SPS_{odkt}^{\lambda}\right] \quad (2)$$

where Tar_{odkt} is the applied bilateral tariff rate for the product sector k exported from origin o to destination d; L_{od} is a vector of bilateral trade promoting or cost variables between o and d, such as common language ($Comlang_{od}$), common colonial tie ($Comcol_{od}$), common border ($Contig_{od}$), or the logarithm of distance ($\ln Dist_{od}$), reflecting not only transportation and shipment costs but also the costs of coordinating trade policy with more distant countries (Head and Mayer 2014). RTA_{odt} is a binary variable that equals one when both trading partners belong to the same regional trade agreement. We also introduce a five-year lagged RTA variable, $RTA_{od,t-5}$, to capture the fact that almost all RTAs contain trade liberalization commitments that are "phased-in" over time (Baier and Bergstrand, 2007; Grant and Lambert, 2008; Grant 2013; Grant and Boys, 2011; Baier et al., 2019).

The primary variable of interest in this study is the set of SPS trade concern policy variables. To examine the impact these SPS measures imposed by importer *d* on product *k* exported from exporter *o*, we generate a treatment variable during the period in which the SPS trade concerns were impacting trade, $STC_{1,odkt}$, and a post-resolution variable for those concerns that were resolved (either completely or partially), $STC_{2,odkt}$.

This allows us to assess the trade effects of SPS measures not only during the active period in which measures were in place, but also the post-resolution period, and to what extent bilateral trade recovered relative to the pre-SPS specific trade concern period. Put another way, the SPS specific trade concern data entail three states of the world for each country-pair-by-product. Period one captures the years leading up to the SPS specific trade concern. For bilateral trade relationships that had been affected for many years predating the beginning of the sample period in 1995, there is no period one. Period two is the treatment effect period and corresponds to the years in which the country-pair-by-product relationship experienced an SPS measure of concern potentially impacting trade. Period three corresponds to the years in which a subset of SPS specific trade concern were resolved. Of course, there are country-pair-by-product relationships in the sample that were not impacted by SPS specific trade concerns and these observations form part of our period one control category.

Importantly, the determination of periods 1, 2, and 3 is not based on the dates reported by the WTO's SPS committee for reasons explained earlier. Rather, we use the language and comments put forward by the exporter in describing the SPS measure of concern documented in the SPS committee meeting minutes, trends in the underlying trade data for each bilateral-pair-by-product, consultations with policymakers and trade associations, and scrutinizing a number of web-based national sources of information on the SPS concern measure. For some SPS trade concerns, the active period two was never resolved, even if it failed to be raised subsequently as an ongoing concern to the WTO's SPS committee. In these cases, there is no period three. Examples include some BSE measures (i.e., US concerns over China's SPS measures on BSE that were not resolved until 2017 - beyond the final year in our sample), multiple periods of concern and resolution over China's measures related to Avian Influenza restrictions in poultry (2009 and 2015), the EU's ban on mangoes and certain vegetables from India which were once again reassessed after the summer of 2016, etc.

In practice, time-varying importer- and exporter-by-product specific fixed effects

($\alpha_{dkt}, \alpha_{okt}$) and time-invariant country-pair fixed effects (α_{odk}) are utilized as consistent controls for the inward and outward multilateral resistance terms, and time-invariant natural factors impacting bilateral trade costs, respectively (Yotov et al., 2016). As for the dependent variable, because of the unignorable presence of zero trade flows and heteroskedasticity in bilateral trade flows, ordinary least squares estimation fails to produce unbiased and consistent estimates. If an SPS policy results in zero trade, then the omission of such observations eliminates important information regarding trade concerns and will result in underestimation of the true impact of the measures.

To address the issue, we follow Silva and Tenreyro (2006) and use the Poisson Pseudo Maximum Likelihood (PPML) estimator that allows for inclusion of zero trade flows and is robust to different patterns of heteroskedasticity. Even if the conditional variance is not proportional to the conditional mean, the PPML estimation method is still consistent and preferred for structural gravity model estimation in both partial and general equilibrium (Yotov et al., 2016; Peterson, Grant, Roberts and Karov 2013).

Substituting equation (2) into equation (1) and adding a well-behaved error term (ε_{odkt}), the PPML specification of the gravity model is expressed as,

$$\begin{aligned} V_{odkt} = exp\big[\alpha_{okt} + \alpha_{dkt} + \alpha_{odk} + \beta ln(1 + Tar_{odkt}) + \gamma_1 RTA_{odt} \\ + \gamma_2 RTA_{odt-5} + \lambda_1 STC_{1,odkt} + \lambda_2 STC_{2,odkt}\big]\varepsilon_{odkt} \end{aligned} \tag{3}$$

An important goal of this study is to quantify and compare the trade incidence of animal health, plant health and food safety related SPS concern measures. A more flexible specification of equation (3) disaggregates the SPS STC treatment effect binary variables ($STC_{1,odkt}$, $STC_{2,odkt}$) into those related to:

1) SPS measures for Animal Health reasons: AH_{odkt},
2) SPS measures for Plant Health reasons: PH_{odkt},
3) SPS measures for Food Safety reasons: FS_{odkt}

The structural gravity model with disaggregated SPS concern categories is then expressed

$$\begin{aligned} V_{odkt} = exp\Bigg[\alpha_{okt} + \alpha_{dkt} + \alpha_{odk} + \beta ln(1 + Tar_{odkt}) + \gamma_1 RTA_{odt} \\ + \gamma_2 RTA_{odt-5} + \sum_{s=1}^{2} \lambda_s AH_{s,odkt} + \lambda_s PH_{s,odkt} + \lambda_s FS_{s,odkt}\Bigg]\varepsilon_{odkt} \end{aligned} \tag{4}$$

where $AH_{s,odkt}$, $PH_{s,odkt}$ and $FS_{s,odkt}$ now denote the SPS treatment effect in periods *s= 1,2* (i.e., active and post-resolution) of animal health, plant health and food safety based SPS concern measures, respectively.

Using the estimation results from above, it is possible to estimate the equivalent ad valorem tariff protection of SPS specific trade concern measures. The AVEs of SPS measures adjust the econometric estimates by the elasticity of substitution to put SPS effects on the same scale as tariffs, which serves as a useful metric for input in simulation model assessments and to convey information to policymakers for comparative purposes. The AVEs are also convenient to identify which types of concerns, if resolved, are likely to yield the largest gains for agricultural producers and consumers.

The AVEs of SPS trade concerns can be computed as follows. First, given that trade costs are multiplicative, the coefficient λ on any one of the specific trade concern policy indicators in equations (3) and (4) is a combination of the impact of the policy variable's effect on trade (denoted δ) and the elasticity of substitution between varieties from different countries (i.e., σ). With $\lambda = \delta(1 - \sigma)$, additional estimates of at least one of these parameters is needed for identification of the AVE effect, and without it, policy interpretations of non-tariff measures can be misleading. For example, if the coefficient on SPS variables produces a large negative impact on bilateral trade, a relevant question becomes whether the non-tariff policy effect is especially trade restrictive or whether the elasticity of substitution is large such that even small changes in the measure yield large changes (i.e., substitution effects) in trade values.

To overcome this identification issue, a common method is to assume exogenous values of σ estimated in the literature (Kee et al., 2008; Soderbery, 2015; Grant et al., 2018). In this study, we rely on very recent trade elasticities estimated in Soderbery (2015; 2018) because of the broad coverage of country-pairs and products and the pair-wise consistent estimation methods used. Because the elasticity of substitution is sensitive to the type of product (and country) aggregation and pulling estimates from the literature may not match well with our product (and country) aggregation contained in the STC database, our preferred is to estimate the values of σ directly through the coefficient on bilateral tariffs as in equation (3) ($\beta = 1 - \sigma$). However, due to data limitations preventing the use of consistent time series bilateral tariff rates, we elected to use the most recent trade elasticities estimated in the literature (Soderbery, 2015; Soderbery, 2018; Grant et al., 2018).

Evaluating the marginal effect of SPS trade concern measures and the *ad-valorem* tariff equivalent (at a rate of τ) yields:

$$\frac{\partial V_{odkt}}{\partial Tar_{odkt}}|_{Tar=\tau} = exp[\beta ln(1 + Tar_{odkt})] \tag{5}$$

$$\frac{\partial V_{odkt}}{\partial STC_{1,odkt}}|_{STC=1} = exp[\lambda] \tag{6}$$

The AVE of SPS specific trade concern measures (AVE^{SPS}) is then the value of τ for which equations (5) and (6) are equal:

$$\tau = AVE^{SPS} = exp\left[\frac{\lambda}{\beta}\right] - 1 = exp\left[\frac{\lambda}{1-\sigma}\right] - 1 \quad (7)$$

IV. Empirical Results

In this section, we report the estimated trade impacts of SPS trade concern measures on the top 30 participating countries and product sectors. First, we present the trade effects of SPS STCs and the corresponding AVEs with a subject-, sector-, and country-pair focus. We then present six selected case studies on the use of SPS measures in particular contexts. A description of these case-studies is contained in Appendix Table A3. These case-studies include: (i) EU Aflatoxin limits on groundnuts and cereals; (ii) EU GMOs policies on cereal grains; (iii) BSE restrictions on beef (various countries); (iv) Japan's MRLs restrictions on cereals, fruits and vegetables; (v) China, EU, Russia, Taiwan and Thailand Ractopamine restrictions on pork and beef; and (vi) China's restrictions on Avian Influenza in poultry.

IV.1 Global SPS Trade Effects

Table 2 presents the aggregate estimated trade impact of SPS measures flagged as specific trade concerns by product sector and subject.[15] The corresponding AVEs of the SPS trade concern measures are plotted in Figure 9 using the calculation in equation (7). The estimated import elasticities of substitution are listed in the last row of Table 2. Soderbery (2015) estimated the trade import elasticity of substitution on a country-pair-by-HS4-product level. We retained the country pair dimension but averaged these estimates to the MTN sector level. We then mapped them to our data to calculate the AVE of SPS trade concern measures.

The estimated marginal effects of active SPS trade concern measures are striking. Bilateral agricultural trade exposed to an active SPS trade concern measure decreases members' trade by 67.8%, on average (Table 2, column (1) Overall). Using Soderbery's (2015) estimated average elasticity of substitution value of 3.36 for the four product sectors included in the sample, the results suggest an overall AVE tariff of 59% imposed by SPS measures of concern, on average (Figure 9). This AVE tariff is more than 3 times higher than the global average applied tariff rate across all agricultural products included in the sample of 18.4% (Figure 9).

[15] We do not report the coefficients of other covariates such as RTAs and tariffs to save space. These results were economically plausible and of the correct sign. Full econometric results are available from the authors upon request.

Table 2: Estimated Trade Impact of SPS Specific Trade Concern Measures

	ALL (1)	Meat Products (2)	Fruit & Vegetables (3)	Dairy Products (4)	Cereals & Preparations (5)
	Marginal effect in aggregate				
STC, active	-0.678***	-0.816***	-0.507***	-0.674***	-0.688***
	(0.023)	(0.030)	(0.041)	(0.041)	(0.046)
STC, post-resolved	-0.139**	-0.297***	-0.096	-0.206**	0.107
	(0.061)	-(0.109)	-(0.078)	-(0.090)	-(0.217)
	Marginal effect by subject				
AH, active	-0.839***	-0.858***		-0.733***	
	(0.027)	(0.028)		0.054	
AH, post-resolved	-0.388***	-0.448***		0.044	
	(0.104)	(0.105)		0.207	
PH, active	-0.612***		-0.629***		-0.503**
	(0.057)		(0.061)		(0.192)
PH, post-resolved	-0.137		-0.268**		1.199
	(0.116)		(0.112)		(0.762)
FS, active	-0.605***	-0.715***	-0.401***	-0.635***	-0.695***
	(0.034)	(0.061)	(0.052)	0.059	(0.048)
FS, post-resolved	-0.016	0.115	0.034	-0.330***	0.018
	(0.084)	(0.254)	(0.104)	0.079	(0.203)
OTH, active	-0.734***		-0.678***		
	(0.045)		(0.109)		
OTH, post-resolved	0.093		-0.084		
	(0.208)		(0.217)		
No. of observations	555,258	109,058	230,701	74,005	141,494
Sigma (σ)	3.364	3.452	3.348	3.387	3.332

Note: All regressions are estimated using PPML, controlling for time-varying importer-product, time-varying exporter-product, and time-invariant importer-exporter-product fixed effects. All results are reported in terms of the marginal effect ($\exp(\hat{\lambda})-1$). Elasticities of substitutions (σ) from Soderbery (2015, 2018) are used for all AVE conversions. Standard errors in parentheses. Asterisks ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

For concerns that have been resolved, the effect continues to be negative, though much smaller in magnitude, with an AVE tariff of just 6%. Overall, SPS measures significantly reduce members' agricultural trade during periods in which trade concerns are active.

In the lower half of Table 2, we report the marginal trade effects of SPS measures for each of the subject categories: animal health, plant health, food safety

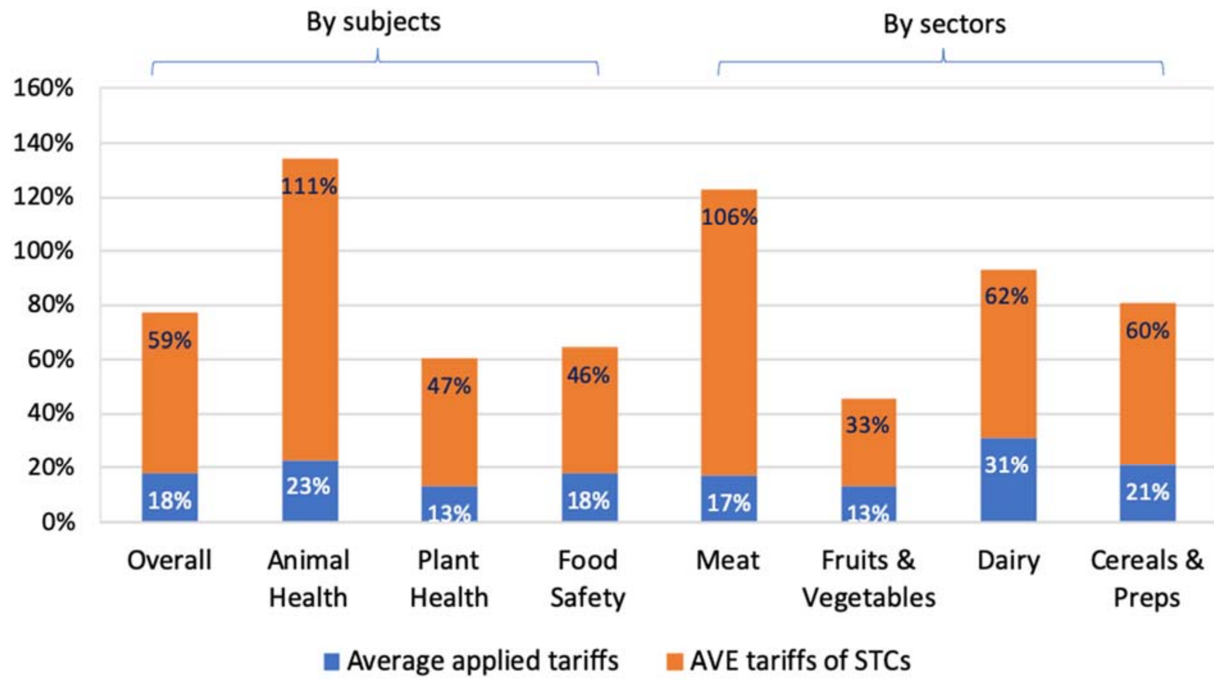

Figure 9. Ad-Valorem Equivalents of SPS Specific Trade Concern Measures
Source: Authors calculations based on results in Table 2.

and other concerns no elsewhere specified. This decomposition of the SPS trade effect into these four categories is important because it allows for a determination of which types of SPS measures are most trade restrictive leading to an overall trade reduction of 67.8%. Here, we find that an important reason for the negative and significant trade reducing effect of SPS measures of concern is due to SPS restriction for animal health reasons. The trade effect of animal health related SPS measures is to decrease exporting countries' trade by a striking 83.9% during the active period in which measures were enforced. This corresponds to an AVE of 111 percent (Figure 9), the largest AVE of any SPS subject category, and nearly five times the average applied tariff level on animal products of 23%.

Interestingly, we find that the trade effect of AH-STCs post-resolution for those concerns that were resolved is smaller but still negative and statistically significant at 39 percent reduction in animal product trade values (Table 2).

The effects of plant health and food safety related STCs are relatively smaller, with the estimated marginal effects of 61.2% and 60.5%, and AVEs tariffs of 47% and 46%, respectively.

Table 2 and Figure 9 also illustrate the results when we estimate the model for the four product sectors. The results indicate that the estimated trade flow effect of SPS measures is the most trade-impeding for meat products, as the majority of animal health concerns fall in this product sector, representing an 85.8% trade reduction or an AVE tariff of 106% when SPS trade concern measures are active. Thus, SPS trade concern measures on meat products, which are related to animal health and food safety concerns such as animal disease outbreaks and restrictions on beta agonists appear to be the most damaging for agricultural exports both in terms of the estimated trade effect and implied AVE.

SPS concern measures applied to cereals & preparations are ranked second in terms of estimated trade impacts with reductions of 68.8%. However, on an AVE basis cereal products rank third with an estimated 60% AVE tariff (Table 2 column 5 and Figure 9). Cereals & preparations are impacted by plant health and food safety concerns such as quarantine treatments, MRLs and restrictions related to GMOs.

SPS measures of concern on dairy products are often affected by animal health and food safety related concerns such as BSE and restrictions on feed and food additives. Here, the impact of SPS measures of concern maintained by importing countries is to reduce exporters' dairy product trade 67.4% (Table 2 column 4). This trade effect represents an AVE effect of 62% in the period in which SPS concern measures were active using Soderbery's (2015) estimated elasticity value of 3.39 (Figure 9).

Fruits & vegetable products experienced the lowest estimated trade effect and the lowest AVE of SPS measures of concern. Fruits and vegetables are frequently affected by plant health and food safety concerns. Examples include Japan's phytosanitary restrictions on fresh fruits and vegetables, its MRL standards, and U.S. phytosanitary inspection procedures for fruits and vegetables. The impact of these specific trade concern measures is to reduce exporters' fruit and vegetable trade by 50.7%, with an AVE effect of 33% – the lowest among the four sectors considered (Table 3 column 3 and Figure 9). Interestingly, fruits and vegetables also have the lowest average applied tariff rate across all 30 countries in the sample at 13%. With the lowest AVE of SPS measures, total protection defined as the sum of the AVE of SPS and the average applied tariff rate (46%) is roughly half the next highest sector (cereals and preparations, 80%) and nearly one-third the overall protection in animal products (123%) when SPS trade concern measures are applied.

IV.2 Country Specific SPS Trade Effects

The U.S., EU, Canada, Brazil and China are major participants not only in raising and maintaining SPS trade concern measures, but also in terms of their shares in world agricultural imports and exports. U.S., EU, Canada, Brazil and China participate in about one-third of total SPS specific trade concerns included in our sample involving 30 countries and account for a share of 45% of global agricultural imports and 49% of global agricultural exports. Given the importance of these five countries and their often opposing participation in raising versus maintaining SPS measures of concern, two important policy questions are:

Table 3. Estimated Trade Effects of SPS Trade Concerns for US, EU and China Imports

	Imports			Exports			
	US	EU	China	US	EU	Canada	Brazil
				Effect in aggregate			
STC, active	-0.517***	-0.764***	-0.965***	-0.852***	-0.832***	-0.902***	-0.841***
	(0.118)	(0.049)	(0.015)	(0.036)	(0.028)	(0.028)	(0.066)
STC, post-resolved	0.019	-0.174	-0.726***	-0.405***	-0.11	-0.521***	-0.168
	(0.311)	(0.226)	(0.110)	(0.132)	(0.215)	(0.116)	(0.261)
				Effect by subjects			
Animal Health, active	-0.645***	-0.903***	-0.921***	-0.866***	-0.890***	-0.893***	-0.955***
	(0.154)	(0.057)	(0.069)	(0.088)	(0.023)	(0.042)	(0.024)
Animal Health, post-resolved	-0.610***	0.459	-0.066	-0.531***	-0.478***	-0.515***	-0.244*
	(0.118)	(0.504)	(0.886)	(0.134)	(0.105)	(0.091)	(0.129)
Plant Health, active	-0.676***	-0.619***	-0.927***	-0.701***	-0.797***	-0.718***	0.16
	(0.096)	(0.081)	(0.005)	(0.044)	(0.060)	(0.091)	(0.129)
Plant Health, post-resolved	-0.276*	-0.320**		-0.342***	-0.379***	-0.536***	1.518***
	(0.150)	(0.133)		(0.107)	(0.118)	(0.173)	(0.342)
Food Safety, active	-0.441***	-0.758***	-0.964***	-0.853***	-0.717***	-0.929***	-0.760***
	(0.147)	(0.060)	(0.016)	(0.023)	(0.091)	(0.173)	(0.342)
Food Safety, post-resolved	0.516	-0.195	-0.727***	-0.196	0.72	-0.521***	-0.164
	(0.409)	(0.272)	(0.110)	(0.180)	(0.707)	(0.149)	(0.477)
Other, active	-0.702***	-0.848***	-0.496***	-0.759***	-0.887***	-0.880***	
	(0.018)	(0.028)	(0.106)	(0.153)	(0.028)	(0.022)	
Other, post-resolved		-0.502***		-0.318	-0.389***	-0.386**	
		-(0.110)		(0.364)	(0.071)	(0.155)	
Importer-product FE	Y	Y	Y	Y	Y	Y	Y
Exporter-product FE	Y	Y	Y	Y	Y	Y	Y
Importer-Exporter-Product FE	Y	Y	Y	Y	Y	Y	Y
Sigma (σ)	2.993	3.176	3.679	3.486	3.504	3.552	3.526
Observations	30,646	33,418	24,728	34,650	34,628	29,854	25,058

Note: All regressions are estimated using PPML, controlling for time-varying importer-product, time-varying exporter-product, and time invariant importer-exporter-product fixed effects. All results are reported in terms of the marginal effect ($\exp(\hat{\lambda}) - 1$). Elasticities of substitutions (σ) from Soderbery (2015, 2018) are used for all AVE conversions. Standard errors in parentheses. Asterisks ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

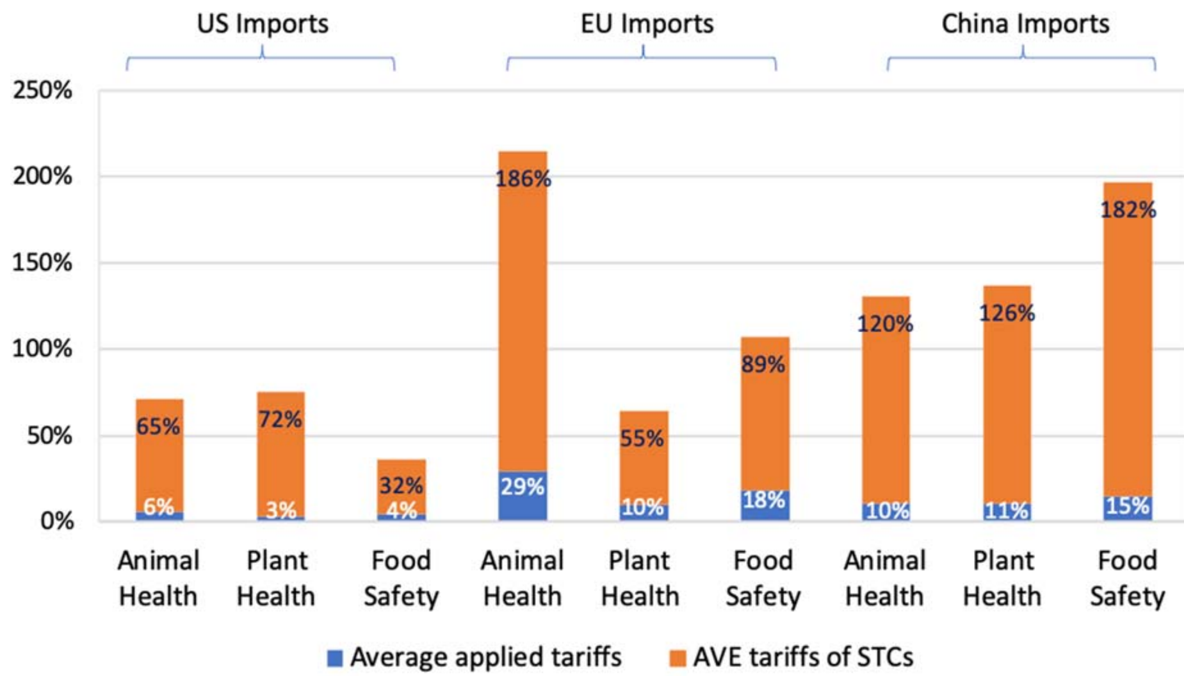

Figure 10. Estimated Ad-Valorem Tariff Equivalents of U.S., EU and China SPS Import Measures of Concern
Source: Authors calculations from Table 3

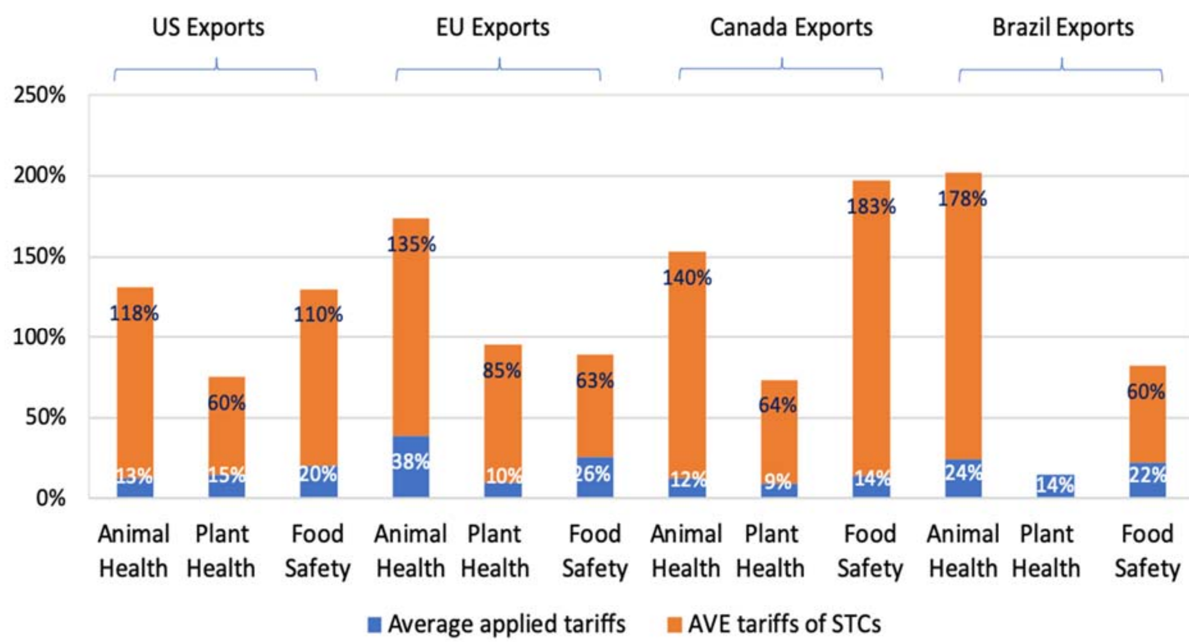

Figure 11. Estimated Ad-Valorem Tariff Equivalents of SPS Export Measures of Concern Faced by U.S., EU, Canada, and Brazil
Source: Authors calculations from Table 3

1. By how much do SPS measures maintained by the U.S., EU and China affect exporters' agricultural trade? And,
2. What is the impact of SPS concern measures on the U.S., EU, Brazil and Canadian exports of agricultural products?

We report the estimated results in Table 3 and the corresponding AVEs in Figures 10 and 11. Comparing the estimated results of U.S., EU and China agricultural imports (columns 1-3 in Table 3 and Figure 10), we find an asymmetric pattern of SPS trade impacts. On average, SPS trade concern measures maintained by China appear to be the most trade restrictive, reducing exporters' trade by a striking 96.5%, on average. China's SPS trade effect corresponds to an AVE tariff of 131% during the period in which AH, PH, or FS concerns were active. This sizable effect is over 8 times higher than China's average applied tariff on agricultural products of approximately 12%. For those concerns that achieved resolution, the effect declines by about a quarter but remains negative, implying an AVE tariff of 38% (Table 3). We also find that trade effect and AVE tariff of China's SPS measures that have been flagged as specific trade concerns are very similar in magnitude across different concern types, with food safety based SPS measures estimated to be the most prohibitive both in the active (an AVE effect of 182%) and post-resolution (an AVE effect of 50%) period.

On the other hand, the trade effect of SPS STCs maintained by EU is estimated to be 76.4%, or an AVE tariff of 92% in the active period – about 5 times higher than the EU's average applied agricultural tariff of 18%. The most prohibitive SPS measures maintained by the EU are related to animal health restrictions (affecting meat and dairy imports), causing estimated trade declines of 90.3%, or an AVE tariff of 186%. EU animal health SPS measures are followed by food safety related SPS measures at 75.8% trade reduction (AVE of 89%), and plant health related SPS measures (61.9% trade reduction; AVE of 55%).

By contrast, the trade effects of SPS STCs maintained by the U.S. are significantly smaller in magnitude, representing an average trade reduction of 51.7%, or an AVE tariff of 42% – less than a half (third) the AVE imposed by EU (China). In particular, food safety based SPS measures imposed by the U.S. are estimated to be the lowest among the three destinations, with an SPS measures reducing trade by 44.1%, or an AVE tariff of just 32%. The effects of U.S. animal and plant health based SPS measures are roughly double the magnitude of U.S. food safety SPS measures raised as concerns. In summary, our results indicate that global agricultural exporters appear to face more stringent SPS regulations in the EU and Chinese markets compared to the U.S. market. Depending on the product and concern type, the effect of SPS STCs varies in scope, ranging from an AVE tariff of 32% to 186%. These results are consistent with Arita et al. (2015) who quantified select SPS/TBT measures affecting US-EU agricultural trade and also found larger AVE effects of these in the latter compared to the former.

Turning attention to exporting countries (Table 3, Exports and Figure 11), we examine the impacts of SPS trade concern measures facing four of the largest agricultural exporting countries: the U.S., EU, Canada and Brazil. The results are reported in Table 3, columns 4-7 and the corresponding AVEs are plotted in Figure 11. On the export side, the trade effects of SPS STCs are somewhat similar in trend. The marginal effects of SPS measures perceived as trade concerns by U.S. and Canadian exporters are slightly higher than those for EU and Brazilian exporters. Averaging over the four country estimates we get a marginal effect of 86% trade reduction, or an AVE tariff of 116%. Perhaps more interestingly, when compared to the trade effects and AVEs on U.S. imports, we find that U.S. agricultural exports face SPS-induced trade reductions and AVEs that are two and three times more restrictive than measures the U.S. applies on its imports. Conversely, exports of EU products are less constrained by SPS measures maintained by other nations than those imposed by the EU on its imported products. This discrepancy is quite significant in the estimates of animal health and food safety based SPS measures. Canadian exports of agri-food products are relatively more constrained by food safety based SPS measures imposed by its trading partners with an AVE tariff of 183% facing its exports. Brazil, on the other hand, faces more restrictive animal health based SPS measures imposed by importing countries with an AVE effect of 178%.

IV.3 Case-Studies of Select SPS Trade Effects

While the global and country-specific effects of SPS measures on agricultural trade are informative, the results may not be fully generalizable to specific SPS measures. To enhance understanding of specific SPS cases that have been discussed extensively in the WTO's SPS committee and highlight their trade effects, we selected six case-studies for further examination. The estimation results are reported Table 4 and AVE tariffs are plotted in Figure 12 below. The six case-studies are as follows and summarized in depth in Appendix Table A3:

1) Stringent maximum limits on Aflatoxins in foodstuffs maintained by the EU;
2) Regulations on genetically modified organisms maintained by the EU;
3) Import restrictions due to BSE outbreaks;
4) Pesticide MRL enforcement system implemented by Japan;
5) Restrictions on the use of Ractopamine in pork for imports into China, Taiwan, Thailand, Russia, and EU; and
6) China's restrictions on U.S. poultry exports due to Avian Influenza.

EU Aflatoxin Standards

Aflatoxins are harmful substances produced by various fungi that are widely spread in nature. They can be found in cereals, oilseeds, and ground and tree nuts, and can lead to serious risks to humans and livestock (Kumar et al., 2017). Because aflatoxins are considered to be genotoxic and carcinogenic, the EU introduced regulations for these toxins in 1998, at levels considered to be as low as reasonably achievable (EFSA 2007). However, concerns were expressed by 22 countries arguing that the EC (European Community) proposal did not seem to be based on a proper risk assessment and would impose severe restrictions on trade. For example, in June of

Table 4. Estimated Trade Effects of Six SPS Specific Trade Concerns

SPS Issue Importing Country Maintaining the Measure	**Aflatoxin** **(EU)**	**GMOs** **(EU)**	**Avian Influenza** **(China)**	**BSE** **(Various countries)**	**MRLs** **(Japan)**	**Ractopamine** **(China, EU, Russia, Taiwan, Thailand)**
				Marginal effect		
Active STCs	-0.374***	-0.685***	-0.916***	-0.684***	-0.455***	-0.847***
	(0.091)	(0.035)	(0.023)	(0.039)	(0.052)	(0.049)
				AVE effect		
Active STCs	21.9%***	56%***	120%***	58%***	26%***	89%***
	(0.075)	(0.067)	(0.190)	(0.077)	(0.047)	(0.203)
Importer-product FE	Y	Y	Y	Y	Y	Y
Exporter-product FE	Y	Y	Y	Y	Y	Y
Importer-Exporter FE	Y	Y	Y	Y	Y	Y
Observations	20,510	91,938	2,872	20,034	112,125	6,604

Note: All regressions are estimated using PPML, controlling for time-varying importer-product, time-varying exporter-product, and time invariant importer-exporter fixed effects. All results are reported in terms of the marginal effect ($\exp(\hat{\lambda}) - 1$). Elasticities of substitutions (σ) from Soderbery (2015, 2018) are used for all AVE conversions. Standard errors in parentheses. Asterisks ***, **, and * denote the 1%, 5%, and 10% significance level, respectively.

2002, Bolivia noted that "although larger Bolivian exporters were able to meet the EC requirements at considerable costs and difficulties, smaller exporters could not fulfil the EC's requirements [on aflatoxin]".[16]

The EU aflatoxin concern was subsequently raised 13 times after the initial round and was reported as resolved in March 2004. The results in Table 4 suggest that stricter EU aflatoxins on Bolivian and other Southern American and Asian developing country exporters reduced EU imports of these products by 37.4%. The average AVE tariff of the EU's aflatoxin maximum limits is 21.9% while the corresponding average applied tariff rate the EU applies at the border is just 2.4%.

EU GMO Policies

Acceptance of genetically modified organisms (GMOs) has been one of the most contentious SPS (and TBT labelling) issues in global agricultural trade. The EU continues to maintain a de facto moratorium on the use and cultivation of GMOs for use in food and animal feed. U.S. GMO standards, in contrast, are typically more flexible and focus on the nature end use of the final products rather than the process in which they are produced. A number of countries including Argentina, Australia, Canada and the U.S. have expressed concerns over the EU's GMO approval process and

[16] Retrieved from: http://spsims.wto.org/en/SpecificTradeConcerns/View/128

traceability and labeling requirements, arguing that EU regulations are not commensurate with the risks and lacked scientific justification.

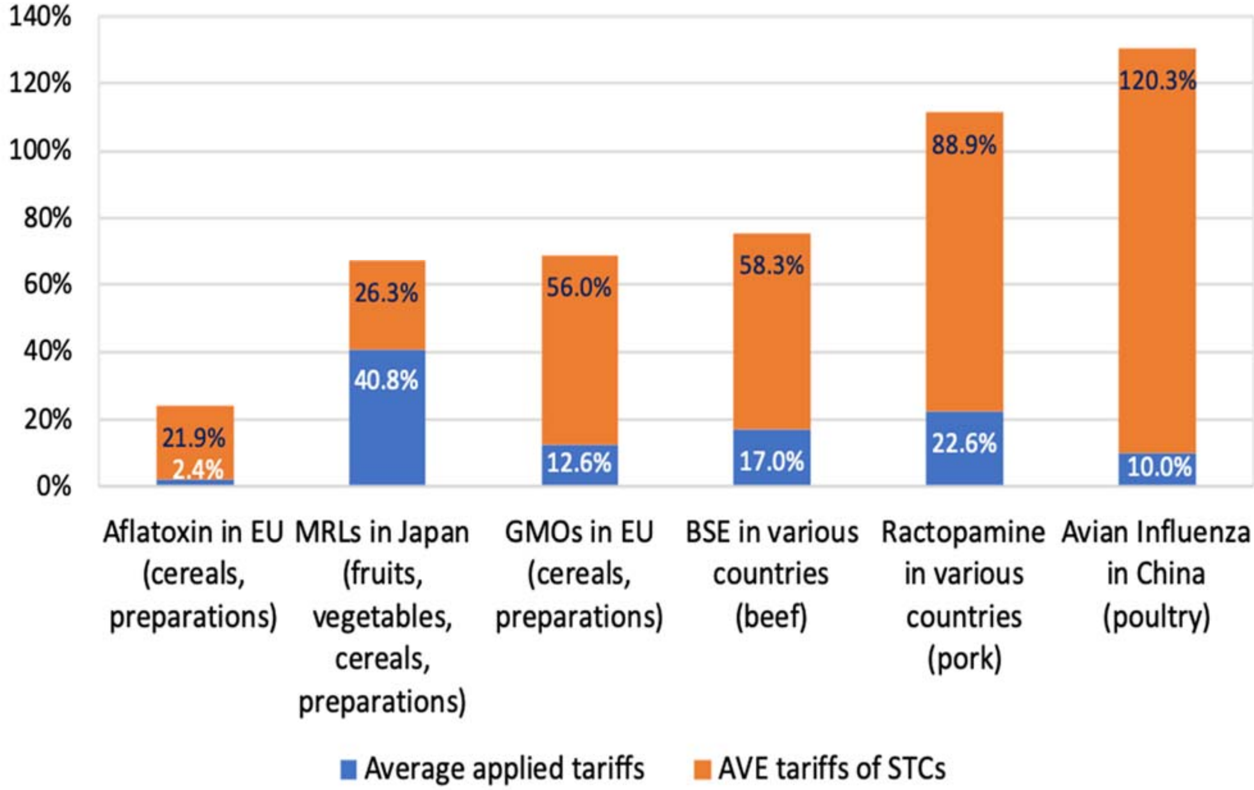

Figure 12. Estimated Ad-Valorem Tariff Equivalents of Six SPS Trade Concern Measures
Source: Authors calculations from Table 4.

The results in Table 4 and Figure 12 show that EU GMO regulations are indeed a barrier to trade, reducing exports by 68.5% on average. This effect translates into an AVE tariff of 56% on agricultural products exported to the EU markets, which is almost five times the level of EU applied tariffs on GMO products.

Restrictions on Beef Trade due to BSE

The discovery of Bovine Spongiform Encephalopathy (BSE, or mad cow disease) in the state of Washington in December 2003 prompted a large international policy response and immediate restrictions on U.S. beef exports to nearly every major destination market. While Mexico and Canada re-opened their markets to U.S. beef relatively quickly, following the BSE outbreak, other markets including many top export destinations in Asia remained closed for a much longer period of time. For example, Japan and South Korea suspended all imports of U.S. beef through 2005/2006, after which both countries eased restrictions on U.S. beef by allowing imports of beef from cattle aged less than 21 and 30 months, respectively. China banned imports of U.S. beef until September 2016, when China announced that it would begin allowing imports of U.S. beef aged less than 30 months, provided U.S. exporters comply with China's traceability and quarantine rules.

Trade restrictions due to BSE continue to linger in some Asian markets. Moreover, the BSE-related SPS trade concern (STC 193) was the most frequently raised concern for exporters, the most recent of which occurred in November, 2018. The effect of SPS restrictions due to BSE reduced exporting countries' beef trade by 68.4%, on average (Table 4). Converting this to an AVE results in BSE restrictions being equivalent to a 58.3% tariff (Figure 12) – the third highest AVE tariff out of the six SPS case-studies considered. When added to existing applied tariffs faced by the U.S., Canada, and EU exporters, our estimates suggest that total protection during the period when BSE SPS measures were in place was equivalent to a 75.3% tariff.

Positive List System for MRLs in Japan

In May 2006, Japan introduced its Positive List System for MRLs of agricultural and veterinary chemicals in food. After implementation of this SPS policy, foods containing residues exceeding Japan's MRLs, or 0.01 ppm in cases where no MRLs were established, were prohibited from entry into Japan.[17] China and many other WTO members expressed concerns about Japan's "uniform standards" of 0.01 ppm for several products. China contended that these new MRL standards were not based on scientific evidence and created serious obstacles to their food exports to Japan. Our results show that Japan's positive list for MRLs reduced exporters trade by 45.5% (Table 4) and is equivalent to a 26.3%, tariff. Given Japan's relatively high tariff rates on certain product lines including rice, this is one case in which the AVE of the SPS specific trade concern is less than the average applied tariff rate.

Restrictions on the use of Ractopamine

Ractopamine is a controversial veterinary drug (beta agonists) used in the production of swine, turkeys and cattle to promote the growth of lean meat. After years of scientific debate, the Codex Alimentarius Commission adopted an MRL standard for ractopamine in July 2012. Nevertheless, some meat importing countries including China, Taiwan, Thailand, Russia, and the EU continue to maintain a policy of zero tolerance for ractopamine in meat products. Our analysis suggests that restrictions on the use of ractopamine represents a significant barrier to trade, reducing pork exporters' trade by nearly 85% (Table 4). Moreover, the AVE of this concern is equivalent to an 88.9% tariff, and is the second most restrictive SPS specific trade concern policy among the six selected STC cases. The AVE tariff is also 4 times higher than the average applied tariff rate (22.6%) on pork trade.

[17] See USDA/FAS GAIN Report (2006) available at: https://apps.fas.usda.gov/gainfiles/200602/146176749.doc

China’s SPS restrictions on poultry related to Highly Pathogenic Avian Influenza (HPAI)

Finally, in Table 4 and Figure 12 we consider the SPS specific trade concern raised by the U.S. and EU against China's import restrictions of poultry related to Highly Pathogenic Avian Influenza (HPAI). As a major producer and consumer of poultry products, China imposed restrictions on imports of poultry meat from the U.S. and EU, despite recommendations by the OIE and regionalization efforts. The results reported in Table 4 and Figure 12 suggest that China's AI restrictions is among the most prohibitive SPS policy measure of the six case studies evaluated. China's AI restrictions have led to estimated export losses of 91.6% and is equivalent to a very high AVE tariff of 120.3%.

V. Concluding Remarks

Using a theoretically consistent gravity model of product line agricultural trade flows, this study examines the SPS measures that have been raised as specific trade concerns in the WTO’s SPS committee over the 1995-2016 period. Because the universe of SPS and TBT notifications of non-tariff measures is diverse and large with over 54,000 total measures (SPS + TBT) notified to the WTO through 2017, a broad-based approach that attempts to quantify their trade impact may lead to ambiguous trade outcomes. Alternatively, we use a data-driven approach to identify country-pair-by-product trade relationships that have been flagged in the WTO’s SPS committee as having been impacted by SPS measures maintained in importing country markets. We focus our analysis on the top 30 agricultural trading countries covering all products within the meat, dairy, fruits & vegetables, and cereals & preparations sectors.

We estimate and compare the SPS trade effect globally, by animal health, plant health an food safety measures, by sector and specific exporter and importer markets, and for six specific SPS case-studies. Our results show that, on average, the trade losses due to SPS measures that have been flagged as trade concerns ranges from 50.8% to 81.5% for the four major product sectors considered during the period in which the SPS trade concerns were active. However, while the SPS trade effect is almost universally negative for SPS trade concerns, the extent to which trade declines varies considerably across product sectors. Meat and dairy exports which are often affected by animal health-related trade concern measures experienced trade reductions of 86% and 73% during years in which SPS trade concern measures were active. Fruit & vegetable and cereals & preparation exports affected by plant health and food safety SPS measures also experienced negative trade flow reductions; however the magnitude of the trade decrease was less than those for meat and dairy sectors.

This study also investigated the trade impact of SPS concern measures for U.S. and EU as importers maintaining measures against exportin countries and as exporters facing SPS measures maintained by other destination markets. In terms of U.S. and EU agricultural exports, we find that both countries experience significant trade reductions due to SPS measures with estimated AVE tariffs of 120 and 104 percent, respectively.

In terms of U.S. and EU SPS measures of concern meaintined in their respective imports, a much more contrasting picture merged. Here, the AVE effect of SPS STCs maintained by the U.S. is estimated to be 41%, less than half the 94% AVE tariff imposed by EU SPS measures.

Finally, we reported SPS trade impact results for six specific trade concern cases that have been discussed extensively in the WTO's SPS committee meetings to provide a more nuanced view of their trade effects. The results show that China's restrictions on AI and ractopamine restrictions imposed by the EU, Russia, China, Taiwan and Thailand are the most prohibitive SPS policies facing exporters among all cases considered.

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Appendix Table A1: List of Countries Included in the Sample

Country	ISO3 Code	Development Level
Argentina	ARG	Developing
Australia	AUS	Developed
Brazil	BRA	Developing
Canada	CAN	Developed
Chile	CHL	Developing
China	CHN	Developing
Colombia	COL	Developing
Costa Rica	CRI	Developing
Ecuador	ECU	Developing
Indonesia	IDN	Developing
India	IND	Developing
Japan	JPN	Developed
Mexico	MEX	Developing
Malaysia	MYS	Developing
New Zealand	NZL	Developed
Philippines	PHL	Developing
Paraguay	PRY	Developing
Russian Federation	RUS	Developing
South Africa	ZAF	Developing
South Korea	KOR	Developed
Switzerland	CHE	Developed
Taiwan	TWN	Developing
Thailand	THA	Developing
Turkey	TUR	Developing
Ukraine	UKR	Developing
Uruguay	URY	Developing
United States	USA	Developed
Venezuela	VEN	Developing
Vietnam	VNM	Developing
European Union	EUR	Developed

Source: World Economic Situation Prospects, United Nations (2014).

Appendix Table A2. MTN Sector Maaping to HS (2007) and SITC (Revision 1) Product Codes

MTN Category	Abbreviation	HS Codes (2007 Revision)	SITC Codes (Revision 1)
--Agricultural Products---------------------------------------			
Animal Products	MEAT	01, 02, 1601-1602	001, 011-013
Dairy Products	DAIRY	0401 - 0406	022-024
Fruits, Veg., and Plants	FV	07, 08, 1105-1106, 2001-2008, 0601-0603, 1211, 13, 14	051-055
Coeffee & Tea	CTS	0901-0903, 18 (except 1802), 2101	071-075
Cereals & Preparations	CER	0407-0410, 1101-1104, 1107-1109, 19, 2102-2106, 2209, 10	025, 041-048, 0554
Oilseeds, Fats, & Oils	OILS	1201-1208, 15 (except 1504), 2304-2306, 3823	0813, 0913-0914, 221, 4113, 421-422, 431
Sugars & Confectionary	SGR	17	061-062, 5129
Beverages & Tobacco	BT	2009, 2201-2208, 24	111-112, 121- 122
Other Ag.	OTHAG	0904-0910, 05, 0604, 1209-1210, 1212-1214, 1802, 230110, 2302-2303, 2307-2309, 290543-290545, 3301, 3501-3505, 380910, 382460, 4101-4103, 4301, 5001-5003, 5301-5302	0811-0812, 0990, 211-212, 262, 265, 291, 292

Note: Mapping to HS Codes is take from World Tariff Profiles (2008). Mapping to SITC Codes (Revision 1) is completed by the authors using the World Bank WITS Concordance tables available at: https://wits.worldbank.org/product_concordance.html

Appendix Table A3. List of Selected Case-Study SPS Specific Trade Concern Measures

Topic	Maintained By:	Raised/Supported By:	Products Covered	Keywords
Aflatoxin (STC 39, 168, 198)	**EU**	Argentina; Australia; Bolivia; Brazil; China; The Gambia; India; Indonesia; Malaysia; Philippines; Senegal; Thailand; Canada; Colombia; Mexico; Pakistan; Paraguay; Peru; Philippines; South Africa; Turkey; United States; Uruguay	Milk, peanuts, other nuts, dried fruits, corn, cereals, other food preparations	Food safety
GMOs (STC 106, 110, 117, 396)	**EU**	Argentina; Australia; Canada; Egypt; Israel; Jordan; Singapore; Chinese Taipei; Paraguay; Philippines; United States	Cereals, grains, food preparations, other animal feeds	Food safety; Other concerns (approval)
BSE (STC 4, 96, 193)	Argentina; Australia; Brazil; Chile; China; Japan; Singapore; South Korea; Thailand; Turkey; Ukraine; European Union; United States	Canada; Switzerland; European Union; United States; Uruguay	Beef	Animal Health
MRLs (STC 212, 267, 283)	Japan	China; Australia; Brazil; Philippines; Ecuador; New Zealand; United States	Fruits and Vegetables	Food Safety
Ractopamine (STC 275)	China; Chinese Taipei; Thailand; European Union; Russian Federation	United States; Brazil; Canada; Costa Rica; Ecuador; Peru	Pork	Food Safety
Avian Influenza (STC 196, 259, 406)	China	United State, European Union, Canada	Poultry	Food Safety

Source: Authors interpretation from WTO Specific Trade Concerns