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The trade effects, protectionism, and political economy of non-tariff measures

Yuan Li
Iowa State University

The trade effects, protectionism, and political economy of non-tariff measures

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Yuan Li

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Major: Economics

Program of Study Committee:

John C. Beghin, Major Professor

Dermot J. Hayes

David A. Hennessy

Kenneth J. Koehler

John R. Schroeter

Iowa State University

Ames, Iowa

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ABSTRACT

Non-tariff measures (NTMs) have become increasingly present in markets whereas border tariffs have been reduced from successive rounds of General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO). This emergence of NTMs, especially standards like NTMs, has been also motivated by concerns about market imperfections to address asymmetric information and external effects. Sorting protectionism from legitimate market intervention has been difficult and attempts have lack formalism. In addition, the empirical evidence on the impact of these NTMs on trade flows has been cluttered with few obvious implications for policy design. The first essay takes a meta-analysis approach to rationalize the systematic variations in the estimated NTM effects on trade in the current literature. The second essay proposes simple yet formal indices to quantify protectionism. The indices are then applied to a large Maximum Residue Limits (MRL) dataset, and provide comprehensive measurements and insights on protectionism across countries, and sectors in food and agricultural industries. The third essay addresses the political economy of NTMs. It proposes a parsimonious model of NTM determination using a partial equilibrium trade model with an externality corrected by a NTM standard in presence of rent-seeking activities. Then a derived reduced form of NTM determination is explored econometrically using the dataset of the second essay.

CHAPTER 1: GENERAL INTRODUCTION

Introduction

As tariffs have been dramatically reduced after successive rounds of General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO), policy makers and researchers have turned their attention to non-tariff barriers (NTBs) or more recently called non-tariff measures (NTMs). NTMs cover all barriers to trade that are not tariffs, that is, a wide range of heterogeneous non-tariff regulations (Deardorff and Stern, 1998). Among NTMs, and important and growing subset is made of technical measures that are standard like measures These standard-like NTMs include health and safety measures (Sanitary and Phyto-Sanitary Measures (SPS)) and technical standards (Technical Barriers to Trade (TBT)) such as maximum residue limits (MRLs), packaging and labeling requirements.

This dissertation focuses on these standard-like non-tariff measures. They have common economic effects as they influence the unit cost of production by imposing standards, and they may influence demand if they address market imperfections (external effects and asymmetric information). Consumers may value the new information or characteristics induced by the standard-like measures. As a result these NTMs have controversial impacts on trade being the net effect of trade-impeding effects from raising the cost of producers and potential demand-enhancing effects from certifying quality and safety to consumers (Ganslandt and Markusen, 2001). In addition, these NTMs are often misused as disguised protection because protectionism is hard to formalize and measure, especially in presence of market imperfections. This last point brings the issue of the political economy underlying the determination of these NTMs. The endogenous standards are determined by a policy maker under the influence of pressure groups. These three aspects (trade patterns, protectionism, political economy) motivate each of the following three essays. The dissertation contribute knew empirical knowledge. It elucidates the conditions under which empirical investigations are likely to find NTMs impeding or enhancing trade; it proposes and implements a formal measure of protectionism of an important type of NTMs; and last, it investigates the political-economy determination of this type of NTMs.

Summary of the three essays

The first essay, "A meta-analysis of estimates of the impact of technical barriers to trade", applies a meta-analysis to explain the variation in estimated trade effects of technical barriers to trade broadly defined, using available estimates from the empirical international trade literature, and accounting for data sampling and methodology differences. Agriculture and food industries tend to be more impeded by these barriers than other sectors. SPS regulations on agricultural and food trade flows from developing exporters to high-income importers tend to impede trade. Not controlling for "multilateral resistance" barriers increase the likelihood to overstate the trade impeding effect of technical measures and not accounting for their potential endogeneity with trade does the opposite. Studies using direct maximum residue limits tend to find more trade impeding effects than other measures and lead to clearer policy implications because they focus on a specific technical measure. Other technical measures proxies tend to find less significant trade effects because either they forego variation in actual policies and/or because they aggregate many NTMs into an index. Policy implications are harder to draw as well. Studies based on a count proxy yield trade-effects estimates that are more likely to be either insignificant or positive. We interpret this result as reflecting the larger coverage of NTMs in count proxies including demand-enhancing policies. The aggregation level of the trade data could also affect the estimated trade effects, and the more disaggregated data tend to provide more positive significant estimated trade effects of technical measures relative to the conditional sample mean of t-values. More disaggregated data lead to more sector-specific policy implications. This first essay has been published in the *Journal of Policy Modeling*.

The second essay, "Protectionism Indices for Non-Tariff Measures: An Application to Maximum Residue Levels", proposes aggregation indices of a subset of NTMs to quantify their protectionism relative to international standards. We apply the indices to national Maximum Residue Limit (MRL) regulations affecting agricultural and food trade and using a science-based criteria embodied in Codex Alimentarius international standards. The approach links two streams of the NTM literature, one concerned with the aggregation of various NTMs into operational indices for econometric and modeling purposes, and the other attempting to evaluate the protectionism of NTMs. The data used in the application come from a large international dataset on veterinary and pesticide MRLs and CODEX MRL standards for a large set of countries. Over-protected, non-protected and under-protected countries and/or sectors are identified. We calculate both trade-weighted and equally weighted scores, since they offer complementary information. Looking at country scores, trade weights do not appear to be pivotal. However, trade weights induce more dispersion of product scores.

Considering or not non-established MRLs is quite important in establishing a country's MRL protectionism. The latter can arise from strict established MRLs or from strict default MRLs, or both. Australia ranks the most protectionist from all three indices: weighted, normalized weighted and equally weighted, because of its tight default value. The Russian Federation ranks the most protectionist from scores based on established MRLs (no default). Other countries ranked differently to various extents based on the different weights used. However, the set of most protectionist countries is remarkably stable over the change of weights in indices. We also find that NAFTA integration on residue standards has been much deeper between Mexico and the United States, than with Canada.

Meat and dairy products have lower protectionism scores in general than other goods. Fruit and vegetable products exhibit the most within-sector variation in protectionism. We checked the robustness of scores to address concerns for products with fewer substances used in their scores. Products with fewer substances seemed consistently biased upward (higher protectionism scores). Products scores based on no more than 3 substances have higher variance or noise. Country level scores are robust to the deletion of products with fewer substances and provide solid policy implications.

The third essay develops a parsimonious partial equilibrium political-economy model for a tradable good with a negative externality addressed by a single quality standard. The policy-maker solves for the standard that maximizes a weighted sum of welfare measures reflecting rent-seeking activities. Comparative statistics are derived and are ambiguous despite the simple setting. Then the investigation empirically implements a reduced form from the conceptual model to econometrically investigate the determinants of protectionism in maximum residue limits affecting food trade among a large number of countries, using the protectionism score from the second essay is the dependent variable, and a set of commodity and country level determinants derived from the political-economy model.

After correcting endogeneity bias, tariff protection shows a 4-times larger impact on MRL protectionism score than without instruments. In addition, tariff and MRL protection are shown to be substitute instruments in protection (NTM and tariff are negatively linked).

A country with a higher income level has a higher protectionism score as expected, and revealed comparative advantage has negative impact on MRL. The price responsiveness of demand has a positive impact on the protectionism score, which may be explained via the negative relationship between demand price responsiveness and tariff, and substitution relationship between tariff and MRL. The investigation also finds an inverted u-shaped MRL protection level in terms of political institution from the least democratic to the most democratic regimes. In addition, comparing existing results with manufacturing industries, and/or coverage ratio measure of NTMs, and different set of NTMs, my results are mostly consistent in the directions of impact on protection level in the literature. Other results on the impact of exchange rates, regional trade agreements, and regulatory quality variables are less robust. The robustness analysis also suggests that income per capita and agricultural import penetration explain a large portion of the departure between actual standards and international ones.

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CHAPTER 2: A META-ANALYSIS OF ESTIMATES OF THE IMPACT OF TECHNICAL BARRIERS TO TRADE

Modified from a paper published in
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Yuan Li and John C. Beghin

Abstract

A meta-analysis explains the variation in estimated trade effects of technical barriers to trade broadly defined, using available estimates from the empirical international trade literature, and accounting for data sampling and methodology differences. Agriculture and food industries tend to be more impeded by these barriers than other sectors. SPS regulations on agricultural trade flows from developing exporters to high-income importers tend to impede trade. Controlling for "multilateral resistance" lowers the propensity to find that these policies impede trade. Estimations correcting endogeneity by using panel data and time fixed effect yield more negative (or less positive) trade effects of technical measures.

Introduction

Since tariffs have been decreasing, more attention has been paid to non-tariff barriers (NTBs), or as more recently called, non-tariff measures (NTMs). Due to their intrinsic heterogeneity, NTBs/NTMs are categorized into several relatively more homogeneous subgroups (Harrigan (1993); Deardorff and Stern (1998); Haveman, Nair-Reichert, and Thursby (2003); and Fontagné, Mayer, and Zignago (2005)). Health and safety measures and technical standards, comprising Sanitary and Phyto-Sanitary Measures (SPS), Technical Barriers to Trade (TBTs), and other standard-like policies are often distinguished from other NTMs and their controversial effects on trade have been extensively analyzed. Ganslandt and

Markusen (2001) explain how standards and technical regulations have both the trade-impeding effects by raising the costs of exporters and similar demand-enhancing effects by certifying quality and safety to consumers.

Our paper focuses on these TBTs SPS and standard-like policies, which we label technical measures[1], and which affect international trade through changing production costs and/or enhancing demand. Empirical knowledge on technical measures has proliferated rapidly since the early 1990s, especially with investigations based on gravity equations. The literature shows a wide range of estimated effects from significantly impeding trade to significantly promoting trade. These results are difficult to rationalize without further formal investigation which we tackle in this paper with a meta-analysis. For example, Otsuki et al. (2001a, 2001b), Wilson and Otsuki (2001), and Wilson et al. (2003) found that stricter Maximum Residue Levels (MRLs) on aflatoxin or drug residues impeded trade. Chevassus-Lozza et al. (2008) found positive trade effects of sanitary measures, and negative or insignificant impacts of phytosanitary and quality measures. Disdier et al. (2008b) showed negative or insignificant impacts of TBTs and SPS on agricultural and food aggregate trade. They also investigated 30 disaggregated industries at the HS2 aggregation level, and found that TBTs and SPS had positive effects for 8 industries, insignificant effects for 12 industries, and negative effects for 10 industries. Disaggregated findings of Nardella and Boccaletti (2004), Fontagné et al. (2005), and others also reveal that the direction and the significance of the technical measures trade effects could vary significantly across product groups and trading partners. In sum, this rich evidence of both trade-impeding and trade-enhancing effects of technical measures muddles their patterns, and creates a need for further

[1]Technical measures include TBTs, SPS and standard-like policies covered by MAST categories A through C.

rationalization.

The variations in findings are partly due to variations in their data samples, mostly variations in industry, country, and aggregation level, among other things. For example, Disdier et al. (2008b) found different TBTs and SPS trade effects for different exporters, and different industries. Beside the differences in data, variations in the trade effects may be caused by different forms of technical measures proxies, model specifications, and other methodology variations. Otsuki et al. (2001a, 2001b), Wilson and Otsuki (2001), and Wilson et al. (2003), use MRLs to proxy the strength of technical measures. MRLs enter the regression as numerical values, a straightforward and accurate measure of the technical measures of interest. However, in most cases, technical measures do not have direct numerical measurements, so proxies have to be constructed. Commonly used proxies of technical measures are dummy variables, ad valorem equivalent (ave) of the policies, frequency ratio, and count variables. Choices among these different proxies may lead to different estimates of trade effects of technical measures. Few researchers have tried and compared different proxies within their investigations (see Disdier et al. (2008b)), and most researchers only chose one.

Since the first foundation for gravity equations by Anderson (1979), advances in the specification of gravity equations have brought many variations and refinements. Empirical studies follow different theoretical underpinnings to different extents, which could also lead to variations in the estimated impact of technical measures on trade.

Deardorff and Stern (1998), Bureau and Beghin (2001), Maskus et al. (2001) distill the earlier literature on technical measures and associated methodologies to measure these policies and their effects. The earlier prevailing methods are still dominant today but with substantial advances. The refined theory underlying gravity equations (Feenstra (2004)) and econometric estimation techniques address new issues, such as the treatment of zero trade flows. In addition, in recent years, researchers tend to analyze technical-measure effects with disaggregated data and wider country and industry coverage.

Our meta-analysis attempts to statistically explain the variations in estimated trade effects of technical measures, taking both data sampling and methodology differences into consideration. Meta-analysis provides a more objective and systematic assessment of the empirical results than narrative reviews do. It uses statistical methods to investigate underlying patterns, which might otherwise look complex, and help us understand the core determinants to the variations in available estimates of the impact of technical measures.

Specifications of the gravity equation

In its simplest and early formulation, the gravity equation says that trade volume between two countries is directly proportional to the product of the countries GDPs and the distance between these two countries. It takes the usual reduced form:

$$\log X_{ij} = \alpha_0 + \alpha_1 \log(Y_i) + \alpha_2 \log(Y_j) + \alpha_3 H_{ij} + \varepsilon_{ij}, \qquad (1)$$

where X_{ij} is the value of trade from country *i* to country *j*. Y_i and Y_j are the Gross Domestic Product (GDP) of country i and country j. GDP is a proxy for production capacity in the exporting country, which at a sectoral level would be the supply of the exporter for that sector. GDP in the importing country is motivated by demand considerations of a representative consumer. Variable H_{ij} includes variables that authors choose to explain the bilateral trade flow, such as distance between trade partners. The choice of the variables to be included is context specific and depends on the problem of interest. Variable ε is the error term.

Many empirical applications of gravity equations are atheoretical. Researchers use equation (1) directly without specifying explicit underlying micro-foundations. This simple approach successfully explains trade flows but leaves the reader wanting for more conceptualization. Theoretical foundations eventually were spelled out. The gravity equation can be derived from a perfect competition model, monopolistic competition model, increasing return theories, or the Heckscher-Ohlin model, among others. Most derivations assume perfect specialization (Helpman (1987); Anderson (1979); and Anderson and van Wincoop (2003 and 2004)). Each country produces its unique variety of goods and exports this unique variety to all other countries. This assumption greatly simplifies the price structure, as shown below (see Evenett and Keller (2002) for an attempt to relax the perfect specialization assumption).

Accounting for trade costs makes derivations and estimations of gravity equation more difficult, because of the different price effects induced by trade costs. To see this, we derive the gravity equation with trade costs, following mostly the notation of Feenstra (2004). Beside the assumption of perfect specialization across countries, we further assume each country only specializes in one unique good for simplicity. In a free trade world without transaction cost, each good has a unique price, which is the same across countries, so we could normalize all prices to one and greatly simplify the problem. However, in real world applications, we need to consider trade costs and the variation of prices over time; normalization only works for one year. Trade costs generally include transportation costs, tariffs, costs related to NTBs, and other trade costs.

Suppose p_{ij} is the price in country j of the product produced in country i, and p_i is the ex-factory price of the product produced in country i before exports take place, that is, net of any trade costs. The aggregate trade cost factor associated with selling the product produced in country i in country j is denoted as T_{ij}. Hence, we have $p_{ij} = T_{ij} p_i$.

With CES preferences, the representative consumer maximizes $U_j = \sum_{i=1}^{C} (c_{ij})^{(\sigma-1)/\sigma}$ subject to $Y_j = \sum_{i=1}^{C} p_{ij} c_{ij}$, where U_j is the utility for country j; number C is the total number of countries. Variable c_{ij} is the consumption in country j of the good produced in country i. Multiplying c_{ij} by price p_{ij} provides the total value of country i's exports to country j, denoted as $X_{ij} = p_{ij}\, c_{ij}$. Aggregate income or GDP of country j, Y_j is equal to the production value $Y_j = p_j y_j$, where y_j is the output production in country j. Corresponding demand functions are $c_{ij} = (p_{ij} / P_j)^{-\sigma} (Y_j / P_j)$, with $P_j = \left(\sum_{i=1}^{C} (p_{ij})^{(1-\sigma)} \right)^{1/(1-\sigma)}$ the overall price index in country j. Combining the latter with $X_{ij} = p_{ij}\, c_{ij}$, we have $X_{ij} = Y_j (\frac{p_{ij}}{P_j})^{1-\sigma}$.

We then substitute $p_{ij} = T_{ij} p_i$ into the latter to obtain a gravity-like function

$$X_{ij} = Y_j (\frac{p_i T_{ij}}{P_j})^{1-\sigma}. \qquad (2)$$

Total production (or GDP) of country i does not appear in (2) as in (1). To further link (2) to the gravity equation, we slightly deviate from Feenstra (2004), which follows the symmetric trade costs assumption ($T_{ij} = T_{ji}$) of Anderson and von Wincoop (2003). We derive a more general gravity expression, and then compare the implications of different restrictive assumptions or estimation methods such as normalization of prices and symmetric trade costs. The market-equilibrium condition $y_i = \sum_{j=1}^{C} c_{ij} T_{ij}$ says that production of good i is equal to the sum of its demands over all destinations and inclusive of the resource cost associated with trade costs (expressed in units of good i). It implies that $Y_i = p_i y_i = p_i \sum_{j=1}^{C} c_{ij} T_{ij}$.

Then we make use of $p_{ij} = T_{ij} p_i$ to obtain $Y_i = \sum_{j=1}^{C} c_{ij} p_{ij}$. Substitute $c_{ij} = (p_{ij} / P_j)^{-\sigma} (Y_j / P_j)$ to get

$$Y_i = \sum_{j=1}^{C} (p_i T_{ij} / P_j)^{1-\sigma} Y_j \ . \qquad (3)$$

Define the world GDP $Y_W = \sum_{j=1}^{C} Y_j$, and country i's share of world GDP $\theta_i = Y_i / Y_W$. Divide both sides of (3) by Y_W and define $\tilde{P}_i = \left(\sum_{j=1}^{C} (p_i T_{ij} / P_j)^{1-\sigma} \theta_j \right)^{1/(1-\sigma)}$ to obtain

$$(\tilde{P}_i)^{\sigma-1} \frac{Y_i}{Y_w} = 1. \qquad (3')$$

Apply (3') to (2) to get

$$X_{ij} = \frac{Y_i Y_j}{Y_w} \left(\frac{T_{ij}}{P_j \tilde{\tilde{P}}_i} \right)^{1-\sigma}, \qquad (4)$$

with $\tilde{\tilde{P}}_i = \tilde{P}_i / p_i$. In equation (4), variables P_j and $\tilde{\tilde{P}}_i$ are called "multilateral resistance" terms. More specifically, P_j is an importer-specific function of overall distortions of prices on all exporters imposed by importer *j* through trade costs. $\tilde{\tilde{P}}_i$ is an exporter-specific function of overall distortions faced by exporter *i* in all destination markets.

Taking the log of (4) provides a generalized expression of the traditional gravity equation (1) under asymmetric cost, which explains the presence of P_j and $\tilde{\tilde{P}}_i$. Both indices depend on trade costs and price indexes of all the trading partners. This specification poses a problem for the empirical estimation, since it is hardly possible to take all trading partners into account. Anderson and von Wincoop (2003) assume symmetric trade costs, and get an implicit solution to the "multilateral resistance" term, which is similar to equating P_j and $\tilde{\tilde{P}}_i$ or to assuming ex- factory prices p_i normalized to one. The symmetric trade costs assumption is unrealistic in most cases. To overcome this undesirable assumption, Harrigan (1996), Hummels (1999), Redding and Venables (2004), and Rose and van Wincoop (2001) introduced country fixed effects to account for P_j and $\tilde{\tilde{P}}_i$. Feenstra (2004) tested the fixed effect method and Anderson and von Wincoop (2003) method, and found they did almost equally well.

To implement the derived gravity equation, one needs to choose a functional form for the trade costs. Authors usually choose multiplicative forms, such as $T_{ij} = \prod_{q=1}^{Q} (TC_{ij}^{q})^{\gamma^q}$, for simplicity, and variables **TC** often come from previous empirical findings and/or certain estimated trade costs the author is interested in. In practice, Variables **TC** typically include distances, tariffs, non-tariff barriers such as TBTs and SPS measures, and others. The estimated responses $\gamma^q(1-\sigma)$ are the coefficient of interest for our meta-analysis when they pertain to technical measures.

In our meta-analysis of the estimates of technical-measure trade effects, we explain the variations of these estimates by two classes of explanatory variables. One class captures the variations in the model specification and estimation techniques, and the other class captures the subpopulation variations. We elaborate on these two points next.

Meta-analysis

We construct explanatory variables based on theoretical arguments as well as conjectures expressed in the literature regarding important matters explaining these estimated impacts. The objective is to control for the determinants that are most likely to matter. The limitation of the data also restricts the determinants we can investigate as collinearity arises from the multiplicity of categorical variables.

Variations in estimation methods

First, we look at classic errors in gravity estimations. Baldwin and Taglioni (2006) pointed out three mistakes in gravity equations that could lead to biasness in gravity equation estimates: the "gold medal error", "silver medal error," and "bronze medal error." The "gold medal error" refers to the failure to include the relative price terms, which are equivalent to P_j and $\tilde{\tilde{P}}_i$ in (4), derived above. The omission of P_j and $\tilde{\tilde{P}}_i$ causes the omitted trade cost variables in the error term to be correlated with the trade cost variables accounted for. As discussed in the gravity equation section, the "multilateral resistance term" or fixed effects approximating the term could correct this mistake.

The "silver medal error" refers to the situation when researchers mistakenly use the logarithm of the average instead of the average of the logarithm of trade flows (average of exports and imports). The "bronze medal error" is caused by inappropriately deflating trade values using the same deflator, say the U.S. consumer price index, and the resulting "spurious" correlation from the common deflator causes biases. This error would be a problem for multi-year data; time-series dummies could correct the biasness. In the meta-analysis, we use dummy variables to control for the presence or not of correction for "gold" and “bronze” errors, or more specifically, the inclusion of country fixed effects and/or time fixed effects used to estimate the technical measure effects. However, as “silver errors” are extremely scarce in our sample of studies, we are not able to consider this category in our analysis.

Second, we consider the treatment of zero-trade flows in the collected investigations. Since the gravity equation takes a log-linear form, the zero trade observations pose a problem for the estimation and raise the issue of sample selection bias, among others. A commonly used technique is to drop the zero trade observations. But if zero trade is due to the missing values, rounding, or no trade, then dropping those observations could lead to bias. Several techniques exist to retain the zeros. A simple practice to deal with the zero-trade problem is to add a small arbitrary number to all trade values, and make the log of zero trade a negative value. This method is quite arbitrary and could lead to some bias although the direction of the bias is not clear. There are some important advances in this issue in recent years. Silva and Tenreyro (2006) suggested a Poisson pseudo-maximum-likelihood (PPML) technique to estimate the gravity equation in its multiplicative form and in levels instead of the commonly used log linear form. This technique naturally solves the numerical problem of zero trade and is also robust to heteroskedasticity in errors. However, it could also be biased as predicted trade is positive with the exponential functional form.

However, Martin and Pham (2008) show that the PPML method could also be seriously biased if zero trades are frequent. The zero-inflated Poisson (ZIP) model (Lambert, 1992) improves upon the PPML and is able to handle excess zeros. More specifically, the probability of having zero trade is estimated with a logit/probit, and the non-zero trade part is estimated with PPML. The Tobit model and the Heckman two-step model are other methods used to address zero trade observations. The choice between these two methods is mostly based on authors' beliefs in the causes of zero trade observations. If zero trade is allegedly caused by censored data, then it is appropriate to use Tobit model. On the other hand, if zero trade is suspected to be caused by decisions or self-selection, they may choose the Heckman two-stage procedure instead. Helpman, Melitz and Rubinstein (2008) (HMR hereafter) developed a novel modified two-stage estimation technique by accounting for firm heterogeneity and the extensive margin from new firms entering into export markets. Their approach enables the investigation of both intensive margin (existing trade) and extensive margin from new firms entering trade, hence differentiation between fixed and variable trade costs.

However, due to the different popularity of procedures and limited availability of the studies, especially the relative scarcity of the studies based on PPML, ZIP, Tobit, Heckman two-stage model or HMR, we can only attempt to distinguish the difference between groups of these econometric procedures (see Appendix for the frequency table of different procedures). We tried three groupings based on our conjectures of their commonality. First, we controlled truncation (dropping zero data) versus other procedures. Second, we grouped modeling procedures that address zero data explicitly (ZIP, Tobit, Heckman two-stage, HMR) versus numerical accommodation of zero data (truncation, PPML, and adding small numbers). Third, we grouped PPML and adding small numbers based on the conjecture that they may cause bias from forcing level equation to accommodate zero data as small positive predicted or actual values. However, the dominant number of estimates from studies relying on truncation leads to similar meta-analysis estimation results[2] between the first and second grouping (excluding or including PPML and adding small number procedure). Further, the third grouping is too skewed for MNL regression. To avoid ambiguity, we choose the first grouping and use a dummy variable, which equals zero if truncation is applied and equals one if zero data are treated with other procedures.

Third, endogeneity of the barriers to trade is another problem that might cause bias, since it is reasonable to argue that trade expands first and regulations, like TBTs, may come after as protectionism. Trefler (1993), and Lee and Swagel (1997) showed that the endogeneity problem could lead to the underestimation of NTMs' impact on trade. Unfortunately, few studies in our sample addressed this problem directly. Baier and Bergstrand (2007) pointed out that a panel data approach could handle the endogeneity problem very well with panel data and fixed time effects. So we account when a paper uses panel data with time fixed effects as a way to address endogeneity.

Fourth, the choice of technical measure proxy used in the investigations provides methodology variation which translates into a variation in data characteristics. Technical measure studies may differ in their choices of policy proxy measures: dummy variables for the existence of measures, count variable, frequency index, and ad-valorem equivalent (AVE) are commonly used. The literature has not settled yet on the best way to measure technical measures and which proxy measure is the best if any. For example, the AVE estimated by Kee et al. (2006) had some potential problems in its estimation procedures as it constrains NTMs effects to be trade restrictive and rules out trade expansion effects. Intuitively, the proxy choice could affect the variation in the estimates. Finally, quite of few

[2] Estimation results for the second grouping are available upon request.

studies based on panel data with time dimension, ignore the time variation in the TBT proxy. This omission may have some systematic impact on the trade effects, so we use a dummy to control whether the proxy exhibits time variation, provided that panel data was used.

Subpopulation characteristics

Data subpopulations used to estimate the effects of technical measures on trade differ by trading partners, industry coverage, and aggregation level. Trading-partner variations can be controlled by the development status of exporters/importers. Further, trade effects could be significantly different across agricultural (sectors HS01-HS15 in the Harmonized System 2-digit level), processed food and beverage (HS16-HS25), and manufacturing products (HS26-HS99). In addition, in the context of North-South trade, we are interested to test the hypothesis that SPS regulations inhibit trade of agricultural products between developing exporters and developed importers rather than being catalyst of trade. This is an unsettled debate in the literature.

Further, the sectoral aggregation level of the trade flow used in the investigations also matters for the size and variation of the trade effects (Hillberry (2002)). We use the digit of the Harmonized System (HS) indicating the aggregation level as the measure of aggregation level of the data. 2-digit HS, 4-digit HS, or 6-digit HS, measure the aggregation level takes values of 2, 4, and 6, respectively. The HS aggregation digit is an ordinal number, but for regression purpose, we use it as cardinal number to measure the disaggregation level with the usual limitations of doing so. The motivation is to limit the multiplicity of dummy variables compounding singularity issues in our investigation.

Our dataset of SPS/TBT studies

Our data set includes 27 papers that use gravity equations to estimate technical-measure effects on trade flows, and totals 618 observations. Table 1 lists the studies and the number of estimates collected from each study and the sector coverage. The selection of our studied sample is based on availability. We have performed extensive searches with Econlit, REPEC, SSRN, IATRC, Agecon Search, and other web-servers and working paper repositories completed by summer 2009.

The first criterion used to select investigations is that the study investigates the trade effects of technical measures. We focus on technical measures, rather than on all NTMs because "all NTMs" include all barriers but tariffs, and lack communality of effects on agents' decisions. For example, many classifications of NTMs include macro policies, price control measures, quantity control measures, etc. (Deardorff and Stern (1998)). Too wide of a policy coverage would dilute the validity and precision of the meta-analysis, but too narrow of a coverage could lack generality on how technical measures are believed to affect international trade through changing production costs and/or enhancing demand through quality and information effects.

The second criterion of our selection is that the empirical model used in the study has to be based on the gravity equation. Using the derived gravity equation (4) and including an explicit technical measure trade cost proxy variable, and then taking logarithm of both sides lead to: $\log X_{ij} = \alpha_0 + \alpha_i + \alpha_j + \alpha_1 \log(Y_i) + \alpha_2 \log(Y_j) + \gamma^1(1-\sigma)TM_{ij} + \gamma^2(1-\sigma)H_{ij} + \varepsilon_{ij}$, (4')

where α_i and α_j correspond to the "multilateral resistance" terms P_i and $\tilde{\tilde{P}}_i$. The coefficients of the log of GDPs are not always restricted to 1 in practice. The coefficient

$\gamma^1(1-\sigma)$ represents the impact of technical measures on trade flows

$\partial(\log X_{ij} \mid Y_i, Y_j, TM_{ij}, H_{ij}) / \partial TM_{ij}$. Given X_{ij} and TM_{ij}, the value of $\gamma^1(1-\sigma)$ depends on the

log linear form of X_{ij} as well as all the information upon which it is conditioned.

Table 1: The list of papers included and the number of estimates per paper

Paper Index	**Author(s)**	**# of Estimates**	**Industry Coverage**
1	Disdier, Fontagné, Mimouni (2008)	38	Ag, Food, Manufacturing
2	Wilson and Otsuki (2004)	2	Ag
3	Disdier and Marette (2009)	2	Ag
4	Olper and Raimondi (2008)	1	Food
5	Chevassus-Lozza et al. (2008)	6	Ag, Food
6	Nardella and Boccaletti (2004)	40	Ag, Food
7	Wilson, Otsuki, and Majumdar (2003)	2	Ag
8	Disdier, Fekadu, Murillo, and Wong (2008)	84	Ag, Food
9	Otsuki, Wilson, and Sewadeh (2001a)	2	Ag, Food
10	Otsuki, Wilson, and Sewadeh (2001b)	3	Ag
11	Wilson and Otsuki (2001)	3	Ag
12	Disdier and Fontagné (2008)	46	Ag
13	Chen, Yang, and Findlay (2008)	5	Ag
14	Babool and Reed (2007)	1	Ag, Food
15*	Gebrehiwet, Naqangweni and Kirsten(2007)	2	Food
16	Anders and Caswell(2006)	9	Ag
17	Nguyen and Wilson (2009)	21	Ag
18	Jayasinghe, Beghin, and Moschini (2009)	6	Ag
19*	Scheepers, Jooste, Alemu (2007)	1	Ag
20	Nardella and Boccaletti (2003)	8	Ag, Food
21	Nardella and Boccaletti (2003)	90	Ag, Food
22	Fontagné, Mimouni, and Pasteels (2005)	182	Ag, Food, Manufacturing
23	Chen, N (2004)	2	Food, Manufacturing
24	Fontagné, Mayer, and Zignago (2005)	1	Food, Manufacturing
25	Blind and Jungmittag (2005)	4	Ag, Food, Manufacturing
26	Blind(2001)	4	Manufacturing
27	Harrigan (1993)	56	Food, Manufacturing
Total		**618**	

* Estimates are dropped because of missing sample size information

We use explanatory variables which capture the variations in information from one study to the next. Hence, estimates from the same gravity model are comparable in a conceptual sense. In addition, papers in our sample differ from the ones that analyze the trade effects of harmonized or reciprocal technical measures as opposed to idiosyncratic measures (Moenius (2004, 2007a, 2007b); Blind (2001); Blind and Jungmittag (2005); and Swann et al. (1996)). The latter investigations of technical measures intend to gauge the impact of the harmonized technical measures as opposed to unilateral national measures. Papers in our sample studied the general technical measure impacts abstracting away from this complication of the potential impact of harmonized or reciprocal policies.

Empirical implementation of the meta-analysis

Pooling the technical measure trade effects in a meta-analysis, we compare the trade effects of different polices or different proxies. Many policies are categorized as technical measures. Nardella and Boccaletti (2005), and Anders and Caswell (2006) estimated the impact of hazard analysis and critical control points on trade. Otsuki et al. (2001a, 2001b) investigated the trade effects of aflatoxin residue standards. In addition, researchers could use different technical measure proxy types (count of measures, dummies, AVEs, among others). One cannot represent these effects under a common metric such as elasticity as was done for distance elasticities in Disdier and Head (2005). This heterogeneity of representations of TBTs creates a conundrum which we resolve as follows.

The estimates of different technical measure proxies have different scales and some are continuous, whereas others are dichotomous. One could think of categorical variables, classifying the available estimates into three sets (negative significant, insignificant, and positive significant, respectively). The latter classification corresponds to the barrier/catalyst view of TBT policies. In addition, one would like to preserve further information, like magnitude of estimates and significance levels which would be lost by just using categorical variables to pigeonhole the estimates. To achieve this, we use the t-values of the available technical measure estimates. The t-value, defined as the point estimate divided its standard error, is unit free, so we make the estimates comparable. By using t-values, we sacrifice the information on the magnitude of the effect but we keep the direction of the effect and the magnitude of the significance of the estimates. A positive coefficient on the right-hand side covariates in the meta-analysis means the explanatory variable has a trade enhancing effect (or less trade-impeding effect), and vice versa.

The basic meta analysis model is: $t^{es} = \beta_0 + \sum_{k=1}^{K} \beta_k Z^{kes} + \mu^{es}$, (5)

where t^{es} is the t-value of the *e*-th estimate of the *s*-th study, Z^{kes} is the *k*-th explanatory variable used to capture the variation in characteristics of the studies. Note that we use multiple estimates from one study so as to keep as much variation and information as possible.

Although we control for some important characteristics as stated above, there are more intrinsic differences among studies left in the error terms μ^{es}. Thus, violations of normality, heteroskedasticity, outliers, and influential data points are likely to exist in our sample of studies. Therefore, we adopt a robust regression technique to deal with the unknown underlying distributions in addition to regular least squares. As we use multiple estimates from one study, the estimates from the same study are likely to be correlated. Robust regression could also down- weight clusters, to prevent the study that provides more estimates from having unduly influence. We detect and down-weight outliers and influential data points by examining residuals and some influence statistics (i.e. Cook's distances, DIFIT, etc). We do not delete them, however, to preserve data. Robust regression mitigates the problem of outliers and influential data points by down-weighting them, and makes the estimates more resistant to their influence (Belsley et al. (1980)).

In addition to the linear OLS and robust regression models, we employ a multinomial logit (MNL) model to help interpretation of results and we check their consistency with the robust regression results. In the MNL approach we split the data into significantly negative estimates (t value smaller than -1.96), insignificant ones (t value comprised within (-1.96, 1.96)), and positively significant ones (t-value larger than 1.96). The approach is

$$\log\left(\frac{\Pr(D=1)}{\Pr(D=2)}\right) = \beta_{10} + \sum_{k=1}^{K} \beta_{1k} Z^{kes} + \mu^{1es},$$

$$\log\left(\frac{\Pr(D=3)}{\Pr(D=2)}\right) = \beta_{20} + \sum_{k=1}^{K} \beta_{2k} Z^{kes} + \mu^{2es}, \qquad (6)$$

where *D* is a categorical variable equal to 1 if the corresponding $t_{ij} \leq -1.96$, equal to 2 if $-1.96 < t_{ij} < 1.96$, and equal to 3 if $t_{ij} \geq 1.96$. Each paper can be seen as a cluster, and we have multiple observations from each cluster and independent clusters. We use a robust estimator of the clustered error structure, assuming independence among clusters, but dependence among observations that are within the same cluster. The estimates from the MNL regression show the impact of the explanatory variables on log odds, not the impact on the probability of the categorical variable *D*. We normalize the probabilities

($\Pr(D=1)+\Pr(D=2)+\Pr(D=3)=1$), to derive the conditional probabilities:

$$P_1 \equiv \Pr(D=1 \mid Z^{1es}, Z^{2es}{}_{,....,} Z^{kes}) = \frac{e^{\beta_{10}+\sum_{k=1}^{K}\beta_{1k}Z^{kes}}}{1+e^{\beta_{10}+\sum_{k=1}^{K}\beta_{1k}Z^{kes}}+e^{\beta_{20}+\sum_{k=1}^{K}\beta_{2k}Z^{kes}}},$$

$$P_2 \equiv \Pr(D=2 \mid Z^{1es}, Z^{2es}{}_{,....,} Z^{kes}) = \frac{1}{1+e^{\beta_{10}+\sum_{k=1}^{K}\beta_{1k}Z^{kes}}+e^{\beta_{20}+\sum_{k=1}^{K}\beta_{2k}Z^{kes}}}, \text{ and} \qquad (7)$$

$$P_3 \equiv \Pr(D=3 \mid Z^{1es}, Z^{2es}{}_{,....,} Z^{kes}) = \frac{e^{\beta_{20}+\sum_{k=1}^{K}\beta_{2k}Z^{kes}}}{1+e^{\beta_{10}+\sum_{k=1}^{K}\beta_{1k}Z^{kes}}+e^{\beta_{20}+\sum_{k=1}^{K}\beta_{2k}Z^{kes}}}.$$

The associated marginal effects are:

$$\frac{\partial P_1}{\partial Z^k} = P_1(\beta_{1k}P_2 + (\beta_{1k} - \beta_{2k})P_3),$$

$$\frac{\partial P_2}{\partial Z^k} = -P_2(\beta_{1k}P_1 + \beta_{2k}P_3), \text{ and} \qquad (8)$$

$$\frac{\partial P_3}{\partial Z^k} = P_3(\beta_{2k}P_2 + (\beta_{2k} - \beta_{1k})P_1).$$

Conditional probabilities and marginal effects all depend on all Z's and β's, so we condition the interpretation on the latter evaluated at the mean of all Z's.

To summarize, the following variables are included in our meta-analysis specification: *Fix_country_pair*: a dummy variable, which equals 1if panel data and the model has country-pair fixed effects; *Panel_fix_time*: a dummy variable, which equals 1 if panel data and the model with time fixed effects; *Panel_var_time*: a dummy variable, which equals 1 if panel data and proxy has time variation; *Zero_treated*: a dummy variable, which equals 1 if zero-trade is treated with two-stage, Tobit, PPML, etc.; *Ag:* a dummy variable, which equals 1 if the related products are agricultural products; *Food*: a dummy variable, which equals 1 if the related products are processed food, beverage; *Manu*: a dummy variable, which equals 1 if the related products are manufacturing products; *dev_SPS*: a dummy variable, which equals 1 if data refer to and developing exporters, and developed importers, and agricultural products affected by SPS measures; *Sample_centered*: a number, the sample size of each study, centered at its mean 14,172.53, and scaled by 10,000; *Agg_hs_centered*: a number, the # of HS digits of the data, centered by the aggregation level 5.14 (average of the variable); *Proxy_dummy*: a dummy variable, which equals 1 if the proxy of technical measures is a dummy variable; *Proxy_count*: a dummy variable, which equals 1 if the proxy of technical measures is a count variable; *Proxy_freq*: a dummy variable, which equals 1 if the proxy of technical measures is a frequency or coverage ratio variable; a *Proxy_mrl*: dummy variable, which equals 1 if a maximum residue level (MRL) is used directly, or equivalently, if the related policy is a MRL; *SPS_no_mrl*: a dummy variable, which equals 1 if the related policy is SPS but not measured by a MRL; and *TBT:* a dummy variable, which equals 1 if the related policy is a TBT.

Table 2 provides summary statistics on how the collected observations are pigeonholed according to their characteristics, and the statistical significance and sign of their TBT estimates. Dummy variables capture the sample or model specification choices, and they are intrinsically uncorrelated. Unlike experimental data with the number of “controlled” observations and “experimental” observations perfectly balanced, for our observational data, we cannot control the “balance” of the data. In the first two columns of table 2, we check the balance of the data by calculating the number of papers and estimates corresponding to each dummy variable applied in the meta-analysis. For example, 21 out of 28 papers estimated trade effects in agricultural sectors, 13 out of 28 papers estimated trade effects in the food sector, and only 7 in manufacturing.

Table 2: Summary statistics on the distribution of observations of categorical variables for D1 (negative significant), D2 (insignificant), and D3 (positive significant)

Explanatory Variable in meta analysis	Number of papers affected by exp. variable (dummy=1)	Number of estimates for which dummy=1	Breakdown for negative effects *D*=1	Breakdown for insig. effects *D*=2	Breakdown for positive effects *D*=3
Fix_country_pair	13	392	101	242	49
Panel_fix_time	7	73	49	24	0
Panel_var_time	8	94	58	32	4
Zero_treated	9	291	88	158	45
Ag	21	347	144	159	45
Food	15	192	77	84	29
Manu	7	177	42	105	30
dev_SPS	8	143	61	74	8
Proxy_dummy	7	169	68	93	8
Proxy_count	6	152	57	55	40
Proxy_freq	5	241	53	155	33
Proxy_mrl	10	20	18	2	0
SPS_no_mrl	13	537	171	296	70
TBT	14	451	116	267	68

Ideally, we would like the coverage to be more evenly distributed across sectoral activities. Similarly, the second column indicates the number of estimates for which a categorical variable is equal to 1. For example, 392 out of 618 estimates are estimated from the gravity equations with country-pair fixed effects. Although we don't have perfectly balanced data, the first two columns show that the data is not very skewed or unbalanced. As we estimate MNL model, every variable must have some variations within each category *D*=1, 2, 3. From the last three columns of table 2, variables *Proxy_mrl* and *Panel_fix_time* have no variations when *D*=3, so we exclude these two variables in the MNL model.

Estimation results

We check the data for some potential collinearity as we have numerous dichotomous variables. If collinearity is a problem , it can confound our estimation. We use the conditioning index, variance inflation index (VIF), and variance-decompositions jointly to diagnose the multi-collinearity problems in our sample (Belsley et al. (1980)). Practically, multicollinearity may be a serious problem when the conditioning index is greater than 30, the VIF is greater than 10, and variance-decomposition proportions for two or more estimated regression coefficient variances are higher than 0.5.

Diagnostic outputs[3] suggest possible strong collinearity between the intercept, variable *Proxy_mrl*, variable *SPS_no_mrl*, and variable *Proxy_count*. Since *Proxy_mrl* has the least variation within the sample, we drop it to break the possible collinearity. Then we run the diagnostic procedure again,possible strong collinearity emerges between variables *Ag*, *Food*, *Manu*. So we drop variable *Manu*, because it seems to have relative high VIF and low explanation power. Following this second step, the diagnostic output suggests no additional

[3] Diagnostic outputs available upon request.

serious collinearity problem. In addition, we informally check the stability of the regression results by sequentially dropping each variable (results reported in Appendix), and we believe collinearity issues have been addressed successfully.

Table 3 presents the results from the OLS, the robust, and the MNL regressions with clustered error structure. In OLS and robust regressions, the dependent variable is the t-value of the estimated technical-measure trade effects. Although we preserve the most variations possible to make trade effects from different studies comparable, a major limitation of using t-values is the difficulty in interpreting the coefficients. The results tell us which variables have significant impacts on the t-values and the direction of the impacts, but we need to know the current t-value to say more.

For example, given a negative coefficient of some variable, an increase in this variable makes the trade effects more negative significant or less positive significant, but we cannot tell whether it becomes negative significant, insignificant, or positive significant unless we have the current value of the t-value. The marginal effects are conditional on the current t-value. To facilitate the interpretation, we centered the sample size variable and aggregation level variable at the mean of the dataset, 14172.53 and 5.14, respectively. So we can interpret the intercept of the linear regression as conditional mean of the t-value when sample size and aggregation level are at the sample mean, and all categorical variables equal zero. We interpret the coefficients of the variables as the impact on the t-values conditional on the t-value being equal to the intercept or the conditional sample mean described above. In addition, the MNL results help to sort out this issue as they provide estimated marginal effects.

Table 3: Regression results

Explanatory Var.	OLS	Robust Regression	Multinomial Logit (MNL) $\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	Marginal Effect of MNL (conditional on sample means) $\frac{\partial P_1}{\partial Z^k}$	$\frac{\partial P_2}{\partial Z^k}$	$\frac{\partial P_3}{\partial Z^k}$
Intercept	-0.11	-0.11	1.88	0.56	0.4	-0.38	-0.02
	(1.12)	(0.73)	(1.21)	(0.93)	(0.27)	(0.26)	(0.08)
Fix_country_pair	2.19***	2.89***	-1.81**	0.17	-0.42**	0.33*	0.09*
	(0.72)	(0.45)	(0.83)	(0.62)	(0.18)	(0.17)	(0.05)
Panel_fix_time	-2.16**	-1.79***	n/a	n/a	n/a	n/a	n/a
	(1.04)	(0.66)					
Panel_var_time	-1.16	-1.07*	1.68**	-1.25*	0.44***	-0.23	-0.20***
	(0.91)	(0.57)	(0.76)	(0.70)	(0.17)	(0.15)	(0.06)
Zero_treated	-3.18***	-2.93***	0.42	0.88**	0.06	-0.13	0.08*
	(0.57)	(0.36)	(0.43)	(0.37)	(0.10)	(0.09)	(0.04)
Ag	-0.86*	-0.93***	0.29	-1.03***	0.11	0.01	-0.12***
	(0.49)	(0.31)	(0.41)	(0.24)	(0.08)	(0.09)	(0.02)
Food	-0.97*	-1.18***	0.68	-0.88**	0.19*	-0.07	-0.12**
	(0.49)	(0.31)	(0.46)	(0.44)	(0.10)	(0.08)	(0.05)
dev_SPS	-3.56***	-2.53***	1.03**	0.2	0.23**	-0.20**	-0.02
	(0.60)	(0.38)	(0.44)	(0.58)	(0.10)	(0.10)	(0.06)
Agg_hs_centered	0.73***	0.56***	-0.1	0.02	-0.02	0.02	0.01
	(0.18)	(0.12)	(0.16)	(0.18)	(0.04)	(0.03)	(0.02)
Sample_centered	0.05	-0.02	0.21**	0.26***	0.04**	-0.06**	0.02***
	(0.04)	(0.02)	(0.09)	(0.09)	(0.02)	(0.02)	(0.01)
Proxy_dummy	2.95***	1.74***	-2.22***	-2.09***	-0.42**	0.55***	-0.13*
	(0.87)	(0.55)	(0.82)	(0.85)	(0.19)	(0.16)	(0.08)
Proxy_count	2.22**	2.12***	-2.27**	0.73	-0.55***	0.38*	0.17***
	(1.00)	(0.63)	(0.99)	(0.76)	(0.21)	(0.21)	(0.06)
Proxy_freq	2.65***	2.17***	-1.48**	-1.97***	-0.26	0.40***	-0.15**
	(0.91)	(0.58)	(0.75)	(0.60)	(0.17)	(0.15)	(0.06)
SPS_no_mrl	-1.13*	-0.81**	-0.48	-0.4	-0.09	0.12	-0.02
	(0.61)	(0.39)	(0.49)	(0.40)	(0.11)	(0.10)	(0.05)
TBT	-0.55	-1.18***	-0.05	-0.08	-0.01	0.01	-0.01
	(0.64)	(0.40)	(0.64)	(0.22)	(0.15)	(0.12)	(0.04)
R^2	0.24	0.16	0.17				
Observations	618	618	618				

*, **, *** denote the significance level of 10%, 5%, and 1% respectively.

We use the MNL regression together with robust regression to obtain a more precise interpretation of the results. For the most part, robust regression results and MNL results agree. In a few cases, MNL results indicate insignificant marginal effects of some variable(s) whereas robust regression shows significant impact of the same variable(s). This is caused by the limited variation of categorical dependent variables and the limited number of observations from splitting the data set into three zones. We use a specific example (figure 1 and table 4) to illustrate the situation later.

The variable *Fix_country_pair* controls for the correction of the "gold medal error." Robust regression shows that including the correction makes the conditional mean of t-values more positive; MNL results show that the estimates in the literature with country-pair fixed effect are less likely to have negative significant technical measure trade effects, and more likely to have insignificant or positive significant technical measure trade effects than models estimated without the correction. The variable *Panel_fix_time* corresponds to the correction of the "bronze error" as well as the endogeneity of the technical measures. The results suggest that the latter correction makes the effects of technical measures more negative relative to the conditional average t-values. Investigations with panel data and time variation (*Panel_var_time*) are more likely to have negative significant trade effects, and less likely to have insignificant and positive significant trade effects. Their t-values tend to be more negative.

MNL results show that the treatment of zero-trade has a marginally small positive impact on the probability of getting positive estimates. However, the robust regression result seems to contradict that of the MNL estimation because it shows the conditional mean of t-values becomes more negative by retaining zero-trade. This is a rare case where robust regression results do not agree with MNL results, and the possible reason could be the limited variation of the categorical dependent variables. We illustrate this issue in figure 1 and table 4 below.

Figure1 shows that t-values are more closely clustered when zero trade is not treated, and t-values are more spread out in the negative range when zero trade is treated. Consequently, we have a negative significant coefficient for variable *Zero_treated* in the robust regression.

Figure 1: t-value against *zero_treated* dummy variable (1=treated)

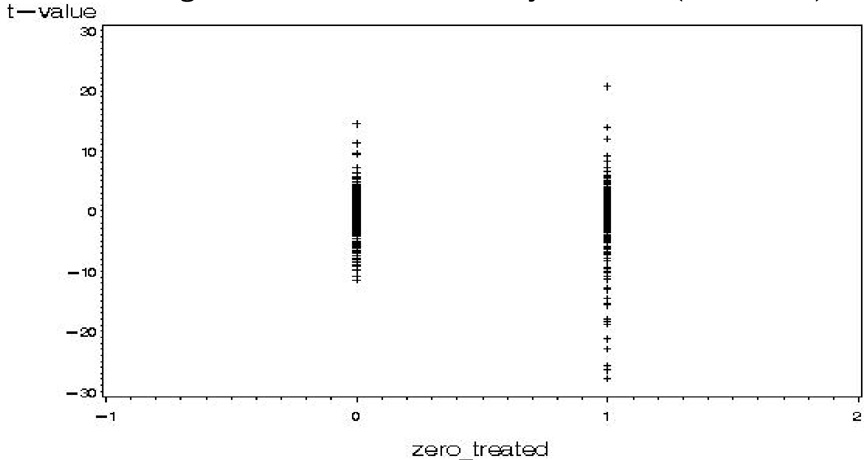

Table 4: Frequency of variable *zero_treated* in each category *D*=1, 2, 3

Zero_treated / *D*	0	1	Total
1	121	88	209
2	162	158	320
3	44	45	89
Total	327	291	618

However, the relative position in the negative end of t-values is not shown in categorical variable *D*, because of its limited variation. Instead, the *D*=3 category has relative more observations (45 out of 291) when zero trade is treated, than when zero trade is not treated (44 out of 327). Hence, the MNL regression results suggest that treating zero trade increase the probability of having positive significant estimates.

For agriculture (*Ag*) and processed food products (*Food*), the technical measure trade effects are less likely to be positive significant. We verify that the finding of SPS regulations having a trade impeding effect for agricultural products produced by developing exporters and going to developed importers is systematic. Both the robust regression and the MNL results show this effect to be significantly present. The result of interaction variable *dev_SPS* shows that the SPS trade effect from developing exporter to developed importer is more negatively affected and is most likely to be negatively significant, and less likely to be insignificant or positively significant.

The aggregation level of the data (*Agg_hs_centered*) is highly significant in the robust regression but not in the MNL. The more disaggregated the trade data, the more positive significant are the trade effects from the conditional mean of the t-values. The larger datasets (*Sample_centered*) tend to bring more conclusive results on the trade effects of technical measures as shown by the MNL results. The probability to have significant trade effects (either positive or negative) increases with the sample size. Not surprisingly, the OLS and robust regressions cannot capture this result.

Last and importantly, choosing the count proxy of technical measures (*Proxy_count*) is more likely to lead to positive or insignificant trade effects and less likely to have negative significant trade effects. Choosing the dummy proxy (*Proxy_dummy*) is more likely to lead to insignificant trade effects and less likely to have negative significant trade effects, while estimates obtained with the frequency proxy (*Proxy_freq*) are less likely to be positive and more likely to be insignificant. Robust regression results suggest that these three proxies have a significant and positive influence on the estimated trade impact of technical measures. The robust regression cannot reject the null hypotheses that these three proxies are the same in terms of the positive and significant effect to the significance of trade effects. However, a similar set of tests in the MNL approach strongly rejects the null hypothesis that *Proxy_dummy* and *Proxy_count* have a similar impact on the probability of the technical measure estimates to fall in the third zone relative to the second zone (P_3/P_2). The null hypothesis that *Proxy-dummy* and *Proxy-freq* are equal in their effect on (P_3/P_2) cannot be rejected, nevertheless. In conclusion, these results are consistent with ruling out a negative influence of these proxies on estimated trade effects, although the two approaches disagree on their relative impacts. Finally, OLS and robust regression results suggest that SPS other than those proxied by MRLs (*SPS_no _mrl*) and TBT (*TBT*) policies lead to more negative trade coefficients. However, MNL results do not suggest any significant patterns.

Robustness check

We consider two major robustness checks, one associated with the existence of influential observations, and another one based on the cut-off values used to separate the three MNL regions into which technical measure estimates fall (negative significant, insignificant, positive significant). First, due to the cluster-structure of our sample, we undertake influential data diagnostics based on clusters represented by the papers included in the dataset, instead of individual observations. We calculate standardized DFbetas and Cook's D statistics[4]. Following the rule of thumb on DFbetas and Cook's D, we flag possible influential clusters 1, 5, 8, 21, because associated DFbetas or Cook's Ds were higher than 1.

[4] Results available upon request.

To further check the influences of these papers, we drop one paper at a time and rerun the meta-analysis and compare regression results with those based on the full sample. Results are shown in Appendix. Dropping observations from paper 1 causes complications with the estimates associated with variables *Proxy_dummy*, *Proxy_count*, and *Proxy_freq*, especially in the MNL model. This is due to a convergence problem in the MNL (the log likelihood does not converge). Variables *Proxy_dummy*, *Proxy_count*, and *Proxy_freq* are nearly co-linear once paper-1 observations are dropped. Results are stable to the deletions of observations from Papers 5, 8, or 21.

Second, we check whether our MNL regression results are robust to different cutoff points of the categorical dependent variable. In the previous MNL regressions, the categorical dependent variable equals to -1, 0, 1 when t-values are larger than 1.96, within (-1.96, 1.96), and smaller than -1.96, respectively. We compares regression results for cut off points +,- 1.96, and +,- 1.64 (see Appendix for details). Changes in the regression results are small and qualitative results on determinants are essentially similar on signs, significance, and order of magnitude of the estimated coefficients. The only difference is that the intercept for the log of the probability to be negative relative to being insignificant ($\log(P_1/P_2)$ is significantly positive, suggesting that estimates of trade effects are more likely to be negative. So we conclude that the choice of cutoff values is not a cause of concern.

Conclusions

We conducted a meta-analysis to explain the systematic variations found in estimated trade effects of technical measures using both data sampling and methodology differences. Although it is impossible to control for all the differences among the studies, we controlled for the determinants that are most likely to matter, based on theoretical findings as well as important conjectures found in the previous empirical literature.

Analyses of agriculture and food industries lead to estimates of trade effects of technical measures, which are less likely to be positive. Trade flows in these sectors tend to be more impeded by technical measures than do trade flows in other sectors. Further, we find systematic impeding effect of SPS regulations on agricultural exports sourced from developing countries and going to high-income countries. Both robust regression and MNL approaches sustain this important finding which suggests that SPS regulations are trade barriers rather than catalysts in the set of studies analyzed here. We find that models that control for the “multilateral resistance” terms using country-pair dummies are more likely to yield positive and significant estimates of trade effects of technical measures than those that do not control for multilateral resistance. Similarly, the former studies are less likely to yield negative significant trade effects than are the latter.

The evidence of the three technical measure proxies is mixed. The three proxies tend to have a positive effect on the estimates of trade effects of technical measures. No strong evidence shows that the three different forms of technical measure proxies (count, frequency, dummy) would lead to systematically different trade effects in the robust regression, however, the MNL results strongly suggest that studies based on a count proxy yield estimates that are more likely to be positive and much less likely to be negative. These two effects are the largest in magnitude for the count proxy. The results on proxies, although convoluted, are consistent with ruling out a negative influence of these proxies on the estimated trade effects of technical measures. The aggregation level of the trade data could also affect the estimated trade effects, and the more disaggregated data tend to provide more positive significant estimated trade effects of technical measures relative to the conditional sample mean of t-values. These effects were found in the robust regression results but could not be confirmed with the MNL approach because of lack of statistical significance.

In the future one could pool our dataset with studies analyzing multilateral, harmonized, and reciprocal technical measures and incorporate technical measure estimates associated with these standards. These standards have a different function with much potential to exhibit trade- expanding ability and with ambiguous effects on cost of production.

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Appendix

Table A: Frequency of Zero-treatment procedures

Procedures	Frequency in observations	Frequency in papers	Negative significant estimate (%)	Insignificant estimate (%)	Positive significant estimate (%)
Adding arbitrary small numbers	4	1	100	0	0
PPML	48	2	58	42	0
Heckman two stage	7	2	71	0	29
Tobit	232	4	22	59	19
Truncation	327	18	37	50	13
Total	618	27			

Table B: Sensitivity of results to variable deletion (one by one)

Explanatory Var.	**Multinomial Logit (all variables)**		**Multinomial Logit**		**Multinomial Logit**	
	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$
Intercept	1.88	0.56	2.15**	-0.36	2.14**	0.37
	(1.21)	(0.93)	(1.11)	(0.99)	(1.10)	(0.90)
Ag	0.29	-1.03***			-0.05	-0.60**
	(0.41)	(0.24)			(0.34)	(0.25)
Food	0.68	-0.88**	0.55	-0.36		
	(0.46)	(0.44)	(0.40)	(0.59)		
Proxy_dummy	-2.22***	-2.09***	-2.29***	-2.25**	-2.22***	-2.37***
	(0.82)	(0.85)	(0.78)	(0.96)	(0.76)	(0.90)
Proxy_count	-2.27**	0.73	-2.24**	0.54	-1.89**	0.27
	(0.99)	(0.76)	(0.98)	(0.97)	(0.94)	(0.75)
Proxy_freq	-1.48**	-1.97***	-1.68***	-1.16*	-1.79***	-1.39***
	(0.75)	(0.60)	(0.66)	(0.64)	(0.73)	(0.56)
Sample_centered	0.02**	0.03***	0.02***	0.03***	0.02***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
SPS_no_mrl	-0.48	-0.40	-0.53	-0.29	-0.51	-0.45
	(0.49)	(0.40)	(0.50)	(0.39)	(0.47)	(0.38)
TBT	-0.05	-0.08	-0.08	0.03	-0.04	-0.11
	(0.64)	(0.22)	(0.65)	(0.23)	(0.62)	(0.22)
Agg_hs_centered	-0.10	0.02	-0.11	0.06	-0.17	0.13
	(0.16)	(0.18)	(0.15)	(0.21)	(0.15)	(0.18)
Panel_var_time	1.68**	1.68**	1.70**	-0.80	1.39**	-0.60
	(0.76)	(0.76)	(0.74)	(0.83)	(0.69)	(0.68)
Fix_country_pair	-1.81**	-1.81**	-1.78**	0.19	-1.61**	0.02
	(0.83)	(0.83)	(0.81)	(0.76)	(0.77)	(0.67)
Zero_treated	0.42	0.42	0.51	0.41	0.62	0.43
	(0.43)	(0.43)	(0.39)	(0.44)	(0.38)	(0.34)
dev_SPS	1.03**	1.03**	1.10***	0.11	1.19***	0.13
	(0.44)	(0.44)	(0.40)	(0.66)	(0.39)	(0.65)

Table B: Sensitivity of results to variable deletion (one by one) (continued)

Explanatory Var.	**Multinomial Logit**		**Multinomial Logit**		**Multinomial Logit**		**Multinomial Logit**	
	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$
Intercept	0.75	-0.44	0.4	1.18***	1.09	-0.64	1.68	0.87
	(1.02)	(1.02)	(0.91)	(0.42)	(1.04)	(0.99)	(1.26)	(1.02)
Ag	0.43	-1.03***	0.19	-1.05***	0.54*	-0.72**	0.44	-0.92***
	(0.44)	(0.27)	(0.47)	(0.26)	(0.33)	(0.35)	(0.44)	(0.34)
Food	0.72	-0.94***	0.36	-0.83**	0.84**	-0.66	0.83*	-0.71
	(0.48)	(0.48)	(0.59)	(0.39)	(0.40)	(0.43)	(0.45)	(0.48)
Proxy_dummy			-1.04*	-2.44**	-1.51**	-1.16	-1.95***	-1.27
			(0.55)	(1.01)	(0.72)	(0.84)	(0.72)	(0.80)
Proxy_count	-0.96	1.86**			-1.23*	2.14***	-2.50***	-0.03
	(0.84)	(0.93)			(0.69)	(0.83)	(0.99)	(1.04)
Proxy_freq	-0.58	-1.33*	-0.39	-2.45***			-1.65**	-2.50***
	(0.70)	(0.70)	(0.47)	(0.63)			(0.83)	(0.85)
Sample_centered	0.01	0.02	0.02**	0.03***	0.03**	0.03***		
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)		
SPS_no_mrl	-0.57	-0.37	-0.41	-0.35	-0.71	-0.61	-0.43	-0.35
	(0.50)	(0.52)	(0.49)	(0.40)	(0.46)	(0.41)	(0.50)	(0.44)
TBT	-0.30	-0.19	-0.35	-0.04	-0.37	-0.41*	-0.11	-0.15
	(0.74)	(0.27)	(0.70)	(0.22)	(0.63)	(0.22)	(0.64)	(0.22)
Agg_hs_centered	-0.28**	-0.16	-0.33***	0.12	-0.12	-0.06	-0.12	0.01
	(0.12)	(0.17)	(0.10)	(0.17)	(0.18)	(0.21)	(0.16)	(0.19)
Panel_var_time	0.72	-2.15**	1.13	-1.19	1.62*	-1.35	1.80***	-1.41
	(0.81)	(0.95)	(0.99)	(1.07)	(0.91)	(0.89)	(0.68)	(1.11)
Fix_country_pair	-1.36*	0.51	-0.62	-0.36	-1.29	0.93	-1.91**	-0.52
	(0.84)	(0.76)	(0.53)	(0.38)	(0.80)	(0.85)	(0.82)	(0.81)
Zero_treated	0.45	1.01**	0.16	1.12***	-0.18	-0.01	0.64	1.50***
	(0.48)	(0.42)	(0.48)	(0.43)	(0.35)	(0.41)	(0.45)	(0.59)
dev_SPS	0.10	-0.80	0.83***	0.21	0.93**	0.14	0.81**	-0.42
	(0.41)	(0.49)	(0.34)	(0.62)	(0.46)	(0.65)	(0.39)	(0.66)

Table B: Sensitivity of results to variable deletion (one by one) (continued)

Explanatory Var.	**Multinomial Logit**		**Multinomial Logit**		**Multinomial Logit**		**Multinomial Logit**	
	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$
Intercept	1.33	-0.04	1.84	0.48	2.20**	0.52	2.07**	0.75
	(0.99)	(0.69)	(1.14)	(0.77)	(1.12)	(0.83)	(0.88)	(0.80)
Ag	0.34	-0.99***	0.30	-1.02***	0.31	-1.03***	0.25	-0.88***
	(0.41)	(0.24)	(0.42)	(0.24)	(0.41)	(0.26)	(0.39)	(0.23)
Food	0.69	-0.88**	0.68	-0.88**	0.75*	-0.90**	0.38	-0.63**
	(0.46)	(0.43)	(0.46)	(0.43)	(0.44)	(0.43)	(0.53)	(0.31)
Proxy_dummy	-2.23***	-2.08***	-2.23***	-2.11***	-2.48***	-1.98***	-1.25**	-3.00***
	(0.84)	(0.84)	(0.80)	(0.85)	(0.64)	(0.55)	(0.53)	(1.03)
Proxy_count	-2.16**	0.87	-2.28**	0.73	-2.64***	0.82	-1.72*	0.38
	(0.92)	(0.68)	(0.99)	(0.75)	(0.69)	(0.74)	(0.91)	(0.56)
Proxy_freq	-1.63**	-2.08***	-1.51**	-2.01***	-1.51**	-1.90***	-1.47	-1.63***
	(0.78)	(0.57)	(0.68)	(0.58)	(0.70)	(0.49)	(0.91)	(0.56)
Sample_centered	0.02*	0.02***	0.02**	0.03***	0.02***	0.03***	0.02***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
SPS_no_mrl			-0.47	-0.3	-0.54	-0.40	-0.53	-0.42
			(0.40)	(0.32)	(0.55)	(0.37)	(0.54)	(0.37)
TBT	0.07	0.06			-0.01	-0.08	-0.59	-0.15
	(0.63)	(0.22)			(0.63)	(0.24)	(0.77)	(0.27)
Agg_hs_centered	-0.13	0.00	-0.10	0.03			-0.26**	0.13
	(0.16)	(0.18)	(0.15)	(0.18)			(0.12)	(0.19)
Panel_var_time	1.72**	-1.19*	1.71***	-1.22*	1.90***	-1.31		
	(0.78)	(0.73)	(0.63)	(0.74)	(0.71)	(0.82)		
Fix_country_pair	-1.80**	0.19	-1.83***	0.14	-2.08***	0.21	-1.41*	-0.02
	(0.80)	(0.61)	(0.73)	(0.65)	(0.61)	(0.70)	(0.86)	(0.53)
Zero_treated	0.47	0.94***	0.44	0.90	0.34	0.84**	0.64	0.53
	(0.44)	(0.34)	(0.39)	(0.36)	(0.46)	(0.37)	(0.58)	(0.34)
dev_SPS	0.94**	0.14	1.03**	0.20	1.12***	0.12	0.56	0.69
	(0.46)	(0.55)	(0.43)	(0.59)	(0.42)	(0.49)	(0.36)	(0.68)

Table B: Sensitivity of results to variable deletion (one by one) (continued)

Explanatory Var.	**Multinomial Logit**		**Multinomial Logit**		**Multinomial Logit**	
	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$
Intercept	0.62	0.74	1.88	0.29	1.42	0.4
	(1.03)	(0.55)	(1.23)	(0.93)	(1.06)	(0.89)
Ag	0.25	-1.09***	0.34	-0.84***	0.50	-0.98***
	(0.45)	(0.28)	(0.36)	(0.28)	(0.39)	(0.25)
Food	0.46	-0.92**	0.73*	-0.68**	0.86**	-0.83*
	(0.59)	(0.42)	(0.40)	(0.38)	(0.42)	(0.45)
Proxy_dummy	-1.58**	-2.03**	-2.27***	-2.22**	-1.31***	-1.86***
	(0.66)	(0.91)	(0.92)	(0.95)	(0.47)	(0.42)
Proxy_count	-0.40	0.58	-2.12**	1.11	-1.98**	0.79
	(0.43)	(0.36)	(1.01)	(0.75)	(0.91)	(0.72)
Proxy_freq	-0.63	-2.08***	-1.13**	-1.07***	-1.38*	-1.89***
	(0.66)	(0.70)	(0.52)	(0.41)	(0.83)	(0.62)
Sample_centered	0.02**	0.02**	0.03**	0.03***	0.01	0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
SPS_no_mrl	-0.53	-0.35	-0.53	-0.50	-0.27	-0.38
	(0.46)	(0.42)	(0.47)	(0.37)	(0.52)	(0.38)
TBT	-0.59	-0.13	-0.14	-0.24	-0.18	-0.10
	(0.72)	(0.28)	(0.62)	(0.22)	(0.70)	(0.23)
Agg_hs_centered	-0.37***	0.02	-0.07	0.06	-0.17	0.03
	(0.10)	(0.19)	(0.18)	(0.19)	(0.13)	(0.16)
Panel_var_time	1.16	-1.22	1.75**	-1.04	1.19	-1.28
	(1.16)	(0.96)	(0.81)	(0.73)	(0.77)	(0.82)
Fix_country pair			-1.63**	0.63	-1.63**	0.25
			(0.82)	(0.61)	(0.82)	(0.59)
Zero_treated	-0.02	0.97**			0.35	0.79**
	(0.37)	(0.40)			(0.50)	(0.41)
dev_SPS	0.81**	0.11	0.99**	0.31		
	(0.33)	(0.59)	(0.50)	(0.69)		

Table C: Robustness checks. Influential cluster check

	Full data set			**Paper 1 observations dropped**		
Explanatory Var.	Robust Regression	Multinomial Logit $\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	Robust Regression	Multinomial Logit $\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$
Intercept	-0.11	1.88	0.56	-1.64**	2.63*	-18.45***
	(0.73)	(1.21)	(0.93)	(0.75)	(1.62)	(1.21)
Ag	-0.93***	0.29	-1.03***	-0.72**	0.11	-1.16***
	(0.31)	(0.41)	(0.24)	(0.33)	(0.50)	(0.19)
Food	-1.18***	0.68	-0.88**	-0.82***	0.48	-0.80*
	(0.31)	(0.46)	(0.44)	(0.32)	(0.56)	(0.45)
Proxy_dummy	1.74***	-2.22***	-2.09***	4.61***	-3.98**	17.72#
	(0.55)	(0.82)	(0.85)	(0.96)	(1.71)	(.)
Proxy_count	2.12***	-2.27**	0.73	4.42***	-3.59**	20.35
	(0.63)	(0.99)	(0.76)	(0.84)	(1.66)	(1.11)
Proxy_freq	2.17***	-1.48**	-1.97***	5.88***	-3.71**	18.37***
	(0.58)	(0.75)	(0.60)	(1.14)	(1.62)	(0.76)
Sample_centered	-0.02	0.21**	0.26***	-0.04	0.02	0.03*
	(0.02)	(0.09)	(0.09)	(0.02)	(0.01)	(0.01)
SPS_no_mrl	-0.81**	-0.48	-0.40	-1.93***	0.25	-0.96***
	(0.39)	(0.49)	(0.40)	(0.55)	(0.38)	(0.17)
TBT	-1.18***	-0.05	-0.08	-1.80***	0.45	-0.58***
	(0.40)	(0.64)	(0.22)	(0.48)	(0.60)	(0.22)
Agg_hs_centered	0.56***	-0.10	0.02	0.71***	-0.18	0.14
	(0.12)	(0.16)	(0.18)	(0.12)	(0.18)	(0.20)
Panel_fix_time	-1.79***	n/a	n/a	-1.72***	n/a	n/a
	(0.66)			(0.64)		
Panel_var_time	-1.07*	1.68**	-1.25*	-1.00*	1.80**	-0.92
	(0.57)	(0.76)	(0.70)	(0.57)	(0.77)	(0.75)
Fix_country_pair	2.89***	-1.81**	0.17	2.07***	-1.65*	-0.10
	(0.45)	(0.83)	(0.62)	(0.47)	(0.86)	(0.63)
Zero_treated	-2.93***	0.42	0.88**	-2.80***	0.67	0.81**
	(0.36)	(0.43)	(0.37)	(0.36)	(0.51)	(0.41)
dev_SPS	-2.53***	1.03**	0.20	-1.77***	0.97**	0.58
	(0.38)	(0.44)	(0.58)	(0.40)	(0.50)	(0.57)

Table D: Robustness check. Influential cluster checks for papers 5, 8, and 2

Explanatory Var.	Full data set: Robust Regression	Full data set: Multinomial Logit $\log(\frac{Pr(D=1)}{Pr(D=2)})$	Full data set: Multinomial Logit $\log(\frac{Pr(D=3)}{Pr(D=2)})$	Paper 5 observations dropped: Robust Regression	Paper 5 observations dropped: Multinomial Logit $\log(\frac{Pr(D=1)}{Pr(D=2)})$	Paper 5 observations dropped: Multinomial Logit $\log(\frac{Pr(D=3)}{Pr(D=2)})$	Paper 8 observations dropped: Robust Regression	Paper 8 observations dropped: Multinomial Logit $\log(\frac{Pr(D=1)}{Pr(D=2)})$	Paper 8 observations dropped: Multinomial Logit $\log(\frac{Pr(D=3)}{Pr(D=2)})$	Paper 21 observations dropped: Robust Regression	Paper 21 observations dropped: Multinomial Logit $\log(\frac{Pr(D=1)}{Pr(D=2)})$	Paper 21 observations dropped: Multinomial Logit $\log(\frac{Pr(D=3)}{Pr(D=2)})$
Intercept	-0.11	1.88	0.56	-0.54	1.90	0.52	-0.59	1.85	0.51	-0.98	2.04	-1.62
	(0.73)	(1.21)	(0.93)	(0.80)	(1.20)	(0.92)	(0.82)	(1.17)	(0.82)	(0.86)	(1.43)	(1.37)
Ag	-0.93***	0.29	-1.03***	-0.88***	0.27	-0.97***	-0.72**	-0.07	-1.17***	-1.06***	0.39	-0.84***
	(0.31)	(0.41)	(0.24)	(0.32)	(0.41)	(0.34)	(0.37)	(0.37)	(0.24)	(0.31)	(0.44)	(0.26)
Food	-1.18***	0.68	-0.88**	-1.13***	0.66	-0.82*	-1.28***	0.76	-0.77**	-1.37***	0.69	-1.71
	(0.31)	(0.46)	(0.44)	(0.32)	(0.47)	(0.47)	(0.37)	(0.49)	(0.41)	(0.32)	(0.57)	(0.25)
Proxy_dummy	1.74***			1.84***	-2.23***	-2.09**	2.45***	-1.24	-1.68		-	
	(0.55)			(0.55)	(0.84)	(1.02)	(0.87)	(1.12)	(1.27)		1.79*	
		-2.22***	-2.09***							1.43***	**	-1.46
		(0.82)	(0.85)							(0.55)	(0.66)	(0.99)
Proxy_count	2.12***	-2.27**	0.73	2.11***	-2.24***	0.53	2.30***	-2.22***	0.75	1.43*	-1.43	1.93*
	(0.63)	(0.99)	(0.76)	(0.63)	(0.98)	(0.85)	(0.71)	(0.91)	(0.66)	(0.75)	(0.95)	(1.02)
Proxy_freq	2.17***	-1.48**	-1.97***	1.98***	-1.47**	-2.07***	2.30***	-1.71**	-2.01***	1.54***	-0.93	-2.15***
	(0.58)	(0.75)	(0.60)	(0.58)	(0.75)	(0.59)	(0.65)	(0.77)	(0.57)	(0.60)	(0.71)	(0.73)
Sample_centered	-0.02	0.21**	0.26***	-0.20	0.02*	0.01	-0.03	0.02*	0.02***	-0.03	0.18*	0.24***
	(0.02)	(0.09)	(0.09)	(0.13)	(0.01)	(0.03)	(0.03)	(0.01)	(0.01)	(0.02)	(0.10)	(0.09)
SPS_no_mrl	-0.81**	-0.48	-0.40	-0.69*	-0.45	-0.43	-0.71*	-0.49	-0.41	-0.97**	-0.29	0.65
	(0.39)	(0.49)	(0.40)	(0.40)	(0.50)	(0.36)	(0.43)	(0.50)	(0.39)	(0.45)	(0.68)	(0.54)
TBT	-1.18***	-0.05	-0.08	-1.04***	-0.08	-0.05	-0.92**	0.27	0.02	-0.26	-0.86	0.22
	(0.40)	(0.64)	(0.22)	(0.41)	(0.66)	(0.24)	(0.48)	(0.66)	(0.23)	(0.55)	(0.69)	(0.62)
Agg_hs_centered	0.56***	-0.10	0.02	0.53***	-0.10	0.04	0.57***	-0.05	0.05	0.33**	-0.06	-0.29**
	(0.12)	(0.16)	(0.18)	(0.12)	(0.16)	(0.18)	(0.13)	(0.12)	(0.17)	(0.16)	(0.32)	(0.13)
Panel_fix_time	-1.79***	n/a	n/a	-1.31*	n/a	n/a	-1.95***	n/a	n/a	-0.96*	n/a	n/a
	(0.66)			(0.72)			(0.75)			(0.58)		
Panel_var_time	-1.07*	1.68**	-1.25*	-1.15**	1.65**	-1.04	-1.44**	1.17	-1.42**	-1.18*	1.10	-1.90***
	(0.57)	(0.76)	(0.70)	(0.57)	(0.78)	(0.87)	(0.73)	(0.93)	(0.58)	(0.66)	(0.77)	(0.69)
Fix_country_ pair	2.89***	-1.81**	0.17	2.90***	-1.80**	0.04	2.81***	-1.78**	0.20	2.95***	-1.52*	0.86
	(0.45)	(0.83)	(0.62)	(0.45)	(0.82)	(0.72)	(0.51)	(0.76)	(0.52)	(0.47)	(0.88)	(0.76)
Zero_treated	-2.93***	0.42	0.88**	-2.74***	0.40	0.99**	-2.90***	0.36	0.81***	-1.98***	-0.10	1.48**
	(0.36)	(0.43)	(0.37)	(0.37)	(0.44)	(0.43)	(0.41)	(0.37)	(0.32)	(0.55)	(0.90)	(0.63)
dev_SPS	-2.53***	1.03**	0.20	-2.58***	1.02**	0.26	-2.30***	1.48***	0.39	-1.85***	0.57	0.08
	(0.38)	(0.44)	(0.58)	(0.38)	(0.43)	(0.62)	(0.49)	(0.40)	(0.45)	(0.49)	(0.42)	(0.93)

Table E: Robustness check on different cutoff points

	Cut off points +,- 1.96		Cut off points +,- 1.64	
Explanatory Var.	Multinomial Logit $\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$	Multinomial Logit $\log(\frac{\Pr(D=1)}{\Pr(D=2)})$	$\log(\frac{\Pr(D=3)}{\Pr(D=2)})$
Intercept	1.88	0.56	1.93*	0.72
	(1.21)	(0.93)	(1.13)	(1.04)
Ag	0.29	-1.03***	0.36	-1.09**
	(0.41)	(0.24)	(0.41)	(0.29)
Food	0.68	-0.88**	0.75	-0.80*
	(0.46)	(0.44)	(0.41)	(0.46)
Proxy_dummy	-2.22***	-2.09***	-1.88***	-1.47**
	(0.82)	(0.85)	(0.75)	(0.68)
Proxy_count	-2.27**	0.73	-2.13**	0.93
	(0.99)	(0.76)	(0.95)	(0.84)
Proxy_freq	-1.48**	-1.97***	-1.24*	-1.72***
	(0.75)	(0.60)	(0.70)	(0.72)
Sample_centered	0.02**	0.03***	0.03***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)
SPS_no_mrl	-0.48	-0.40	-0.47	-0.42
	(0.49)	(0.40)	(0.46)	(0.43)
TBT	-0.05	-0.08	-0.05	-0.25
	(0.64)	(0.22)	(0.55)	(0.24)
Agg_hs_centered	-0.10	0.02	-0.06	-0.02
	(0.16)	(0.18)	(0.15)	(0.19)
Panel_fix_time	n/a	n/a	n/a	n/a
Panel_var_time	1.68**	-1.25	1.34**	-1.29**
	(0.76)	(0.70)	(0.73)	(0.56)
Fix_country_pair	-1.81**	0.17	-1.70**	0.24
	(0.83)	(0.62)	(0.80)	(0.66)
Zero_treated	0.42	0.88**	0.31	0.93**
	(0.43)	(0.37)	(0.42)	(0.44)
dev_SPS	1.03**	0.20	0.92**	-0.24
	(0.44)	(0.58)	(0.40)	(0.43)

CHAPTER 3: PROTECTIONISM INDICES FOR NON-TARIFF MEASURES: AN APPLICATION TO MAXIMUM RESIDUE LEVELS

A paper submitted to *Food Policy*

Yuan Li and John C. Beghin

Abstract

We propose aggregation indices of Non-Tariff Measures (NTMs) to quantify their protectionism relative to international standards. We apply the indices to national Maximum Residue Limit (MRL) regulations affecting agricultural and food trade and using a science-based criteria embodied in Codex Alimentarius international standards. The approach links two streams of the NTM literature, one concerned with the aggregation of various NTMs into operational indices for econometric and modeling purposes, and the other attempting to evaluate the protectionism of NTMs. The data used in the application come from a large international dataset on veterinary and pesticide MRLs and CODEX MRL standards for a large set of countries.

Introduction

We fill a gap in the literature on empirical measures of protectionism of nontariff measures (NTMs) by proposing simple yet formal aggregation indices of NTMs. The indices measure the protectionism of Maximum Residue Limit (MRL) standards relative to science-based criteria embodied in international standards such as Codex Alimentarius. MRLs set limits on harmful substances, like pesticide residues, veterinary drug residues, and other harmful substances, that importing countries allow on similar imported and domestic products as implied by national treatment. MRLs are often substance, product, and country specific. MRLs can also be used to impede trade to protect domestic producers rather than protecting health or the environment.

We link two streams of the NTMs literature, each addressing a specific problem. These two problems have been vexing and remain largely unresolved. One stream is concerned with the aggregation of various NTMs into meaningful indices, to characterize NTM regimes and to be used in econometric analyses of trade flows or to model and analyze policy impact (Disdier, Fontagné, and Mimouni (2008)). The other stream attempts to evaluate the protectionist nature of NTMs. Unlike tariffs for which the presumption is that they distort trade and welfare, NTMs may improve welfare because they address some market imperfection (Beghin et al. (2012)). So quantification, aggregation, and delineation of the potential protectionism of NTMs are a complex and important issue in the analysis of NTMs.

Empirical studies of NTMs almost inevitably involve quantification and aggregation of several policies. Unlike tariffs, a single policy type whose numerical values can be directly used and interpreted, NTMs cover a lot of intrinsically different policies. For example, a Multi-Agency Support Team (MAST) of international organizations proposed a classification of NTMs, which consists of 16 major categories, including Sanitary and Phytosanitary (SPS) measures, Technical Barriers to Trade (TBT), other technical measures, price control measures, quantity control measures, etc. These NTMs can be qualitative and/or quantitative standards. For qualitative standards, like labeling, no numerical values can be directly used. Further, these qualitative policies affect different components of cost of production and marketing and cannot be easily aggregated into a single price equivalent. Evaluating the protectionist component of these numerous qualitative policies into a protectionist score is likely to remain a challenge. For quantitative NTM policies, we show that aggregation is a much more manageable task

Individual NTMs have been used empirically in a disaggregated fashion (Disdier and Marette (2010); Wilson and Otsuki (2004)). For qualitative standards, dummies are usually used to indicate the existence of such a standard. For quantitative standards, like Maximum Residue Limits (MRLs), the numerical levels may be directly used in the model (Xiong and Beghin (2012)). However, a single disaggregated NTM has limited application. Usually, a myriad of standards work together to regulate the quality of a product, and picking just one of the NTMs may lead to subjective selection bias and a mischaracterization of the set of NTMs regulating the market under study. In addition, even if there is no bias, a single NTM is not exhaustive and may not be representative.

Based on that concern, researchers often aggregate regulations and standards in summary indicators (Winchester et al., forthcoming). Indices involve aggregating over different regulations and standards, like labeling and MRL, and/or aggregating over products of different importance. Recent investigations focus on measuring the heterogeneity of NTMs across countries and products. Kox and Lejour (2006) propose an index based on a binary indicator of NTMs similarity. Rau, Shutes, and Sclueter (2010) developed a heterogeneity index of trade (HIT) of NTMs that can be applied to binary, ordered, or quantitative NTMs. The HIT is non-directional which means it measures the bilateral dissimilarity of NTMs, but gives no information about the relative strictness of NTMs. Winchester et al. (forthcoming) extend the HIT, to a directional HIT (DHIT) capturing the asymmetric stringency between two countries and apply it to MRL data in an investigation of bilateral trade of agricultural products. Vigani, Raimondi, and Opler (2009), Drogué and DeMaria (forthcoming), and Achterbosch et al. (2009) offer alternative scalar measures of dissimilarity of policies.

An alternative to these indices, the frequency ratio, is often used (Harrigan (1993); Fontagné, Mimouni, and Pasteels (2005); Disdier, Fontagné, Mimouni (2008)). It calculates the coverage of NTMs of product categories relative to the total number of product categories of at aggregated level (say HS4 or HS2 digit) and weighted by production levels. Other aggregate or summary NTM proxies exist. See Li and Beghin (2011) for a systematic review of various NTM proxies and aggregators used in econometric investigations.

Many NTMs investigations assume NTMs impede trade (and implicitly welfare) and rule out trade or welfare enhancing effects. However, we know market imperfections such as asymmetric information and externalities abound and NTM policy interventions could increase welfare and may be trade-impeding or trade enhancing while increasing welfare. NTMs may also be protectionist of course. Nevertheless, some agnostic priors on their protectionist nature ought to prevail. The empirical literature actually shows numerous cases of trade-enhancing NTMs (Li and Beghin 2011). There is no simple mapping between NTMs and their trade and welfare effects in presence of market imperfections.

To complicate further, market imperfections may justify some NTMs but do not exclude protectionism because the level of the chosen measure may be overly stringent, hence, protectionist by creating unnecessary frictions in trade. This is an increasing preoccupation in policy forums (Disdier and van Tongeren (2010)). Several investigations correlate frequency and trade frictions, without formalizing what is protectionism. For example, Disdier and van Tongeren (2010) make the conjecture that protectionism is responsible for some variance of incidence of NTMs across agri-food products. Disdier, Fontagné, Mimouni (2008) posit that protectionism may exist when a SPS measure is enforced by only a few countries. Finally, Winchester et al. (forthcoming) investigate how bilateral stringency differences in NTMs affect bilateral trade. Reducing stringency differences to common lower stringency levels would increase trade; the welfare grounds to do so are less clear, unless protectionism is presumed to prevail in the most stringent countries. These "conjectures" are intuitive, but lack formalism.

Formalizing protectionism

When defining protectionism of NTMs one can start with the simple science-based test. In absence of scientific evidence establishing market imperfections or risk, a NTM is protectionist.[5] In presence of established risk or imperfections, identifying protectionism is more cumbersome.

More conceptually, Fischer and Serra (2000) provide a formal criterion for gauging protectionism in presence of market imperfection. They conceptually analyze the protectionism behavior of a local social planner (LSP) setting up a quality standard to lower a negative consumption externality. The authors define a standard as protectionist if its optimum level is higher under a local LSP than under a global social planner treating all firms competing for the domestic market (foreign and domestic firms) as purely domestic. They find that when there a negative consumption externality the LSP always set the optimum domestic standard at a higher (protectionist) level than the level chosen by the global planner. Their results hinge on the domestic firms being more efficient at meeting the

[5] There is a caveat of the precautionary principle which lets a country introduce a NTM while establishing the science. A precautionary policy without the pursuit of evidence is protectionist according to the WTO.

quality standard than foreign firms are. Marette and Beghin (2010) show that if foreign firms are much more efficient at meeting the standard, the domestic LSP will choose an anti-protectionist standard, lower than the global standard. Berti and Falvey (2009) extend the analysis of Fisher and Serra and incorporate rent seeking industries influencing the way the LSP sets standards. They investigate how rent-seeking and socially optimum standards vary from autarky to free trade. Rent-seeking under free trade between two countries promotes the harmonization of standards that were heterogeneous under autarky. Finally, earlier on, Baldwin (1970) defines a NTM as protectionist whenever it lowers global real income. The latter criteria could conceptually accommodate cases with market imperfections.

These conceptual efforts provide clear definitions of protectionism. However, they are difficult to operationalize in realistic empirical applications when many NTMs are imposed at once and because informational requirements are extensive. The issue of an aggregator lurks again in presence of many NTMs. Further, the Fisher and Serra criterion is not directly applicable when the supply is only made of foreign firms as in the case of tropical exports to most of the Northern hemisphere (e.g., the EU peanut market). The Baldwin criterion is also difficult to implement in real empirical cases given the “world” dimension of the criteria.

The World Trade Organization (WTO) does not set standards but encourages countries to use internationally accepted science-based standards, like Codex Alimentarius standards whenever available. However, the WTO allows its members to set their own standards away from international ones, as long as their individual standards are science based, non-discriminating, and least trade restrictive (WTO Doha Ministerial (2001)). The issue of “appropriate level of protection” is still under discussion, and the WTO has not yet disambiguated what this means practically. Yet the science-based argument is a corner stone to fight protectionism and has led to several ruling by the WTO against policies in the EU, Japan, and Australia which could not be justified using scientific evidence (see WTO dispute cases DS245, DS367, and DS26).

In the next section, we propose indices of NTM protectionism based on their departures from international science-based standards. We consider MRL measures, which are quantitative standards and give us a basis for comparison and aggregation. We use the Codex Alimentarius MRL standards as the non-protectionist science-based reference level. MRLs that exceed Codex levels are defined to be protectionist, a simple criterion. It extends naturally from the WTO recommendation to use international standards. We also limit our analysis to science-based situations for each of which an international standard exists.

Defining protectionism indices

Different aggregation levels have specific purposes. A measure of the protectionism for a given importer and given good provides detailed information for importers by commodities. This aggregator is useful for cross section (goods and countries) econometric investigations. Aggregate-country level protectionism scores over all considered goods facilitate straightforward country differences in MRL protectionism. These most aggregate scores allow us to assess and rank countries by their relative protectionism. These could also be compared to summary protection measures via tariffs and farm subsidies to analyze the policy composition of protectionism. Product level protectionism scores facilitate straightforward high-level interpretation in the sector or commodity differences in MRL protectionism and are the building blocks of the other two aggregation scores.

We define an importer's MRL to be protectionist when its stringency exceeds the corresponding science-based international MRL. If an importer's MRL is higher than the corresponding international MRL, then we deem the MRL non-protectionist. The aggregation over a multitude of substances (and goods) provides robustness to the indices. An "unintended" accidental protectionist MRL will be swamped by other non-protectionist MRLs included in the three indices proposed below if a country is mostly non-protectionist.

Define $M_{ijk_{(j)}}$ the maximum residue level of importer *i*, for good *j*, and harmful substance $k_{(j)}$; and let $M_{intl,jk_{(j)}}$ be the international maximum residue level for the same good and harmful substance. Denote total number of importers as *I*, total number of goods as *J*, and total number of chemical/pesticides applied to product *j* as $K_{(j)}$. To each of the three problems stated above, we propose the following indices:

$$S_{ij} = \frac{1}{K_{(j)}}\left(\sum_{k_{(j)}=1}^{K_{(j)}} \exp\left(\frac{M_{intl,jk_{(j)}} - M_{ijk_{(j)}}}{M_{intl,jk_{(j)}}}\right)\right), \qquad (1)$$

$$S_i = \sum_{j=1}^{J}\sum_{k=1}^{K_{(j)}} \frac{1}{K_{(j)}} \exp\left(\frac{M_{intl,jk(j)} - M_{ijk_{(j)}}}{M_{intl,jk_{(j)}}}\right) \times w_{ij}, \qquad (2)$$

$$\text{and } S_j = \sum_{i=1}^{I}\sum_{k=1}^{K_{(j)}} \frac{1}{K_{(j)}} \exp\left(\frac{M_{intl,jk(j)} - M_{ijk_{(j)}}}{M_{intl,jk_{(j)}}}\right) \times w'_{ij}, \qquad (3)$$

where w_{ij} is the weight assigned to product j when we aggregate over products for given country i. Ideally, weights should reflect the dead-weight loss associated with each product in aggregation over products for a given country. However, dead-weight loss data are not readily available, and we substitute import value instead. Similarly, w'_{ij} is the weight assigned to country i when we aggregate over countries for given product j to obtain total in that product. More specifically, $w_{ij} = IM_{ij} \Big/ \sum_{j=1}^{J} IM_{ij}$ and $w'_{ij} = IM_{ij} \Big/ \sum_{i=1}^{I} IM_{ij}$, where IM_{ij} is the import value of country i for total trade of product j. Below, we refer to the traded scores as "trade-weighted" or simply "weighted" and we refer to the unweighted scores as "equally-weighted" or "unweighted." [6]

To summarize, index S_{ij} measures the protectionism of the MRLs for a given product and importer, aggregating over substances; S_i measures the protectionism of MRLs for a given importer, aggregating over substances and products; and S_j measures the protectionism of MRLs for a given product, aggregating over substances and importers.

Properties of the indices

By design, the indices have the following properties: invariance to scale, increasing marginal difficulty of attaining stricter standards (convexity in protectionism), invariance to regulation intensity, monotonicity (non-decreasing in MRL stringency of different countries, same product and same harmful substance, other things equal), and lower and upper bounded.

First, we subtract the importer's MRL from the international MRL, because, by the definition of protectionism, only the part of the importer's MRL that is more stringent than the international MRL contributes to protectionism. When the MRL is laxer than the international standard, it is anti-protectionist. MRLs have different scales, which could vary from 0.01 ppm(parts per million) to 10ppm or more. To make the index invariant to the scale of different residue levels, we scale the differences between importer and international MRLs by the international MRL. Second, the lower (i.e, stricter) the standard the harder it is for exporters to achieve. For example, some importers may relax all but one MRL above the international accepted level. But the one stringent MRL may become tough to achieve. By

[6] In the empirical section, we also investigate normalized trade weights by dividing trade weights by a measure of aggregate trade openness.

taking the exponential of the protectionism contributing part of the MRL, we put more weight on the MRLs that are relatively more stringent.

Third, the number of substances regulated varies by products in many cases. In our application, this number of substances ranges from over a hundred to below 10. For example, the United States has established 107 pesticide MRLs for apples, and only 7 pesticide MRLs for coconut. The different regulatory intensity is possibly due the heterogeneous popularity of products with consumers. By averaging the sum of protectionism scores of each pesticide by the total number of pesticides, we make the protectionism indices invariant the regulation intensity. This property is further analyzed later in the paper as the regulatory intensity may be confounded with some missing data issue.

Fourth, the indices are non-decreasing in stringency ($M_{ijk_{(j)}}$ getting smaller) for different countries given the same j, $k_{(j)}$ and all other things being equal. If a country's standard is more stringent, its protectionist scores will be nondecreasing in that stringency. Last, the scores are bounded by 0 at the lower bound and $e \approx 2.72$ at the upper bound. A score of 1 indicate a non-protectionist policy. Scores larger than 1 indicate "protectionism" of policies as MRLs can be more stringent than Codex, and scores below 1 indicate the "anti-protectionism," of policies as MRLs can be laxer than Codex.[7]

Application and data description

The MRL data used here are publicly available and come from the USDA FAS

[7] In an earlier version, we truncated the indices below at 1 by constraining MRLs to have a score of 1 if they are not protectionist, including anti-protectionist MRLs. Avoiding truncation allows for anti-protectionism and provides a better measure of the variation in scores within a given index, but allows to have protectionism and anti-protectionism offsetting each other within the index. The latter would be reflected in an index with a large variance.

International MRL database (http://www.mrldatabase.com/) made available on line in 2010. The database consists of pesticide MRLs and veterinary drug MRLs. Pesticide and veterinary drug MRLs are maintained in two separate databases and their data structures are different. We discuss the pesticide MRLs database first.

The pesticide MRLs database covers 341 products (Table 1), 19,486 (product by pesticide) pairs, and 83 countries (Table 2), and has 1,617,338 records. Among the 83 countries covered by the pesticide MRLs database, 29 countries completely comply with Codex standards; 18 countries comply with EU standards; 7 countries defer to exporting countries standards; 5 countries comply with Gulf Cooperation Council (GCC) standards; and Mexico adopted U.S. standards. Finally, 22 out of 83 countries set their own standards only or partially combined with Codex or EU standards.

This rich database has several shortcomings, however. First, there is some redundancy in the listed products. This is not a problem when we calculate product-level protectionism indices. However, when we aggregate over products to calculate country-level protectionism indices, this redundancy causes larger influence for the redundant products. The redundancy is a result of different names of products that different countries use. Specifically, there are two types of redundancies. One is exact redundancy: same product with alternative names but with similar MRL data. For example, “Beet”, “Beet, Garden”, and “Beet, Garden, Roots” are the same commodity. These product names are listed separately in the database but with the same MRL data. We manually detect and delete the redundant names.

The second type of redundancy occurs when some specific commodities belong to a general commodity group, and all commodities in the group are listed in the database.

Table 1: Product categories in the pesticide database

Category	Count
Grains & Oilseeds	14
Poultry & Eggs	6
Dairy	2
Horticultural & Tropical Products	313
Animal Products	15

For example, "Beans", "Bean Dry", "Broad Bean Dry", "Mung Bean", "kidney Bean", and "Lima Bean" are listed separately. But “Beans” include “Broad Beans”, “Mung Beans”, “Kidney Beans”, etc. Some countries specify their MRLs for specific kinds of beans (“Mung Mean”,” Pink Bean”, etc), but some other countries just specify MRL for "Beans" in general. This type of redundancy is more complicated, and harder to resolve. We keep the redundant products of this kind, in order to make the product list consistent and comparable across countries but with the caveat in mind.

A second issue is that the MRL database only lists chemicals that are available to U.S. farmers. This problem also applies to the veterinary drug database. A foreign MRL for a product or chemical is only included in the database if there is a U.S. MRL for that product or chemical. Hence, the foreign country could be regulating other residues but we do not know for which chemical and the corresponding MRLs. Luckily the U.S list is the most extensive so this limitation is not frequent.

The third problem with the database resides with non-established MRLs. This problem also applies to Veterinary Drug database. Usually, the default MRLs defined by countries may apply when no MRLs are established. But there are rare cases when chemicals are exempt or banned. Since the database only includes the chemicals that the United States has positively listed, it is unlikely that these chemicals are considered exempt by other countries. In addition, it is difficult to find lists of banned chemicals maintained by other countries. We have no further information to distinguish between the situations when a not-established MRL means default, exempt, banned, or just plain missing data. Because the

Table 2: Established Pesticide MRL Standards for All Countries

Category	**Number of countries**	**Country list**	**Additional notes**
Countries set their own standards	22	Argentina, Australia, Brazil, Canada, Chile, China, India, Indonesia, Israel, Japan, Korea, Russia, Singapore, Switzerland, South Africa, Taiwan, Thailand, Turkey, New Zealand, Vietnam, United Arab Emirates, Malaysia	Countries may set their standards and defer to codex if there is not set standards
Countries defer to Codex	29	Algeria, Angola, Barbados, Bermuda, Bahamas, Bangladesh, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, El Salvador, Guatemala, Hong Kong, Honduras, Jordan, Kenya, Lebanon, Morocco, Netherlands Antilles, Nicaragua, Pakistan, Panama, Peru, Philippines, Trinidad and Tobago, Tunisia, Venezuela	defer to codex completely
Countries defer to EU standards	18	Belgium, Denmark, Finland, French Pacific Islands, France, French West Indies, Germany, Greece, Ireland, Italy, Jamaica, Netherland, Norway, Poland, Portland, Spanish, Sweden, United Kingdom	
Countries defer to GCC standards	5	Bahrain, Kuwait, Saudi Arabia, Oman, Qatar	
Countries defer to exporting countries standards	7	Albania, Antigua and Barbuda, Cayman Island, Haiti, Nevis, Sri Lanka, St. Lucia	
Countries defer to US standards	2	United States, Mexico	

exempt and banned cases are rare, we substitute non-established MRLs with individual country's default MRLs (see table 3). Missing data remain a concern. The USDA database was considerably updated in 2012 after its initial (2010) release with many non-established data being eventually updated by actual MRLs. Presumably missing data have been greatly reduced.

Table 3: Default Values for Not-established Pesticide MRLs

Default values for non established Pesticide MRLs	**Countries**	**Number of Countries**
0 ppm	Australia, Taiwan	2
0.01ppm	European Union, Malaysia, South Africa[8], Japan, Argentina	5
0.1ppm	Canada	1
Codex	Chile, China, Gulf Cooperation Countries (GCC), Indonesia, India, South Korea, Singapore, Thailand, Brazil, Russia, New Zealand, United Arab Emirates	12
EU	Switzerland, Turkey[9]	2

The original veterinary drug database covers 7 product groups (hogs, chickens, turkeys, sheep, cattle, milk, and eggs), 19 countries and/regions and international standards (Codex) and contains 8,820 records. The non-established MRLs are substituted with default values (table 4). However, for Chile, China, Hong Kong, Indonesia, Malaysia, Thailand, and Vietnam, we did not find their default veterinary drug MRLs. So we deleted the non-established MRLs from these countries. Since Chile and Indonesia only have non-established veterinary drug MRLs shown in the database, all of their veterinary drug MRLs are deleted unfortunately.

Unlike the pesticide MRLs database, which is a balanced country by (product and pesticide) panel data set, the veterinary data are unbalanced. In the pesticide MRLs database, almost every country has the same products and pesticides associated with these products. In

[8] The veterinary drug default for South Africa is 0.05ppm
[9] We did not find the default MRL for Turkey, but assumed it to be EU MRLs.

contrast, for the veterinary drug database, products and the veterinary drugs associated are different for different countries. To combine pesticide MRLs with veterinary drug MRLs, we matched the products based on the pesticide database. Due to the incompleteness of the second dataset, at the commodity level, veterinary drugs are included for some countries but not for other countries.

Table 4: Default Values for Non-established Veterinary Drug MRLs

Default Values for Non-established Veterinary Drug MRLs	**Countries**
0.01ppm	Japan
0 ppm	Australia, Canada, European Union, United States, Taiwan
Codex	Colombia, Dominican Republic, Egypt, Guatemala, Honduras, Peru, Philippines, Venezuela,
Unknown	Chile, China, Hong Kong, Indonesia, Malaysia, Thailand, Vietnam

The products covered by the MRL databases are manually mapped into 6-digit or 4-digit Harmonized System classification (HS) (Appendix A). The mapping between the products listed in the MRL database and HS is not bijective. Correspondences exist both ways. One product could be mapped into multiple 6-digit HS code, and one 6-digit HS code could be mapped with more than one product in the MRL database, given that some products are very specific and others are broadly defined. Given the HS 6 or HS 4 digits codes, we compile the trade data from the United Nations Comtrade database. Trade weights, which are used in calculating trade weighted indices, are the average of trade values for all products falling under the same HS 6-digit (or 4-digit) category if more than one product are mapped to one HS 6-digit (or 4 digit) category. If one product is mapped to multiple HS 6-digit (or 4-digit) categories, we sum up trade values of the mapped HS categories.

We use the Codex MRL standards as the non-protectionism science-based reference levels. Codex is established using scientific expert advice and established science, and aims to protect consumer health and the environment. Codex MRL standards are set by the Codex Alimentarius Commission (CAC), which is a joint Food and Agriculture Organization (FAO) and World Health Organization (WHO) commission. Some Codex standard may not be established, and the reasons for that may be hard to determine. CAC may decide not to establish the MRL, or decide the chemical should not be allowed, or that the chemicals are not harmful, or it might be that the standard setting process is still undergoing. Codex MRLs are established through a multi-year process by the Codex Commission on Pesticide Residue (CCPR). Member countries nominate MRLs they wish to establish. It takes an average of two to four years for Codex to complete a standard (Roberts and Josling (2010)). However, Codex maintains a rather extensive list of chemical MRLs, and more than half of the countries in our dataset completely or partially defer to Codex standards.

Therefore, to avoid ambiguity in our investigation, we focus on the subset of products and chemicals for which Codex MRLs are established. For countries that have non-established standards for certain chemicals, we substitute their default values based on that individual country's default MRLs (see Table 3 and Table 4). In addition, since the GCC standards are not available in the database, we remove the 5 GCC countries from our sample.

The final combined MRL dataset for calculation in this paper consists of 273 products, 77 countries, and includes 411,304 records. Note that the chemicals applied to each product may differ, and the set (product x chemicals) associated with different countries may vary due to the unbalanced veterinary drug data we mentioned above. In addition, we added EU-27 as a group, in addition to the individual EU countries. So, in total we have 77 countries

(83 countries (all countries in the original MRL database), minus 5 excluded GCC countries, minus 2 data unavailable countries (Switzerland and Norway), plus one aggregate EU-27 as a group).

Results

We calculated 21,021 country-by-product level protectionism scores[10] with non-established MRLs substituted with default levels (method 1) and 18,758 country-by-product level protectionism scores with non-established MRLs deleted (method 2). For each method, we then aggregated country-by-product scores to country level and product level with trade weights, and then equal weights. We have 50 trade-weighted country level indices and 77 equally-weighted country level indices (Appendix B). Note that the difference in number of countries is due to the availability of COMTRADE trade data of year 2009 (in 2011). In addition, EU countries have the same EU standards and similar trade structures, so, instead of individual EU countries, we report for the aggregate EU-27. Mexico complies with U.S. standard, yet it has a slightly different protectionism score, which is caused by its own import structure leading to different weights in the indices' aggregation.

Table 5 presents the protectionism scores by country. The first two columns are un-weighted scores with method 1 and method 2 respectively, the next two columns are the trade-weighted protectionism scores, and third set of two columns shows the normalized trade-weighted scores, which are the trade-weighted scores normalized by the openness. For simplicity of discussion, we refer the (un)weighted protectionism scores calculated with method 1 and method 2 as (un)weighted score 1 and (un)weighted score 2. The last column is the sum of non-established MRLs count by country. 12 countries have non-zero count of

[10]Detailed results are available upon request.

non-established MRLs. The number of non-established MRLs range from 4883 (China) to 856 (EU).

The openness is measured by the ratio of total agricultural imports over GDP of the country. The normalized score is intended to correct the potential upward biasness in scores for countries with stricter MRL standards and large imports. The latter does not have an upper bound. Caution should be used in interpreting the normalized protectionism indices. Adjusting for openness reduces the influence of trade-weights used in aggregating over products. The indices, by design, put heavier weights on the products with higher imports, which indicate the importance of the related products. Whether protectionism scores for large importers should be adjusted downwards is an open question. The MRLs could also be endogenous and may have appeared after an import surge (Trefler (1993)). We believe that different measures presented in table 5 offer complementary insights into the protectionist question. On the one hand, one could argue these large importers are not protecting their domestic industries –trade is sizeable-- even though their standards exceed international norms. Instead, the stringency could be intended to protect their consumers with higher health standards. The political analysis of Kono (2006) states that politician in more democratic societies tend to be more sensitive to public safety, health and environment. Producers and consumers may demand higher standards.

On the other hand, higher imports may indicate higher demand, but strict MRLs pose a hurdle for other countries with laxer MRL standards. Therefore, their imports come from both countries with equal or stricter MRLs or other non-protectionist countries that incurred extra cost to meet stricter standards. For those lower-standard countries, where MRLs are based on internationally accepted standards or even lower, the strict MRLs of large importers could represent protectionism.

Table 5: Country-level Protectionism Scores[11]

country	Equally-weighted Protectionism Score		Trade-Weighted Protectionism Score		Normalized Weighted Protectionism Score*		Count non-established MRLs
	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2	
Australia	1.95 (0.58)	1.19 (0.43)	1.66 (0.55)	1.20 (0.39)	572.81	414.53	2219
Japan	1.71 (0.76)	0.93 (0.26)	1.57 (0.71)	1.11 (0.29)	291.92	206.52	1580
Jamaica	1.51 (0.58)	1.27 (0.39)	1.22 (0.41)	1.12 (0.27)	41.31	37.94	856
European Union	1.51 (0.57)	1.27 (0.38)	1.23 (0.59)	1.09 (0.41)	337.20	298.63	856
Turkey	1.50 (0.58)	1.30 (0.57)	1.26 (0.47)	1.75 (0.70)	187.36	259.25	4499
Canada	1.46 (0.50)	1.20 (0.43)	1.29 (0.44)	1.09 (0.36)	157.72	132.52	2751
Israel	1.06 (0.20)	1.06 (0.20)	1.06 (0.08)	1.06 (0.08)	118.07	118.07	0
Brazil	1.04 (0.11)	1.29 (0.48)	1.10 (0.12)	1.25 (0.22)	470.54	534.87	4342
Chile	1.03 (0.15)	1.01 (0.32)	1.04 (0.10)	1.05 (0.14)	101.77	103.37	2684
Argentina	1.03 (0.09)	1.03 (0.09)	1.04 (0.07)	1.04 (0.07)	374.36	374.36	0
Russian Federation	1.03 (0.10)	1.55 (0.75)	1.07 (0.14)	1.83 (0.79)	76.90	130.97	4744
Rep. of Korea	1.01 (0.16)	0.98 (0.46)	1.00 (0.11)	0.99 (0.21)	99.93	98.82	3867

[11]Countries not listed have protectionism scores equal to one. All figures are rounded to the second digit after the decimal point.

Table 5: Country-level Protectionism Scores[12] continued

country	Equally-weighted Protectionism Score		Trade-Weighted Protectionism Score		Normalized Weighted Protectionism Score*		Count non-established MRLs
	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2	
China	1.01 (0.05)	1.04 (0.40)	1.03 (0.10)	1.17 (0.37)	145.56	165.04	4883
Malaysia	0.99 (0.04)	0.99 (0.04)	0.99 (0.04)	0.99 (0.04)	37.25	37.25	0
United Arab Emirates	0.99 (0.03)	0.99 (0.03)	0.99 (0.03)	0.99 (0.03)	31.25	31.25	0
United States	0.98 (0.36)	0.98 (0.36)	0.89 (0.35)	0.89 (0.35)	356.85	356.85	0
Mexico	0.98 (0.35)	0.98 (0.35)	0.97 (0.26)	0.97 (0.26)	72.93	72.93	0
India	0.97 (0.14)	0.96 (0.18)	1.03 (0.09)	1.05 (0.13)	163.84	166.77	1859
New Zealand	0.97 (0.07)	0.97 (0.07)	0.97 (0.04)	0.97 (0.04)	137.79	137.79	0
Singapore	0.96 (0.13)	0.96 (0.13)	0.98 (0.11)	0.98 (0.11)	55.15	55.15	0
South Africa	0.87 (0.15)	0.87 (0.15)	0.82 (0.11)	0.82 (0.11)	113.40	113.40	0
Sri Lanka	0.53 (0.20)	0.55 (0.20)	0.43 (0.15)	0.47 (0.16)	19.92	22.02	0[13]

*Note: Normalized Weighted Protectionism Score=Weighted Protectionism Score / (Ag Import/GDP), where Ag Import is the import value of agricultural sectors HS02, HS04, HS06, HS07, HS08, HS09, HS10, HS12, and HS15 that we covered in this paper (see table 6 below for sector descriptions). Trade data come from COMTRADE, GDP data come from World Bank, and these data are of the year 2009.
**Note: Numbers within parentheses are standard deviations of the (country×product) level protectionism scores.

[12] Countries not listed have protectionism scores equal to one. All figures are rounded to the second digit after the decimal point.

[13] Sri Lanka complies with exporter's MRLs. We substitute the maximum MRLs of matching country×product×substance as Sri Lanka MRLs. The maximum could change as the datasets of method 1 and method 2 differ, so we observe slight difference between score1 and score2 given Sri Lanka has no non-established MRLs.

The variation of scores for a given country comes from two sources: the difference between method 1 and method 2; and the weights and normalization method. The difference between scores 1 and 2 (under similar weights) depends on the number of non-established MRLs and differences between the default MRL level and the other established MRLs for that country. A much larger score 1 than score 2 indicates a default MRL being relatively stricter than established MRLs and indicates that protectionism in that country is caused by a protectionist default rather than by a concerted effort to be stringent on a particular MRL. The data could also have some missing MRLs, which are confounded with non-established MRLs. We keep this caveat in mind when drawing implications about discrepancies between scores 1 and 2.

We also note some differences between trade-weighted and equally-weighted scores for a given country; the trade-weighted score could be higher or lower than or close to the equally-weighted score. Self-evidently, if a country has higher trade-weighted scores relative to equally-weighted scores, products with strict MRLs are heavily imported. Conversely, if a country has lower trade-weighted scores than equally-weighted scores, products with less stringent MRLs are heavily imported.

Australia, Japan, the EU, Jamaica, Turkey, and Canada rank among protectionist MRL regimes based on score1 both weighted and unweighted. Australia and Japan have substantial difference between score 1 and score 2, because of their large number of non-established MRLs and their tight default levels (0 ppm for Australia, and 0.01 ppm for Japan) leading to their score 1 being larger than their score 2. Much of the protectionism in MRLs in these two countries arises from the tight default. Australia also exhibits some protection in established MRLs. Again here the caveat applies on potentially missing data and the implied upward bias in score 1. The EU, Canada, and Jamaica have similar but more moderate patterns given their tight default (0.01 ppm) but smaller number of non-established MRLs.

Chile, Korea, and India, despite their large number of non-established MRLs, have close score 1 and score 2. The default MRL level of these countries (Codex) is similar to their established MRLs. Since score 1 and score 2 are close, we feel confident to conclude that these countries do not exhibit MRL protectionism. The United States is not protectionist based on any of the unweighted/weighted scores 1 and scores 2, and even shows evidence of slight "anti-protectionism" (below Codex) based on trade-weighted scores. South Africa and Sri Lanka have score 1 and score 2 well below one, indicating they might be under protecting their consumers. Singapore and New Zealand show scores very close to but slightly under 1.

Also notable, the Russian Federation and Brazil have higher protectionist scores 2 than scores 1, suggesting that their established MRLs is chiefly responsible for their MRL protectionism. Their low default and large number of non-established MRLs make them appear moderately protectionist and mitigates the protectionism of establish MRLs. Turkey illustrates the importance of weights. With trade weights, it appears that protectionism arises more from established MRLs, whereas with unweighted scores, Turkey's protectionism seems to come from both established and default MRLs. For the EU and the US, trade-weighted scores are lower than equally-weighted scores, indicating that some heavily imported products face less stringent standards. For some other countries, we observe trade-weighted scores higher than unweighted scores for one of or both score 1 and score 2. Stringent MRLs exceeding international norms affect heavily traded products, possibly as a reaction to import surges.

If we normalize the protectionism score by openness, Brazil, Argentina, Australia, the

EU and the US come to the top. For Australia and the EU, this normalization does not alter the notion that they exhibit MRL protectionism, but for Jamaica, the normalized scores are very low and mitigating the conclusion that this country shows some MRL protectionism. Finally, NAFTA integration on residue standards has been much deeper between Mexico and the United States, relative to what Canada has done with its own standards, a surprising finding. Unlike for tariffs, MRL regulations have not been harmonized across the three NAFTA members.

Each score comes with an estimated standard deviation, reflecting the variation of product scores for each country. For trade-weighted scores' standard deviations, products with smaller import shares count for less and vise-versa. Generally, notable differences between scores 1 and 2 for any country, extend to their standard deviations. A significantly higher score (either 1 or 2) for a country tends to show higher standard deviation for the corresponding score. Hence, we do not see evidence of countries being non-protectionist "on average" by offsetting protectionist MRLs with anti-protectionist ones. In most cases, standard deviations are small relative to scores suggesting the scores and indices are informative. We turn to product scores next. We average them over all countries and regulated substances by product (detailed scores presented in Appendix A).

The averaging over all countries leads to smaller variations. The maximum of equally-weighted scores 1 is 1.28 (Green onion) and minimum is 0.75 (Guava). The maximum of equally-weighted score 2 is 1.21 (Belgian endive) and minimum is 0.74 (Guava). Adding trade weights expands the variation of the scores. The maximum of trade-weighted score 1 is 2.47 (Belgian endive) and minimum is 0.42 (Guava); the maximum of trade-weighted scores 2 is 2.10 (Belgian endive) and minimum is 0.19 (Plantain).

Figure1: Boxplot of Weighted Protectionsim Scores by HS 2-digit Sectors

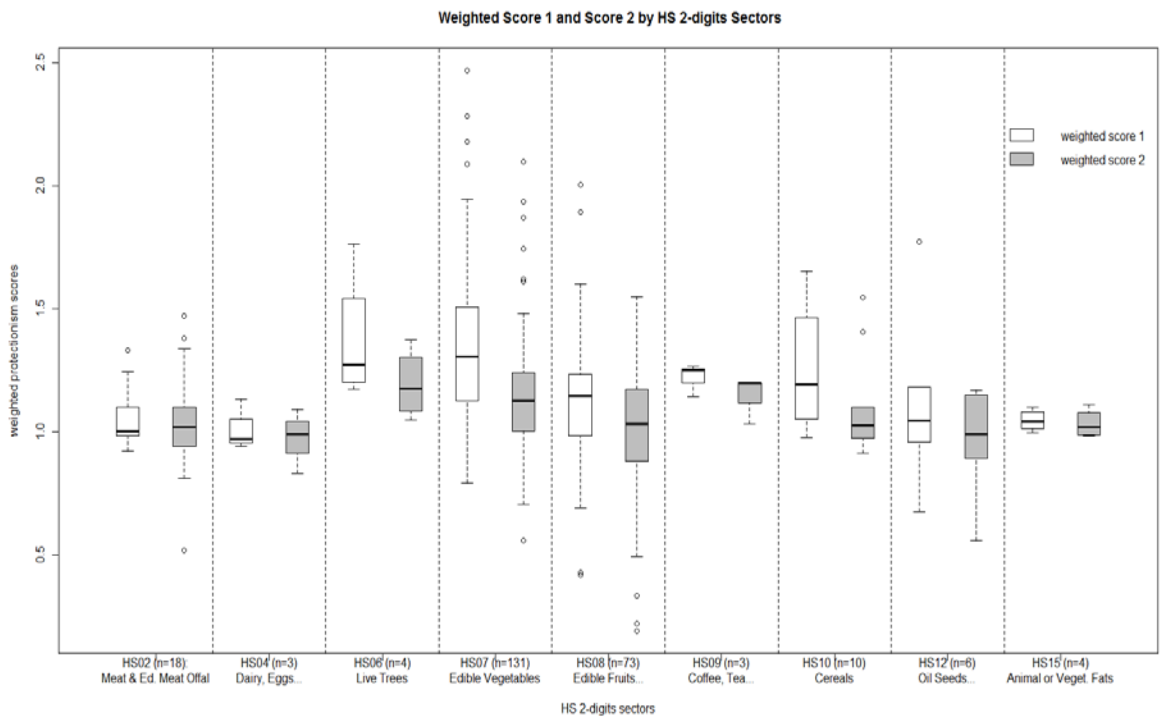
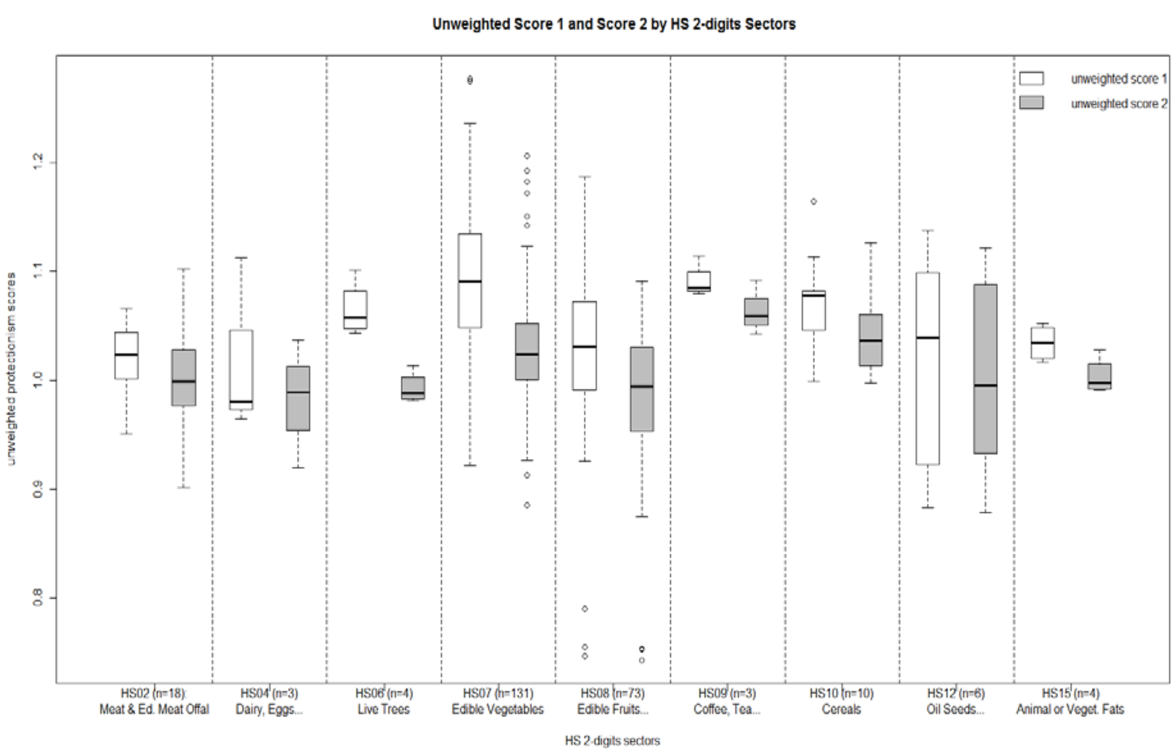


Figure2: Boxplot of Unweighted Protectionsim Scores by HS 2-digit Sectors



To better elucidate the product-level protectionism, we look at score distribution plots by grouping products by HS2 digit sectors, and then select a few commonly-discussed products to investigate their MRL protectionism. Table 6 shows HS2 digit sectors, associated products that fall into each sector, the number of products in each sector, and the number of non-established MRLs for the product. The boxplots of weighted protectionism scores and unweighted scores for each sector are presented in figures 1 and 2. Score 1 shows a wider dispersion and higher mean than score 2 for fruit and vegetables. This observation shows that substituting non-established MRLs with default levels risks inflating these products' protectionism scores. Animal products (HS02 and HS15) seem have little discrepancy between score 1 and score 2. Meat, diary, and egg products have the lowest average, and mostly span in the lower protectionism region.

Disdier and van Tongeren (2010) clustered products based on three criteria: the number of notified NTMs, the number of SPS trade concerns officially communicated to the WTO, and the share of imports affected by notified NTMs. They show that meat products and many dairy products fall in the clusters with high NTM trade coverage, high number of notifications, and high/very high number of concerns. However, they did not explicitly measure the strictness of individual policies. Their stylized facts together with our results on product-level protectionism suggest that meat and dairy products are subjected to a high number of NTM notifications but which are relatively less stringent.

Table 6: Products categorized in HS 2-digit sectors

HS 2-digit sector descriptions	**Number of products**	**Count of non-established MRLs**	**Details of products**
02: MEAT & EDIBLE MEAT OFFAL	18	11,505	cattle by-products, cattle meat, cattle liver, etc.
04: DAIRY, EGGS, HONEY, & ED. PRODUCTS	3	1,879	egg, milk, milk fat
06: LIVE TREES & OTHER PLANTS	4	355	chicory roots, chufa, dasheen corm, canna edible
07: EDIBLE VEGETABLES	131	20,229	bean, cabbage, pea, spinach, turnip, tomato, etc.
08: ED. FRUITS & NUTS, PEEL OF CITRUS/MELONS	73	17,899	apple, almond, banana, cherry, lemon, strawberry, etc
09: COFFEE, TEA, MATE & SPICES	3	290	ginger, pepper, savory summer
10: CEREALS	10	1,450	barley grain, corn grain, rice grain, etc.
12: OIL SEEDS/MISC. GRAINS/MED.PLANTS/STRAW	6	1,575	cotton seed, hop dried cones, mustard seed, peanut, sesame seed, sugar beet
15: ANIMAL OR VEGET. FATS, OILS & WAXES	4[14]	192	cattle fat, hog fat, poultry fat, sheep fat

These heavily regulated sectors may not be heavily protected, but rather may involve more health and food safety concerns. Disdier and van Tongeren (2010) also found that vegetable products are spread over several clusters with high or low number of notifications. We observe a similar variation in protectionism scores for vegetable products; their protectionism scores have the widest span. The protectionism span is related to the large number of the products in this sector. Fruit product protectionism scores are also found to exhibit large variations. Disdier and van Tongeren (2010) suggest fruit products overall have

[14] Cattle fat and hog fat fall into both HS15 and HS02.

a high number of notifications and high number of concerns. This again indicates the complexity of gauging protectionism. Frequency of notifications and concerns are not sufficient to establish protectionism; the actual stringency of the standards should also be taken into consideration.

Table 7: Top Contributors of Protectionism Scores for Selected Products

product	Score type and level		top 5 contributing countries	total contribution	Subs. Count	non-established MRLs count
Apple	weighted score 1	1.11	EU (32%), Russia (20%), Canada (5%), Mexico (5%), US (5%)	67%	64	580
	weighted score 2	1.17	EU (30%), Russia (26%), Mexico (5%), US (5%), Canada (4%)	70%		
	unweighted score 1	1.02	Australia (3%), Turkey (3%), Argentina (3%), Brazil (3%), Israel (3%)	15%		
	unweighted score 2	1.03	Turkey (4%), Russia (3%), Brazil (3%), Argentina (3%), Israel (3%)	16%		
Banana	weighted score 1	0.88	EU (46%), US (19%), Japan (10%), Russia (8%), Canada (6%)	89%	21	121
	weighted score 2	0.85	EU (48%), US (20%), Japan (11%), Canada (6%), Russia (4%)	89%		
	unweighted score 1	0.96	Canada (3%), Israel (3%), Brazil (3%), Singapore (2%), Argentina (2%)	13%		
	Unweighted score 2	0.95	Canada (3%), Brazil (3%), Israel (3%), Singapore (3%), Argentina (3%)	15%		
Cattle, meat	weighted score 1	1.17	US (17%), Japan (15%), Russia (14%), EU (14%), Mexico (7%)	67%	90	1152
	weighted score 2	1.38	Russia (27%), US (14%), Japan (13%), EU (11%), Mexico (6%)	71%		
	unweighted score 1	1.05	Australia (3%), Jamaica (3%), EU (3%), Mexico (3%), Japan (3%)	15%		
	Unweighted score 2	1.08	Russia (5%), Jamaica (3%), EU (3%), Mexico (3%), Australia (3%)	17%		

Table 7: Top Contributors of Protectionism Scores for Selected Products Continued

product	Score type and level		top 5 contributing countries	total contribution	Subs. Count	non-established MRLs count
Corn, grain	weighted score 1	0.98	EU (21%), Malaysia (19%), US (18%), Canada (7%), Russia (5%)	70%	42	243
	weighted score 2	0.97	Malaysia (20%), EU (20%), US (18%), Canada (7%), Russia (5%)	70%		
	unweighted score 1	1	Australia (3%), Israel (2%), China (2%), India (2%), Turkey (2%)	11%		
	Unweighted score 2	1	China (3%), Turkey (3%), Indonesia (2%), Israel (2%), India (2%)	12%		
Hog, meat	weighted score 1	1.24	Japan (43%), Russia (16%), Mexico (8%), US (8%), Korea (5%)	80%	62	403
	weighted score 2	1.47	Japan (35%), Russia (30%), Mexico (7%), US (6%), Korea (4%)	82%		
	unweighted score1	1.07	Jamaica (3%), EU (3%), Mexico (3%), Australia (3%), Japan (3%)	15%		
	Unweighted score 2	1.09	Russia (6%), Jamaica (4%), Mexico (4%), EU (4%), Canada (3%)	21%		
Grapefruit	weighted score 1	1.27	EU (63%), Japan (19%), Russia (9%), Canada (6%), Hong Kong (1%)	98%	43	241
	weighted score 2	1.32	EU (60%), Japan (16%), Russia (16%), Canada (4%), Hong Kong (1%)	97%		
	unweighted score 1	1.06	Australia (4%), Turkey (4%), EU (4%), Canada (4%), Argentina (3%)	19%		
	Unweighted score 2	1.08	Russia (6%), Turkey (5%), EU (4%), Brazil (3%), Argentina (3%)	21%		

Table 7: Top Contributors of Protectionism Scores for Selected Products Continued

product	Score type and level		top 5 contributing countries	total contribution	Subs. Count	non-established MRLs count
Poultry, meat	weighted score 1	0.98	Hong Kong (17%), Russia (16%), China (13%), Japan (13%), Mexico (9%)	68%	45	281
	weighted score 2	1.04	Russia (21%), Hong Kong (16%), China (12%), Japan (12%), Mexico (8%)	69%		
	unweighted score 1	0.97	Russia (2%), Japan (2%), EU (2%), Chile (2%), Singapore (2%)	10%		
	Unweighted score 2	0.98	Russia (3%), Japan (2%), Chile (2%), Singapore (2%), Thailand (2%)	11%		
Sheep, meat	weighted score 1	1.33	EU (53%), US (17%), United Arab Emirates (6%), Japan (4%), Canada (4%)	84%	66	487
	weighted score 2	1.34	EU (50%), US (17%), United Arab Emirates (6%), Canada (5%), China (5%)	83%		
	unweighted score 1	1.06	Jamaica (3%), Australia (3%), EU (3%), Japan (3%), Mexico (3%)	15%		
	Unweighted score 2	1.1	Russia (6%), Canada (4%), Jamaica (3%), Australia (3%), EU (3%)	19%		
Wheat, grain	weighted score 1	1.05	EU (10%), Algeria (9%), Egypt (8%), Japan (7%), Indonesia (7%)	41%	38	200
	weighted score 2	1.1	Turkey (9%), EU (9%), Algeria (9%), Egypt (7%), Indonesia (7%)	41%		
	unweighted score1	1.05	Australia (3%), Canada (3%), Turkey (3%), India (3%), China (3%)	15%		
	Unweighted score2	1.07	Turkey (5%), China (3%), Australia (3%), India (3%), Russia (3%)	17%		

The differences between trade-weighted and equally-weighted scores are quite obvious for product-level scores. Most of the large trade-weighted scores are higher than their equally-weighted scores counterparts, and conversely for low-level scores. A trade-weighted score being higher than its unweighted counterpart means that larger importers tend to have stricter MRLs for that product; and vise versa. To see this clearly, we list the top country contributors to the scores of selected products in table 7.

The top contributors to unweighted scores are countries that have the tightest MRLs for the corresponding product. Trade weights temper or exacerbate these with import shares. Countries, that contribute large percentage to weighted scores, have large import share and/or large unweighted scores contribution. Top contributors to weighted scores are generally consistent from score 1 to score 2. In contrast, Australia and Japan, probably due to their tight default values and the discrepancy between default with the rest of their MRLs, sometimes appear to be the top contributors of unweighted score 1 but not for unweighted score 2 (i.e., apple, corn grain, grapefruit). On the other hand, The Russian Federation, sometimes is the top contributor for unweighted score 2, but not for unweighted score1 (i.e., cattle meat, hog meat, grapefruit). This is probably due the discrepancy between its relatively “low” default value (Codex) and its tight established MRLs.

A weighted score is larger than its unweighted counterpart when countries with stricter MRLs are large or dominant importers (i.e., sheep meat, hog meat, grapefruit, etc.). A weighted score is close to or smaller than its unweighted counterpart, when there are no dominant importers or when countries with less stringent MRLs are large importers (i.e., banana, poultry meat, wheat, etc.).

Further, for selected meat products (cattle, hog, sheep, and poultry meat), score 2 is always higher than score 1. Unweighted score1 and score 2 are similar and close to one (slightly above or below 1). Accounting for the trade weights, we observe some obvious increase from score 1 to score 2 in weighted scores. Cattle, hog, and sheep meat have larger weighted score well above 1 (1.17, 1.24, 1.33 for score 1, and 1.38, 1.47, 1.34 for score 2), and poultry meat has trade-weighted score close to 1 (0. 98 for score 1 and 1.04 for score 2). It shows that cattle, hog, sheep meat are more protected than poultry meat product overall. In addition, we observe relatively large increase from weighted score 1 to weighted score 2 for cattle meat and hog meat. Russia is playing an important role in driving this discrepancy for cattle and hog with its high established MRLs for cattle and pork products which are much tighter than its default. Russia is also a large importer of cattle and hog products, which induces large differences for trade-weighted scores.

A look at the top contributors in scores is interesting. For example, the dominant top contributor to weighted score 1 for sheep meat is the EU (43%), and the EU sheep meat MRLs are among the tightest (one of the top contributors to unweighted scores). Therefore, we see a big increase form unweighted scores to weighted scores. Australia, on the other hand, does not import much sheep meat while keeping tight MRLs. Australia is a large exporter, so it set its MRLs to meet high EU standards. The economic and rent-seeking determinants of protectionism scores will be investigated in a subsequent investigation.

Looking at selected fruit products, the weighted scores for apple are 1.11 and 1.17 for score 1 and score 2 respectively, larger than that of unweighted scores. Banana has weighted scores smaller than unweighted scores, and weighted scores are well below 1 (0.88 and 0.85 for score 1 and score 2 respectively). The dominant contributor, the EU (46%), has lax MRLs and a score of 0.9 for banana.[15] The EU imports a lot of banana, and clearly exhibits MRL anti-protectionism for banana. This explains why we observe the weighted scores of banana

[15] Countries by product protectionism score results are available upon request.

being even smaller than the unweighted scores. Grapefruit weighted scores are 1.27 and 1.32 for score 1 and score 2. The EU is the dominant importer and has tight grapefruit MRLs, hence the EU is the top contributor to weighted scores (63%). Among these three fruit products, grapefruit is more protected than apple, and banana is "under" protected.

Regarding grains, corn scores are around 1. The top contributors EU (21%), Malaysia (19%), and US (18%) have lax MRLs, and hence corn is a non-protected product overall. Weighted scores for oats are also around 1. The dominant contributor to weighted score, the US (72%), has lax oat grain MRLs (0.94 and 0.88 for score 1 and score 2), which drives the overall weighted scores below 1. Weighted and unweighted scores for wheat are slightly above 1. This is because there are no dominant importers of wheat and specific influences are diffused.

Robustness check

We evaluate the robustness of our scores with a focus on the weights used in the scores (between trade weighted scores and unweighted scores), and also on data limitations and their potential impact on the stability of the protectionism scores. Since we have several products with small substance counts, we find it imperative to check the robustness of the product-level protectionism scores as well as country-level protectionism scores relative to the variation in substance count per product score.

In the dataset, the number of substances for each product ranges from 1 to 98, and we conjecture that this number is likely to be positively related with the "true" number of substances regulated for this product. One of the possible explanations for the variations could be that some products may raise more health concerns than others. The other potential reason, mentioned before, is that the list is determined by the U.S. list of substances. We have 13% of the products (34 out of 252) with less or equal to 5 substances (Appendix C). The protectionism scores for products with fewer substances may still be valid, but we certainly have more confidence in the scores calculated with more substances. In order to systematically check the robustness, bias, variance as well as identify outliers in the product protectionism scores, we look at box plots of scores grouped by substance count, Quantile-Quantile plots (QQ-plots) with small counts against the rest, and compute some statistical tests, when applicable.

Figure 3 shows the histograms of combinations of weighted and unweighted score 1 and score 2. The variation shows the patterns for weighted-unweighted, and score 1- score 2. Trade weight creates more dispersion and higher scores. Figures 4 and 5 show the boxplots of weighted and unweighted protectionism scores grouped by the number of substances. For both weighted and unweighted, products with fewer substances (say substance count <20) tend to have higher score 1 and a wider dispersion than products with more substances (say substance count >20). But no obvious difference is found for products with different substance counts for scores 2, both weighted and unweighted.

Figure 3: Histograms of Protectionism Scores

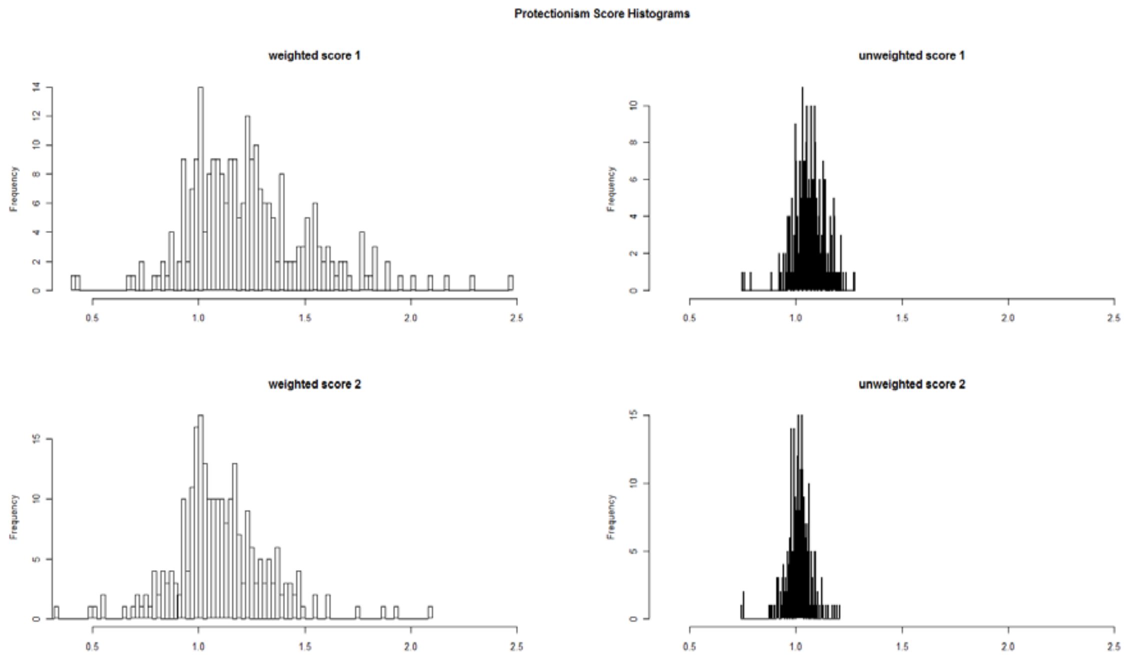


Figure 4: Boxplots of Weighted Scores by Groups of Substance Count

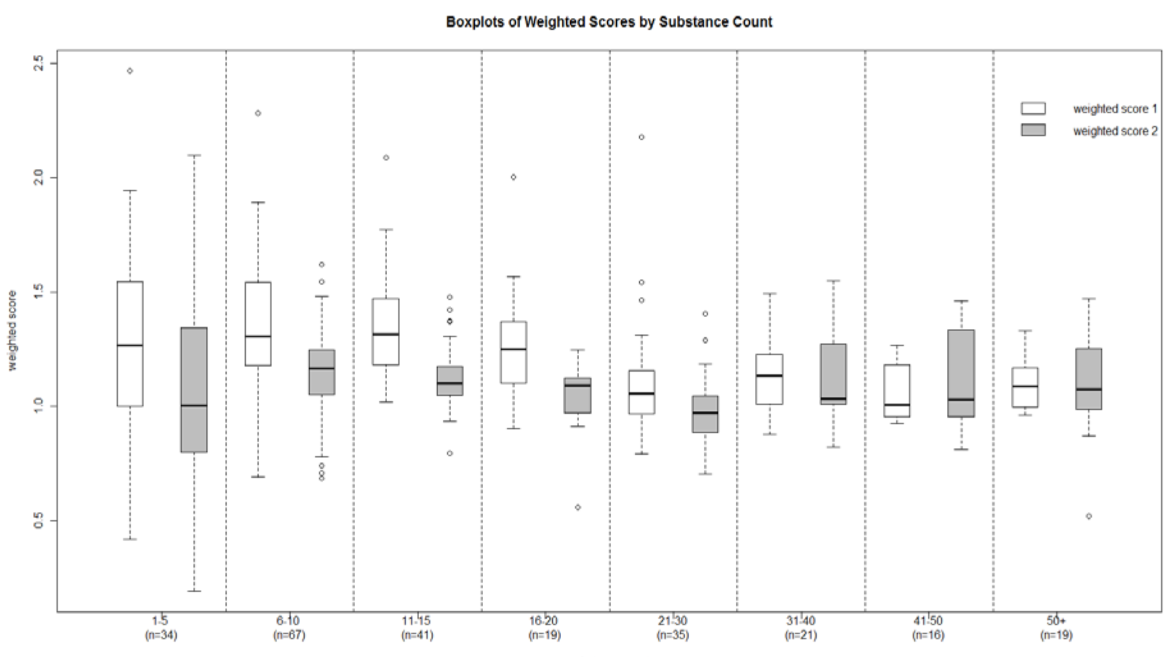
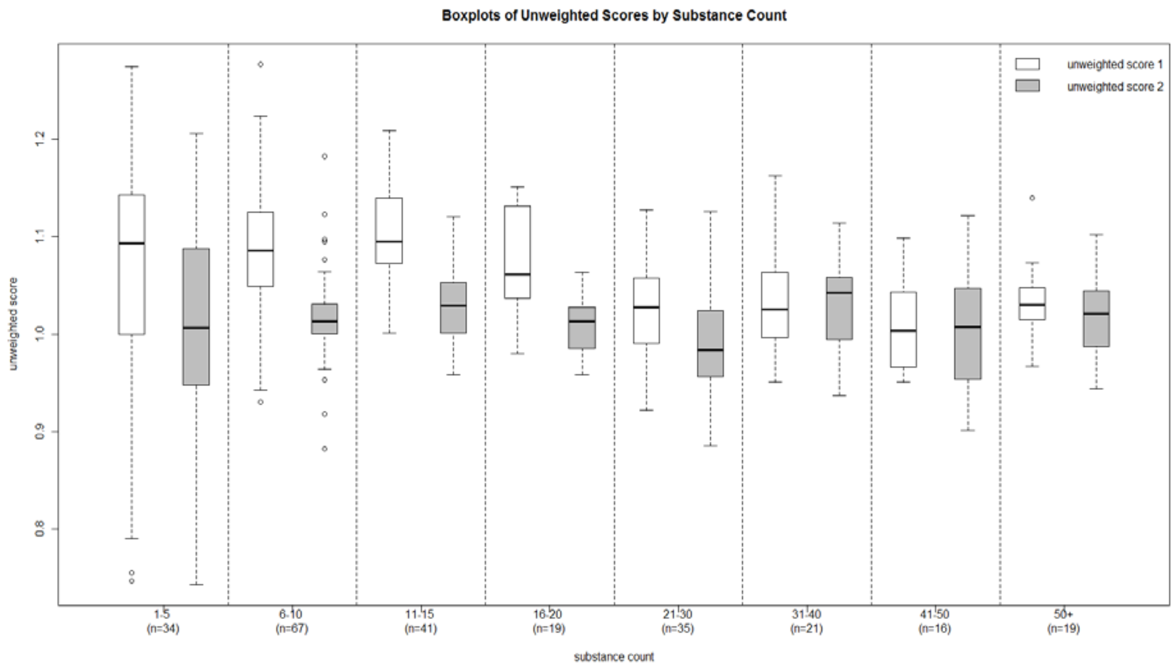


Figure 5: Boxplots of Unweighted Scores by Groups of Substance Count



QQ plots of product scores (available upon request) are sorted out using cut off numbers of substances. The difference between weighted and unweighted scores is not obvious, but we observe systematic difference between score 1 and score 2. Score 1 of products with smaller substance count show more variation (fatter left tail) in the lower side and similar variation but higher scores on the upper side, comparing to the same score 1 of products with larger substance count. Scores 2 for products with smaller substance count show more variation (fatter tails) in both lower and upper tails than products with larger substance count. This is consistent with the box plots. Scores with substance count of less or equal to 4 do not line up close to the 45-degree line but show a much steeper pattern.

In addition to the plots, we conduct non-parametric Cochran tests for the variability and differences among product scores groups. We group products by substance count, i.e., substance count equals 1-4, 5-9, 9-10, etc., and try to make each group of similar size of about 30 products. The test suggests that the product group with less or equal to 4 substances have “outlying variance” for all combinations of weighted/unweighted/score1/score 2, which means that the scores of products with no more than 4 substances exhibit more variability than the rest. However, there is a caveat to the test, which is that it maintains normality, which is rejected for unweighted scores and for some groups of weighted scores.

We also check the robustness of country-level scores. We compare the country protectionism scores by gradually deleting products with up to 5 substances, and recalculate them. We see only negligible variations in the scores and country ranking, which strongly suggests that country level scores are robust to the presence of products scores established based on fewer substances (results are available upon request).

Conclusions

We proposed aggregation indices of NTMs to quantify the protectionism of Maximum Residue Limit (MRL) regulations at various level using a science-based criteria embodied in international standards such as Codex Alimentarius. We applied the aggregators to a large international dataset on pesticide and veterinary drug MRLs and associated CODEX MRL standards. We calculated both trade-weighted and equally-weighted scores, since they offer complementary information. Looking at country scores, trade weights do not appear to be pivotal. However, we found trade weights induce more dispersion of product scores. Considering or not non-established MRLs is quite important in establishing a country’s MRL protectionism. The latter can arise from strict established MRLs or from strict default MRLs, or both.

Country-level results show that Australia ranks the most protectionist from all three indices: weighted, normalized weighted and equally weighted, using score 1 because of its tight default value. The Russian Federation ranks the most protectionist from scores based on established MRLs (no default). Other countries ranked differently to various extents based on the different weights used. However, the set of most protectionist countries is remarkably stable over the change of weights in indices. We also found that NAFTA integration on residue standards has been much deeper between Mexico and the United States, than with Canada.

Product level protectionism scores are shown by sector-wise distribution first. Meat and dairy products (HS02, HS04, HS15) have lower protectionism scores in general than other goods. Fruit and vegetable products (HS07, HS08) exhibit the most within-sector variation in protectionism. Breaking down scores by top contributors, we found that products like beans, apple, cattle meat, etc. are controlled by a few dominant importers who set stricter MRLs than other small importers. We checked the robustness of scores to address concerns for products with fewer substances used in their scores. Products with fewer substances seemed consistently biased upward (higher protectionism scores). Some evidence suggest that products scores based on no more than 3 substances have higher variance or noise. As a positive note, country level scores are robust to the deletion of products with fewer substances and provide solid policy implications.

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Appendix A: Product level weighted and unweighted protectionism scores and standard deviations

product	Unwtd. score1	Unwtd . std1	Unwtd . score2	Unwd . std2	Wtd. score 1	Wtd . std1	Wtd. score 2	Wtd. std2	Subs . Cnt.	HS 2	HS6
Almond	0.96	0.18	0.94	0.14	0.93	0.09	0.93	0.12	48	8	080211, 080212
Amaranth, Leafy	1.09	0.32	1.02	0.15	1.36	0.62	1.16	0.33	10	7	070990
Apple	1.02	0.17	1.03	0.23	1.11	0.19	1.17	0.33	64	8	080810, 081330
Apricot	1.04	0.18	1.05	0.24	1.23	0.33	1.55	0.71	33	8	080910, 081310
Arracacha	1.12	0.39	1.02	0.19	1.54	0.60	1.28	0.35	8	7	071490
Arrowroot	1.06	0.28	1.03	0.21	1.38	0.52	1.23	0.32	8	7	071490
Artichoke	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	3	7	070910
Artichoke, Chinese	1.12	0.39	1.02	0.19	1.54	0.60	1.28	0.35	8	7	071490
Artichoke, Jerusalem	1.06	0.28	1.03	0.21	1.38	0.52	1.23	0.32	8	7	071490
Arugula	1.07	0.31	1.01	0.11	1.27	0.58	1.07	0.20	10	7	070990
Asparagus	1.00	0.27	0.98	0.36	0.85	0.52	0.78	0.55	10	7	070920
Avocado	1.00	0.18	0.96	0.26	0.83	0.37	0.74	0.41	4	8	080440
Balsam Apple	1.14	0.43	0.98	0.08	1.27	0.59	0.99	0.07	19	8	081090
Balsam Pear	1.13	0.43	0.98	0.09	1.57	0.85	0.97	0.09	19	7	070990
Banana	0.96	0.14	0.95	0.16	0.88	0.15	0.85	0.19	21	8	080300
Barley, grain	1.08	0.20	1.13	0.32	1.15	0.18	1.40	0.58	25	10	1003
Bean	1.16	0.40	1.10	0.32	1.67	0.64	1.48	0.54	9	7	070820, 071022
Bean, Adzuki	1.17	0.44	1.05	0.25	1.60	0.83	1.03	0.07	12	7	071332
Bean, Broad	1.20	0.43	1.18	0.36	1.80	0.64	1.62	0.49	10	7	071029
Bean, Broad Dry	1.11	0.30	1.07	0.25	1.10	0.29	1.05	0.15	11	7	071350
Bean, Broad Succulent	1.16	0.43	1.09	0.29	1.60	0.68	1.48	0.62	11	7	070890
Bean, Dry	1.05	0.22	1.03	0.27	1.11	0.27	1.08	0.29	26	7	071331, 071332, 071339 071333
Bean, Edible Podded	1.09	0.34	1.03	0.18	1.31	0.46	1.11	0.17	12	7	070820, 071022
Bean, Kidney	1.09	0.37	0.96	0.29	1.54	0.85	0.96	0.24	26	7	071333
Bean, Lablab	1.15	0.39	1.01	0.25	1.61	0.77	1.19	0.30	8	7	070890
Bean, Lima	1.14	0.40	1.07	0.22	1.33	0.49	1.24	0.36	15	7	071339
Bean, Moth	1.21	0.50	1.04	0.17	1.38	0.56	1.17	0.29	12	7	071339
Bean, Mung	1.13	0.43	0.96	0.30	1.17	0.50	0.98	0.10	26	7	071331
Bean, Navy	1.07	0.30	1.00	0.31	1.23	0.38	1.19	0.40	26	7	071333

Bean, Rice	1.18	0.48	1.00	0.31	1.29	0.51	1.09	0.19	12	7	071339
Bean, Runner	1.07	0.30	1.01	0.16	2.09	1.18	1.03	0.08	14	7	070890, 071029
Bean, Snap	1.09	0.31	1.04	0.24	2.18	1.24	1.17	0.28	23	7	070890, 071029
Bean, Tepary	1.18	0.48	1.04	0.24	1.29	0.51	1.10	0.14	12	7	071339
Bean, Urd	1.18	0.48	1.01	0.30	1.29	0.51	1.10	0.17	12	7	071339
Bean, Yardlong	1.08	0.37	0.98	0.10	1.21	0.36	1.05	0.09	13	7	070890
Beechnut	1.05	0.31	0.97	0.16	1.15	0.51	0.85	0.19	24	8	080290
Beet, Garden, Roots	1.01	0.27	0.96	0.14	1.12	0.44	1.07	0.25	8	7	070690
Beet, Garden, Tops	1.14	0.43	1.02	0.13	1.51	0.75	1.22	0.34	3	7	070990
Blackberry	1.04	0.21	1.00	0.14	1.21	0.34	1.14	0.30	12	8	081020, 081120
Blueberry	1.06	0.22	1.02	0.18	1.19	0.33	1.12	0.26	20	8	081040, 081190
Boysenberry	1.08	0.32	1.00	0.17	1.40	0.61	1.17	0.41	11	8	081020, 081190
Broccoli	1.07	0.29	1.06	0.30	1.19	0.32	0.99	0.17	33	7	070410
Broccoli, Chinese	1.10	0.34	1.03	0.19	1.30	0.61	0.93	0.19	18	7	070490
Broccoli, Raab	1.16	0.46	1.07	0.29	1.40	0.62	1.12	0.25	12	7	070490
Brussels Sprouts	1.02	0.25	0.99	0.24	1.08	0.41	0.95	0.34	20	7	070420
Butternut	1.09	0.38	0.99	0.16	1.26	0.60	0.78	0.25	24	7	070990
Cabbage	1.08	0.24	1.11	0.30	1.13	0.28	1.09	0.40	33	7	070490
Cabbage, Chinese, Bok Choy	1.11	0.34	1.05	0.18	1.39	0.63	1.10	0.19	12	7	070490
Cabbage, Chinese, Napa	1.18	0.43	1.10	0.26	1.54	0.67	1.42	0.49	14	7	070490
Calamondin	1.16	0.50	1.05	0.28	1.49	0.75	1.41	0.64	32	8	080520
Canna, Edible	1.10	0.32	1.01	0.24	1.76	0.78	1.37	0.46	8	6	060210
Cantaloupe	1.00	0.14	1.00	0.20	1.03	0.22	1.05	0.29	42	8	080719
Carrot	1.00	0.15	0.98	0.22	1.02	0.15	0.91	0.22	22	7	070610
Cashew	0.97	0.20	0.94	0.23	0.93	0.24	0.88	0.15	25	8	080131, 080132
Cassava, Leaves	1.21	0.57	0.99	0.03	1.83	1.06	1.00	0.01	3	7	070990
Cassava, Roots	1.09	0.28	1.06	0.20	1.02	0.12	1.14	0.19	9	7	071410
Cattle, by products	1.02	0.10	1.01	0.08	0.99	0.07	0.97	0.08	57	2	020629
Cattle, fat	1.02	0.16	1.00	0.09	1.06	0.12	1.05	0.11	26	15	1502
Cattle, kidney	1.01	0.11	0.98	0.15	0.97	0.11	0.94	0.17	98	2	020629
Cattle, liver	1.00	0.15	0.98	0.21	0.99	0.05	0.52	0.67	92	2	020622

Cattle, meat	1.05	0.15	1.08	0.24	1.17	0.21	1.38	0.56	90	2	0201, 0202
Cauliflower	1.06	0.26	1.05	0.26	1.11	0.23	0.94	0.18	28	7	070410
Celeriac, root	1.05	0.28	1.02	0.20	1.23	0.48	1.28	0.51	7	7	070690
Celery	0.98	0.26	0.96	0.30	0.90	0.26	0.56	0.51	16	7	070940
Celery, Chinese	1.13	0.36	1.09	0.25	1.60	0.60	1.61	0.61	1	7	070940
Chayote, fruit	1.13	0.43	0.98	0.09	1.27	0.59	0.99	0.07	19	8	081090
Cherry	1.03	0.19	1.03	0.24	1.24	0.37	1.34	0.58	48	8	080920, 081190
Chervil	1.11	0.35	1.04	0.19	1.42	0.66	1.24	0.44	10	7	070990
Chervil, Turnip, Roots	1.13	0.42	1.01	0.19	1.29	0.52	1.31	0.54	7	7	070690
Chestnut	0.97	0.23	0.94	0.19	0.87	0.14	0.79	0.20	24	8	080240
Chickpea	1.09	0.28	1.01	0.27	1.18	0.31	1.19	0.33	8	7	071320
Chicory, Roots	1.04	0.27	0.98	0.27	1.17	0.41	1.11	0.27	7	6	060120
Chicory, Tops	1.14	0.40	1.07	0.18	1.48	0.75	1.08	0.13	3	7	070521
Chrysanthe mum, Edible Leaved	1.17	0.50	1.00	0.10	1.84	1.08	1.01	0.20	10	7	071290
Chufa	1.05	0.33	0.99	0.23	1.32	0.51	1.23	0.41	8	6	060110
Citron, Citrus	1.05	0.21	1.06	0.28	1.25	0.29	1.35	0.51	37	8	080590
Coconut	0.94	0.37	0.87	0.28	0.73	0.49	0.65	0.46	2	8	080111, 080119
Collards	1.13	0.44	1.03	0.24	1.33	0.60	0.98	0.20	16	7	070490
Corn Salad	1.08	0.36	1.00	0.09	1.45	0.83	1.00	0.11	10	10	1005
Corn, grain	1.00	0.14	1.00	0.14	0.98	0.07	0.97	0.08	42	10	100510
Corn, pop	1.11	0.34	1.06	0.25	1.51	0.66	1.17	0.19	19	7	070990
Corn, Sweet, Kernels Plus Cob With Husks Removed	0.92	0.16	0.89	0.19	0.79	0.20	0.70	0.24	24	7	071040
Cottonseed	1.10	0.20	1.12	0.24	1.13	0.21	1.15	0.23	44	12	120720
Cowpea	1.14	0.39	1.08	0.24	1.33	0.49	1.24	0.39	12	7	071339
Crabapple	1.05	0.27	0.99	0.11	1.06	0.17	1.03	0.15	30	8	081090
Cranberry	1.03	0.19	1.01	0.20	1.23	0.34	1.12	0.30	19	8	081040, 081190
Cress	1.10	0.41	1.02	0.17	1.35	0.70	1.15	0.38	10	7	070990
Cress, Garden	1.07	0.31	1.01	0.11	1.27	0.58	1.07	0.20	10	7	070990
Cress, Upland	1.21	0.50	1.17	0.44	1.94	0.95	1.93	0.93	1	7	070990
Cucumber	0.97	0.17	0.97	0.20	0.96	0.18	1.02	0.31	49	7	070700
Currant	1.07	0.32	1.04	0.26	1.26	0.37	1.21	0.29	10	8	081030,

										081120
Dandelion, leaves	1.17	0.50	1.00	0.10	1.69	0.98	0.99	0.19	10	7	070990
Dasheen, Corm	1.06	0.32	0.99	0.21	1.23	0.57	1.05	0.20	8	6	060120
Date	1.15	0.44	1.06	0.23	1.11	0.39	1.03	0.14	1	8	080410
Dewberry	1.09	0.33	1.01	0.16	1.39	0.51	1.17	0.34	10	8	081020, 081120
Dock	1.09	0.32	1.03	0.15	1.36	0.61	1.17	0.33	10	7	070990
Eggplant	1.03	0.16	1.01	0.16	1.02	0.27	0.97	0.20	27	7	070930
Eggs	0.96	0.14	0.92	0.20	0.94	0.13	0.83	0.31	42	4	0407, 0408
Elderberry	1.05	0.30	0.98	0.19	1.05	0.19	0.93	0.34	8	8	081090
Endive	1.05	0.16	1.02	0.11	1.37	0.42	1.15	0.22	11	7	070529
Endive, Belgian	1.27	0.59	1.21	0.49	2.47	1.30	2.10	1.10	1	7	070529
Fennel	1.24	0.54	1.19	0.47	1.89	0.94	1.87	0.92	1	7	070990
Fennel, Florence, Fresh Leaves and Stalk	1.01	0.41	0.95	0.34	0.95	0.90	0.75	0.78	2	7	070990
Fruit, Passion	0.76	0.41	0.75	0.41	0.73	0.40	0.49	0.48	1	8	081090
Garlic	1.02	0.17	0.99	0.23	1.08	0.19	1.10	0.28	11	7	070320
Ginger	1.11	0.39	1.09	0.33	1.25	0.53	1.20	0.45	1	9	091010
Gooseberry	1.05	0.30	0.98	0.18	1.22	0.35	1.15	0.27	9	8	081030, 081120
Gourd, Edible	1.13	0.43	0.96	0.14	1.57	0.85	0.97	0.09	19	7	070990
Grape	1.03	0.17	1.04	0.24	1.15	0.22	1.16	0.30	60	8	080610
Grapefruit	1.06	0.21	1.08	0.30	1.27	0.35	1.32	0.50	43	8	080540
Groundcherry	1.08	0.31	1.03	0.12	1.07	0.18	1.07	0.13	13	8	081090
Guar	1.19	0.49	1.04	0.21	1.82	0.84	1.47	0.58	8	7	070890
Guava	0.75	0.41	0.74	0.41	0.42	0.52	0.33	0.54	1	8	080450
Hazelnut	0.98	0.28	0.90	0.22	0.93	0.12	0.92	0.12	28	8	080221
Hog, by products	1.04	0.11	1.03	0.10	1.00	0.05	1.00	0.04	41	2	020649
Hog, fat	1.05	0.23	1.03	0.13	1.10	0.20	1.11	0.19	18	2	020900, 1501
Hog, fat	1.05	0.23	1.03	0.13	1.10	0.20	1.11	0.19	18	15	1501
Hog, kidney	1.03	0.10	1.01	0.09	1.01	0.03	1.03	0.05	66	2	020649
Hog, liver	1.01	0.08	1.01	0.08	1.00	0.03	1.00	0.05	68	2	020641
Hog, meat	1.07	0.17	1.09	0.26	1.24	0.25	1.47	0.59	62	2	0203
Honeydew	1.00	0.13	0.99	0.20	1.03	0.19	1.04	0.27	39	8	080719
Hop, Dried Cones	1.10	0.31	1.09	0.27	1.18	0.31	1.17	0.26	22	12	121010
Horseradish	1.03	0.19	1.02	0.21	1.09	0.20	1.22	0.45	9	7	070690
Huckleberry	1.14	0.45	0.97	0.11	1.55	0.80	0.96	0.10	14	8	081040

Jackbean	1.18	0.47	1.01	0.08	1.63	0.79	1.13	0.17	9	7	070890
Juneberry	1.19	0.51	1.03	0.24	1.32	0.65	0.93	0.46	5	8	081090
Kale	1.07	0.25	1.03	0.22	1.18	0.32	1.01	0.17	15	7	070490
Kiwifruit	0.99	0.17	0.98	0.19	1.09	0.25	1.00	0.31	5	8	081050
Kohlrabi	1.07	0.34	0.96	0.31	1.22	0.56	0.94	0.19	13	7	070490
Kumquat	1.00	0.32	0.95	0.13	1.27	0.76	0.90	0.18	1	8	080590
Leeks	0.97	0.34	0.91	0.28	1.07	0.24	0.88	0.15	4	7	070390
Lemon	1.01	0.00	1.02	0.00	1.01	0.00	1.02	0.00	43	8	080530
Lentil	1.09	0.23	1.06	0.25	1.20	0.42	1.12	0.37	10	7	071340
Leren	1.13	0.39	1.02	0.19	1.32	0.46	1.40	0.51	8	7	070690
Lettuce, Head	1.02	0.17	1.06	0.35	1.04	0.27	0.82	0.28	34	7	070511
Lettuce, Leaf	1.05	0.18	1.06	0.22	1.31	0.35	0.93	0.15	26	7	070519
Lime	1.01	0.00	1.02	0.00	1.01	0.00	1.02	0.00	39	8	080530
Loganberry	1.07	0.31	1.01	0.16	1.26	0.41	1.20	0.34	10	8	081020, 081120
Loquat	1.03	0.18	0.99	0.13	1.08	0.19	1.10	0.23	24	8	081090
Lupin, Grain	1.11	0.33	1.04	0.30	1.56	0.61	1.55	0.63	10	10	100890
Mango	0.94	0.24	0.88	0.27	0.82	0.47	0.71	0.43	7	8	080450
Melon	0.98	0.12	0.97	0.15	1.00	0.15	1.01	0.19	35	8	080719
Milk	0.98	0.14	0.99	0.14	0.97	0.14	0.99	0.16	77	4	0401, 0402
Milk, fat	1.11	0.46	1.04	0.41	1.13	0.56	1.09	0.60	10	4	0405
Millet, pearl, grain	1.16	0.43	1.02	0.13	1.65	0.85	1.01	0.09	8	10	100820
Millet, proso, grain	1.08	0.25	1.03	0.14	1.23	0.43	1.09	0.13	8	10	100820
Mizuna	1.09	0.34	1.02	0.12	1.37	0.65	1.16	0.27	12	7	070990
Mushroom	1.09	0.27	1.09	0.29	1.27	0.27	1.39	0.49	5	7	070951, 071230
Muskmelon	0.99	0.13	0.97	0.23	1.01	0.17	1.02	0.26	38	8	080719
Mustard Greens	1.06	0.23	1.05	0.28	1.25	0.38	1.16	0.29	18	7	070990
Mustard Spinach	1.14	0.43	1.01	0.07	1.77	1.04	1.01	0.05	12	12	120750
Mustard, Seed	1.02	0.31	1.01	0.25	1.03	0.37	0.99	0.09	2	7	070990
Nectarine	1.04	0.19	1.04	0.22	1.14	0.28	1.39	0.63	44	8	080930
Nut, Brazil	0.99	0.20	0.94	0.12	0.91	0.30	0.84	0.16	25	8	080121, 080122
Nut, Hickory	1.05	0.31	0.97	0.16	1.15	0.51	0.85	0.19	24	8	080290
Nut, Macadamia	0.96	0.18	0.91	0.19	0.87	0.21	0.84	0.16	26	8	080290
Nut, Pine	1.02	0.56	0.97	0.47	1.39	1.06	1.34	1.08	1	8	080290
Oat, grain	1.04	0.25	1.01	0.23	0.98	0.34	0.91	0.17	16	10	1004
Okra	1.11	0.31	1.09	0.33	1.39	0.46	1.26	0.30	9	7	070890
Olive	1.13	0.33	1.14	0.35	1.76	0.75	1.74	0.70	4	7	071120

Onion, bulb	1.00	0.17	0.99	0.19	0.97	0.21	1.00	0.32	27	7	070310
Onion, Green	1.28	0.60	1.03	0.08	2.28	1.22	1.17	0.17	9	7	070390
Onion, Welsh	1.10	0.33	1.05	0.20	1.54	0.71	1.26	0.34	2	7	070390
Orach	1.18	0.54	0.99	0.08	1.69	0.98	0.99	0.19	10	7	070990
Orange	1.04	0.19	1.05	0.27	1.22	0.30	1.38	0.59	47	8	080510
Papaya	0.98	0.22	0.92	0.19	0.80	0.36	0.68	0.27	10	8	080720
Parsley, fresh	1.13	0.36	1.15	0.39	1.43	0.50	1.46	0.50	1	7	070990
Parsley, Turnip Rooted	1.07	0.35	1.01	0.20	1.24	0.51	1.25	0.52	8	7	070690
Parsnip	1.02	0.19	1.00	0.14	1.05	0.17	1.12	0.26	8	7	070690
Pawpaw	1.13	0.59	0.92	0.28	1.22	1.09	0.22	0.81	1	8	080720, 081340
Pea	1.08	0.26	1.04	0.25	1.41	0.44	1.23	0.32	17	7	070810, 071021
Pea, Dry	1.07	0.29	1.06	0.29	1.07	0.21	1.08	0.20	13	7	071310
Pea, Edible Podded	1.04	0.24	0.98	0.12	1.23	0.37	1.03	0.15	13	7	070810, 071021
Pea, English	1.10	0.33	1.05	0.24	1.50	0.58	1.37	0.50	14	7	070810, 071021
Pea, Field	1.13	0.34	1.12	0.32	1.20	0.33	1.23	0.29	13	7	070810, 071021, 071310
Pea, Garden	1.11	0.32	1.06	0.24	1.50	0.58	1.37	0.50	14	7	070810, 071021
Pea, Green	1.11	0.32	1.06	0.24	1.50	0.58	1.37	0.50	14	7	070810, 071021
Pea, Pigeon	1.22	0.52	1.06	0.26	1.07	0.33	1.02	0.17	9	7	071390
Pea, Succulent	1.10	0.35	1.04	0.21	1.47	0.60	1.31	0.41	15	7	070810, 071021
Pea, Sugar Snap	1.09	0.33	1.03	0.20	1.24	0.37	1.08	0.07	13	7	070890
Peach	1.07	0.21	1.09	0.26	1.18	0.30	1.33	0.51	51	8	080930, 081340
Peanut	0.98	0.16	0.98	0.19	0.96	0.09	0.89	0.17	27	12	1202
Pear	1.03	0.17	1.05	0.26	1.16	0.23	1.34	0.55	55	8	080820, 081340
Pear, Oriental	1.03	0.28	0.98	0.13	1.05	0.17	1.03	0.11	30	8	081090
Pecan	0.97	0.22	0.94	0.17	0.88	0.23	0.84	0.18	38	8	080290
Pepino	1.09	0.31	1.03	0.13	1.10	0.21	1.13	0.20	13	8	081090
Pepper	1.08	0.30	1.04	0.21	1.14	0.47	1.03	0.28	31	9	0904
Pepper, Non-Bell	1.09	0.33	1.05	0.23	1.25	0.46	1.17	0.35	35	7	070960
Pimentos	1.14	0.50	1.02	0.25	1.33	0.76	0.87	0.20	52	7	070960
Pineapple	0.93	0.20	0.95	0.28	0.69	0.32	0.74	0.43	6	8	080430
Pistachio	0.99	0.18	0.98	0.18	0.98	0.10	0.97	0.06	29	8	080250
Plantain	0.79	0.37	0.75	0.39	0.43	0.62	0.19	0.60	2	8	080300
Plum, prune, dry	1.18	0.51	1.00	0.12	1.89	1.06	1.05	0.24	6	8	081320

Plum, prune, fresh	1.02	0.16	1.03	0.20	1.21	0.30	1.27	0.42	36	8	080940
Pomegranate	0.93	0.29	0.91	0.26	0.93	0.30	0.80	0.29	3	8	081090
Potato	0.97	0.15	0.94	0.15	0.96	0.16	0.98	0.16	56	7	070190
Poultry, byproducts	0.95	0.13	0.94	0.13	0.92	0.13	0.89	0.14	33	2	020713, 020714, 020726, 020727, 020735, 020736
Poultry, fat	1.04	0.34	0.99	0.19	1.00	0.20	0.98	0.16	7	2	020900, 1501
Poultry, kidney	0.95	0.14	0.93	0.18	0.92	0.15	0.81	0.31	41	2	0207
Poultry, liver	0.96	0.12	0.90	0.20	0.92	0.10	0.92	0.10	41	2	020734
Poultry, meat	0.97	0.10	0.98	0.12	0.98	0.09	1.04	0.20	45	2	0207
Pummelo	1.05	0.22	1.06	0.31	1.23	0.28	1.32	0.49	31	8	080590
Pumpkin	1.00	0.15	0.93	0.21	1.00	0.15	0.97	0.16	24	7	070990
Purslane, Garden	1.09	0.32	1.03	0.15	1.36	0.61	1.17	0.33	10	7	070990
Purslane, Winter	1.09	0.32	1.03	0.15	1.36	0.61	1.17	0.33	10	7	070990
Quince	1.03	0.18	1.02	0.22	1.16	0.26	1.29	0.47	30	8	080820
Radish	1.00	0.19	0.97	0.12	1.02	0.11	1.00	0.17	11	7	070690
Radish, Tops	1.12	0.35	1.12	0.35	1.49	0.67	1.43	0.52	9	7	070990
Raisin	1.15	0.44	1.02	0.07	2.00	1.14	1.10	0.14	18	8	080620
Rape Greens	1.17	0.48	1.01	0.07	1.71	0.95	1.05	0.12	12	7	070990
Raspberry	1.03	0.20	1.00	0.14	1.15	0.33	1.09	0.30	17	8	081020, 081120
Rice, grain	1.05	0.17	1.04	0.19	1.07	0.18	1.04	0.17	25	10	1006
Rutabaga, Roots	1.04	0.23	1.03	0.20	1.13	0.26	1.26	0.44	7	7	070690
Rutabaga, Tops	1.20	0.54	0.99	0.03	1.78	1.00	1.00	0.01	3	7	070990
Salsify, Roots	1.03	0.22	1.03	0.21	1.11	0.22	1.30	0.46	7	7	070690
Salsify, Tops	1.21	0.57	0.99	0.03	1.83	1.06	1.00	0.01	3	7	070990
Savory, Summer	1.08	0.32	1.06	0.23	1.26	0.48	1.20	0.32	1	9	091099
Sesame, Seed	0.88	0.35	0.88	0.37	0.68	0.41	0.56	0.48	1	12	120740
Shallots	1.04	0.22	1.04	0.12	1.08	0.29	1.13	0.19	2	7	070310
Sheep, by products	1.03	0.10	1.03	0.08	1.11	0.19	1.10	0.17	52	2	020680, 020690
Sheep, fat	1.02	0.22	0.99	0.09	1.02	0.14	0.99	0.04	12	15	1502
Sheep, kidney	1.04	0.21	0.98	0.16	1.08	0.17	1.06	0.16	72	2	020680, 020690
Sheep, liver	1.02	0.10	0.99	0.19	1.08	0.16	1.07	0.17	65	2	020680, 020690
Sheep, meat	1.06	0.17	1.10	0.26	1.33	0.33	1.34	0.31	66	2	0204

Skirret	1.13	0.42	1.01	0.19	1.29	0.52	1.31	0.54	7	7	070690
Sorghum, grain	1.08	0.25	1.06	0.20	1.46	0.77	0.97	0.12	25	10	1007
Spinach	1.02	0.25	1.01	0.26	1.17	0.29	0.79	0.33	14	7	070970
Spinach, New Zealand	1.04	0.18	1.02	0.15	1.46	0.52	1.02	0.13	10	7	070970
Spinach, Vine	1.18	0.53	0.98	0.05	1.66	0.97	0.92	0.09	10	7	070990
Squash, Summer	1.00	0.16	1.01	0.31	1.00	0.20	1.01	0.36	40	7	070990
Squash, Winter	1.00	0.16	0.97	0.13	1.00	0.18	0.97	0.19	26	7	070990
Strawberry	1.03	0.18	1.01	0.18	1.15	0.31	1.01	0.20	32	8	081010, 081110
Sugar, Beet, Roots	0.92	0.13	0.93	0.13	0.97	0.12	0.97	0.12	24	12	121291
Sweet Potato	1.00	0.17	1.00	0.26	1.06	0.10	1.25	0.49	17	7	071420
Swiss Chard	1.08	0.24	1.05	0.18	1.31	0.39	1.23	0.34	11	7	070990
Swordbean	1.18	0.47	1.01	0.08	1.63	0.79	1.13	0.17	9	7	070890
Tangelo	1.06	0.22	1.07	0.26	1.23	0.31	1.43	0.57	37	8	080520
Tangerine	1.07	0.21	1.09	0.28	1.22	0.27	1.46	0.62	42	8	080520
Tanier	1.06	0.30	1.00	0.21	1.23	0.35	1.23	0.36	9	7	070990
Taro	1.02	0.18	1.00	0.25	1.13	0.18	1.15	0.26	9	7	071490
Tomatillo	1.09	0.35	1.02	0.10	1.07	0.20	1.07	0.13	13	8	081090
Tomato	1.03	0.20	1.04	0.25	1.09	0.22	1.18	0.43	64	7	070200
Turnip	1.00	0.19	0.99	0.21	1.05	0.20	1.06	0.23	11	7	070610
Turnip, Tops	1.07	0.27	1.01	0.17	1.31	0.54	1.13	0.39	8	7	070990
Walnut	0.97	0.20	0.95	0.16	0.93	0.21	0.93	0.22	36	8	080231, 080232
Watercress	1.12	0.31	1.09	0.23	1.47	0.54	1.44	0.48	2	7	070990
Watermelon	1.03	0.10	1.05	0.27	1.01	0.18	1.05	0.40	26	8	080711
Wheat, grain	1.05	0.16	1.07	0.22	1.05	0.12	1.10	0.26	38	10	1001
Yam Bean	1.06	0.34	1.03	0.36	1.18	0.32	1.19	0.37	8	7	070890
Yam, True, Tuber	1.05	0.20	1.08	0.27	1.28	0.28	1.27	0.28	10	7	071490
Youngberry	1.12	0.44	0.97	0.16	1.60	0.84	0.86	0.19	6	8	081020, 081120

Appendix B: List of countries with weighted, unweighted scores and their standard deviations

country	Unweighted Scores				Weighted Scores			
	Score 1	Score 1 std.	Score2	Score 2 std.	Score 1	Score 1 std.	Score 2	Score 2 std.
Australia	1.95	0.58	1.19	0.43	1.66	0.55	1.20	0.39
Japan	1.71	0.76	0.93	0.26	1.57	0.71	1.11	0.29
Jamaica	1.51	0.58	1.27	0.39	1.22	0.41	1.12	0.27
European Union	1.51	0.57	1.27	0.38	1.23	0.59	1.09	0.41
Turkey	1.50	0.58	1.30	0.57	1.26	0.47	1.75	0.70
Canada	1.46	0.50	1.20	0.43	1.29	0.44	1.09	0.36
Israel	1.06	0.20	1.06	0.20	1.06	0.08	1.06	0.08
Brazil	1.04	0.11	1.29	0.48	1.10	0.12	1.25	0.22
Chile	1.03	0.15	1.01	0.32	1.04	0.10	1.05	0.14
Argentina	1.03	0.09	1.03	0.09	1.04	0.07	1.04	0.07
Russian Federation	1.03	0.10	1.55	0.75	1.07	0.14	1.83	0.79
Rep. of Korea	1.01	0.16	0.98	0.46	1.00	0.11	0.99	0.21

China	1.01	0.05	1.04	0.40	1.03	0.10	1.17	0.37
Hong Kong	1.00	0.01	1.00	0.01	1.01	0.01	1.01	0.01
Thailand	1.00	0.02	1.00	0.02	1.00	0.02	1.00	0.02
Vietnam	1.00	0.08	1.00	0.08	0.99	0.05	0.99	0.05
Indonesia	1.00	0.01	1.00	0.07	1.02	0.03	1.08	0.13
Peru	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Colombia	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Guatemala	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Philippines	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Dominican Republic	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Honduras	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Algeria	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Bahamas	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Barbados	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Bermuda	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00

Costa Rica	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Ecuador	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Egypt	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
El Salvador	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Jordan	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Kenya	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Lebanon	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Morocco	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Nicaragua	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Pakistan	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Panama	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Trinidad and Tobago	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Tunisia	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Venezuela	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Malaysia	0.99	0.04	0.99	0.04	0.99	0.04	0.99	0.04

United Arab Emirates	0.99	0.03	0.99	0.03	0.99	0.03	0.99	0.03
United States	0.98	0.36	0.98	0.36	0.89	0.35	0.89	0.35
Mexico	0.98	0.35	0.98	0.35	0.97	0.26	0.97	0.26
India	0.97	0.14	0.96	0.18	1.03	0.09	1.05	0.13
New Zealand	0.97	0.07	0.97	0.07	0.97	0.04	0.97	0.04
Singapore	0.96	0.13	0.96	0.13	0.98	0.11	0.98	0.11
South Africa	0.87	0.15	0.87	0.15	0.82	0.11	0.82	0.11
Sri Lanka	0.53	0.20	0.55	0.20	0.43	0.15	0.47	0.16

Appendix C: The number of products under each substance count

Substance Count	Number of Products with Corresponding Substance Count
1	14
2	7
3	7
4	3
5	3
6	3
7	9
8	19
9	12
10	24
11	8
12	14
13	9
14	7
15	3
16	3
17	3
18	5
19	6
20	2
21	1
22	2
23	1
24	8
25	5
26	9
27	3
28	2
29	1
30	3
31	2
32	2
33	4
34	1

35	2
36	2
37	2
38	3
39	2
40	1
41	3
42	4
43	2
44	2
45	1
47	1
48	2
49	1
51	1
52	2
55	1
56	1
57	1
60	1
62	1

CHAPTER 4: THE POLITICAL ECONOMY OF FOOD STANDARD DETERMINATION: INTERNATIONAL EVIDENCE FROM MAXIMUM RESIDUE LIMITS

Abstract

I build a parsimonious partial equilibrium political-economy model for a tradable good with a negative externality addressed by a single quality standard. The policy-maker solves for the standard that maximizes a weighted sum of welfare measures reflecting rent-seeking activities. Comparative statics are derived and are ambiguous despite the simple setting. Then I empirically implement a reduced form derived from the conceptual model to econometrically investigate the determinants of protectionism in maximum residue limits affecting food trade among a large number of countries. Protectionism is measured as proposed in essay 2, that is, an index of strictness of MRLs relative to Codex international standards. Higher-income countries tend to protect their domestic market and their consumers' health more than lower income countries do; MRL and tariff are substitute policy instruments; the impact of democratization on strictness of MRLs shows a inverted u-shaped pattern; the quality of governmental institutions increases MRL protection.

Introduction

In the second essay, we calculated the protectionism scores of maximum residue limits (MRLs) at country and product levels. We observed variations across countries, across products, as well as variations across products within a given country. In this essay, we take these scores one step further and attempt to rationalize their variations as explained by political economy motives. We develop a parsimonious political economy model to motivate a set of specifications which are then explored econometrically using the scores as dependent variables and a set of commodity and country level determinants derived from the political-economy model.

Agricultural protection and its political economy have been enduring topics. With very few exceptions, most of the literature on agricultural protection is devoted to price-related policies and distortions through macro-economic policies such as over-valued currencies (See Swinnen and Vandemoortele (2008) and (2009); and Farnsworth (2012) for exceptions). Anderson (2009) reviewed the extensive literature on Agricultural protection. As Tariffs are being lowered by multilateral and preferential trade agreements, the focus of attention has switched to non-tariff measures (NTMs) and non-tariff barriers (NTBs) in agricultural protection. NTMs, which are intended to regulate markets and protect health and/or the environment, have been allegedly used increasingly as disguised protection purposes. This conjecture motivated my second essay.

Traditional price-related protection measures are easier to identify and could also be specific to the direction of trade flows (imports versus exports). For example, to protect domestic producers from import competition, traditional measures include tariffs, tariff rate quotas, direct payment/transfer, etc. On the other hand, to make export sectors more competitive, export subsidies, direct payment/transfers, etc, can be used. Rodrick (1995) conducted a thorough review of endogenous trade policy models, which typically link the level of trade price policy to the amount of lobbying resources. But for NTMs and NTBs, and Maximum Residue Limits (MRLs) specifically, standards are set for and faced by both domestic producers and importers. In addition, many NTMs and NTBs potentially serve to internalize and mitigate negative externalities, unless they are overtly protectionist that is, not based on science or a legitimate precautionary motive. This market-imperfection possibility makes it less obvious to define the non-protectionist benchmark when external effects such as health risk exist. Since last decade, conceptual work by Fischer and Serra (2000), Swinnen and Vandemoortele (2008), Marette and Beghin (2010), and Berti and Falvey (2011) has emerged on the endogeneity and protectionism of NTM/NTBs, especially, standard-like NTMs. These conceptual models for NTMs differ from those of tariffs in that they build the positive externality (or reducing negative externality) effects of NTMs into the models. In particular, Fisher and Serra (2000), and Marette and Beghin (2010) compare what a global social planner and a domestic counterpart would do to maximize welfare. If the optimum NTM set by the global planner is less stringent than the one set by the domestic planner, then the domestic standard is deemed protectionist. In the methodology section, we provide more details about the conceptual model setup.

A few studies tried to explain the variations of NTBs in a political economy context. NTBs in these studies encompass all standards-like policies but also other quantitative restrictions and other non-tariff policies. The prior is that NTBs have similar effects as tariffs do and are set by a similar political economy context. Ray (1981) first started to simultaneously model tariff and NTBs for manufacturing industries. His measure of NTBs was the “Index of the Incidence of Nontariff Barriers” constructed by the U.S. Tariff Commission, which measures the comprehensiveness of nontariff protection. Without defining protectionism explicitly, the author took the protection in tariff and nontariff in a similar manner: NTM existence simply means NTM protection.

Trefler (1993) similarly conducted an empirical study of NTBs in U.S. manufacturing industries. He treated NTBs as being endogenous and simultaneously estimated imports and NTBs. The author used the coverage ratio to measure of NTBs. Mansfield and Busch (1995) conducted a cross-national analysis to explain how the coverage ratio of NTBs is determined by the number of constituencies, the unemployment rate, exchange rate, etc. Cropper et al. (1992) is one of the rare investigations of the determinants of pesticide regulations, EPA pesticide cancellation in particular. The latter investigation is restricted to the U.S. domestic context and abstracts from trade or protectionist considerations.

Empirical studies of protectionism based on NTMs and NTBs are relative few, mostly due to the following two reasons. First, protectionism as defined in the conceptual papers cited above is hard to implement empirically because production cost information is difficult to collect and the relevant international sector hard to define. Second, as mentioned above, quantification and aggregation of NTMs and NTBs are challenging tasks relative to collecting data on border tariffs. The latter tasks are hard or impossible given the different nature and impacts of many NTBs and NTMs. The coverage ratio is the most commonly used measure, but the coverage ratio of NTBs is not necessarily the same as of the intensity and stringency of standard-like NTMs. It is a relatively gross proxy of stringency of policy.

Recently, USDA FAS has provided access to the MRL database used in my second essay. The database covers about three hundreds products for more than eighty countries, and millions of MRL records. In the second essay, we proposed aggregation indices applied to this newly available MRL database to solve these two problems, using Codex MRLs as the non-protectionist science-based benchmark. Related (but different) to my effort here, Farnsworth (2012) also conducted a related investigation based on the same MRL raw dataset but selected only a small subset of products and did not provide a structural model leading to the estimated reduced forms. Farnsworth did not formalize his protectionism measure. Instead, he constructed “strictness” measures, based on maximum and averages of MRLs.

In this third essay, we systematically study the variation of protectionism scores calculated in essay two. In particular we investigate the relationship between MRL protectionism scores at the product level and across countries, and traditional determinants of agricultural protection as posited in the literature and derived from the proposed conceptual model. We also investigate the relationship between MRL protection and tariff protection to see whether they are substitutes or complements in protection.

In the next section, we provide the simple conceptual framework following Fischer and Serra (2000) and others, to derive the theoretical underpinning for the empirical regressions. Then, we discuss the data steps, the variables used, and their sample statistics. Following the data section, we present the estimation results which are followed by robustness checks. Finally, we close with a summary of the major findings and their implications.

Methodology

We follow the spirit of Fisher and Serra (2000), Marette and Beghin (2010), and Berti and Falvey (2011) and their parsimonious two-country model with an externality addressed by a single NTM standard and the weighted sum of surplus measures of Berti and Falvey (2011). The NTM standard impacts cost and a negative externality, which is decreasing in the standard's stringency. The negative externality can be thought of as the negative health consequences of consuming unsafe food, but it could be more general. We incorporate the previous theoretical literature but with a slightly more general setup, with N countries and no pre-assumed direction of trade. Producers produce homogeneous products, freely trade between each other, and without any explicit constraints on the direction of trade. The drawback of the more general approach is that it is impossible to sign the comparative statics of changes in the NTM standard induced by underlying variables. The gain is that this less constrained-characterization is more appropriate for an empirical investigation.

The cost function for producer at country i, supplying country j is c_{ij}, where

$$c_{ij} = e^{\lambda_j}\gamma_{ij}q_{ij} + \frac{1}{2}(q_{ij})^2.$$

The quality of the export has to meet the stringency of the standard of the destination market (λ_j), which can be either higher or lower than the domestic standard (λ_i) (Berti and Falvey (2011)). The cost is increasing in the standard level, at an increasing rate (Fischer and Serra (2000)). Following Marette and Beghin (2010), We use parameter γ_{ij}, which captures the relative cost efficiency/advantage of producers in country i to producers located in country j. The output produced in country i then exported to country j is q_{ij}. The variable cost of the production exported from country i to country j that does not depend on the standard is $\frac{1}{2}(q_{ij})^2$.

We assume no additional fixed cost for supplying foreign markets. The total cost, C_i, for producers in country i is obtained by summing over the individual cost for supplying all destination markets. That is expressed as

$$C_i = \sum_{j=1}^{N} e^{\lambda_j} \gamma_{ij} q_{ij} + \frac{1}{2}(q_{ij})^2.$$

Standards do not directly affect the demand, but the price, p_j, will be shown to be an implicit function of the standard.

On the consumer side, we assume that the consumer cares about her health but is not aware of any particular food safety status of a specific good. This simple structure allows to separate the externality and the demand of the good and avoid feedback from the externality into the demand. The consumer's welfare is additive into the consumer surplus from consumption and the health externality. A more complicate structure is conceivable but would further clutter the model (see Marette and Beghin (2010) on this point). Demand at destination market country j depends on the market size, a_j, own-price elasticity of demand, ε_j, and the domestic price p_j, that is,

$$Q_j = a_j - \varepsilon_j p_j.$$

Following Fischer and Serra (2000), we assume the unit dollar amount externality is decreasing in the standard, at a diminishing rate. The parameter λ_0 puts a lower bound to the unit externality, $-e^{\lambda_0}$, when the standard imposed by the country where the consumption takes place is very low. Note that I implicitly assume the dollar valuation of heath is the same across all countries. We could add a country specific scalar to the unit externality and let it vary across countries. The parameter would reflect the country differences in valuing the externality. For example, consumers in some countries may value health externalities from food intake more than consumers in other countries, depending on their income, medical cost, etc. For simplicity's sake, we stipulate the externality as

$$L_j = -e^{(\lambda_0 - \lambda_j)} Q_j.$$

The product associated with the standard is homogenous, except for the standard, but receives different prices at different consumption markets due to different standards and associated cost, and local demands in the destination markets. A country can be both an importer and exporter as long as the unit profit is the same across all destination markets (Berti and Falvey (2011)).

The profit maximization problem for the producer in country i is

$$\max_{q_{ij}} \sum_{j=1}^{N} (p_j - \delta_{ij} t_j)\, q_{ij} - e^{\lambda_j} \gamma_{ij} q_{ij} - \frac{1}{2}(q_{ij})^2$$

with variable t being the tariff imposed in the destination market j, except the home market($\delta_{ij} = 1$ if $i \neq j, \delta_{ii} = 0$ for all i). First order conditions are:

$$\frac{\partial \pi_i}{\partial q_{ij}} = p_j - \delta_{ij} t_j - e^{\lambda_j} \gamma_{ij} - q_{ij} = 0\,.$$

Then we have optimum output for firms in country i to destination j as

$$q_{ij} = p_j - \delta_{ij} t_j - e^{\lambda_j} \gamma_{ij} \qquad (1).$$

Together with the demand function, we can determine the equilibrium quantity and price at destination market j, where $Q_j = \sum_{i=1}^{N} q_{ij}$ and is the sum of domestic produced and imported products. We have

$$\sum_{i=1}^{N} p_j - \delta_{ij} t_j - e^{\lambda_j} \gamma_{ij} \; = \; a_j - \varepsilon_j p_j \,,$$

then

$$p_j^* = \frac{(N-1)t_j + a_j + e^{\lambda_j}\gamma_{.j}}{\varepsilon_j + N},$$

and

$$q_{ij}^* = \frac{(N-1)t_j + a_j + e^{\lambda_j}\gamma_{.j}}{\varepsilon_j + N} - \delta_{ij} t_j - e^{\lambda_j}\gamma_{ij} \,,$$

and

$$q_{jj}^* = \frac{(N-1)t_j + a_j + e^{\lambda_j}\gamma_{.j}}{\varepsilon_j + N} - e^{\lambda_j}\gamma_{jj},$$

where $\gamma_{.j} = \sum_{i=1}^{N} \gamma_{ij}$, is the sum of relative cost efficiency/advantage of country *j* to every country. It measures the overall relative cost efficiency/advantage of country *j* to the rest of the world. The equilibrium price in market *j* is p_j^* , and the equilibrium quantity imported from market *i* to market *j* is q_{ij}^* as shown above. So, the equilibrium consumption in any country *j* is

$$Q_j^* = \sum_{i=1}^{N} q_{ij}^* = \sum_{i=1}^{N} p_j^* - \delta_{ij} t_j - e^{\lambda_j}\gamma_{ij} = N p_j^* - (N-1)t_j - e^{\lambda_j}\gamma_{.j} \,.$$

The associated equilibrium consumer surplus in country *j* is

$$CS_j^* = \tfrac{1}{2} Q_j^* \left(\frac{a_j}{\varepsilon_j} - p_j^*\right). \qquad (2)$$

The equilibrium externality in country *j* is

$$L_j^* = -e^{(\lambda_0 - \lambda_j)} Q_j^* \;.$$

To introduce political economy, we assume that the policymaker maximizes a weighted sum of surpluses with weights representing influence obtained through the political process. This is a generic way to proceed in political-economy modeling. de Gorter and Swinnen (2002) reviewed several political economy models that lead to such weighted sum of surpluses objective function, such as Beghin and Foster(1992) and the protection-for-sale model of Grossman and Helpman (1994).

The political-economy objective function of policymaker of country j is

$$\max_{\lambda_j} W_j = \omega\, \pi_j^* + (1-\omega)\left(CS_j^* + L_j^*\right),$$

or

$$W_j = \omega \sum_{i=1}^{N}((p_i^* - \delta_{ji}t_i)q_{ji}^* - \gamma_{ji}e^{\lambda_i}q_{ji}^* - \tfrac{1}{2}{q_{ji}^*}^2) + (1-\omega)\left(\tfrac{1}{2}Q_j^*\left(\frac{a_j}{\epsilon_j} - p_j^*\right) - e^{(\lambda_0-\lambda_j)}Q_j^*\right).$$

(3)

The first order condition to maximize the weighted sum of surpluses with respect to the standard is

$$\frac{\partial W_j}{\partial \lambda_j} = \omega\left(p_j^*\frac{\partial q_{jj}^*}{\partial \lambda_j} + q_{jj}^*\frac{\partial p_j^*}{\partial \lambda_j} - \gamma_{jj}e^{\lambda_j}q_{jj}^* - \gamma_{jj}e^{\lambda_j}\frac{\partial q_{jj}^*}{\partial \lambda_j} - q_{jj}^*\frac{\partial q_{jj}^*}{\partial \lambda_j}\right) +$$

$$(1-\omega)\left(\frac{1}{2}\frac{a_j}{\varepsilon_j}\frac{\partial Q_j^*}{\partial \lambda_j} - \frac{1}{2}\frac{\partial Q_j^*}{\partial \lambda_j}p_j^* - \frac{1}{2}\frac{\partial p_j^*}{\partial \lambda_j}Q_j^* - \frac{\partial Q_j^*}{\partial \lambda_j}e^{(\lambda_0-\lambda_j)} + Q_j^*e^{(\lambda_0-\lambda_j)}\right) = 0. (4)$$

Note that since we assume no interaction among countries' standards, the export volume $q_{ji(i\neq j)}^*$ does not depend on the producer's domestic standard, λ_j, but rather depends on the importing country's standard, λ_i. This simplifying assumption implies that $\partial(\sum_{i=1}^{N}(p_i^* - \delta_{ji}t_i)q_{ji}^* - \gamma_{ji}e^{\lambda_i}q_{ji}^* - \tfrac{1}{2}{q_{ji}^*}^2)/\partial\lambda_j = \partial(p_j^*q_{jj}^* - \gamma_{jj}e^{\lambda_j}q_{jj}^* - \tfrac{1}{2}{q_{jj}^*}^2)/\partial\lambda_j$.

Next, we substitute equilibrium values and arrange terms, The first order condition becomes

$$\frac{e^{\lambda_j}\gamma_{.j}\left(\omega+\varepsilon_j(1-\omega)\right)\left((N-1)t_j+a_j+e^{\lambda_j}\gamma_{.j}\right)}{(\varepsilon_i+N)^2}$$

$$+\frac{Na_j(1-\omega)e^{(\lambda_0-\lambda_j)}-(N-1)t_j\left(\omega\gamma_{jj}e^{\lambda_j}+(1-\omega)\varepsilon_j e^{(\lambda_0-\lambda_j)}\right)}{\varepsilon_j+N}$$

$$-\frac{2\omega\gamma_{jj}\,\gamma_{.j}e^{2\lambda_j}+a_je^{\lambda_j}\left(\omega\gamma_{jj}+(1-\omega)\gamma_{.j}\right)}{\varepsilon_j+N}+\omega\left(e^{\lambda_j}\gamma_{jj}\right)^2=0.\,(5)$$

Equation (5) is not likely to have closed-form solutions, despite the parsimonious approach. So next we differentiate this implicit function (5) with respect to key variables of interest that is the quality standard, the market size, price responsiveness of demand, comparative advantage at home and abroad, the political economy weight, the tariff, and the lower-bound standard. Note that standard depends on all other variables in the model, which makes it difficult to sign. This remark holds for most of the other variables. Nevertheless the value added of the conceptual model is to provide a sound specification for the empirical investigation.

Differentiating with respect to the standard λ_j, we obtain

$$f_\lambda=\frac{e^{\lambda_j}\gamma_{.j}\left(\omega+\varepsilon_j(1-\omega)\right)\left((N-1)t_j+a+2e^{\lambda_j}\gamma_{.j}\right)}{(\varepsilon_j+N)^2}$$

$$-\frac{e^{(\lambda_0-\lambda_j)}(1-\omega)\left(Na_j+\varepsilon_j\right)+\omega\gamma_{jj}e^{\lambda_j}\left((N-1)t_j-4e^{\lambda_j}\gamma_{.j}\right)-a_je^{\lambda_j}\left(\omega\gamma_{jj}+(1-\omega)\gamma_{.j}\right)}{\varepsilon_j+N}$$

$$+2\omega\left(e^{\lambda_j}\gamma_{jj}\right)^2.$$

Differentiating with respect to market size a_j, leads to

$$f_a = \frac{e^{\lambda_j}\gamma_{.j}\left((\omega + \varepsilon_j(1-\omega)\right)}{(\varepsilon_j + N)^2} + \frac{N(1-\omega)e^{(\lambda_0-\lambda_j)} - e^{\lambda_j}\left(\omega\gamma_{jj} + (1-\omega)\gamma_{.j}\right)}{\varepsilon_j + N}.$$

Next differentiate with respect to the price responsiveness of demand ε_j. We have

$$f_\varepsilon = -\frac{2e^{\lambda_j}\gamma_{.j}\left(\omega + \varepsilon_j(1-\omega)\right)\left((N-1)t_j + a_j + e^{\lambda_j}\gamma_{.j}\right)}{\left(\varepsilon_j + N\right)^3}$$

$$+\frac{e^{\lambda_j}\gamma_{.j}(1-\omega)\left((N-1)t_j + 2a_j + e^{\lambda_j}\gamma_{.j}\right) + e^{\lambda_j}\gamma_{jj}\omega\left((N-1)t_j + a_j + 2e^{\lambda_j}\gamma_{.j}\right)}{\left(\varepsilon_j + N\right)^2}$$

$$+\frac{(1-\omega)e^{(\lambda_0-\lambda_j)}\left((N-1)t_j\varepsilon_j - Na_j\right)}{(\varepsilon_j + N)^2} - \frac{t_j(N-1)(1-\omega)e^{(\lambda_0-\lambda_j)}}{(\varepsilon_j + N)}.$$

Then differentiate with respect to abroad cost efficiency γ_{ji} , where $i \neq j$. We have

$$f_{\gamma_{j^-}} = \frac{e^{\lambda_j}\left(\omega + \varepsilon_j(1-\omega)\right)\left((N-1)t_j + a + 2e^{\lambda_j}\gamma_{.j}\right)}{(\varepsilon_j + N)^2}$$

$$-\frac{2\omega\gamma_{jj}e^{2\lambda_j} + (1-\omega)a_j e^{\lambda_j}}{\varepsilon_j + N}.$$

Differentiating with respect to own-cost efficiency γ_{jj}, we get

$$f_{\gamma_j} = \frac{e^{\lambda_j}\left(\omega + \varepsilon_j(1-\omega)\right)\left((N-1)t_j + a_j + 2e^{\lambda_j}\gamma_{.j}\right)}{(\varepsilon_j + N)^2}$$

$$-\frac{2\omega e^{2\lambda_j}\left(\gamma_{jj} + \gamma_{.j}\right) + t_j\omega e^{\lambda_j}(N-1) + a_j e^{\lambda_j}}{\varepsilon_j + N} + 2\omega e^{2\lambda_j}\gamma_{jj}.$$

Differentiating with respect to weights chosen by policy maker ω, we have

$$f_w = \frac{e^{\lambda_j}\gamma_{.j}\left(1-\varepsilon_j\right)\left((N-1)t_j + a_j + e^{\lambda_j}\gamma_{.j}\right)}{\left(\varepsilon_j + N\right)^2}$$

$$+\frac{e^{(\lambda_0-\lambda_j)}\left((N-1)t_j\varepsilon_j - Na_j\right) - e^{\lambda_j}\gamma_{jj}\left((N-1)t_j + 2e^{\lambda_j}\,\gamma_{.j}\right) - a_j e^{\lambda_j}(\gamma_{jj}-\gamma_{.j})}{\varepsilon_j + N}$$

$$+\ \left(\gamma_{jj}e^{\lambda_j}\right)^2.$$

Next the differentiation with respect to the tariff t_j is derived:

$$f_t = \frac{e^{\lambda_j}\gamma_{.j}(N-1)\left(\omega+\varepsilon_j(1-\omega)\right)}{(\varepsilon_j+N)^2} - \frac{(N-1)\left(\omega\gamma_{jj}e^{\lambda_j} + (1-\omega)\varepsilon_j e^{(\lambda_0-\lambda_j)}\right)}{\varepsilon_j+N}.$$

Finally, differentiating with respect to the lower bound standard λ_0 , we have

$$f_{\lambda_0} = \frac{Na_j(1-\omega)e^{(\lambda_0-\lambda_j)} - (N-1)(1-\omega)t_j\varepsilon_j e^{(\lambda_0-\lambda_j)}}{\varepsilon_j+N}.$$

Using these differentiation components, we summarize the total differentiation of the first order condition as

$$f_\lambda d\lambda_j + f_a da_j + f_\varepsilon d\varepsilon_j + \ f_{\gamma_j^-}\left(\textstyle\sum_{i\neq j} d\gamma_{ji}\right) + \ f_{\gamma_j} d\gamma_{jj} + \ f_w d\omega_j + f_{t_j}\, dt_j + f_{\lambda_0}\, d\lambda_0 = 0; (6)$$

or

$$d\lambda_j = f_a/f_\lambda da_j + f_\varepsilon/f_\lambda d\varepsilon_j + \ f_{\gamma_j^-}/f_\lambda\left(\textstyle\sum_{i\neq j} d\gamma_{ji}\right) + \ f_{\gamma_j}/f_\lambda d\gamma_{jj} + \ f_w/f_\lambda d\omega_j + f_{t_j}/f_\lambda\, dt_j +$$

$$f_{\lambda_0}\,/f_\lambda d\lambda_0 \ (7).$$

Equation (7) explains the variation in the endogenous standard as explained by the variation in important underlying determinants.

Model implementation

Equation (7) provides guidance for the determinants of the endogenous NTM standard in the econometric investigation. The differential multipliers ($f./f_\lambda$) have ambiguous signs as they depend on numerous variables and parameters. Later when we discuss empirical results based on equation (7), we provide empirically established signs for these effects to add understanding to the comparative statics above. Next we explain how we implement a variation of equation (7) (see equation (9) below) and match it to the empirical data.

Recall that the protectionism score of country *j* in the second essay are

$$S_j = \frac{1}{K}(\sum_k \exp(\frac{M_{intl,k} - M_{jk}}{M_{intl,k}})). \ (8)$$

Note that we only considered one standard case in the theoretical model, but, in reality, countries regulate each food product through a vector of standards. To formally link my protectionism measure with the theoretical model above, we map the score (8) into the unique NTM standard of the conceptual model in equation (7). We have

$$S_j = \exp(1 - \frac{M_j}{M_{intl}}),$$

where $\frac{M_j}{M_{intl}}$ is the standardized MRL, and

$$d(S_j) = \frac{1}{K}\sum_k e^{\left(1-\frac{M_{jk}}{M_{intl,k}}\right)} d\left(-\frac{M_{jk}}{M_{intl,k}}\right).$$

Standard λ_j relates to the MRL as $\lambda_j = -\frac{M_j}{M_{intl}}$ .Together with eq. (2), I have

$$f_{\lambda(\cdot)} d\left(-\frac{M_j}{M_{intl}}\right) + f_a da_j + f_\varepsilon d\varepsilon_j + f_{\gamma_j^-}\left(\sum_{i\neq j} d\gamma_{ji}\right) + f_{\gamma_j} d\gamma_{jj} + f_w d\omega_j + f_{t_j} dt_j + f_{\lambda_0} d\lambda_0 = 0.$$

That is,

$$d\left(-\frac{M_{jk}}{M_{intl,k}}\right) = \frac{-1}{f_{\lambda(\cdot)}}\left(f_a da_j + f_\varepsilon d\varepsilon_j + f_{\gamma_j^-}\left(\sum_{i\neq j} d\gamma_{ji}\right) + f_{\gamma_j} d\gamma_{jj} + f_w d\omega_j + f_{t_j} dt_j + f_{\lambda_0} d\lambda_0\right).$$

Then I have the final equation used for the regressions as

$$d(S_j) = e^{\left(1-\frac{M_j}{M_{intl}}\right)} d\left(-\frac{M_j}{M_{intl}}\right), \text{ or}$$

$$d(S_j) = -\frac{e^{\left(1-\frac{M_j}{M_{intl}}\right)}}{f_{\lambda(\cdot)}}\left(f_a da_j + f_\varepsilon d\varepsilon_j + f_{\gamma_j^-}\left(\sum_{i\neq j} d\gamma_{ji}\right) + f_{\gamma_j} d\gamma_{jj} + f_w d\omega_j + f_{t_j} dt_j + f_{\lambda_0} d\lambda_0\right) \quad (9).$$

Note that in the empirical investigation, we use the aggregated protectionism measures based on the vector of MRLs for each product. The reduced form (9) provides the theoretical foundation for empirical application to explain the variations of protectionism scores.

Variables used

The protectionism scores are taken from the results of second essay and based on the same data source. We removed the truncation of the MRL scores when countries impose more relaxed MRLs than Codex to preserve variation in the dependent variable. This allows any anti-protectionism situation to arise that was ignored in essay 2. We have detailed descriptions of the database used to compute the protectionism scores in the second essay. To avoid redundancy, we do not repeat them here but will when the essay is submitted for publication.

We use per capita GDP based on purchasing power parity to capture the market size or income factor of country j (a_j); we use the number of tariff lines of the HS classification system under each product to approximate the number of substitutes of the product, therefore the inverse of the demand elasticity of country j ($1/\varepsilon_j$). Variable γ_{jj} represents the cost advantage or competitiveness of country j ; variable $\sum_{i\neq j}\gamma_{ji}$ represents the total cost advantage or competitiveness of the rest of the world. If normalize the cost advantage by $\sum_{i\neq j}\gamma_{ji}$, we have the relative comparative advantage or relative competitiveness of country j . We will use the revealed comparative advantages or the so-called Balassa index

(Balassa (1965)) to capture the information on competitiveness. The Balassa index (BI) is the most frequently used index measure of revealed comparative advantage (RCA). BI uses the normalized export share to calculate the relative advantage/disadvantage of certain product for a certain country. More specifically, $BI_{jk} = \frac{E_{jk}/\sum_k E_{jk}}{\sum_j E_{jk}/\sum_j \sum_k E_{jk}}$, where E_{jk} is the export of product k of country j. In other words, BI of product k in country j is calculated as the export share of product k of country j 's total export, normalized by the export share of product k of a group of reference countries' total exports.

Variable ω_j represents the weight the policymaker puts on producer surplus versus the weight ($1-\omega_j$) put on the consumer surplus *cum* externality. This variable is related to political systems as well as lobbying activities. Beghin and Kherallah (1994) empirically examined the impact of political institutions framing rent-seeking on agricultural producer support. They found significant impact differences between multiparty and other party systems. Similarly, Opler (2001) found that protection is the highest in democratized countries with multiparty systems. Olper, Falkowski, and Swinnen (2009) found democratization would increase agricultural protection. We control for political institution systems with dummy variables for each level of Legislative Indices of Electoral Competitiveness (LIEC).

We also control other forms of protection or price policy distortions as summarized by the tariff variable in the model. It is obvious that tariffs affect market size (recall the tariff affects the price and quantity produced and consumed), but also the endogenous NTM again with much ambiguity on the sign of the impact of the import tariff on the domestic NTM standard. Systematic data on these distortions are hard to find for a large set of countries.

Several previous investigations of agricultural distortions are based on price-related distortions, Producer support equivalent (PSE) in particular (see Beghin and Kherallah (1994), and others). PSE data cover only 19 countries and 15 products, which is much fewer than my NTM protectionism measure coverage. Another price-related agricultural distortion database developed by Kym Anderson et al. (Anderson, et al. (2009)) covers 77 products and 75 countries. However, the product coverage is unbalanced per country, and only a dozen products per country on average. Again matching that data base with the MRL scores would induce a big loss of observations. In order to preserve the maximum observations of the scores, we use the real exchange rate from the World Bank (WDI) and import tariffs from WITS to capture the macro policy distortion and major price distortion in each market. These are the main form of price distortions but they do not cover agricultural subsidies unfortunately. All variables and their source are summarized in Table 1.

The retained empirical specification based on equation (9) is

$$S_{jk} = \alpha_0 + \alpha_1 GDP\_PPP_j + \alpha_2 Elas\_Inv_{jk} + \alpha_3 RCA_{jk} + \alpha_4 RCA\_ROW_{jk} + \alpha_5 Pol_j + \alpha_5 Tariff_{jk} + \alpha_6 Exchage_j + \alpha_7 X_{jk} + \varepsilon_{jk}. \quad (9)$$

Similarly to Trefler (1993), no hypothesis would be tested, since the theoretical model does not yield unambiguous and therefore testable hypothesis. This illustrates the essential limitations even using a parsimonious framework as here. On the other hand, the estimated coefficients may shed some light on the determinants of endogenous NTM protection.

Data

The per capita GDP based on purchasing power parity and real effective exchange rate data were obtained from Penn World Table Version 6.3 (Heston et. al. 2009). The tariff and the number of tariff line data are downloaded from TRAINS. We downloaded the

Revealed Comparative Advantage (RCA) index from World Integrated Trade System (WITS) using the underlying UN COMTRADE data. We are aware the possible simultaneity problem of imports and MRLs as pointed by Trefler (1993). With a few exceptions, we used lagged trade data in year 2009 (MRL data in the year 2011) to accommodate the potential bias. When the 2009 data were unavailable, the latest available data was used to substitute. Political institution data were obtained from the Database of Political Institutions 2010 (Beck et. al. 2001). The worldwide governance indicators (WGI) data come from the World Bank and were downloaded from The World Bank website (http://info.worldbank.org/governance/wgi/index.asp).

Other considerations

To investigate the potential endogeneity of trade policies, we develop some instruments based on the existing trade literature on endogenous protection (See Trefler (1993), Mansfield and Busch (1995), etc.). We use the agriculture labor/land ratio to measure the labor and capital (land, in this case) ratio. Agriculture labor endowment is the count of labor force employed in agriculture sector; the labor endowment is the area of agriculture land. These data were obtained from World Bank. The formula to compute the labor/land ratio is as follows: Ag labor/land ratio = Employment in agriculture / agriculture land area). Agriculture import penetration rate, a second instrument, is a measure of the importance of Ag import. We downloaded the gross import and export data for ISC division 1-5 from WITS, and used the agriculture value added data from World Bank. We then followed Trefler (1993) and his formula to calculate the Agriculture import penetration ratio: import penetration ratio = (Gross imports / (Domestic production + net imports)) X 100.

Table 1: Variable Definition and sources

Variable Name	**Definition**	**Source**
$Score_{jk}$	Protectionism scores for country *j* product *k*, where non-established MRLs are substituted with default levels	Essay 2
Intercept	Protectionism score at Codex level	USDA MRL database
GDP_PPP_j	Gross domestic product at purchasing power parity per capita	Penn World Table Version 6.3 (Heston et. al. 2009).
$GDP\_PPP\_Scaled_j$	GDP_PPP /1000, Gross domestic product at purchasing power parity per capita in 1000 dollars.	Penn World Table Version 6.3 (Heston et. al. 2009).
$Elas\_Inv_{jk}$	Country *j* total tariff lines for product *k*	TRAINS
$Elas\_Inv\_Scaled_{jk}$	Country *i* total tariff lines for product *k* in 10 tariff lines	TRAINS
RCA_{jk}	Revealed Comparative Advantage index at product level	WITS, UN COMTRADE
RCA_ROW_{jk}	Summing over the Revealed Comparative Advantage index of all other exporters except country *j* for product *k*	WITS, UN COMTRADE
$Tensys_j$	the number of years the country been autocratic or democratic, respectively	Database of Political Institutions 2010 (Beck et. al. 2001)
VA_j	Voice Accountability, one of the aggregate indicators of governance.	World Bank
PS_j	Political Stability and Absence of Violence/Terrorism, one of the aggregate indicators of governance.	World Bank
GE_j	Government Effectiveness, one of the aggregate indicators of governance.	World Bank
RQ_j	Regulation Quality, one of the aggregate indicators of governance.	World Bank
RL_j	Rule of Law, one of the aggregate indicators of governance	World Bank
CC_j	Control of Corruption, one of the aggregate indicators of governance.	World Bank

Table 1: Variable Definition and sources continued

Variable Name	Definition	Source
$Liec_j$	Legislative Indices of Electoral Competitiveness, categorical variable. Scale is as follows: no legislature (1); unelected legislature (2); elected, 1 candidate (3); 1 party, multiple candidates (4), multiple parties are legal but only one party won seats (5); multiple parties DID win seats but the largest party received more than 75% of the seats (6); largest party got less than 75% (7).	Database of Political Institutions 2010 (Beck et. al. 2001)
$Tariff_{jk}$	Country *j* simple average of effectively applied rates over all tariff lines for product *k*	TRAINS
$Exchange_j$	real exchange rate in 2009	Penn World Table Version 6.3 (Heston et. al. 2009).
$AgLaborLand_j$	number of Ag labor for every square kilometer of Ag land	World Bank
$AgLaborLand\_Scaled_j$	AgLaborLand /100, the number of Ag labor for every 0.01 square kilo meter of Ag land.	World Bank
$AgImportPenetration_j$	Agriculture import penetration ratio * 100, in percentage	World Bank, WITS
RTA_j	the number of unique Regional Trade Agreement (RTA) partner.	Regional Trade Agreements Information System by the World Trade Organization
RTA_Scaled_j	RTA/10, the number of unique Regional Trade Agreement (RTA) partner in 10 partners.	Regional Trade Agreements Information System by the World Trade Organization

We also account for constraints on protection via preferential and multilateral trade agreements which constrain the ability to use tariffs for protection. We counted the number of unique regional trade agreement partners as a proxy for the intensity of trade integration.

The original data was compiled from Regional Trade Agreements Information System by the World Trade Organization (http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx). The types of agreements considered include Custom Union (CU), Free Trade Agreement (FTA), Partial Scope Agreement (PSA), and Economics Integration Agreement (EIA). We are aware of the different extent of the integration by different types of agreements. For transparency, however, we count each agreement equally. The country trading partner which is involved in more than one agreement will only be counted once.

Finally, we take the EU as one aggregate group, and take the average of values of individual EU countries if necessary when EU data are not available. For example, we use the average WDI, exchange rate, and GDP at purchasing power parity per capita, of all EU countries.

Data Distribution and Sample Statistics

In this section, we discuss the distribution of nontruncated protectionism scores, and the sample statistics of all variables. The total sample contains 11,885 observations. From figure 1, one can observe a spike of scores is at the value of 1. More specifically, 7,577 out of 11,885 values equal one (about 74%). This means that they are set at the international standard level.

Figure1: Histograms of score 1.

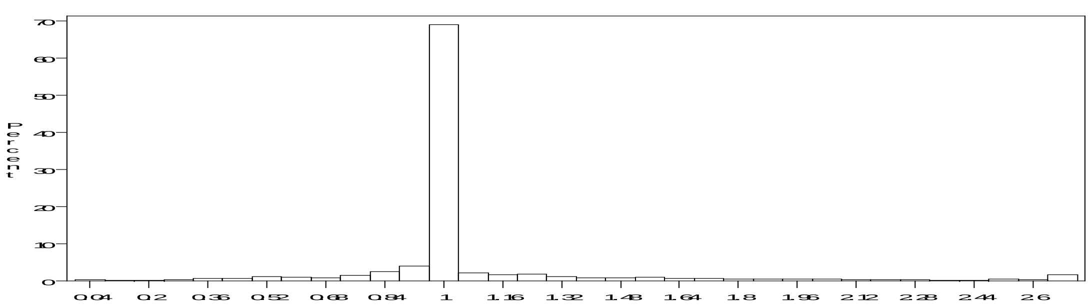

Table 2: sample statistics of numerical variables

	Min.	Median	Mean	Max.	Standard Deviation
score1	0.00	1.00	1.08	2.72	0.38
GDP _PPP	1403.01	10521.17	16645.84	65864.35	15165
GDP_PPP_Scaled	1.40	10.52	16.65	65.86	15.16
Elas_Inv	1.00	8.00	34.56	2531.0	147.44
Elas_Inv_Scaled	0.1	0.8	3.46	253.1	14.74
RCA	0.00	0.11	4.48	3743.45	43.61
LogRCA[16]	-9.90	-2.19	-2.52	8.23	3.38
RCA_ROW	4.38	118.08	203.96	6502.54	257.55
LogRCA_ROW	1.48	4.77	4.77	8.78	1.06
Tensys	1.00	20.0	24.28	79.0	21.36
VA	-1.72	0.07	0.6	1.48	0.84
PS	-2.68	-0.13	-0.23	1.14	0.91
GE	-0.95	0.17	0.33	2.27	0.85
RQ	-1.54	0.26	0.29	1.83	0.83
RL	-1.59	-0.16	0.08	1.92	0.91
CC	-1.19	-0.30	0.14	2.43	0.98
Tariff	0.00	7.20	14.09	800.3	23.34
Exchange	0.71	7.76	666.19	17941.0	2850
LogExchange	-0.34	2.05	2.62	9.79	2.46
AgLaborLand	0.09	25.44	125.97	3739.24	532.68
AgLaborLand_Scaled	0.00	0.25	1.26	37.39	5.32
AgImportPenetration	0.00	0.02	0.19	4.63	0.79
LogAgImportPenetration	-6.09	-4.11	-3.94	1.53	1.39
RTA	1.00	44.00	37.56	113	25.16
RTA_Scaled	0.1	4.4	3.76	11.3	2.52

[16] RCA is added by 0.0001 when taking log if RCA is zero.

Table 3: sample statistics of categorical variable

***liec*:**
legislative indices of electoral competitiveness

level	Description	count
2	elected, 1 candidate	249
3	1 party, multiple candidates	493
4	multiple parties are legal but only one party won seats	380
6	multiple parties DID win seats but the largest party received more than 75% of the seats	874
7	Largest party got less than 75%.	9889

For the *liec* categorical variable, since category 7 is dominant amount of observations, and we use *liec*=7 as baseline. We also included HS4 sector dummies, and used the base line to be the combination of multiple HS4 sectors that appear to cause collinearities with other independent variables.

Regression Results

Collinearity

We check the data for some potential collinearity[17]. Collinearity is a problem with data itself, and it can be, but not need to be, harmful. We use conditioning index, variance inflation index (VIF) and variance-decompositions jointly to diagnose the multi-collinearity problems in my sample as described in Belsley et al. (1980). Practically, multicollinearity may be a serious problem when the conditioning index is greater than 30, the VIF is greater

[17] Results available upon request.

than 10, and variance-decomposition proportions for two or more estimated regression coefficient variances are higher than 0.5.

Estimation

The endogeneity of tariff has been a recurrent issue in the trade literature. Rodrik(1995) reviewed some of the most commonly used approaches to endogenize trade policy by linking the level of the trade policy, such as a tariff, to the amount of lobbying resources. Ray (1981) simultaneously estimated the endogenous tariff and nontariff restrictions equations. I conduct a Hausman test for the endogeneity of tariff, and the test results support the endogeneity of tariffs. Hence, we use 2-Stage Least Square to correct the endogeneity. Further, we use all the variables we have in the second stage plus the tariff bindings as the instruments in the first stage. The tariff binding mean members of World Trade Organization commit not to increase tariffs beyond the agreed level (www.wto.org). The tariff binding data was obtained from WITS.

In table 4, we listed the marginal effects of the preferred regression results, based on 2-Stage-Least-Square (2SLS). The results bring the following remarks. The intercept is the protectionism score for *liec*=7 and omitted HS4 sectors and implicitly the codex standard score since the latter is equal to 1. Variable *GDP_PPP* , the measure of PPP income, has significant positive impact on protectionism scores. This result shows that higher income countries tend to protect domestic market and their consumers more than lower income countries do. This is expected as consumers may value food safety more than consumers in poorer countries, and it is also consistent with other related studies on agricultural protection increasing with development (see Beghin and Kherallah (1994), Mansfield and Busch (1995), etc.)

Table 4: Marginal Effect from preferred 2SLS

Variable	2SLS Marginal Effects
Intercept	0.630*** (0.033)
GDP_PPP_scaled	0.020*** (0.001)
Elas_Inv_scaled	0.001*** (0.001)
RCA[18]	-0.0007*** (0.0002)
RCA_ROW	-0.00002 (0.00002)
tensys	-0.005*** (0.000)
RQ	0.026*** (0.007)
liec2[19]	-1.061*** (0.036)
liec3	-0.163*** (0.018)
liec4	-0.027 (0.020)
liec6	0.203*** (0.017)
tariff	-0.002*** (0.000)
Exchange_rate	0.00001*** (0.000003)
AgLaborLand_Scaled	-0.020*** (0.001)
AgImportPenetration	-0.453*** (0.021)
RTA_Scaled	-0.003** (0.001)
R^2=0.230	

[18] The marginal effects of log-transformed variables are calculated using mean values.
[19] The marginal effects of *liec* dummy variables are compared against *leic7*.

The inverse of demand price elasticity, which is approximated by the count of the number of tariff lines under HS6 shows that the higher the demand elasticity the lower the MRL strctiveness. Elastic markets tend to have lower tariff protection and domestic distortions (Gardner, 1987), and our results show MRLs have consistent patterns as other distortion methods.

The Revealed Comparative Advantage (RCA) variable shows a negative impact on protectionism scores. If a country exhibits comparative advantage, meaning it has advantage in exporting, then it maybe that the sector is competitive and does not fear competing imports. Hence, demand for protection maybe smaller from export oriented sectors as opposed to less competitive sectors that may fear the competition of imports and may demand higher NTMs to block imports. On the other hand, we found negative, but not significant impact of the RCA of the rest of world on the protectionism score. The magnitude of the coefficients are consistent with what we show in the conceptual model part, that is the impact of the RCA of the rest of world should be smaller than the impact of RCA, but the former is not significant. This may happen because the measure of the RCA of the rest of the world is not good enough to capture the actual variation in RCA.

Moving to the political institutions variables, variable *Tensys* is the years in place for the current government and it's a measure of the political stability. We find that the longer the government in power, the lower the protectionism scores. This is somewhat a surprise as one associates political stability with higher income countries. In the robustness section below, We found that the estimate of *Tensys* from 2SLS and univariate OLS have opposite and significant sign, which suggest the result may be unstable.

Regulation Quality (*RQ*) is a government quality index. There are total six government quality indices in the World Bank database, and they are highly positively correlated (correlation coefficient above 0.7). We chose RQ since it seems to have the most power among the seven measures to explain variation in MRL protectionism scores. RQ has a positive impact on protectionism score, showing that the higher quality of regulation the higher the MRL scores. The result is stable; coefficient loses significance in 3 out of 10 robustness runs but do not alternate signs.

Political institution dummies (*liec*s) show an inverted u-shape impact on protectionism scores. The *liec2* has the lowest protectionism scores, then *liec3* is lower than *liec4*, *liec6* has the highest protectionism scores, and *liec7* is lower than *liec6*. The more democratic the system leads to the higher protectionism scores up until *liec6*. This pattern is consistent with that Beghin and Kherallah (1994) found in explaining the role of political institutions in determining producer subsidy equivalent (PSE).

The higher the tariff, the lower are the MRL scores. This result shows that tariff and non-tariff measures are substitute instruments in protection. Countries with high tariffs tend to have less stringent MRL-based NTMs, while countries with lower tariffs tend to have stricter NTMs. This is different from Ray (1981) found in manufacturing industry, which showed nontariff protection had supplemented tariff restrictions. Note that his nontariff indices restrictions covered 15 quantitative restriction categories, including quotas, licensing, minimum price, restrictions, etc. Consistent with the results here, Mansfield and Busch (1995) showed that tariff and NTBs are substitutes in protection as well. Therefore, the interaction between tariff and nontariff may have evolved overtime because of successive round of General Agreement of Tariff and Trade (GATT).

The real exchange rate is the other measure of policy distortion. Results for this variable were not robust. The sign of the real exchange rate impact on the scores is sensitive to the inclusion/exclusion of *GDP_PPP* (the income level variable). See the robustness check section for further results. Before controlling for *GDP_PPP*, the real exchange rate variable has a negative impact on the protectionism score, and after controlling for *GDP_PPP*, the real exchange rate has a positive impact on the protectionism scores. Such sign reversal suggests being cautious interpreting the results on exchange rates.

The Agricultural labor/land ratio is related to the domestic cost of production of agricultural products. It has a negative impact on protectionism, showing that the more labor per square kilometer Agriculture land, the lower the protectionism. In other words, the country that is more labor intensive in agriculture tend to have less protection via MRLs than a country that is more capital intensive in agriculture. This result is consistent with most other studies found in other agriculture protection policies. See de Gorter and Swinnen (2002) for a summary of the studies that found a similar negative impact of the agricultural labor/ capital ratio on the level of protection.

The agricultural import penetration ratio measures the importance of agricultural imports to the overall economy. Grossman and Helpman (1994) provide a theoretical justification for this positive link. The higher the import penetration the lower the trade protection. My results seem support this prediction with standard-like NTM, that agricultural import penetration ratio has negative impact on MRL scores, indicating that countries which rely heavily on agricultural imports tend to have lower MRL scores. We are aware the possible simultaneity problem of imports and MRLs as pointed by Trefler (1993). We use lagged trade data in year 2009 (MRL data in the year 2011) to accommodate the potential bias.

RTA, the number of Regional Trade Agreement partners, measures the integration level with partner countries. Everything else equal, *RTA* has a negative impact on protectionism scores, which shows economic integration reduces MRL scores. This could be due to the fact that very integrated economies have overcome protectionist tendencies and may have rationalized some of their NTMs through these RTAs. The estimated *RTA* impact is not very stable (lose significance 4 out of 10 runs of robustness check), and particularly sensitive to the political institution dummy variables *liec*'s (with a sign reversal).

Variable Correlation and Robustness Check

Our independent variables are clearly correlated as it is often the case with social science data. A better understanding of their correlation patterns would help us gauge the robustness of the results, and also deepen our understanding of these results. In a multivariate regression system, correlations among variables are complex, could potentially have various directions and magnitudes. Different combinations of variable may make the coefficients quite different.

In this section, we first compare 2-stage least square with OLS, and single variable OLS. Please note that single variable OLS suffer obviously from omitted variable bias issues, but it provides an essential benchmark for my discussion and allows seeing how the direction and significance of the direction persist and survive the addition of additional variables.

Then we compare the 2SLS results with the OLs runs (full runs and runs with one variable deleted at each run, to see how sensitive other variables' estimates to any one variable. This is to help us better understand the impact of the correlations on estimates.

Table 5: 2SLS, OLS, and Univariate OLS

Variable	2SLS (R^2=0.230)	OLS (R^2=0.208)	Univariate OLS
Intercept	0.630*** (0.033)	0.552*** (0.026)	1.078*** (0.003)
GDP_PPP_scaled	0.020*** (0.001)	0.019*** (0.001)	0.007*** (0.000)
Elas_Inv_scaled	0.001*** (0.001)	0.002*** (0.0002)	0.004*** (0.000)
logRCA	-0.003*** (0.001)	-0.001 (0.001)	-0.002* (0.001)
logRCA_ROW	-0.005 (0.005)	-0.001 (0.003)	-0.00006 (0.003)
tensys	-0.005*** (0.000)	-0.005*** (0.000)	0.004*** (0.000)
RQ	0.026*** (0.007)	0.023*** (0.007)	0.131*** (0.004)
liec2	-1.061*** (0.036)	-1.023*** (0.035)	-0.102*** (0.024)
liec3	-0.163*** (0.018)	-0.143*** (0.018)	-0.092*** (0.017)
liec4	-0.027 (0.020)	-0.014 (0.020)	-0.093*** (0.020)
liec6	0.203*** (0.017)	0.179*** (0.017)	-0.107*** (0.013)
tariff	-0.002*** (0.000)	-0.0005*** (0.0001)	-0.0005*** (0.000)
logExchange_rate	0.007*** (0.002)	0.006*** (0.002)	-0.015*** (0.001)
RTA_Scaled	-0.003** (0.001)	-0.004*** (0.001)	-0.002 (0.001)
AgLaborLand_Scaled	-0.020*** (0.001)	-0.018*** (0.001)	-0.004*** (0.001)
logAgImportPenetration	-0.086*** (0.004)	-0.085*** (0.004)	0.003 (0.003)

The coefficients are rather stable comparing 2SLS with OLS, but show noticeable discrepancy with univariate OLS results. More specifically*, GDP_ PPP, Elas_scaled, logRCA, logRCA_ROW, RQ, liec2, liec3 tariff, AgLaborLand_Scaled,* are consistent in sign and significance from 2SLS, OLS, and univarate OLS, though the magnitudes are different which is to be expected as omitted variables bias these univariate magnitudes. Also note that, after the tariff is instrumented in 2SLS, the estimated effect of tariff is four times larger than the non-instrumented tariff effect. *logExchange_rate*, *tensys* and *liec6* are still significant but sign reversed. *RTA* lost significance and *liec4* gained significance.

Further based on the 2SLS with one variable deleted at each run, I observe the following patterns. *Tariff* appears to be very robust to most of the single deletions, but lost its significance if not controlling for different political systems (the *liec*s). *GDP_PPP*, *Elas_Inv_scaled*, *RCA*, *RCA_ROW*, t*ensys*, *liec2*, *liec3*, *AgLaborLand*, *AgImportPenetration* are robust to the exclusion of any single variable. Their sign and significance are consistent for 9 out of 10 robustness check runs.

logExchange_rate is sensitive to the deletion of *GDP_PPP*. Without controlling for country income level, the exchange rate has negative impact on protectionism score, but after controlling income levels, *logExchange_rate* has positive impact on protectionism score. In other words, given the same country income level, the higher exchange rate the higher protectionism score, but ignoring income level, higher exchange rate values are associated with lower protectionism scores. *logExchange_rate* appears to lose its significance if we don't control the political institutional differences (*liec*s). In conclusion, the results associated with the real exchange rate variable are not robust.

Variable *RQ* has positive significant results for the most cases, but tend to lose significance if I do not control for the *logExchange_rate*, *tensys*, or *AgImportPenetration* effects. Similarly, *RTA* is not very stable either. It loses significance 4 out of 10 runs of robustness check), and particularly sensitive inclusion/deletion to the political institution dummy variables *liec*'s with a sign reversal.

The intercept captures the impact of the international standard (value of 1), in addition to the defaults of variables (liec=7, and HS4 sectors). Abstracting from these 2 categorical variables, one can see that the international standard on average explains roughly 63 percent of the standards and than other elements are also important. Looking at Table 6, one can see that income variation and agricultural import penetration explain the major portion of the departure from the international standard (1 versus .63). Once either variable is omitted, the estimated intercept goes back to around one (see table 6 columns omitting the income and agricultural import penetration variables).

Table 6: 2SLS results with one variable deleted at each run

Intercept	1.010*** (0.032)	0.618*** (0.033)	0.643*** (0.032)	0.605*** (0.021)	0.690*** (0.033)	0.625*** (0.033)	0.731*** (0.032)	0.630*** (0.033)	0.658*** (0.032)	0.583*** (0.033)	1.017*** (0.028)	0.622*** (0.033)
GDP_PPP_scaled	—	0.020*** (0.001)	0.020*** (0.001)	0.020*** (0.001)	0.014*** (0.000)	0.021*** (0.000)	0.007*** (0.000)	0.020*** (0.001)	0.019*** (0.001)	0.015*** (0.001)	0.015*** (0.001)	0.020*** (0.001)
Elas_Inv_scaled	0.002*** (0.000)	—	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
logRCA	-0.010*** (0.001)	-0.003** (0.001)	—	-0.003*** (0.001)	-0.004*** (0.001)	-0.002* (0.001)	-0.007*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.004*** (0.001)	-0.0004 (0.001)	-0.003*** (0.001)
logRCA_ROW	-0.001 (0.005)	-0.002 (0.005)	-0.006 (0.005)	—	-0.003 (0.005)	-0.005 (0.005)	-0.0003 (0.005)	-0.005 (0.005)	-0.005 (0.005)	-0.003 (0.005)	-0.006 (0.005)	-0.004 (0.005)
tensys	-0.0005** (0.0002)	-0.005*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)	—	-0.005*** (0.000)	-0.001*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)	-0.003*** (0.000)	-0.003*** (0.000)	-0.005*** (0.000)
RQ	0.171*** (0.006)	0.026*** (0.007)	0.021*** (0.007)	0.027*** (0.007)	0.011 (0.007)	—	0.105*** (0.006)	0.026*** (0.007)	0.034 (0.007)	0.043*** (0.007)	0.010 (0.007)	0.027*** (0.007)
liec2	-0.136*** (0.025)	-1.059*** (0.036)	-1.079*** (0.035)	-1.060*** (0.036)	-0.709*** (0.031)	-1.117*** (0.032)	—	-1.061*** (0.036)	-1.033*** (0.035)	-0.738*** (0.033)	-0.927*** (0.036)	-1.053*** (0.035)
liec3	-0.142*** (0.019)	-0.163*** (0.018)	-0.166*** (0.018)	-0.163*** (0.018)	-0.079*** (0.018)	-0.160*** (0.018)	—	-0.163*** (0.018)	-0.168*** (0.018)	-0.067*** (0.018)	-0.270*** (0.018)	-0.156*** (0.018)
liec4	0.141*** (0.020)	-0.027 (0.020)	-0.032 (0.019)	-0.027 (0.020)	0.017 (0.020)	-0.050* (0.019)	—	-0.027 (0.020)	-0.002 (0.019)	0.001 (0.020)	-0.016 (0.020)	-0.028 (0.020)
liec6	-0.013 (0.01)	0.196*** (0.017)	0.200*** (0.017)	0.203*** (0.017)	0.133*** (0.016)	0.209*** (0.017)	—	0.203*** (0.017)	0.180*** (0.016)	0.027* (0.015)	0.078*** (0.016)	0.196*** (0.016)
tariff	-0.001*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)	-0.001*** (0.000)	-0.002*** (0.000)	-0.0003 (0.0002)	-0.002*** (0.000)	-0.002*** (0.000)	-0.001** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)
logexchange_rate	-0.010*** (0.002)	0.007*** (0.002)	0.007*** (0.002)	0.007*** (0.002)	0.009*** (0.002)	0.008*** (0.001)	-0.001 (0.001)	0.007*** (0.002)	—	0.001 (0.002)	0.007*** (0.002)	0.007*** (0.002)
AgLaborLand_scaled	-0.008*** (0.001)	-0.020*** (0.001)	-0.020*** (0.001)	-0.020*** (0.001)	-0.014*** (0.001)	-0.021*** (0.001)	-0.007*** (0.001)	-0.020*** (0.001)	-0.019*** (0.001)	—	-0.022*** (0.001)	-0.020*** (0.001)
logAgImport Penetration	-0.025*** (0.004)	-0.084*** (0.004)	-0.084*** (0.004)	-0.086*** (0.004)	-0.051*** (0.004)	-0.084*** (0.004)	-0.062*** (0.004)	-0.086*** (0.004)	-0.085*** (0.004)	-0.095*** (0.004)	—	-0.085*** (0.004)
RTA_scaled	-0.001 (0.001)	-0.001 (0.001)	-0.003** (0.001)	-0.003** (0.001)	-0.002 (0.001)	-0.003** (0.001)	0.003** (0.001)	-0.003** (0.001)	-0.003** (0.001)	-0.005*** (0.001)	-0.001 (0.001)	—
R-Square	0.152	0.224	0.229	0.230	0.206	0.229	0.169	0.230	0.229	0.199	0.201	0.229

Conclusion

The empirical literature about endogenous standard-like NTMs, especially MRLs, and the determinants of their protection level is limited. In this paper, I built a parsimonious partial equilibrium trade model with an externality addressed by a single NTM standard. The policy maker solves for the standard that maximizes a weighted sum of welfare measures. I derive the comparative statics of underlying determinants to see how they impact the political-economy standard. Despite the parsimonious structure, it is impossible to sign comparative statics. Then, I undertake an empirical investigation of the determinants of endogenous standards based on the MRL protectionism score developed in my second essay. I attempt to explain its variation in terms of the determinants derived from the simple conceptual model.

After correcting for endogeneity bias, tariff protection shows 4 times larger impact on the MRL protectionism score than without instruments. In addition, tariff and MRL protections are shown to be substitute instruments in protection (NTM and tariff are negatively linked). A country with a higher income level has a higher protectionism score as expected, and comparative advantage as measured by RCA has a negative impact on the MRL stringency. Demand price responsiveness has a negative impact on protectionism score, which is consistent with results in existing literature of tariff protection and domestic distortions (Gardner, 1987). We also found an inverted u-shaped MRL protection level in terms of political institutions from the least democratic, “elected, 1 candidate” to most democratic, “largest party got less than 75%”. In addition, comparing existing results with manufacturing industries, and/or coverage ratio measure of NTMs, and different set of NTMs, our results are mostly consistent in the directions of impact on protection level.

The robustness analysis suggests that the estimates of exchange rate, *Tensys*, and *liec6* may be less robust, since we found sign reversals by comparing results from 2SLS with univariate OLS. We also check how sensitive coefficients are to the deletion of variable one at a time. Regional Trade Agreement, real exchange rate, and regulation quality index seem to be relatively less robust than other variables. The robustness analysis also suggests that income per capita and agricultural import penetration explain a large portion of the departure of actual standards and international ones.

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