# Retaliatory Use of Public Standards in Trade

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**Abstract**

This research investigates the extent to which countries use public standards as a means of political retaliation in the international policy arena. We construct a dataset that matches the adoption of sanitary and phytosanitary (SPS) standards between 1996–2015 with SPS committee data on specific trade concerns and annual, bilateral trade flows. We evaluate the presence and frequency of retaliation by assessing the extent to which measures imposed by one country against another increase the probability that the country targeted by the original measure will respond with a measure of their own. We observe that this type of tit-for-tat behavior commonly occurred outside the product group of the original measure and for politically strategic goods. At the two digit level, we find that about 3,000 bilateral trade flows globally—or just over $110 billion in trade—were subject to retaliatory standards in 2015.

*Keywords:* non-tariff barriers, public standards, political retaliation, trade protectionism, trade wars

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*". . . trade wars are good, and easy to win."*

Donald Trump (March 2, 2018).

# 1 Introduction

Recent months have seen a resurgence in politicians' willingness to engage in overt trade wars (Fajgelbaum et al., 2019). Tariff wars, in which one country raises tariffs in response to tariff hikes in another country, are a well-documented and classic example of this type of retaliatory behavior (Kennan and Riezman, 1988). Public backlash made tariff wars rare in the era of free-trade politics (The Economist, 2018). Yet, incentives for protectionism and retaliation persisted. In this paper, we ask whether—between 1996–2015—politicians satisfied the proclivities for retaliation through more subtle, non-tariff mechanisms. Specifically, we investigate the manner and extent to which countries used public standards as a means of political retaliation.

Public standards are requirements that goods must satisfy in order to enter a country's stream of commerce. As such, they represent non-tariff barriers to trade (NTBs). As tariffs have fallen in light of WTO restrictions, the use of public standards affecting trade has grown (Ehrich and Mangelsdorf, 2018; Yu, 2000). When used legitimately, public standards serve to correct market failures (Fischer and Serra, 2000; Marette and Beghin, 2010; Swinnen and Vandemoortele, 2011). However, although there is evidence to the contrary (Bao and Qiu, 2012), the body of evidence suggests the imposition of a standard is trade-reducing from the perspective of the targeted country (Achterbosch et al., 2009; Beghin and Melatos, 2012; Crivelli and Gröschl, 2016; Disdier, Fontagné and Mimouni, 2008; Fontagné et al., 2015; Vigani, Raimondi and Olper, 2009; Wei, Huang and Yang, 2012; Wieck, Schlüter and Britz, 2012). Such negative trade effects may incentivize politicians to use standards for illegitimate purposes, such as domestic protectionism (Aisbett and Pearson, 2012; Baylis, Martens and Nogueira, 2009; Baylis, Nogueira and Pace, 2012; Besedina and Coupe, 2015).

In this paper, we study the use of Sanitary and Phytosanitary (SPS) measures as an

instrument for political retaliation. We construct a dataset that matches the adoption of SPS standards between 1996–2015 with WTO committee notes and annual, bilateral trade flows. We develop a multi-tiered empirical strategy designed to test whether (i) countries targeted with an SPS measure respond with an SPS standard of their own and (ii) if such response exists, whether it follows a pattern consistent with retaliation. We first ask whether countries that have explicitly raised concerns of unjust implementation or administration of an SPS measure by another country increases the probability that the former country will implement its own standard. Next, we assess the extent to which measures imposed by one country against another increase the probability that the country targeted by the original measure will respond with a measure of their own—i.e., whether countries exhibit "tit-for-tat" behavior in the adoption of public standards. Within this analysis, we ask whether "tit-for-tat" behavior depends on the politically strategic nature of subject trade partners and goods.

This paper contributes to various strands of literature on the political economy of retaliation in international trade policy. Disagreement persists among academics as to whether retaliation constitutes a thinly veiled mechanism by which to pursue protectionism or a crucial strategy to enforce commitments under international rules. Recent theoretical evidence tends to support the latter over the former. Martin and Vergote (2008) develop a game-theoretic model to show that retaliation via import tariffs creates efficient equilibrium in the enforcement of trade agreements. Dluhosch (2016) show further that this is true even in the presence of powerful domestic interest groups in the retaliating country. To date, empirical investigation of retaliation is limited to the administration of anti-dumping duties, which operate as import tariffs. Feinberg and Reynolds (2006) show that countries exhibit tit-for-tat behavior in the initiation and administration of antidumping laws. Blonigen and Bown (2003) find that even the threat of retaliation can pre-empt countries from levying antidumping duties.

To the authors' knowledge, our paper is the first to empirically examine global retaliation in the use of NTBs. Public standards represent particularly interesting instruments for

which to assess the extent to aims of political retaliation. Several papers have shown that implementation and application of public standards often exhibit patterns consistent with protectionism. Baylis, Martens and Nogueira (2009) show that the application of public standards in the U.S. is subject to lobbying expenditure. Baylis, Nogueira and Pace (2012) present evidence that tariff reductions are associated with an increase in the application of SPS standards in the EU. Grundke and Moser (2019) compare U.S. import refusals with national unemployment data and find that import refusals are consistent with protectionistic reactions to fluctuations in the business cycle.

Our findings are consistent with the theoretical findings in Martin and Vergote (2008). Our results indicate that retaliatory behavior commonly occurred in the use of SPS standards—at the two digit level, about 3,000 bilateral trade flows globally ($110 billion in trade) were subject to tit-for-tat standards in 2015. Further, holding constant regulatory behavior of trade partners, strong trade networks reduce the use of SPS standards. However, such networks equally *increase* the probability of regulatory response when a partner country threatens the relationship through implementation of an SPS measure. Moreover, there are two dimensions along which the strategic nature of a product can affect retaliatory behavior. The first dimension of this strategic nature relates to the importance of the product hit with the *original* measure from the perspective of the target country. The second dimension of the "strategic nature" of goods relates to the political sensitivity of the product against which retaliation occurs—from the perspective of the country that instigated the original measure.

The remainder of the paper is structured as follows. Section 2 reviews international rules related to SPS administration and documents the use of such standards over time. In Section 3, we provide a description of our data and explain our empirical methodology. Section 4 presents results, and Section 5 concludes.

# 2 The SPS agreement

The WTO categorizes public standards that impact trade under two agreements: the *Agreement on the Application of Sanitary and Phytosanitary Measures* (referred to hereinafter as the SPS Agreement) and the *Agreement on Technical Barriers to Trade* (referred to hereinafter as the TBT Agreement). These agreements provide exceptions from rules barring non-tariff barriers (NTBs) for regulatory measures that satisfy conditions on justification and scope of use. SPS measures must be implemented on the basis of animal, plant, and human health protection, whereas the TBT Agreement covers technical regulations, standards, and procedures that are related to products or processes and production methods (Ahn, 2002).[1] Under the SPS Agreement, countries are required to notify the WTO whenever they adopt a new (or change or withdraw an existing) SPS requirement affecting trade. The WTO maintains a repository, known as the SPS Information Management System containing all past SPS notifications.

According to the SPS Agreement, WTO-member countries may implement non-tariff barriers on the basis of animal, plant, and human health protection, so long as such restrictions are not "arbitary and unjustified". The SPS Agreement also provides exemptions from most-favoured nation and national treatment requirements to allow discrimination against one or more countries. Discrimination is allowed because member-countries differ with respect to pest and disease profiles and food safety conditions. Accordingly, SPS measures vary in obligations for compliance and product- and country-scope. Measures sometimes target only a specific country or set of countries, but may be heavily restrictive, such as mandating long quarantine periods or outright bans on products from disease-endemic areas.[2]

[1] The U.S. ban on imports of citrus seeds from certain countries (instituted in 2009) to protect the U.S. citrus industry against citrus greening disease is an example of an SPS measure. Maximum tolerance levels for automobile emissions to control air pollution is an example of a TBT measure.

[2] SPS measures are broadly defined to include "all relevant laws, decrees, regulations, requirements and procedures including, *inter alia*, end-product criteria; processes and production methods; testing, inspection, certification and approval procedures; quarantine treatments including relevant requirements associated with the transport of animals or plants, or with the materials necessary for their survival during transport; provisions on relevant statistical methods, sampling procedures and methods of risk assessment; and packaging

There is a critical distinction between what constitutes an "arbitrary and unjustified" SPS measure as a matter of law and the underlying economic purpose (or set of purposes) for implementing a given measure. If a country implements a standard that fails to meet the legal criteria of not being "arbitrary and unjustified", affected countries can bring legal action against the instigating country through the WTO Dispute Settlement Body (DSB). However, the criteria of "arbitrary and unjustified" is a relatively low legal barrier. If an implementing country is able to provide evidence demonstrating that a standard is not completely arbtirary and that there is some justification for the standard, it is legitimate as a matter of international law, even if the true purpose of the measure is domestic protection. In reality, countries often implement and administer SPS standards in a way that meets the legal criteria, but are nevertheless rooted in protectionistic (Aisbett and Pearson, 2012; Baylis, Martens and Nogueira, 2009; Baylis, Nogueira and Pace, 2012; Besedina and Coupe, 2015). In these instances, targeted countries have no recourse in the DSB.

The WTO has established an informal forum, known as the SPS committee, in which countries negatively affected by specific SPS measures can discuss such standards, request clarifications from the implementing country, and signal that they do not believe the true purpose of the standard is protection of human, plant, or animal health Horn, Mavroidis and Wijkström (2013). These complaints are referred to in the SPS committee as Specific Trade Concerns (STCs), and, in the first decade of the WTO, more than 400 STCs were raised at the SPS Committee.

## 2.1 Conceptual Framework for Retaliation

Martin and Vergote (2008) develop a two-good, two-country model of trade in which countries interact repeatedly to study retaliation via import tariffs. The authors assume that preferences of governments are subject to random shocks that affect their relative valuation of the import-competing sector. In this setup, governments would benefit from having the flexibility to

and labeling requirements directly related to food safety" (Ahn, 2002).

raise their import tariffs when their valuation of the import-competing sector is high, and to decrease them otherwise. However, governments cannot observe the preferences of their trading partner. This information asymmetry gives rise to a problem of incentive compatibility: because governments are always incentivized to set relatively high tariffs in order to affect the terms of trade in their favor, they have a tendency to overstate their preference for protection at any point in time. To prevent them from doing so, there must be some cost associated with the use of high tariffs. In a world of restricted trade instruments, governments can impose such costs on one another by using their remaining policy instruments in a flexible way.

In this setting, retaliation is desirable as a mechanism to maximize joint welfare. Within the context of the WTO, there are two main channels to control potential deviations: (a) retaliate directly through the use of import tariffs, or (b) to challenge them in the context of the DSB. Martin and Vergote (2008) argue that countries are often dis-incentivized to incur the costs and uncertainty associated with the DSB when they can pursue retaliation directly—they can avoid WTO litigation in favor of pursuing reciprocal justice. In this way, governments find it jointly optimal to allow import tariffs to vary with their desired levels of protection. Incentive compatibility stems from the face that each country's tariffs are directly related to the contemporaneous tariffs of its trading partner. Hence, tariffs are never set at their optimal levels because, in each period, they are jointly used to accommodate the governments' shifting preferences for protection. "Vigilante" retaliation occurring outside the WTO DSU does not undermine the international trading system. Instead, it serves as a necessary way to accommodate shocks.

While Martin and Vergote (2008) limit their analysis to retaliation through the use of duties, we argue that retaliation in the use of NTBs is—at the very least—equally plausible. Like import duties, imposition of public standards alters terms of trade. Indeed, it is common practice to measure the *ad valorem* equivalent impacts of such instruments. Similarly, SPS standards can be used to target specific products and countries. Moreover, when one WTO member implements a *legally* valid SPS measure against another, the negatively

affected country has no recourse under the WTO dispute settlement mechanism. "Tit-for-tat" retaliation would be the only effectively enforcement mechanism available to this violation of the commitment towards free trade expressed through WTO commitments.

## 2.2 Use of SPS Measures in Practice

We use two decades of data from the SPS-IMS database, running from 1996–2015, on the adoption of public standards in WTO member-countries. SPS measures are disaggregated by reporter, target country, and product.[3] During the time period considered in this paper, 22,294 SPS measures were issued, affecting 380,941 importer-exporter-product (IEP) trade flows). Adoption of standards is further disaggregated by year in Figure 1.

Figure 1: SPS Measures Initiated, by year

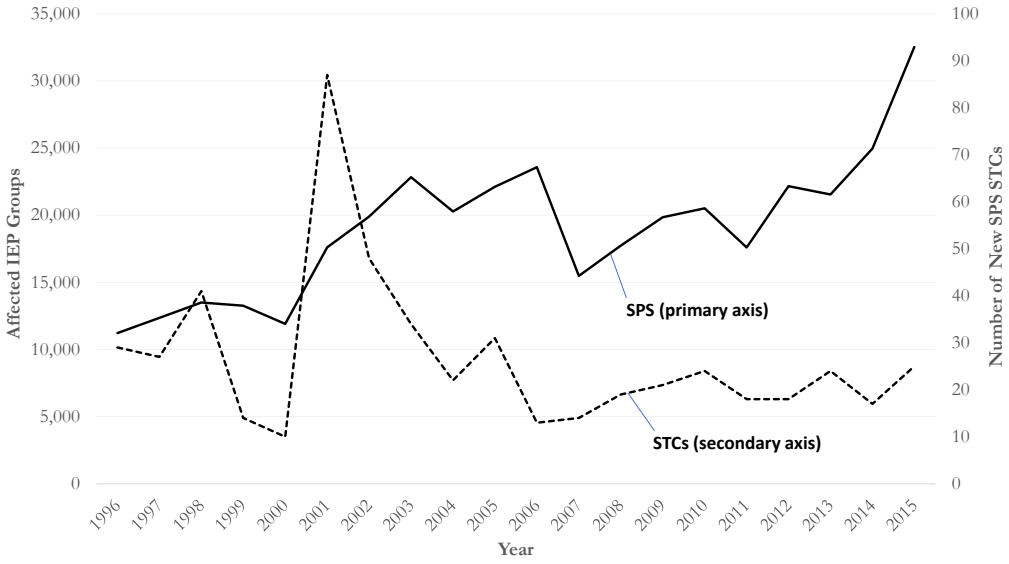



Table 1 disaggregates SPS use by sector. SPS standards are present in all sectors, but—in practice—SPS measures tend to be used more frequently for agricultural products. Approximately 90% of all IEP groups affected by SPS fall within food and animal sectors (i.e., HS codes 01–24). This is not surprising. Food and animal products have a high-risk

[3]For purposes of the analysis, we treat the European Union (EU) as a single country. So, for example, a measure taken against Belgium counts as a notification against the EU. Sub-national restrictions are treated in the same way. A measure directed at Uttar Pradesh or Odisha is treated as a notification against India as a whole.

profile relative to other products, both with respect to human health, through food safety threats like pesticide residues and mycotoxins, and plant and animal health, through pest and disease vectors.

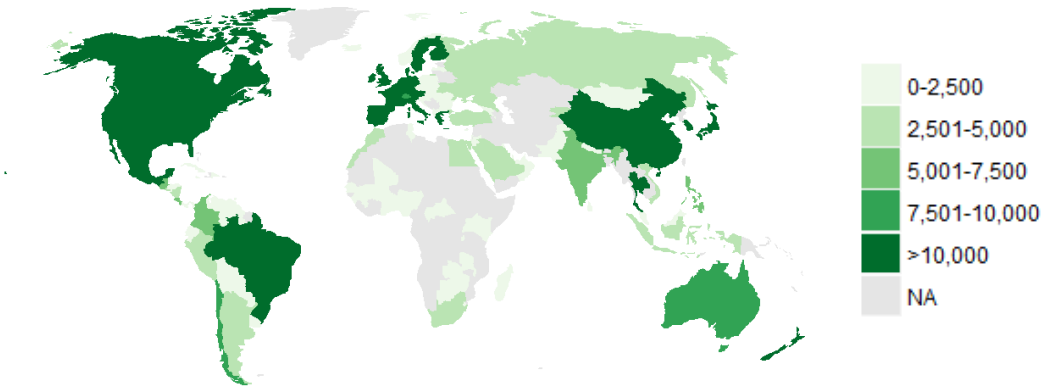
Table 1: Public Standards by Sector, 1996–2015

| HS Codes | Product Group | SPS |
|---|---|---|
| | | *(Affected IEP Groups)* |
| 01–05 | Animals and Animal Products | 102,114 |
| 06–15 | Vegetable products | 117,268 |
| 16–24 | Foodstuffs | 79,920 |
| 25–27 | Mineral Products | 4,553 |
| 28–38 | Chemicals and Allied Industries | 36,940 |
| 39–40 | Plastic/Rubbers | 10,562 |
| 41–43 | Raw Hides, Skins, Leather, & Furs | 3,631 |
| 44–49 | Wood & Wood Products | 12,494 |
| 50–63 | Textiles | 3,180 |
| 64–67 | Footwear/Headgear | 304 |
| 68–71 | Stone/Glass | 1,538 |
| 72–83 | Metals | 2,075 |
| 84–85 | Machinery/electrical | 1,931 |
| 86–89 | Transportation | 1,179 |
| 90–97 | Miscellaneous | 3,252 |
| | **Total** | **380,941** |

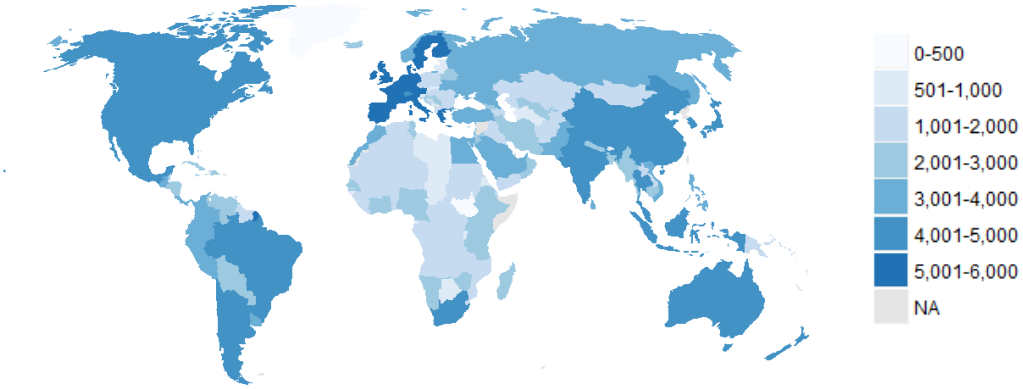
Figure 2 shows the geographic distribution of SPS measures. Panel (a) of the Figure shows the number of IEP groups against which the country has issued SPS measures. Panel (b) of the Figure show the number of IEP groups that are subject to SPS measures that have been issued abroad. As one would expect if the adoption of standards is motivated—at least partially—by protection of domestic industry, large importers are the primary users of SPS measures. The U.S., EU, and China, for example, are the top three importers across almost all product categories over this period. Referring to Panel (a) of Figure 2, these countries also represent the predominant share of SPS users.

Turning to Panels (c) and (d) of Figure 2, the EU, China, Canada, and the U.S. face the highest number of IEP groups subject to SPS standards. These are also some of the world's largest exporters, by value. Brazil—a large exporter of food and animal products—is a

Figure 2: Geographic Distribution of Public Standards




(a) SPS User Country




(b) SPS Affected Country

In Panel (a) shading corresponds to the number of IEP groups against which standards have been issued by the user country. In Panels (b) shading corresponds to the number of IEP groups within the affected country against which standards have been taken.

common target and frequent user of SPS. Although some African and Central Asian countries are large exporters, especially of agricultural products, these regions are generally infrequent users and targets of public standards according to Figure 2.

Of the SPS measure discussed above, more than 400 measure were brought before the

SPS committee as special trade concerns (STCs). Figure 1 shows the number of new STCs voiced per year from 1996–2015. The countries that raised the most STCs were the USA (101), the EU (84), Argentina (44), China (42), and Brazil (36). The countries against whom STCs were most frequently brought to the committee were the EU (130), the USA (61), China (42), Japan (34), and Australia (30).

In the following section, we use the SPS and STC data described here to develop an empirical strategy that tests whether—in light of the retreat from tariff wars in the modern era of free trade politics—"tit-for-tat" retaliation occur in the adoption and use of non-tariff measures.

# 3 Methdology

Our empirical methodology is designed to test whether (i) countries targeted with an NTB (i.e., an SPS measure for our purposes) respond with an NTB of their own and (ii) if such a response exists, does the response follow a pattern consistent with retaliation. We address these questions through four separate, but complementary, analyses:

1. We first examine whether a country who has explicitly raised concerns of unjust implementation or administration of an SPS measure by another country increases the probability that the former country will implement its own SPS measure targeting the latter.

2. We then determine whether trade flows "treated" with an SPS measure are more likely to induce regulatory response from the targeted country than those that are "untreated" with a measure.

3. Next, we model an importing country's decision to adopt a SPS standard against another country to determine whether the decision of the importing country to initiate an SPS regulation depends on whether the exporter has previously initiated a trade barrier affecting the importer.

4. Finally, we ask whether 'tit-for-tat' behavior in the adoption of SPS measures occurs more frequently for strategic trade partners and politically sensitive goods.

Estimation details for these four analyses are as follows.

**Specific Trade Concerns:** To investigate the existence and extent of retaliation against standards that a country explicitly considers unjust, we match information from WTO committe notes on Specific Trade Concerns (STCs) with data from the SPS-IMS. We empirically assess whether a country voicing STCs increases the probability that the country will implement its own SPS measure targeting the country that is the subject of the STC complaint. To do so, we estimate the following equation:

$$\text{SPS}_{iet} = \alpha^S + \beta_S^S \text{STC}_{iet} + \beta_m^S X + \theta^S Z + \epsilon_{eit}^S \tag{1}$$

where $i$ denotes the importer, $e$ denotes the exporter, and $t$ denotes the year of observation. The dependent variable, $\text{SPS}_{iet}$, is a dummy indicating whether the importer $i$ issued an SPS notification against the exporter $e$ in year $t$. Vector $X$ contains a set of control variables, which include GDP of the exporter and importer, and an indicator for whether countries $i$ and $e$ are members of a mutual free trade agreement (FTA). Vector $Z$ includes importer, exporter, and year fixed effects. The model is estimated via linear probability model (LPM).[4]

The variable of interest for this analysis is $STC_{eit}$, which takes value one if if the importer has raised an STC against the exporter in the given period, and zero otherwise. We consider two alternative constructions of this variable. First, variable $STC$ takes value one only in the first year the exporter raises the STC. Second, we define variable $STC$ to take value one in the first year the STC is raised and for all years in which the concern is ongoing.[5]

Note that the specification in equation (1) is not at conducted the product level because the WTO Committee notes do not tie STCs to speciifc product categories. In contrast to

[4]Appendix A.1 presents Probit estimates for robustness purposes.

[5]Appendix A.1 presents results for specifications in which variable STC is defined as the *number* of complaints lodged by one country against another, rather than an indicator for whether at least one complaint exists.

the STC analysis, all subsequent analyses are at the two-digit product level. Importantly, we distinguish between SPS measures that are issued seemingly in response to the original measure that are issued within the same two-digit HS code from responsive SPS measures that are issued outside the original HS code. The rationale for this distinction is that there are non-protectionistic reasons why countries would issue responsive standards within the same HS code, whereas there are fewer justifications for responses outside the original measure. In the context of STCs, there are no concerns regarding non-protectionistic justifications for responsive SPS measures because the responding country has already stated that the original measure is administered in violation of WTO rules.

**Difference-in-Differences Analysis:** Next, using SPS-IMS data at the two-digit product level, we use a difference-in-difference experimental design to determine whether HS codes "treated" with an SPS measure are more likely than those that are "untreated" to induce regulatory response from the targeted country. To this end, we estimate the following model:

$$SPS_{iept} = \sum_{t=1996}^{2015} \left(\lambda_t + \gamma_t SPS_{eit,\sim p}\right) \iota_t + \epsilon_{iept} \tag{2}$$

where $\iota_t$ is an indicator variable that takes value one in period $t$. The treatment variable, $SPS_{eit,\sim p}$, takes value one if in year $t$, the exporter has previously instituted an SPS measure affecting the importer in any product category outside $p$. Because usage of SPS regulations has changed dramatically over time (Figure 1), we allow the treatment effect to differ by year. Thus, the coefficients of interest are parameters $\gamma_t$ on the interaction between the treatment variable and the time indicator. In each year, "untreated" HS codes receive a placebo effect measured by parameters $\lambda_t$.

We consider two alternative data samples on which to conduct this analysis. First, we estimate equation (2) using only observations for which the exporter is the United States. This is done to mirror the ongoing (and overt) tariff war in which the United States—by issuing the original steel and aluminum tariffs—was the instigating country against which other

countries have responded with retaliatory tariffs (i.e., the exporter for the purposes of our sample). Thus, we believe that—if retaliation does occur in the use of public standards—the United States is a good benchmark case with which to begin the analysis. After estimating equation (2) for the United States, we then generalize the sample to include the complete set of exporters and importers. Of course, findings from this analysis are by no means conclusive. There exist many reasons why some sets of countries or products elicit a higher regulatory response than others. We attempt to incorporate these differences among countries and products in the analysis that follows.

**Standards Adoption Analysis:** We next construct a LPM of a country's decision to adopt a public standard against another country, which allows for (but does not impose) use of public standards for retaliatory purposes.[6] For this analysis, we construct a dataset with annual observations on importer- and exporter-use of SPS standards, bilateral importer-exporter-product (IEP) trade flows, use of other trade barriers, and country characteristics to empirically model the adoption decision. We are primarily interested to determine whether the decision of an importing country $i$ to initiate an SPS regulation on product $p$ from country $e$ depends on whether country $e$ has previously initiated a trade barrier affecting country $i$. We estimate the following equations at the IEP level via ordinary least squares (OLS):

$$\text{SPS}_{iept} = \alpha + \beta_S \text{SPS}_{eipt} + \beta_g \text{SPS}_{eit,\sim p} + \beta_m^S X + \theta^S Z + \epsilon_{eipt}^S \tag{3}$$

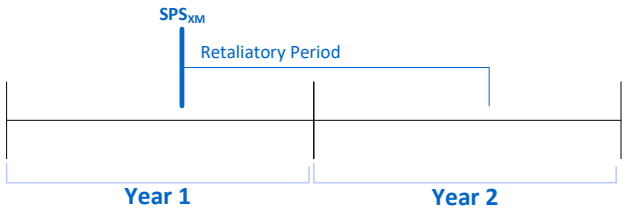
where vector $X$ contains control variables, including log of GDP for both the importer and the exporter and the log of value of trade for product $p$ between the importer and exporter. Vector $Z$ contains various fixed effects, including year dummies, and importer-product and exporter-product fixed effects. These variables account for any exporter- or importer-specific

[6] In both Equations (1) and (3), we employ LPM estimation as opposed to a Probit or Logit estimator due to the large number of fixed effects. Non-linear estimators—such as probit or logit—are inconsistent in the presence of a large number of fixed effects due to the incidental parameter problem. In addition, in a probit estimation, IEP groups with no variation in the dependent variable are dropped from the analysis. In our analysis, this means that groups in which the responding country never retaliates get dropped from the analysis, possibly generating upward bias in the probit estimates. Nevertheless, Appendix A.2 presents Probit results for robustness purposes.

differences across in the use of international regulations and control for the fact that some products and regions are more susceptible to SPS issues than others. The final term, $\epsilon$, is the residual, which we have clustered at the importer-exporter level and assumed to satisfy the usual *i.i.d.* properties.

We include two variables to assess whether public standards imposed by one country against another increase the probability that the country targeted by the original measure will respond with a measure of their own. The first variable, $\text{SPS}_{eip}$, measures an importers' response within the same product code to a standard implemented by the exporting country. The second variable, $\text{SPS}_{ei,\sim p}$, measures an importers' response outside the product code of the original standard implemented by the exporting country.[7] These variables are indicators taking value one if, for importing country $i$ and product $p$, the exporting country $e$ instituted a standard affecting the importing country $i$ within the previous 365 day period (see Figure 3).[8]

Figure 3: Construction of SPS Response Variables




[7]Note that we are unable to apply this identification strategy in the STC analysis in equation (1). We are unable to match STC complaints to specific SPS measure. Thus, we are unable to preform the analysis on product level, which is the basis for the identification strategy utilised for the tit-for-tat retaliation. However, as the STC are brought to the SPS committee by exporters that consider the underlaying SPS measure unjustly implemented, the issue identifying retaliation is less likely to occur in responses to STCs.

[8]An alternative specifications could be defining the SPS variables as the number of notifications between countries $i$ and $e$ for product $p$ in year $t$. There are pros and cons of both specifications. On one hand, in the alternative specification, in which standards variables are continuous, makes use of all available information. On the other hand, this information creates the potential for noise in the estimation process. To see this, consider two scenarios regarding the use of SPS measures. First, consider a scenario in which a country issues an SPS measure against all live animals from a given country. This measure would be counted as a single notification in the first specification. Alternatively, consider a scenario in which a country issues two SPS measures: one against imports of zoo elephants and one against imports of hamsters. When standards variables are treated continuously, as in the first specification, this scenario counts as two SPS standards. Clearly, the scope and effect of the measure in the first scenario is larger than the measure in the second scenario; yet, the second scenario is treated as a higher barrier to trade.

Variable $\text{SPS}_{ei,\sim p}$, measuring outside-product response is our primary variable of interest for measuring retaliation. Although retaliation could conceivably occur within the original product group of the original measure,[9] there are alternative, non-retaliatory explanations for observing 'tit-for-tat' behavior regarding SPS standard imposition within the same product code. Issues such as spatial spread (or risk of spread) of trans-boundary disease or harmonization of food safety standards could justify a targeted country to institute a standard of its own. Within the same product code of the original measure (variable $\text{SPS}_{eip}$), we cannot separate responses by targeted countries motivated by retaliation from responses motivated by more legitimate reasons.

However, in the context of, say, citrus greening, a legitimate response would likely be confined to HS codes related to citrus imports. We argue that implementation by Brazil of an SPS measure against the U.S. for another product (e.g., live animals) would be strong evidence of retaliation. That is, if an importer responds with an SPS measure directed at a product category other than citrus, the motivation is likely retaliation rather than a legitimate concern. Retaliation outside the product code is consistent with current tariff trade wars. The United States' original tariffs applied to steel and aluminum products. Retaliating countries, with the exception of Russia, have responded with tariffs primarily on agricultural of food products (Hopkinson, 2018).

To further minimise potential identification problems due to jusitifed within-product responses, the observations are aggregated at the two-digit level of the harmonized tariff classification system (HS code).[10] This high-level of aggregation is unlikely to lead to incorrect inference in the current context: we are interested merely in understanding whether retaliation occurs, and, if so, how frequently it is motivated by domestic protectionism (demonstrated by retaliation within the same sector) and/or by geopolitical suasion (evidenced by retaliation

[9]For instance, if, say, Norway issued an SPS measure against Chilean salmon and Chile responded with a standard against Norwegian salmon

[10]UN Comtrade is divided into different levels based on the aggregation of product codes. For instance, the two-digit code 08 is trade in fruit, the 4-digit level 0805 is trade in citrus, and the 6-digit level 080550 is trade of lemons or limes.

outside the sector of the original trade barrier). Aggregation allows us to avoid or reduce many compounding intra-sector issues, like cross-product trade diversion or the presence of standards that are motivated by domestic protectionism, but that fall under a slightly different tariff line from the original trade barrier at, say, the 4- or 6-digit HS level.

**Strategic Trade Partners & Goods:** Lastly, we ask whether 'tit-for-tat' behavior in the adoption of SPS measures occurs more frequently for strategic trade partners and politically sensitive goods. First, we focus regulatory response among members of a mutual regional trade agreement. If our conceptual framework for retaliation is valid, mutual membership to a regional trade agreement may increase the probability of retaliatory response to standards deemed unjusitifed by the targeted country. Mutual members of a regional trade agreement have made a commitment towards trade liberalization, spanning beyond WTO concessions. If one country were to violate this commitment through the use of an illegitimate standard, the incentives to punish this violation is elevated in light of the higher commitment towards free trade expressed through the regional trade agreeement. To investigate whether mutual membership in a regional trade agreement increases the frequency of 'tit-for-tat' behavior in the use of SPS measures, we re-estimate equation (3) including interaction terms $FTA_{eit} \times \text{SPS}_{eipt}$ and $FTA_{eit} \times \text{SPS}_{eit,\sim p}$. Positive coefficients on these interaction terms suggest affected countries are more likely to respond to SPS measures when the instigating and targeted countries are members of a mutual trade agreement.

Next, we ask whether 'tit-for-tat' behavior is more likely to occur for "strategic goods". Importantly, there are two dimensions along with the strategic nature of a product can affect retaliatory behavior. The first dimension of this strategic nature relates to the importance of the product hit with the *original* measure from the perspective of the target country.[11] To account for this dimension of the "strategic nature" of goods, we restrict the sample only to

[11]To see this, suppose an instigating country instituted an SPS measure banning all imports of cotton from all global trade partners. From the perspective of a country that produces little cotton and seldom exported to the instigating country, such a measure would be binding in a legal sense, but the country would be relatively unaffected in an economic sense. Accordingly, one would not anticipate a high probability of retaliatory response from this countries towards the instigating country.

product codes for which we observe non-zero bilateral trade flows in at least 10 of the years within our sample.[12] The second dimension of the "strategic nature" of goods relates to the political sensitivity of the product against which retaliation occurs—from the perspective of the country that instigated the original measure. For example, because agricultural and food products are politically sensitive from the U.S. perspective, these products were the primary targets of retaliation in the current trade war. To account for this dimension of the "strategic nature" of goods, we construct an indicator variable *Strategic* taking value 1 for bilateral trade flows with a positive trade flow in at least 10 of the years within our data sample—from the perspective of the instigating country. We interact this variable with our measurs of regulatory response $\text{SPS}_{eip}$ and $\text{SPS}_{ei,\sim p}$. We re-estimate equation (3) for the restricted sample only and inlcuding the strategic goods interaction terms.

## 3.1 Final Dataset

We merge the SPS data with annual observations on the value of trade (in US$) for the corresponding IEP trade flow, obtained from UN comtrade. We also include controls for GDP for both importer and importer, obtained from the World Bank. In the analysis that follows, these control variables are specified in natural logarithmic form. Because the sample includes zero trade flows, the log of trade value is transformed as $\log(value + 1)$.[13]

The final dataset contains data on all IEP groups for which at least one non-zero trade flow occurred between 1996–2015. We restrict our sample to importers and exporters that

[12] We do not consider positive trade flows in all years because of the inherent endoneity between trade flows and SPS measures. If, for example, the SPS measure is a ban, trade flows would be zero even if the affected bilateral trade flow is "strategic".

[13] We note that the United Nations Conference on Trade and Developments Trade Analysis and Information Systems (TRAINS) database and the WTO Integrated Database (IDB) and Consolidated Tariff Schedules (CTS) database contain limited information on bound and applied tariff rates at the IEP level. We elect not to use this data for three reasons. First, the data are not updated on an annual basis and updates are not done systematically across IEP groups. Second, tariff information is available only for a small portion of IEP groups in our sample, primarily in high- and middle-income countries. Thus, inclusion of tariff information creates a significant risk with respect to selection bias. Finally, we do not believe exclusion of tariff data is problematic for the validity of the analysis. Because results in Section 4 include fixed effects at the IEP level, variation in tariff rates is likely to be minimal within the unit of observation and is absorbed in the individual year effects.

are members of the WTO, who have issued at least SPS measure over the sample period. Summary statistics are reported in Table 2. The data contain 129 exporters and 104 importers. The collapsed data used in the STC analysis include 198,245 observations. The panel for the Standards Adoption analysis contains 97 product groups and a total of 8,623,271 observations.

Table 2: Summary Statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Specific Trade Concerns Analysis** | | | | | |
| $SPS_{ei}$ | 198,245 | 0.25 | 0.43 | 0 | 1 |
| $\text{STC}_{ei}$ (initial) | 198,245 | 0.00 | 0.05 | 0 | 1 |
| $\text{STC}_{ei}$ (ongoing) | 198,245 | 0.02 | 0.14 | 0 | 1 |
| $\text{Ln(GDP)}_{i}$ | 198,245 | 24.13 | 2.26 | 19.67 | 30.50 |
| $\text{Ln(GDP)}_{e}$ | 198,245 | 24.61 | 2.21 | 19.97 | 30.50 |
| $\text{FTA}_{ie}$ | 198,245 | 0.05 | 0.22 | 0 | 1 |
| $\text{Ln(Trade)}_{ie,t-1}$ | 198,245 | 10.50 | 7.50 | 0 | 26.91 |
| **Standards Adoption Analysis** | | | | | |
| $SPS_{iep}$ | 8,623,271 | 0.03 | 0.18 | 0 | 1 |
| $SPS_{eip}$ | 8,623,271 | 0.03 | 0.18 | 0 | 1 |
| $SPS_{ei,\sim p}$ | 8,623,271 | 0.46 | 0.50 | 0 | 1 |
| $\text{Ln(GDP)}_{i}$ | 8,623,271 | 25.17 | 2.28 | 19.97 | 30.50 |
| $\text{Ln(GDP)}_{e}$ | 8,623,271 | 25.25 | 2.26 | 19.71 | 30.50 |
| $\text{FTA}_{ie}$ | 8,623,271 | 0.09 | 0.29 | 0 | 1 |
| $\text{Ln(Trade)}_{ie,t-1}$ | 8,623,271 | 5.13 | 6.19 | 0 | 26.14 |

# 4 Results

Results from estimating the models described in the previous section provide empirical evidence that SPS standards are used for retaliatory purposes. First, our analysis of specific trade concerns (STCs) shows that countries who have explicitly raised specific trade concerns (STCs) of unjust SPS measures in another country are more likely to implement an SPS measure affecting that other country. Second, our difference-in-difference analysis shows that trade flows treated with an SPS measure are more likely to induce regulatory response than those that are untreated. Third, our model of standards adoption shows that the imposition of an SPS measure by one country increases the probability that the targeted country will

impose an SPS measure of its own against the instigating country. Finally, we show that this tit-for-tat behavior occurs predominantly among politically strategic trade partners and for strategic products.

## 4.1 Specific Trade Concerns

Table 3 reports results for the STC analysis, obtained by estimating equation (1). Column (1) of the Table reports results for a the specification in which the STC indicator variable is defined to take value one only in the year when the complainant first raises the STC. Column (2) of the Table reports results for the specification in which the STC indicator takes value one for all years in which the STC is ongoing. Recall that in both specifications, the exporting country is defined as the country voicing the STC against the importer. The dependent variable is a binary indicator for whether the exporter has instituted an SPS against the importer.

We refer first to coefficient estimates on the control variables in Table 3. In both Columns (1) and (2) importer GDP is positive and statistically significant (at 99%), whereas exporter GDP is negative and statistically insignificant at conventional levels. In other words, marginal changes in the income status of a given exporter are not associated with strong changes in its propensity to institute SPS measures. On the other hand, marginal changes in the income status of the importer are associated with changes in its propensity to be the subject of SPS measures. In some sense, these results are unsurprising and do not indicate that SPS regulations are more likely to target rich countries. Increases in GDP in an importing country (for the purposes of the observed trade flow) are likely associated with higher volumes of its own out-bound trade, making it more likely the country will be hit with SPS regulation abroad. On the other hand, from the perspective of the observed exporter, we explicitly and separately control for changes in trade volumes. Moreover, exporter-specific fixed effects likely control for the exporting country's general predilection for regulation. Referring to coefficient estimates on variables FTA and Ln(Trade) in Columns (1) and (2), we see that

Table 3: Specific trade concerns results

| VARIABLES | Initial (1) | Ongoing (2) |
|---|---|---|
| $STC_{ei}$ | 0.0312** | 0.0295*** |
| | (0.0153) | (0.0072) |
| $Ln(GDP)_i$ | 0.1169*** | 0.1169*** |
| | (0.0077) | (0.0077) |
| $Ln(GDP)_e$ | -0.0019 | -0.0020 |
| | (0.0078) | (0.0078) |
| FTA | 0.0552*** | 0.0549*** |
| | (0.0048) | (0.0048) |
| $Ln(Trade)_{ie,t-1}$ | 0.0057*** | 0.0057*** |
| | (0.0002) | (0.0002) |
| Constant | -2.5900*** | -2.5878*** |
| | (0.2701) | (0.2701) |
| Observations | 198,245 | 198,245 |
| R-squared | 0.5392 | 0.5393 |

Standard errors are clustered at the country-pair level. The regressions include importer, exporter, and year fixed effects.
*** p<0.01, ** p<0.05, * p<0.1

membership to a mutual trade agreement and increases in the value of bilateral trade also increase the probability (both significant at 99%) that the trade will be subjected to SPS regulation. The fact that increases in the size of trade flow increases the probability that it will be regulated is consistent with previous research on protectionism and trade (Aisbett and Pearson, 2012; Baldwin, 1989; Baylis, Nogueira and Pace, 2012).

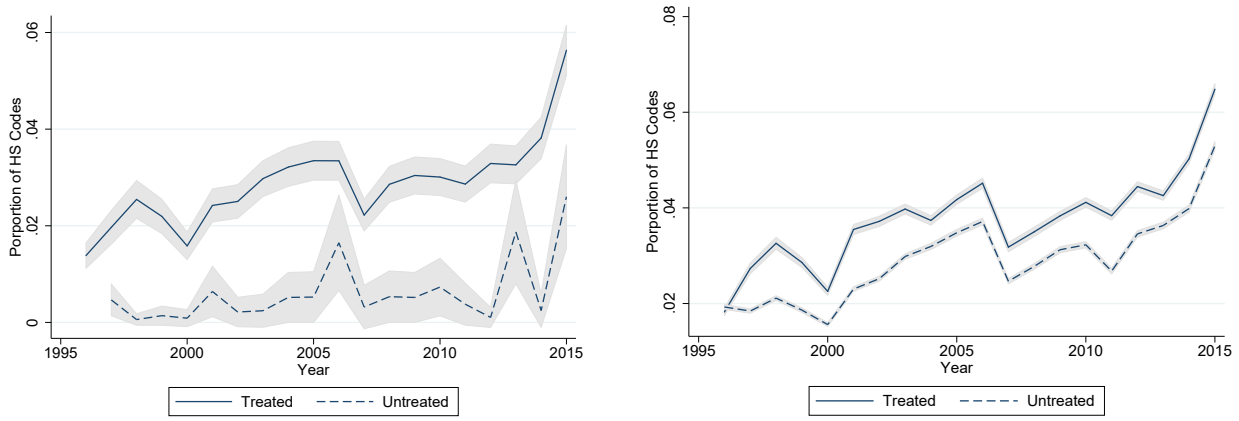
We now turn to coefficient estimates for the variable of interest $STC_{ei}$. In both Columns (1) and (2), we see that STCs initiated by the exporter towards the importer are associated with a positive response in the probability that the exporter will implement an SPS measure affecting the importer. Interpreted in words, this suggests that exporters who have explicitly raised STCs of unjust SPS measures in an importing country are approximately 3.1% (Column 1) more likely to implement an SPS measure of their own affecting the importing country. This response appears to endure—at only slightly smaller magnitude of 2.95% (Column

2)—in subsequent years if the STC is not resolved. These estimated responses are statistically significant at 95% in Column (1) and 99% in Column (2). Appendix A.1 provides robustness checks for these results with respect to the construction of STC variables and use of linear probability modeling (LPM).

## 4.2 Difference-in-Difference Estimation

Figure 4 reports the results of our difference-in-difference analyses. These analyses measure whether trade flows treated with an SPS measure are more likely to induce regulatory response (in a tariff code falling outside the original measure) than those that are untreated. As noted in Section 3, we first present results for trade flows treated with SPS measures instituted by the U.S. for the purposes of comparability with the ongoing tariff wars. These results are presented in panel (a) of Figure 4. We then present results for trade flows treated with SPS measures instituted by any country. These results are presented in panel (b) of the Figure.

Figure 4: Difference-in-difference results




(a) Response to U.S. measures

(b) Response to measures from any exporter

As shown in panel (a) of Figure 4, when the U.S. institutes a standard against a given product, countries affected by the standard are substantially more likely to implement a standard against the U.S. than U.S. trade partner who were not affected by the original standard. This correlation is statistically significant at 99% for all years within the sample.

These findings hold in panel (b) of Figure 4 when we generalize to standards instituted by any trade partner.

Note that—while these findings are consistent with the pattern of behavior observed in the ongoing tariff war—the observed relationship in Figure 4 is not specifically causal. A country's decision whether to adopt SPS regulation is a complex function involving many considerations. As mentioned in Section 2, some products are more amenable to regulation than others and imports from some countries are inherently more "risky" than others. The following results attempt to control for these factors.

## 4.3 Tit-for-tat retaliation

Table 4 presents results for the analysis to determine whether there is an observed "tit-for-tat" nature to the adoption of SPS standards. Colulmn (1) reports the results for the full sample of importing and exporting countries. In Column (2), we restrict the sample to include only high-income exporters and importers as defined by the World Bank. This is to omit any potential biases from the fact that developing countries had difficulty registering their notifications in the early years of the WTO Bacchetta and Beverelli (2012). Comparing across Columns (1) and (2) of Table 4, we see that results are robust to this sample restriction.

In both columns of Table 4, coefficient estimates for control variables are similar in direction and magnitude to those from the STC analysis in Table 3. Marginal changes in GDP for the importing country correspond to an increase propensity to implement a standard (statistically significant at 99%). The same is not true for exporting country GDP. The probability that an importer adopts an SPS standard is also increasing in the value of (lagged) bilateral trade for the corresponding exporter-product.

Turning to the regulatory response variables $SPS_{eip}$ and $SPS_{ei,\sim p}$, we find that when one country implements an SPS standard affecting another country, such a measure increases the probability that the targeted country will respond with a standard of its own directed at the instigating country. We observe this response within the product group of the original

Table 4: Tit-for-tat retaliation results

| VARIABLES | Full sample (1) | High-income (2) |
|---|---|---|
| $SPS_{eip}$ | 0.0272*** | 0.0257*** |
| | (0.0010) | (0.0017) |
| $SPS_{ei,\sim p}$ | 0.0108*** | 0.0115*** |
| | (0.0004) | (0.0007) |
| $\text{Ln(GDP)}_i$ | 0.0265*** | 0.0172*** |
| | (0.0016) | (0.0031) |
| $\text{Ln(GDP)}_e$ | -0.0017 | -0.0043 |
| | (0.0014) | (0.0030) |
| FTA | -0.0001 | -0.0009 |
| | (0.0004) | (0.0007) |
| $\text{Ln(Trade)}_{ie,t-1}$ | 0.0000** | 0.0001*** |
| | (0.0000) | (0.0000) |
| Constant | -0.5965*** | -0.2992*** |
| | (0.0542) | (0.1101) |
| Observations | 8,623,269 | 2,522,761 |
| R-squared | 0.3758 | 0.4302 |

Standard errors are clustered at the country-pair level.
The regressions include year, importer*product, and exporter*product fixed effects.
*** p<0.01, ** p<0.05, * p<0.1

measure ($SPS_{eip}$) and outside the product group of the original measure ($SPS_{ei,\sim p}$). An SPS notification within a product group increases the probability of a SPS with 2.72% in Column (1) and 2.57% in Column (2). As noted above, we cannot identify a response within a product code as retaliation due to potential legitimate spatial spread of disease. Because it is reasonable to assume that these legitimate responses only occur within the product groups affected by the original measure, we interpret a response to a SPS notification in another product group as strong evidence of retaliation.

The outside-product-group regulatory response is measured as 1.08% in Column (1) and 1.15% in Column (2). Note that—because we have included both the within- and outside-product response, variable $SPS_{ei,\sim p}$ is interpreted *ceteris paribus* relative to the within-product response. Thus, this behavior cannot be explained by standards—such as

changes to food safety laws—which affect many product codes at once. Note also that the coefficient estimate on $SPS_{ei,\sim p}$, measured as approximately 1% in both Columns (1) and (2), is the average probability of response for a *single* product code, whereas the probability of outside-product retaliation across *all* products is this probability multiplied by the total number of product codes with non-zero trade value, which are not affected by the original measure. At the two digit level, the coefficient estimate on $SPS_{ei,\sim p}$ suggests that about 3,000 bilateral trade flows—or just over $110 billion in trade—were subject to retaliatory standards in 2015.

## 4.4 Strategic goods and trade partners

Having found evidence of "tit-for-tat" behavior in the adoption of SPS measures, we next ask whether the types of products and trade partners against which we observe such behavior exhibit patterns consistent with retaliation. Table 5 reports results for the frequency of "tit-for-tat" standards adoption for strategic trade partners and politically sensitive goods. Column (1) focuses on regulatory response among members of mutual regional trade agreements. Column (2) focuses on regulatory response for strategic goods (as defined in Section 3).

Most interestingly, coefficient estimates for control variables $FTA$ and Ln(Trade) across Columns (1) and (2) of Table 5 suggest that—holding constant SPS regulatory behavior of trade partners—strong trade networks *reduce* the use of SPS standards. Refer first to the coefficient estimates on $FTA$. Recall that this variable was statistically insignificant in the baseline estimates in Table 4. In contrast, in both Columns of Table 5, coefficient estimates on $FTA$ are negative and statistically significant at 95%. Coefficient estimates for Ln(Trade) suggest a similar conclusion. In Table 4, the variable elicited a positive and statistically significant regulator response. In contrast, while the value of trade remains positively correlated with standards adoption in Column (1) of Table 5, the correlation is effectively zero in magnitude. The variable is associated with a negative and statistically insignificant response in Column (2). Coefficient estimates for importer and exporter GDP

Table 5: Retaliation: Strategic trade partners & goods

| VARIABLES | FTA (1) | Strategic Goods (2) |
|---|---|---|
| $SPS_{eip}$ | 0.0258*** | 0.0141*** |
| | (0.0011) | (0.0016) |
| $SPS_{ei,\sim p}$ | 0.0106*** | 0.0011 |
| | (0.0004) | (0.0008) |
| $SPS_{eip}$ *FTA | 0.0113*** | |
| | (0.0031) | |
| $SPS_{ei,\sim p}$*FTA | 0.0024** | |
| | (0.0010) | |
| $SPS_{eip}$*Strategic | | -0.1153*** |
| | | (0.0057) |
| $SPS_{ei,\sim p}$*Strategic | | 0.1859*** |
| | | (0.0061) |
| $\text{Ln(GDP)}_i$ | 0.0264*** | 0.0256*** |
| | (0.0016) | (0.0029) |
| $\text{Ln(GDP)}_e$ | -0.0017 | 0.0052* |
| | (0.0014) | (0.0029) |
| FTA | -0.0019*** | -0.0049** |
| | (0.0006) | (0.0019) |
| $\text{Ln(Trade)}_{ie,t-1}$ | 0.0000** | -0.0000 |
| | (0.0000) | (0.0001) |
| Constant | -0.5956*** | -0.7659*** |
| | (0.0543) | (0.1049) |
| Observations | 8,623,269 | 3,333,263 |
| R-squared | 0.3758 | 0.435037 |

Standard errors are clustered at the country-pair level. The regressions include importer, exporter, and year fixed effects.
*** p<0.01, ** p<0.05, * p<0.1

are consistent with those for the STC and Standards Adoption analyses above. As in Tables 3 and 4, we observe a positive, and statistically significant, relationship between importer GDP and adoption of standards. The same does not hold for exporter GDP.

Whereas coefficient estimates for control variables suggest that—holding constant SPS regulatory behavior of trade partners—strong trade networks reduce the use of SPS standards, the variables of primary interest in Column (1) of Table 5 suggest that such networks equally *increase* the probability of regulatory response when a partner country threatens the relationship. Consistent with results in Table 4, coefficient estimates for $SPS_{eip}$ and $SPS_{ei,\sim p}$ are positive and statistically significant in Column (1). When these variables are interacted with our indicator for the existence of a mutual trade agreement, this regulatory response increases. The coefficient estimate for variable $SPS_{ei,\sim p}$ in Column (1) of Table 5 suggests that imposition of an SPS measure by one country affecting another country increases the probability that the second country will institute an SPS measure of its own directed at the first country (in a product group outside that of the original measure). For a trade partner with whom the affected country is not in a mutual trade agreement, this increase in probability is 1.06% for a given product category. This is almost identical to response measured under the baseline results in Table 4 (1.08%). Referring to the interaction term $SPS_{ei,\sim p}$*FTA, the regulatory response increases to 1.30% when the instigating country and targeted country are members of a mutual trade agreement.

Referring to Column (2) of Table 5, we examine the observed regulatory response for the subset of observations for which the original standard is implemented against a strategic trade flow from the perspective of the exporter. For this subsample of observations we contrast regulatory response against products that are strategic (as defined in Section 3) from the perspective of the importing country versus products that are not considered strategic. Results are highly suggestive of retaliation.

For "non-strategic" product categories from the perspective of the importing country, indicator $SPS_{eip}$ suggests a within-product regulatory response similar to that from the

baseline specification in Table 4, though smaller in magnitude. As discussed throughout this manuscript, non-retaliatory and legitimate justifications likely comprise a substantial component of indicator $SPS_{eip}$. For outside-product regulatory response, for which there is no legitimate justification, we do not observe a regulatory response targeting non-strategic products from the perspective of the instigating country. The coefficient estimate for variable $SPS_{ei,\sim p}$ is small in magnitude and statistically insignificant.

In contrast, for "strategic" products from the perspective of the importing country, we see an extremely large regulatory response, for which there is no reasonable justification for such "tit-for-tat" behavior. The coefficient estimate for the interaction $SPS_{ei,\sim p}$*Strategic suggests this response is 18.70% (0.1859 + 0.0011) for a given strategic product, compared to 1.08% in the baseline results. We observe exactly the opposite for within-product "tit-for-tat" behavior in strategic product categories. Referring to interaction $SPS_{eip}$*Strategic, we see that the strategic nature of the product category reduces the probability of within-product regulatory response by 10.12% (-0.1153 + 0.0141).

# 5 Conclusion

The disconnect between what constitutes a legitimate standard as a matter of law and the underlying economic purposes for implementing such a standard creates situations in which countries have been negatively affected by public standards are nevertheless left without recourse under the WTO dispute settlement mechanism when such measures statisfy the low hurdle for *legal* legitimacy under international rules. In this research, we construct a dataset that matches adoption of sanitary and phytosanitary (SPS) standards between 1995–2015 with SPS committee data on specific trade concerns and annual, bilateral trade flows to test whether (i) countries targeted with a public standard respond with a standard of their own, and (ii) if such a regulatory response exists, whether it follows a pattern consistent with retaliation.

We find that SPS measures imposed by one country against another increase the probability that the country targeted by the original measure will respond with an SPS measure of its own. We observe that this type of tit-for-tat behavior commonly occurred outside the product group of the original measure and for politically strategic goods. At the two digit level, our results suggest that about 3,000 bilateral trade flows globally—or just over $110 billion in trade—were subject to retaliatory standards in 2015.

These findings are of significance to current policy debates. In many countries, recent months have seen an increased willingness among politicians to engage in public tariff wars. Such practices result in economic inefficiencies that generate deadweight losses to affected industries (Gros, 1987). This paper documents the use of "under-the-radar" retaliation in the use of public standards between 1996–2015. Though these "standards wars" generate less public outcry than overt tariff wars, they are likely a less economically efficient mechanism—in *ad valorem* equivalent terms—to achieve retaliation. Levied duties increase taxpayer revenues to offset a portion of the deadweight losses to industry caused by a tariff war. Such is not the case in the context of retaliation via NTBs.

Of course, as with any research, our findings are not without qualifications. Perhaps most importantly, our analysis focuses on a very narrow mechanism of retaliation—use of SPS measures in response to SPS measures. We believe sanitary and phytosanitary measures are a particularly desirable mechanism through which to search for retaliation because such measures primarily target agricultural and food products, an important aspect of trade (either imports or exports or both) for virtually every country in the world. However, a much broader set of political actions may induce retaliation via public standards and, likewise, use of public standards may induce retaliation through a broader set of political actions. We leave for future research analysis of these broader political actions both as catalysts or vehicles for economic retaliation.

Additionally, current research suggests that—in limited situations—some public standards may be trade *enhancing* for the targeted countries and products. Implementation of trade-

enhancing standards is unlikely to induce retaliation. For the purposes of our analysis, we are unable to distinguish between standards that negatively affect trade with the targeted countries and those that act as a catalyst to trade. One can imagine as an avenue for future research some sort of two-step model which first determines whether a particular standard was trade-enhancing or trade-reducing and then analyzes whether regulatory response in affected countries varies depending on the outcome of the first stage.

# References

**Achterbosch, Thom J, Alejandra Engler, Marie-Luise Rau, and TR Toledo.** 2009. "Measure the measure: the impact of differences in pesticide MRLs on Chilean fruit exports to the EU."

**Ahn, Dukgeun.** 2002. "Comparative Analysis of the SPS and the TBT Agreements." *International Trade Law and Regulation*, 8(3): 85–96.

**Aisbett, Emma, and Lee M Pearson.** 2012. "Environmental and Health Protections, or new protectionism? determinants of SPS notifications by WTO members."

**Bacchetta, Marc, and Cosimo Beverelli.** 2012. "Trade and public policies: A closer look at non-tariff measures in the 21st century." 19, International Trade Centre.

**Baldwin, Robert E.** 1989. "The political economy of trade policy." *The Journal of Economic Perspectives*, 3(4): 119–135.

**Bao, Xiaohua, and Larry D Qiu.** 2012. "How do technical barriers to trade influence trade?" *Review of International Economics*, 20(4): 691–706.

**Baylis, Kathy, Andrea Martens, and Lia Nogueira.** 2009. "What drives import refusals?" *American Journal of Agricultural Economics*, 91(5): 1477–1483.

**Baylis, Kathy, Lia Nogueira, and Kathryn Pace.** 2012. "Something fishy in seafood trade? The relationship between tariff and Non-Tariff Barriers." *Unpublished paper. Available at http://works. bepress. com/kathy_baylis/34*.

**Beghin, John, and Mark Melatos.** 2012. "The Trade and Welfare Impacts of Australian Quarantine Policies: The Case of Pigmeat." *The World Economy*, 35(8): 1006–1021.

**Besedina, Elena, and Tom Coupe.** 2015. "Beggar Thy Neighbor? Application of SPS measures by the Russian Federation and Case Study: The Impact of the Russian Import Ban on Ukrainian Confectionary Producers."

**Blonigen, Bruce A, and Chad P Bown.** 2003. "Antidumping and retaliation threats." *Journal of International Economics*, 60(2): 249–273.

**Crivelli, Pramila, and Jasmin Gröschl.** 2016. "The impact of sanitary and phytosanitary measures on market entry and trade flows." *The World Economy*, 39(3): 444–473.

**Disdier, Anne-Célia, Lionel Fontagné, and Mondher Mimouni.** 2008. "The impact of regulations on agricultural trade: evidence from the SPS and TBT agreements." *American Journal of Agricultural Economics*, 90(2): 336–350.

**Dluhosch, Barbara.** 2016. "Tit-for-tat in trade policies: nothing but a fest for vested interests?" *Journal of Institutional Economics*, 12(1): 217–239.

**Ehrich, Malte, and Axel Mangelsdorf.** 2018. "The role of private standards for manufactured food exports from developing countries." *World Development*, 101: 16–27.

**Fajgelbaum, Pablo D, Pinelopi K Goldberg, Patrick J Kennedy, and Amit K Khandelwal.** 2019. "The Return to Protectionism*." *The Quarterly Journal of Economics*, 135(1): 1–55.

**Feinberg, Robert M, and Kara M Reynolds.** 2006. "The spread of antidumping regimes and the role of retaliation in filings." *Southern Economic Journal*, 877–890.

**Fischer, Ronald, and Pablo Serra.** 2000. "Standards and protection." *Journal of International Economics*, 52(2): 377–400.

**Fontagné, Lionel, Gianluca Orefice, Roberta Piermartini, and Nadia Rocha.** 2015. "Product standards and margins of trade: Firm-level evidence." *Journal of International Economics*, 97(1): 29–44.

**Gros, Daniel.** 1987. "A note on the optimal tariff, retaliation and the welfare loss from tariff wars in a framework with intra-industry trade." *Journal of international Economics*, 23(3-4): 357–367.

**Grundke, Robert, and Christoph Moser.** 2019. "Hidden protectionism? Evidence from non-tariff barriers to trade in the United States." *Journal of International Economics*, 117: 143–157.

**Hopkinson, J.** 2018. "Profiles and Effects of Retaliatory Tariffs on US Agricultural Exports." *Report R45448. Congressional Research Service*.

**Horn, Henrik, Petros C Mavroidis, and Erik N Wijkström.** 2013. "In the shadow of the DSU: Addressing specific trade concerns in the WTO SPS and TBT committees." *Journal of World Trade*, 47(4): 729–759.

**Kennan, John, and Raymond Riezman.** 1988. "Do big countries win tariff wars?" *International Economic Review*, 81–85.

**Marette, Stéphan, and John Beghin.** 2010. "Are Standards Always Protectionist?" *Review of International Economics*, 18(1): 179–192.

**Martin, Alberto, and Wouter Vergote.** 2008. "On the role of retaliation in trade agreements." *Journal of International Economics*, 76(1): 61–77.

**Swinnen, Johan FM, and Thijs Vandemoortele.** 2011. "Trade and the political economy of food standards." *Journal of Agricultural Economics*, 62(2): 259–280.

**The Economist.** 2018. "The rules-based system is in grave danger." *The Economist*.

**Vigani, Mauro, Valentina Raimondi, and Ro Olper.** 2009. "The Imperialism of Standards An Empirical Strategy for Measuring the Effects of GMO Regulations on International Trade Flows."

**Wei, Guoxue, Jikun Huang, and Jun Yang.** 2012. "The impacts of food safety standards on China's tea exports." *China Economic Review*, 23(2): 253–264.

**Wieck, Christine, Simon W Schlüter, and Wolfgang Britz.** 2012. "Assessment of the impact of avian influenza–related regulatory policies on poultry meat trade and welfare." *The World Economy*, 35(8): 1037–1052.

**Yu, Zhihao.** 2000. "A model of substitution of non-tariff barriers for tariffs." *Canadian Journal of Economics/Revue canadienne d'économique*, 33(4): 1069–1090.

# Appendix A

This appendix explores the robustness of our STC and "tit-for-tat" results to alternate variable construction and the use of the Probit estimator. As shown in Sections A.1 and A.2, our findings are generally robust to these analysis. As noted in Section 3, non-linear estimators, including Probit, are inconsistent here due to the incidental parameters problem. Nevertheless, we presents Probit results for robustness purposes.

## A.1 Robustness for STC estimation

Columns (1) and (2) of Table A1 report results for *continuous*, rather than indicator, constructions of the SPS and STC variables. As in Table 3, we report results both for initial and ongoing STCs. As seen in Table A1, STC results are robust to this alternative construction of SPS and STC variables. As shown in Columns (1) and (2), the coefficient estimate on $\text{STC}_{ei}$ is positive and statistically significant at 99%. Because both the dependent and explanatory variable are defined continuously, the interpretation of this coefficient has changed. The coefficient estimate in Column (1) suggests that—at the margin—an *additional* STC raised by the exporter against the importer corresponds to an additional 3 SPS measures instituted by the exporter against the importer. The interpretation is similar for the ongoing STC construction in Column (2).

Columns (3) and (4) of Table A1 present results of conducting the STC estimation via Probit rather than LMP. Coefficient estimates reported in Columns (3) and (4) are the average marginal effect from the Probit estimator. Note that for the purposes of the Probit estimation, we have returned to the indicator specifications of the STC and SPS variables used in the body of the manuscript. Consistent with results for the primary specifications in Section 4, we see that initiation of an STC by an exporter against an importer is associated with an increase in the probability that the exporter will institute an SPS standard against the importer outside the products included in the original measure. We note that this effect

Table A1: STC robustness results

| | **Continuous** | | **Probit** | |
|---|---|---|---|---|
| | Initial | Ongoing | Initial | Ongoing |
| VARIABLES | (1) | (2) | (3) | (4) |
| $STC_{ei}$ | 3.1745*** | 1.1216*** | 0.0207 | 0.0105* |
| | (0.7796) | (0.1962) | (0.0168) | (0.0061) |
| $Ln(GDP)_i$ | -3.2665*** | -3.2592*** | 0.1911*** | 0.1910*** |
| | (0.5357) | (0.5355) | (0.0131) | (0.0131) |
| $Ln(GDP)_e$ | 0.2679 | 0.2727 | -0.0051 | -0.0052 |
| | (0.3191) | (0.3193) | (0.0094) | (0.0094) |
| FTA | 2.1795*** | 2.1765*** | 0.0317*** | 0.0316*** |
| | (0.2432) | (0.2435) | (0.0043) | (0.0043) |
| $Ln(Trade)_{ie,t-1}$ | 0.0303*** | 0.0308*** | 0.0072*** | 0.0072*** |
| | (0.0040) | (0.0039) | (0.0002) | (0.0002) |
| Constant | 74.4510*** | 74.1199*** | | |
| | (14.8395) | (14.8373) | | |
| Observations | 198,245 | 198,245 | 154,868 | 154,868 |
| R-squared | 0.4702 | 0.4713 | 0.4720 | 0.4720 |

Standard errors are clustered at the country-pair level. The regressions include importer, exporter, and year fixed effects.
*** p<0.01, ** p<0.05, * p<0.1

loses significance under Probit estimation in Column (3) when the STC variable is defined to include only initial—rather than on-going—STC complaints.

## A.2 Robustness for 'tit-for-tat' estimation

Table A2 provides the results of Probit robustness checks for the standards adoption analysis. Column (1) reports Probit results for the baseline specification and sample. Columns (2) and (3), respectively, report results for strategic trade partners and strategic goods. As with Appendix A.1, "tit-for-tat" results are generally robust to the Probit analysis.

Referring to Column (1) of Table A2, coefficient estimates for variables $SPS_{eip}$ and $SPS_{ei,\sim p}$ are positive and statistically significant as in Table 4. The magnitude of the within-product coefficient is comparable in magnitude to LPM results: 2.66% in Table A2 versus 2.72% in Table 4. The outside-product coefficient ($SPS_{ei,\sim p}$) is substantially larger in

Table A2: Tit-for-tat Probit results

| VARIABLES | (1) Full Sample | (2) FTA | (3) Strategic Goods |
|---|---|---|---|
| $SPS_{eip}$ | 0.0266*** | 0.0273*** | 0.1809*** |
| | (0.0014) | (0.0015) | (0.0049) |
| $SPS_{ei,\sim p}$ | 0.0595*** | 0.0591*** | -0.0757*** |
| | (0.0020) | (0.0020) | (0.0041) |
| $SPS_{eip}$ *FTA | | -0.0046 | |
| | | (0.0034) | |
| $SPS_{ei,\sim p}$*FTA | | 0.0031 | |
| | | (0.0047) | |
| $SPS_{eip}$*Strategic | | | -0.2865*** |
| | | | (0.0088) |
| $SPS_{ei,\sim p}$*Strategic | | | 0.3760*** |
| | | | (0.0064) |
| $\text{Ln(GDP)}_i$ | 0.2177*** | 0.2177*** | 0.0260*** |
| | (0.0085) | (0.0085) | (0.0008) |
| $\text{Ln(GDP)}_e$ | -0.0057 | -0.0057 | -0.0162*** |
| | (0.0075) | (0.0075) | (0.0008) |
| FTA | -0.0068*** | -0.0081** | -0.0103** |
| | (0.0020) | (0.0035) | (0.0044) |
| $\text{Ln(Trade)}_{ie,t-1}$ | 0.0001 | 0.0001 | -0.0009*** |
| | (0.0001) | (0.0001) | (0.0002) |
| Observations | 1,542,972 | 1,542,972 | 672,730 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

magnitude in the Probit specification (5.95% in Table A2 versus 1.08% in Table 4) because product categories for which we observe only zero trade flows are dropped from the analysis.

Similarly, in Column (2) of Table A2 coefficient estimates for variables $SPS_{eip}$ and $SPS_{ei,\sim p}$ are also positive and statistically significant. Results are of comparable magnitude to those in Column (1) of the Table. Referring to interaction term $SPS_{ei,\sim p}$*FTA, the point estimate is positive as with our LPM estimates. However, results are statistically insignificant in Table A2.

Results of the strategic goods analysis in Column (3) of Table A2 are also qualitatively unchanged comapred to the LPM results reported in Section 4.4 of the manuscript. Compare

interaction terms for "tit-for-tat" behavior in product categories that are strategic from the perspective of the importing country ($SPS_{eip}$*Strategic and $SPS_{ei,\sim p}$*Strategic) versus regulatory response for product categories that are not strategic ($SPS_{eip}$ and $SPS_{ei,\sim p}$). For non-strategic goods, we observe a positive and statistically significant within-product regulatory response. However, this within-product regulatory response turns substantially negative for strategic trade flows. The opposite is true for the oustide-product regulatory reponse in which retaliation would most likely occur. For non-strategic products, we observe a negative response of 7.57%. For strategic product categories, we observe a very large, positive and statistically significant response to standards implemented against trade flows that are strategic from the perspective of the exporter.