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Estimating the Effects of Selected Sanitary and Phytosanitary Measures and Technical Barriers to Trade on U.S.-EU Agricultural Trade

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Abstract

This study investigates the effects of selected sanitary and phytosanitary measures (SPS) and technical barriers to trade (TBT) on agricultural trade between the United States and the European Union (EU). It identifies data, methodological, and conceptual challenges to quantify such non-tariff measures (NTM) in the context of free-trade agreements. An empirical strategy combining market analysis with gravity model econometric methods is used to quantify the extent of protection afforded by major NTMs in U.S.-EU agricultural trade. In most of the commodities investigated with specific SPS/TBT concerns, estimated ad valorem tariff equivalents (AVE) of NTMs were found to be considerably higher than existing tariffs. EU NTMs on U.S. poultry, pork, and corn were found to have the most trade-impeding effects, with estimated AVE effects of 102, 81, and 79 percent, respectively; EU NTMs on U.S. beef, vegetables, and fruits were also found to be significant. The AVE effect of U.S. NTMs on EU exports ranges from 37 percent for vegetables to 45 percent for fruits.

Keywords: Non-tariff measures, NTMs, gravity model, agricultural trade, trade agreement, Transatlantic Trade and Investment Partnership, T-TIP, United States, European Union, EU, sanitary and phytosanitary measures, SPS, technical barriers to trade, TBT

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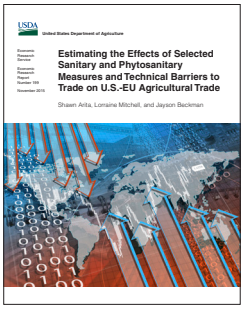

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Estimating the Effects of Selected Sanitary and Phytosanitary Measures and Technical Barriers to Trade on U.S.-EU Agricultural Trade

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What Is the Issue?

The proposed Transatlantic Trade and Investment Partnership (T-TIP) is a trade and investment agreement under negotiation by the United States and the European Union (EU). Along with tariff reduction, the removal of non-tariff measures (NTM) has emerged as a key focus of negotiations. For agriculture, the most frequently cited policy barriers to trade are sanitary and phytosanitary (SPS) measures intended to address food safety and animal or plant health issues and technical barriers to trade (TBT) that set out requirements for a product, such as technical standards and labeling. Given that addressing NTMs is a key goal of trade negotiations, there is growing interest in quantifying the extent of protection embodied in these measures and the effects of their removal on trade.

What Did the Study Find?

The EU and U.S. SPS/TBT measures econometrically investigated in this study were found to be impediments to U.S.-EU agricultural trade. Across most measures examined, the ad valorem tariff equivalent (AVE) effects of these measures were estimated to be larger trade barriers than existing tariffs and tariff-rate quotas (TRQ) levied on the same products. The findings suggest that addressing these SPS/TBT measures has the potential to generate agricultural trade expansion between the two trading partners. Key findings from the econometric analysis follow:

- *Beef*: EU SPS restrictions, such as the ban on growth hormones, impede U.S. beef exports. The AVE effects of these measures were estimated to be equivalent to a 23- to 24-percent tariff. However, the gains from addressing these SPS restrictions may be restrained by the EU's current TRQ regime, which imposes high out-of-quota tariffs (70-percent AVE).

- *Pork*: EU restrictions on beta agonists, trichinae, and other measures were found to limit U.S. pork exports. The AVE effect of these measures was estimated to be 81 percent. The currently applied EU tariff rate is 25 percent.

- *Poultry*: The EU pathogen-reduction treatment restriction on poultry is a de facto ban on U.S. products. The estimated effect of the measure was found to be equivalent to a prohibitive 102-percent tariff. The currently applied EU tariff rate is 21 percent.

- *Corn and soy*: The EU's SPS/TBT measures on genetically engineered (GE) varieties of corn and soy were found to impede U.S. exports. While these commodity products enter the

EU largely duty free, the AVE effects of these SPS/TBT measures were estimated to be 79 percent for corn and 17 percent for soy.

- *Fruits and vegetables*: The EU's maximum-residue limits of pesticide residues and other harmful substances were found to be impediments for U.S. exports of fruit and vegetable products. The AVE effects of EU requirements were estimated to be 35 percent for fruits and 53 percent for vegetables (the average currently applied EU tariff rates are 10 and 14 percent, respectively). The U.S. import approval process for new types of fruit and vegetable products was also found to impede EU fruit and vegetable exports, with estimated AVE effects of 45 and 37 percent (the current average U.S. tariff rates are 2 and 5 percent, respectively).

How Was the Study Conducted?

In contrast to typical broad-based approaches that provide generalized estimates of NTMs and do not distinguish among different types of measures, this study estimates specific NTMs. The analysis focuses on exports of commodities that face SPS/TBT measures that have been raised as significant concerns by U.S. and EU exporters. Individual gravity models were estimated for each of the concerns to measure the specific effect of NTMs. The approach takes advantage of recent theoretical and empirical advances in the literature to estimate appropriately specified econometric models.

The estimates are not intended to be exhaustive but to capture a sample of SPS/TBT concerns that have been raised in EU-U.S. trade discussions. Due to data and modelling limitations, not all SPS/TBT measures were evaluated. Furthermore, other trade-related measures, such as administrative and customs requirements, rules of origin, geographic indicators, and Government procurement, were not examined. The level of regulatory convergence or reform from a possible T-TIP agreement could include more (or fewer) NTMs than were examined in this study.

Estimating the Effects of Selected Sanitary and Phytosanitary Measures and Technical Barriers to Trade on U.S.-EU Agricultural Trade

Introduction

The reduction in global tariffs over the past few decades has shifted the focus of trade policy research to better understanding the impacts of non-tariff measures (NTM). NTMs are defined as policy measures other than tariffs that can potentially have an economic effect on international trade (UNCTAD, 2010). For agriculture, sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) stand out as costly impediments to trade (Cadot et al., 2015; Skorobogatova and Knebel, 2011). While SPS and TBT measures are intended to ensure that imports meet food safety, animal or plant health, and technical regulations of the importing countries, these requirements may affect trade by adding increased compliance, inspection, and operational costs.[1] Exporters have claimed that some SPS/TBT measures have requirements disproportionate to the actual levels of risk and excessively impede trade, often acting as disguised barriers to trade.

The proposed Transatlantic Trade and Investment Partnership (T-TIP) is a trade and investment agreement under negotiation by the United States and the European Union (EU). NTMs are frequently described as an important source of potential trade gains for T-TIP and are a key focus of negotiations (ECORYS, 2009; Fontagne et al., 2013; Josling and Tangermann, 2014). However, measuring the economic effects of these types of measures can be difficult. Unlike tariffs, NTMs are neither transparent nor easily quantified, leading to several data, methodological, and conceptual challenges.

This study empirically examines the effects of SPS/TBT measures on U.S.-EU agricultural trade in the context of the proposed T-TIP agreement.[2] In contrast to broad-based approaches that seek generalized estimates of NTMs and do not distinguish between different types of measures, this analysis applies a more tailored strategy that examines the effects on trade in commodities with specific SPS/TBT concerns raised by U.S. and EU exporters. The study econometrically investigates these measures using a gravity model framework to estimate the protection afforded and forgone levels of trade. The results of each of these estimates are discussed in terms of the nature of the concerned SPS/TBT and its economic relevance. The appendix provides estimates of the forgone losses of trade due to these measures, a discussion of the caveats of these estimates, and further steps that may be pursued to evaluate welfare effects.

[1]Under the World Trade Organization's (WTO) SPS Agreement, countries may take measures to protect human, animal, and plant health against threats arising from additives, contaminants, toxins, pests, and diseases in food, beverages, and feed as long as they are based on science, implemented with adequate risk assessment, and do not discriminate against foreign producers. The WTO's TBT agreement states that technical standards and regulations should fulfill a legitimate objective and not unnecessarily impede trade.

[2]A complementary ERS study, *Agriculture in the Transatlantic Trade and Investment Partnership: Tariffs, Tariff-Rate Quotas, and Non-Tariff Measures* (Beckman et al., 2015), quantitatively assesses the economic implications of T-TIP using the SPS/TBT estimates of this report.

Assessing SPS/TBT Measures in U.S.-EU Agricultural Trade

The empirical challenges of assessing NTMs are substantial (Deardorff and Stern, 1997; Ferrantino, 2010; Beghin et al., 2012). Unlike tariffs, NTMs are not directly quantifiable, they are not easily modeled, and data and information are limited. Indirect estimation of NTM costs is a challenge because in most cases, one does not observe the true counterfactual—that is, the value of trade had the measure not been in place. Finally, the idiosyncratic nature of NTMs makes estimation difficult to generalize and apply on a large-scale basis. (For information on additional challenges to assessing NTM costs, see box "Price-Gap Versus Quantity-Gap Methods.")

A further empirical issue in estimating the effects of NTMs in the context of free-trade agreements (FTAs) is the question of scope (i.e., selecting the sample of NTMs to evaluate). Many countries apply NTMs across a wide range of imported products. While previous FTAs contain provisions that address concerns about NTMs, they offer little guidance in predicting the terms of their use in future trade deals. For agricultural trade, some FTAs offer only to reaffirm the commitments of the World Trade Organization's (WTO) SPS/TBT agreements. Others seek to go beyond the WTO commitments and reform specific SPS/TBT measures.[3] These latter agreements vary in scope, ranging from the establishment of SPS committees to detailed annexes that outline explicit commitments in addressing specific NTMs.

Price-Gap Versus Quantity-Gap Methods

The costs of non-tariff measures (NTM) are largely unobservable and must be measured indirectly. The literature on the different methods used to examine NTM costs is extensive (Deardorff and Stern, 1997; Beghin and Bureau, 2001), but there is little consensus on which method is most effective. One commonly used method calculates a "price gap." Price gaps infer NTM costs by comparing the imported price of a commodity facing an NTM to a reference price (Calvin and Krissoff, 1998; Bradford, 2003). However, product differentiation, data limitations, and aggregation issues can make it difficult to find appropriate reference prices for comparison. Furthermore, in cases of zero trade, comparable reference prices do not exist.

In contrast to the price-gap method, gravity models apply a quantity-based approach and estimate a bilateral trade model to predict the amount of trade that would occur without the NTM in place. The level of forgone trade, or quantity gap, may then be converted to an ad valorem tariff equivalent (AVE)[1] of the NTM. While this approach is sensitive to the econometric specification, recent advances in the gravity model literature have provided strong theoretical and methodological support for these techniques (Anderson, 2010; Silva and Tenreyro, 2006). Relative to the price gap method, the gravity model approach is more suitable for dealing with cases of zero trade and aggregation of different commodities.

[1]An ad valorem tariff is a customs duty calculated as a percentage of the value of the product.

[3]For example, the U.S.-Peru and U.S.-Colombia agreements included a mutual recognition of meat and poultry inspection systems and certificates (OECD, 2015); the EU-Chile and EU-Mexico agreements included the establishment of special committees to address SPS measures that go far beyond WTO commitments (Rudloff and Simons, 2004).

To examine the potential gains of removing NTMs in FTAs, studies typically employ "broad-based" approaches. Under a broad-based approach, the potential effects of NTMs are assessed by attempting to cover the widest scope of NTMs that is reported. A compilation of the total number of SPS/TBT notifications reported to the WTO is often used as a measure to account for the level of NTM costs.[4] An average NTM effect for these notifications may then be econometrically estimated by a gravity-type model (Kee et al., 2009; WTO, 2012) for a generalized assessment of total NTM costs. Broad-based approaches have been applied for NTM assessment in T-TIP. The European Parliament (2014) employed WTO SPS/TBT notifications reported to the WTO in a gravity model framework to estimate the role of NTMs in EU-U.S. agricultural trade. In a separate study assessing the possible gains of T-TIP, ECORYS (2009) used business surveys to create highly aggregated indices of NTMs for the U.S. and EU markets. The aggregated indices of NTMs were also estimated in a gravity model.[5]

While broad-based approaches are useful for developing a "big picture" view of the effects of NTMs, the inability to differentiate among different types of measures is a limitation of the generalized estimates. Because there are many SPS and TBT measures that have not been raised as concerns, a generalized estimate of all NTMs likely overstates their cost in the context of FTA negotiations.[6] A further limitation of the broad-based approach is that the resulting estimates are based on the assumption that all NTMs affect each country equally. Thus, this approach may lead to imprecise measures of NTM effects, which vary across exporting countries. For example, although one would expect the EU beef hormone restriction to significantly affect U.S. and Canadian beef exporters (because both countries use hormones extensively), one would not expect the SPS restriction to affect South American exporters to the EU because South American producers are largely banned from using hormones.

This study estimates specific SPS/TBT measures that have been raised as concerns by U.S. and EU exporters.[7] Unlike broad-based studies investigating the effects of NTMs, the approach here focuses on specific measures frequently discussed in trade negotiations.[8] We examine U.S. and EU SPS/TBT measures that have been reported as concerns by EU and U.S. exporters to the U.S. Trade Representative (USTR), the European Commission, and the WTO. Table 1 presents a list of SPS/TBT concerns as compiled from USTR's *2014 Report on Sanitary and Phytosanitary Measures*, the European Commission's *Market Access Database* (http://madb.europa.eu/madb/indexPubli.htm), the WTO's specific trade concerns (http://spsims.wto.org/ and http://tbtims.wto.org/), and formal WTO complaints citing the SPS and TBT agreement (www.wto.org/english/tratop_e/dispu_e/dispu_status_e.htm). The list includes the concerns that were active during the period of study.

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[4]United Nations Conference on Trade and Development (UNCTAD) Trade Analysis and Information System (TRAINS) makes an effort to more systematically arrange notifications under different types of measures.

[5]The study did not include a separate agricultural sector.

[6]Studies employing broad-based estimates typically assume that only a certain percentage of the NTMs are removed in their simulations. The European Parliament study assumed 25 percent of NTM costs were removed; ECORYS simulated a 25- to 50-percent removal scenario.

[7]While other types of NTMs may also affect trade, SPS and TBT measures have been reported as the most burdensome and challenging types of NTMs faced by agricultural exporters (Cadot et al., 2015; Skorobogatova and Knebel, 2011) and is the focus of our study (the appendix includes a brief discussion of other types of NTMs).

[8]Our study only estimates the economic effect of these concerns on trade. We do not assess the scientific basis behind the measures examined nor do we attest to the justification behind each of the raised concerns.

Table 1

EU- and U.S.-specific SPS/TBT trade concerns

Specific trade concern*	Products affected	Assessed in this study
Concerns raised by U.S. exporters about EU SPS/TBT measures:		
Restrictions on the use of pathogen-reduction treatments (PRTs)[1,3]	Poultry, pork, and beef	Yes for poultry, pork, and beef
Restrictions on the importation and use of agricultural commodities derived from agricultural biotechnology[1,3]	Various products	Yes for soybeans and corn
Prohibition on beef and beef products raised with growth-promoting hormones[1,3]	Beef and beef products	Yes
Low level of maximum-residue limit (MRL) tolerances; MRLs not established for some products[1]	Fruits, vegetables, nuts	Yes for fruits, vegetables, and nuts
Restrictions on pork and other livestock produced with beta agonists[1]	Pork and other meat products	Yes for pork
Testing requirements for karnal bunt spores[1]	Wheat	Yes
Requirements on tallow products that exceed World Organisation for Animal Health recommendations[1,3]	Animal byproducts	No
Limits on the number of somatic cells permitted in raw milk[1]	Milk and milk products	No
Phytosanitary restrictions on seed re-export[1]	Seeds	No
Concerns raised by EU exporters about U.S. SPS/TBT measures:		
Restrictions on beef products due to BSE concerns[2,3]	Beef and beef products	Yes**
Lengthy import approval procedures for new types of plant products[2,3]	Plants and plant products	Yes for fruits and vegetables
U.S. standards on dairy products that differ from EU requirements[2,3]	Dairy products	No

Notes: *Specific concerns on wine, distilled spirit, and seafood products were not included. **Only forgone losses of trade estimated (ad valorem equivalents not estimated). SPS = sanitary and phytosanitary. TBT = technical barrier to trade.

Sources: [1]U.S. Trade Representative, *2014 Report on Sanitary and Phytosanitary Measures*; [2]European Commission, Market Access Databases; [3]World Trade Organization (formal complaints and specific trade concerns).

Within the set of measures identified in table 1, we assessed the degree to which specific SPS/TBT measures affect trade depending on data availability and the capacity of econometric models to identify the NTM effects. Due to data and modelling limitations, we did not econometrically analyze several of the measures. We did not examine the EU's measures on tallow due to limited global trade in this sector that provided insufficient information for estimation. The effects of EU somatic cell limits on raw milk could not be estimated because the requirements took effect primarily after the period of study. Finally, the effects of EU phytosanitary restrictions on seed re-export and of U.S. standards on dairy products could not be precisely identified due to the broad application of the NTM across all foreign sources. All other measures were tested with commodity analysis incorporated in the empirical design of each of these cases and the interpretation of results.

The analysis and estimates in this study do not exhaust NTM issues but attempt to capture a subset of NTM issues that have been prominent in trade discussions thus far. We focused our study on selected SPS and TBT concerns that have been reported to the sources described above. Our examination does not include other SPS/TBT measures that may be of concern as well as other NTM issues, such as tariff-rate quotas (TRQs), price control measures, licensing, administrative and customs requirements, geographic indicators, rules-of-origin issues, discriminatory taxes on exporters, State-specific requirements, and Government procurement policies that may also be addressed through a T-TIP agreement (see appendix 1 for a discussion of several NTMs not econometrically assessed in this study).

Methodology

To estimate the effects of SPS/TBT measures on U.S.-EU agriculture trade, we employ a gravity model (see box "Price-Gap Versus Quantity-Gap Methods" on page 2). In its basic form, the gravity model predicts that bilateral trade flows increase as the sizes of the economies of the trading partners increase (analogous to Newton's law of gravity) and decrease as trade costs increase. A formalized theoretical structure was developed to show that the gravity equation could arise out of monopolistic competition, factor endowments, and Ricardian trade models (Bergstrand, 1985; Deardorff, 1998; Eaton and Kortum, 2002). In current empirical applications, the model's theoretical foundation is most frequently guided by the work of Anderson and van Wincoop (2003), who explicitly model multilateral resistance terms.[9] Recent studies, including Disdier and Marette (2010), the European Parliament (2014), and ECORYS (2009), used a gravity model to estimate the effects of NTMs on agricultural trade.

Following Anderson and van Wincoop (2003) and Peterson et al. (2013), a constant elasticity of substitution (CES) subutility specification with commodity-level expenditure shares may be expressed by the following commodity-level gravity equation:

$$p_{ij}^k x_{ij}^k = v_{ij}^k = \left(\frac{Y_i^k E_j^k}{\sum_i Y_k^i} \right) \left(\frac{t_{ij}^k}{P_i^k \Pi_j^k} \right)^{1-\sigma_k} \quad (1)$$

Where $x_{ij}^k, p_{ij}^k,$ and v_{ij}^k is the total quantity, average price, and value of commodity k supplied by region i to region j. Y_i^k is the value of total production of commodity k for country i; E_j^k is the total expenditure on commodity k by country j; t_{ij}^k is trade costs, including transport, contracting, and logistical costs; and σ_k is the elasticity of substitution parameter. P_i^k and $\prod_j^k$ are price index terms and are designed to capture the general equilibrium effects of relative prices related to the level of inward and outward multilateral resistance terms that arise from trade costs. Bilateral trade with an individual partner is increasing in the level of multilateral resistance with the rest of the world.

The model assumes trade separability, whereby the allocation of output and expenditures by firms and households to domestic varieties is separable from the allocation to foreign varieties. These assumptions, combined with a nested CES subexpenditure function, allow for the estimation of the partial effect on imports of changes in trade barriers, where supply and expenditure are taken as given. In estimating the effects of SPS/TBT measures, the gravity model may only estimate the level of forgone trade holding other factors constant. This partial effect ignores demand changes and other welfare effects that may result from removing the NTM (see box "NTMs and Consumer Demand"). Furthermore, this partial effect does not account for general equilibrium issues related to adjustments in other markets and supply constraints.

[9]Anderson and van Wincoop (2003) show that trade between two countries depends not only on direct trade costs between the two partners but on the level of overall resistance to the rest of the world. Modeling the relative trade with multilateral trade resistance terms is needed to appropriately identify trade costs.

NTMs and Consumer Demand

NTMs frequently arise when countries use different production processes or apply different regulations and standards on traded goods. Findings in many studies suggest that the willingness of consumers to pay for goods may vary with production processes (Costa-Font et al., 2008). For example, EU consumers are found to have high levels of concern about the use of hormones in food production and are willing to pay premiums for non-hormone-treated beef (Lusk et al., 2003; Tonsor et al., 2005; Alfnes, 2004; Alfnes and Ryckertsen, 2003, 2004 for all food). Some consumers are found to be willing to pay a premium to avoid consuming genetically engineered (GE) food (Burton et al., 2001; Moon et al., 2007; Hartl and Herrmann, 2009; Curtis and Moeltner, 2007; Carlsson et al., 2007) or foods produced from animals fed with GE feed (Curtis and Moeltner, 2007). The degree of consumer willingness to pay may vary across countries, and this is particularly noticeable when European consumers are contrasted with U.S. consumers (Lusk et al., 2003; Lusk et al., 2005; Moon and Balasubramian, 2001).[1]

The NTM parameter estimates the effect of the NTM holding all other factors constant. Theoretically, this parameter accounts for consumer preferences across countries; however, in cases where removal of the NTM may change the quality or characteristics of the product, consumer preferences may also change. For example, in the case of the EU's ban on imports of beef treated with hormones, removal of the NTM would allow the export of hormone-treated beef alongside with non-hormone-treated beef. As some study findings suggest that European consumers have a preference for non-hormone-treated beef, the two products may not be perfect substitutes, with NTMs possibly carrying unobserved demand-altering characteristics. Similarly, when the NTM improves product quality or helps communicate information about the good, the measure may increase the overall demand for the good, even if it also increases production costs (Josling et al., 2004; Disdier et al., 2008; Xiong and Beghin, 2014). NTMs are intended to address certain production factors; their removal not only lowers the cost of trade but carries other welfare implications, such as the elimination of phytosanitary protections against pests. Thus, the demand parameters captured by bilateral trade resistance in the gravity model may be affected by unobserved factors not accounted for in the model.

[1]These studies can be regarded as providing an upper-bound estimate of consumer willingness to pay to avoid certain food production processes. In general surveys, consumers frequently overestimate their willingness to spend on a particular food characteristic in an unconscious attempt to please the interviewer (Lusk, 2003). Even experimental auctions may not represent true consumer behavior because consumers who participate are rarely spending their own money in a true market setting.

In practice, econometric estimation of equation (1) commonly employs exporter and importer fixed effects to control for $Y_i^k \left(\Pi_j^k\right)^{1-\sigma_k}$ and $E_j^k (P_i^k)^{(1-\sigma_k)}$ (Feenstra, 2003). In addition to controlling the multilateral resistance terms, the importer and exporter fixed-effect terms are effective at controlling for all other country-level characteristics that would affect trade, such as size, income level, comparative advantages in agriculture, and demand structure. Taking the natural logarithm of equation (1), we arrive at:

$$lnv_{ij}^k = \alpha_i^k + b_j^k - \left(\sigma^k - 1\right) lnt_{ij}^k + \varepsilon_{ij}^k \qquad (2)$$

α_i^k and b_j^k are the fixed exporter and importer effects, respectively. We specify the trade cost as a multiplicative function of the following components (additive in logarithmic terms):

$$\ln t_{ij}^k = \gamma^k NTM_{ij}^k + \delta^k \ln Distance_{ij} + \ln\left(1 + tariff_{ij}^k\right) + \xi^k FTA_{ij} + \eta^k EU_{ij} + \varsigma^k shared\_border_{ij} + \rho^k common\_language_{ij} \quad (3)$$

Trade costs t_{ij}^k are proxied by a set of control variables that include tariffs ($tariff_{ij}^k$), a binary variable that equals one when both belong to the same free-trade agreement (FTA_{ij}), a binary variable that takes the value of one when both countries are members of the EU, (EU_{ij}), distance between countries ($Distance_{ij}$), a binary variable that equals one when both countries share a border ($shared\_border_{ij}$), and a binary variable that equals one when both countries share a common language ($common\_language_{ij}$). NTM_{ij}^k is a binary variable that equals one when there is a specific SPS/TBT raised as a concern by country *i* for exports to country *j* (in *k*). Because this study focuses on U.S.-EU agricultural trade, it only considers EU (U.S.) SPS/TBT concerns raised by U.S. (EU) exporters (see table 1).

This study's approach to estimating the effects of NTMs differs notably from that of other NTM studies. First, it allows NTM effects to vary across commodities, *k*. As the aim here is to test specific NTM concerns, we estimate the model separately across individual commodities as opposed to identifying an average NTM effect. Second, the measure of NTMs is bilateral and is intended to capture the country-specific nature of SPS/TBT measures. This is more appropriate for many of the SPS/TBT measures of concern in T-TIP, which contain requirements that are not relevant for trading partners not part of the agreement. Our estimate of the effects of SPS/TBT measures is linked only to the countries in which the NTM is of concern. For cases in which a U.S. (EU)-raised SPS/TBT concern may affect a non-EU (U.S.) country (e.g., EU beef hormone restrictions affecting Canada and Mexico production), NTM_{ij}^k is also set equal to one for the relevant country or countries. Additionally, for cases in which there are SPS/TBT concerns in both directions, such as fruits (the United States has raised concerns over EU maximum-residue limits (MRLs), while the EU has raised concerns over U.S. plant product import approvals), we estimate the respective NTM concerns simultaneously.

An additional concern in estimating equation (3) is the prevalence of zero trade flows that may lead to biases if ignored. To address this concern, we follow Silva and Tenreyro (2006) and use a Poisson Pseudo Maximum Likelihood (PPML) estimator that allows for inclusion of zero trade flows and corrects for certain biases that occur in the logarithmic specification.[10] In the Poisson regression, our dependent variable, exports, is specified in levels rather than in logarithms while the independent variables are specified in the log terms. In estimating each individual commodity *k* separately, we may suppress the commodity superscripts and estimate the following Poisson specification:

$$v_{ij} = \exp[\alpha_i + b_j + \beta_1 NTM_{ij} + \beta_2 \ln(Distance_{ij}) + \beta_3 \ln\left(1 + tariff_{ij}\right) + \beta_3 FTA_{ij} + \beta_4 EU_{ij} + \beta_5 shared\_border_{ij} + \beta_6 common\_language]\varepsilon_{ij} \quad (4)$$

Estimation of β_1 provides our assessment of the NTM's effect on trade for each commodity *k*. The estimated model can be used to predict the levels of trade that would occur without the NTM in

[10]Standard logarithm specifications cannot estimate zero trade flows. The Poisson estimator is usually employed for count data. Silva and Tenreyro (2006) show that using PPML provides unbiased and consistent estimates for gravity model parameters when there is a significant level of zero trade flows.

place. The difference between the actual and predicted level of trade is the forgone trade effect of the NTM. The AVE effect is the tariff that provides the equivalent forgone trade effect as the NTM.[11]

The model is estimated using data from 2010 to 2012 (annual average). For each commodity, we include a global sample of countries that includes the United States, the EU (disaggregated by country and including the largest markets), and a broad range of other markets. The number of exporting and importing countries included in the model is selected to account for the bulk of trade activity while moderating excessive levels of zero trade flows. For each commodity *k,* the sample of exporters includes all countries that export over $100 million per year and all importers that import over $100 million of products in the respective commodity per year. Additionally, we also impose a minimum floor of 20 importing and exporting countries—for commodities where the $100 million cutoff does not meet this criterion, we include the top 20 exporters (or importers). This criterion resulted in 20-35 importing and exporting countries accounting for more than 90 percent of trade across most commodities where zero trade flows accounted for approximately 5-40 percent of all observations.

Bilateral trade data are from UN COMTRADE. Tariff information is from MAcMaps and is reported in AVEs. MAcMaps tariffs include estimated AVEs for specific tariff rates and TRQs. For TRQs, MAcMaps applies the following assumptions:

1. If the fill rate of quota is less than 90 percent, an in-quota tariff rate is assumed.
2. If the fill rate of quota is above 98 percent, an out-of-quota rate is assumed.
3. If quota is between 90 and 98 percent, a simple average is assumed.

Shared border, common language FTAs are from Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). Distance is equal to the number of kilometers between the capital cities of two countries. Because of the likelihood of collinearity across policy trade cost variables, we run three different specifications that vary our set of control variables: (1) including tariffs, EU, FTA, (2) including only tariffs, and (3) including only EU, and FTA.

[11]Calculation of the AVE effect requires information on the elasticity of substitution. We employ elasticity of substitution parameters provided by Hertel et al. (2007).

Gravity Model Estimates and NTM Results

Effects of EU NTMs on U.S. Beef Exports

In 1989, the EU implemented a strict ban on the use of hormone growth promotants in cattle raised for beef products. The ban has been a concern for the United States and other beef exporters, including Canada and Mexico, where the use of growth hormones is common in production practices. To supply the EU market, U.S. producers must participate in USDA's Non-Hormone Treated Cattle (NHTC) program, wherein all beef products must be fully certified as free from these production technologies. Certification requires documentation of all program requirements and on-site visits by USDA's Agricultural Marketing Service to inspect herds, check documentation, and examine feed sources. Producers pay for initial site visits and subsequent compliance audits. Packers must comply with noncomingling requirements and random residue testing. In addition, the EU imposes restrictions on pathogen-reduction treatments[12] and bans the use of beta agonists[13] in beef production (Arita et al., 2014).

This gravity model is used to estimate the effect of EU NTMs on U.S. beef exports. As Canada and Mexico employ similar hormone growth promotant technologies as the United States, we model the EU's beef NTMs that have been raised as U.S. trade concerns to also affect Canadian/Mexican exports. The estimated effects on bilateral exports of beef are reported in table 2. Three different specifications including different trade cost control variables are estimated. Column 1 reports results from estimating the full model specification. The specification reported in column 2 excludes the FTA and EU variables. Column 3 excludes the tariff control variable. The beef model includes 25 exporting and 36 importing countries for 2010-12.

The coefficient for EU NTMs on U.S. beef is statistically significant at the 1-percent level in all three specifications. Based on gravity model results, if the EU NTMs were not in place, the level of U.S. beef exports should be significantly larger than the observed level in 2010-12 (forgone trade estimates are provided in the appendix). We estimate an AVE effect of the NTM by identifying the tariff rate that would be equivalent to reducing the amount of predicted U.S. beef exports without the NTM to the actual level observed with the NTM. The coefficients suggest a tariff AVE of 23-24 percent (see table 2). However, gains from removal of the NTM may be restrained by several factors. The expansion of beef exports hinges heavily on the structure of the TRQ imposed by the EU on U.S. beef exports. Currently, the EU TRQ is already at a binding level;[14] without an expansion of quota, U.S. beef exports would be expected to increase by only a small amount given the high out-of-quota tariff rate. Furthermore, the potential gains would also depend on the willingness of EU consumers to purchase hormone-treated beef (see box "NTMs and Consumer Demand" on page 6).

In each of the specifications shown in table 2, the control variables generally have the expected signs and are significant. Distance between two countries is negative and highly significant. Shared border and common language was found to be an insignificant factor but of the correct sign. The relatively high coefficients for tariffs may be in part due to the inclusion of fixed importer effects that capture a large part of the overall level of market barriers, relegating the tariff variable effects to deviations

[12]In 2013, the EU approved the use of lactid acid as a pathogen-reduction treatment.

[13]A feed additive that is used to promote the growth of lean meat.

[14]The EU high-quality beef out-of-quota tariff rate is 12.8 percent plus $1,838-$3,944 per metric ton. At the end of 2014, the quota reached its critical fill levels (above 90 percent).

Table 2

Effects of EU NTMs on beef trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-1.38 *** (0.62)	-1.46 *** (0.62)	-1.41 *** (0.62)
ln(1+tariff)	-3.83 (2.72)	-5.57 *** (0.89)	
EU	0.42 (1.42)		2.27 *** (0.52)
FTA	0.7 (0.48)		0.9 ** (0.47)
ln(Distance)	-1.17 *** (0.18)	-1.20 *** (0.18)	-1.20 *** (0.18)
Shared border	0.31 (0.23)	0.35 (0.22)	0.33 (0.23)
Common language	0.53 (0.29)	0.63 (0.27)	0.53 (0.29)
Number of observations	885	885	885
R^2	0.77	0.77	0.76

Notes: Robust standard errors reported in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement.

Effects on U.S. beef exports

EU NTM ad valorem tariff equivalent	**23%**	**24%**	**23%**

Note: Elasticity of substitution used to calculate ad valorem tariff equivalent is from Hertel et al. (2007).

Source: USDA, Economic Research Service.

across exporters for each importing country. In specifications 2 and 3, tariff, FTA, and EU coefficients are of the expected sign and significant. The level of significance is reduced when combining all three variables together (column 1), suggesting some multicollinearity among the variables. The pseudo R-squared values are fairly high (0.76-0.77), reflective of the high predictive power of gravity models for international trade. The effects of the control variables and predictive power of the gravity model are generally consistent in the other cases that follow.

Effects of EU NTMs on U.S. Pork Exports

U.S. pork exporters have raised concerns about several EU NTMs, most notably the prohibition on beta agonists, including ractopamine, which increases U.S. feed efficiency. To export pork to the EU, U.S. exporters must participate in USDA's Pork for the EU (PFEU) program, which requires verification for beta agonists-free pork and plant approval. In addition to the ban on beta agonists, U.S. pork exporters face several other EU SPS requirements, including trichinae testing[15] and a ban on PRTs.

[15]Trichina is a parasite that occurs in a small amount of U.S. pork (0.194 per million animals) and has been nearly eradicated in U.S. commercial pork production.

The gravity model estimates of the effects of EU NTMs on U.S. pork exports are reported in table 3. We expect that the EU NTMs on pork also affect pork exports from Canada and Mexico, which employ production technologies similar to those of the United States. The results suggest that EU NTMs significantly impeded U.S. pork exports in 2010-12. Estimates are significant at the 1-percent level for specifications 1 and 3 but are insignificant for specification 2. The control variables are generally of the expected sign, with high levels of significance for tariffs, distance, and shared border. In specification 1, the EU effect is negative; however, this may be due to collinearity with the tariff variable.

The AVE effect of the EU NTMs on U.S. pork is estimated to be 62-81 percent. Currently, the fill rate of the TRQ is low, so the gains from removing the NTM may not be affected by the TRQ regime. However, elimination of the in-quota tariff rate[16] combined with removal of all the NTMs could make the quota binding. Additionally, similar to the case for U.S. beef exports, consumers in the EU may not be willing to purchase imported pork if the restriction on beta agonists is removed.

Table 3
Effects of EU NTMs on pork trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-4.63 ***	-2.33	-3.76 ***
	(0.83)	(1.43)	(0.74)
ln(1+tariff)	-16.9 ***	-12.1 *	
	(6.22)	(7.10)	
EU	-3.42 **		0.82
	(1.60)		(0.59)
FTA	0.06		0.31
	(0.45)		(0.50)
ln(Distance)	-1.20 ***	-1.11 ***	-1.11 ***
	(0.19)	(0.19)	(0.20)
Shared border	0.79 ***	0.84 ***	0.95 ***
	(0.22)	(0.22)	(0.23)
Common language	0.20	0.23	0.10
	(0.29)	(0.28)	(0.30)
Number of observations	654	654	654
R^2	0.86	0.86	0.86

Notes: Robust standard errors reported in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement. AVE = ad valorem tariff equivalent.

Effects on U.S. pork exports

EU NTM ad valorem tariff equivalent	**81%**	**n.s.**	**62%**

Note: Elasticity of substitution used to calculate AVE is from Hertel et al. (2007). n.s. = NTM effect not significant.

Source: USDA, Economic Research Service.

[16]The in-quota rate for the EU pork TRQ is $325-$1,020 per metric ton. The out-of-quota rate is $697-$1,130 per metric ton.

Effects of EU NTMs on U.S. Poultry Exports

The EU restricts the use of PRTs—antimicrobial treatments applied to broiler meat after slaughter in the final stages of processing. In the United States, PRTs include chlorine dioxide, trisodium phosphate, peroxyacids, and other antimicrobial rinses (Johnson, 2015). The EU banned the use of PRTs in 1997 when it passed a regulation stating that "food business operators shall not use any substance other than potable water"—or, when otherwise permitted, "clean water—to remove surface contamination from products of animal origin," unless use of another substance has specifically been approved by the EU.

Gravity model estimates suggest that EU NTMs on U.S. poultry products significantly impede trade (table 4). The coefficients are significant at the 1-percent level. This is not surprising, as restrictions on PRTs have reduced U.S. poultry exports to the EU to negligible amounts. The AVE effect of the EU NTMs on U.S. poultry is estimated to be 95-102 percent. Once again, the willingness of EU consumers to purchase treated poultry could hold back any potential gains; however, several of the countries that have recently joined the EU imported U.S. broiler products prior to their accession, and it is plausible that these countries would resume imports from the United States. The amount of imports, however, would be sensitive to current TRQ allocations.

Table 4
Effects of EU NTMs on poultry trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-5.49 *** (0.86)	-5.47 *** (1.03)	-5.19 *** (0.73)
ln(1+tariff)	2.01 (3.13)	-3.45 (3.82)	
EU	0.95 (0.8)		
FTA	1.74 *** (0.54)		0.88 *** (0.76)
ln(Distance)	-1.14 *** (0.28)	-1.91 *** (0.23)	1.70 *** (0.53)
Shared border	0.55 ** (0.26)	0.33 (0.28)	-1.16 ** (0.27)
Common language	0.77 *** (0.22)	0.66 *** (0.24)	0.54 *** (0.26)
Number of observations	586	586	586
R^2	0.87	0.81	0.87

Notes: Robust standard errors reported in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement.

Effects on U.S. poultry exports

EU NTM ad valorem tariff equivalent	**102%**	**102%**	**95%**

Note: Elasticity of substitution used to calculate ad valorem tariff equivalent is from Hertel et al. (2007).

Source: USDA, Economic Research Service.

Effects of EU NTMs on U.S. Corn Exports

Ninety percent of corn acres in the United States are planted with GE varieties (Fernandez-Cornejo et al., 2014). Although some varieties have been approved in the EU, approval for a number of others is still pending (EC, 2015b). Segregating the corn varieties that have been approved can add costs to U.S. corn exports. These costs stem from keeping the corn separate for transport and shipping, as well as certification and testing (Bullock et al., 2000; Maltsberger and Kalaitzandonakes, 2000). The EU's delays on approving GE varieties and other measures such as traceability and labelling requirements have been a significant impediment for U.S. corn exporters (Disdier and Fontagne, 2010).[17] Argentina and Canada have joined the U.S. complaint to the WTO about the lag in biotech-event approvals, so restrictions on biotech corn affect exports from these countries as well. In addition, a number of other countries have planted significant acreage in GE corn varieties. We therefore also consider EU corn imports from major corn-exporting countries that had greater than 50 percent of their acreage planted to GE varieties,[18] namely Brazil, South Africa, and Uruguay.

The gravity model results indicate significant bilateral trade resistance in corn exports from major GE corn producers to the EU (table 5). AVE estimates of the EU NTMs on U.S. corn range from 79 to 130 percent. Shared border and common language are not significant in determining corn exports, suggesting that comparative advantage, climate, or economies of scale may be more important determinants of corn exports. Gains from removing EU NTMs could be affected by EU consumer concerns about GE products (for further details, see box "NTMs and Consumer Demand" on page 6).

Effects of EU NTMs on Soy Exports

The United States exports hundreds of millions of dollars of soybeans to the EU every year; however, the U.S. share of EU soy imports declined from the late 1990s until 2012,[19] as the share from other soy-exporting countries, notably Brazil, has increased. The majority of U.S. soy exports to the EU are GE varieties that must be approved by the EU. This case differs slightly from that of corn, as U.S. soy producers have largely chosen to grow the herbicide-tolerant GE soy variety that has been approved by the EU. Some of the decline in demand may be attributable to private retailer standards. When biotech food restrictions were introduced in the EU, major retailers pledged to privately remove GE products from their own-brand products.[20] Many major food processors followed suit. Some retailers, but not all, also offer meat from animals fed GE-free feed (The Grocer, 2013). In the EU, many retailers produce their own brand products and have standards that their suppliers must also meet (IRI, 2013; Kesko, 2009). Retail is heavily concentrated in the EU, so if retailers reject a particular version of a product, the effects on imports may be large.

Because the difficulties of accessing the EU soy market may be attributed in part to private retailer standards, we note that the effects may not entirely be interpreted as a policy barrier. We include in the binary measure of trade resistance all countries except Brazil that have more than 50 percent of their acreage planted to biotech soybeans—the United States, Canada, Argentina, Paraguay, and Bolivia.

[17]Disdier and Fontagne (2010) estimated that the export losses due to the EU's moratorium on approving GE varieties and other GE requirements resulted in over $900 million (average annual for 2003-05).

[18]Data source is the International Service for the Acquisition of Agri-biotech Applications in 2012 and 2013.

[19]The share rose in 2013 and again in 2014.

[20]Most U.S. soybeans exported to the EU are crushed into oil and animal feed.

Table 5

Effects of EU NTMs on corn trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-1.58 *** (0.59)	-2.25 *** (0.46)	-1.57 *** (0.59)
ln(1+tariff)	-7.78 ** (3.73)	-7.34 ** (3.73)	
EU	1.80 *** (0.56)		1.77 *** (0.55)
FTA	0.74 *** (0.28)		0.72 *** (0.27)
ln(Distance)	-1.84 *** (0.21)	-2.11 *** (0.20)	-1.85 *** (0.21)
Shared border	0.01 (0.28)	0.02 (0.28)	0.05 (0.28)
Common language	0.02 (0.39)	-0.22 (0.40)	0.13 (0.27)
Number of observations	996	996	996
R^2	0.85	0.84	0.85

Notes: Robust standard errors reported in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement.

Effects on U.S. corn exports

EU NTM ad valorem tariff equivalent	**79%**	**130%**	**79%**

Note: Elasticity of substitution used to calculate ad valorem tariff equivalent is from Hertel et al. (2007).

Source: USDA, Economic Research Service.

Brazil is a large exporter of non-GE soy to the EU,[21] so rejection of GE soy may be considered a transfer from the bulk of Brazilian producers to Brazilian producers of non-GE soy.

The gravity model results indicate statistically significant bilateral trade resistance between the United States and the EU for exports of U.S. soy to the EU (table 6). The gravity model estimates an AVE effect of 17-21 percent for the EU NTMs. Tariffs are positive and significant, while the FTA variable is negative and also significant. This result may stem from applied tariff rates already being very low and our inclusion of fixed importer effects providing little information to exploit across exporter pairs. Additionally, soy grows in very particular climate and soil conditions, with exports largely dictated by comparative advantage. All the other variables are of the expected sign; with the exception of common language, these variables are also significant.

Effects of EU NTMs on U.S. Fruit, Vegetable, and Nut Exports

Exporters from the United States and other countries are affected by the EU's maximum-residue limits (MRL) on fruits, vegetables, and nuts. MRLs are country-level requirements that set the

[21]See Varacca et al., 2014.

Table 6

Effects of EU NTMs on soy trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-0.61 *** (0.25)	-0.73 *** (0.26)	-0.63 ** (0.25)
ln(1+tariff)	6.12 ** (2.55)	6.02 * (2.55)	
EU	3.25 *** (0.94)		3.33 *** (0.92)
FTA	-0.88 ** (0.46)		-0.88 ** (0.44)
ln(Distance)	-0.90 *** (0.34)	-0.68 * (0.38)	-0.88 *** (0.34)
Shared border	1.99 *** (0.51)	2.04 *** (0.58)	1.98 *** (0.51)
Common language	0.47 (0.41)	0.38 (0.40)	0.47 (0.40)
Number of observations	609	609	609
R^2	0.94	0.94	0.94

Notes: Robust standard errors reported under in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement.

Effects on U.S. soy exports

EU NTM ad valorem tariff equivalent	**17%**	**21%**	**17%**

Note: Elasticity of substitution used to calculate ad valorem tariff equivalent is from Hertel et al. (2007).

Source: USDA, Economic Research Service.

maximum allowable level of pesticide residues and other harmful substances for a product. U.S. horticulture producers have raised concerns over the EU's harmonized pesticide MRL system. Moreover, there are concerns that exporters cannot supply new plant products where EU MRLs have not been established or are set too low by default.[22]

Xiong and Beghin (2013, 2014) empirically examined the effects of MRL standards on trade in horticulture products using an MRL stringency score introduced by Li and Beghin (2014).[23] The stringency index provides a measure of a country's MRL level by aggregating the products through different weighing schemes. The EU was among the countries with the most stringent standards, while the United States had stringency levels below international standards set by Codex.[24] Xiong and Beghin (2013) found that the effect of MRLs on imports depends on the level of stringency of

[22]Grant et al. (2015) examined the effects of phytosanitary treatment requirements (cold treatment, fumigation, vapor heat, and others) on U.S. fresh fruit and vegetable exports across foreign markets. They find that these requirements may also significantly reduce U.S. fruit and vegetable exports, with the negative effect of the SPS requirements diminishing as exporters accumulate SPS treatment experience.

[23]Li and Beghin's index employs 2008-11 MRL data.

[24]The Codex Alimentarius committee was established by the Food and Agriculture Organization of the United Nations and the World Health Organization to develop international standards based on available science.

the exporters' home markets. Strict MRL stringency was found to negatively affect imports only for countries that practiced relatively less stringent standards. For example, the study found that while high MRL stringency standards, such as the levels imposed by the EU, significantly affected U.S. horticulture exports, the standards did not affect exporters from Canada, who were required to follow high stringency standards in the domestic market.

Using the gravity model, we estimate the effect of EU NTMs on U.S. exports of fruits, vegetables, and nuts. Following Xiong and Beghin (2013), we assume that strict MRL standards impose a relative effect, whereby exporters from countries with less stringent standards are more affected by stringent foreign MRL standards.[25] Gravity model results indicate a statistically significant level of EU NTMs for U.S. fruit exports (table 7). The coefficients are significant at the 5- to 10-percent level. The model estimates that EU NTMs on U.S. fruits are equivalent to a 26- to 40-percent tariff.

Table 7
Effects of EU NTMs on fruit agricultural trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-0.81 **	-0.63 *	-0.91 **
	(0.34)	(0.35)	(0.36)
U.S. NTMs	-1.00 ****	-0.88 ***	-0.69 ***
	(0.28)	(0.24)	(0.25)
ln(1+tariff)	-15.44 ****	-13.48 ***	
	(3.56)	(3.01)	
EU	-0.79 ****		-0.30
	(0.30)		(0.27)
FTA	0.16		0.46 *
	(0.26)		(0.25)
ln(Distance)	-1.12 ****	-1.07 ***	-1.23 ***
	(0.12)	(0.11)	(0.13)
Shared border	0.30 **	0.35 **	0.29 *
	(0.17)	(0.18)	(0.17)
Common language	-0.30	-0.27	-0.27
	(0.23)	(0.22)	(0.23)
Number of observations	1,166	1,166	1,166
R^2	0.76	0.76	0.76

Notes: Robust standard errors reported in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement.

Effects on U.S. and EU exports

EU NTM ad valorem tariff equivalent	**35%**	**26%**	**40%**
U.S. NTM ad valorem tariff equivalent	**45%**	**39%**	**29%**

Note: Elasticity of substitution used to calculate ad valorem tariff equivalent is from Hertel et al. (2007).

Source: USDA, Economic Research Service.

[25]We assume that all countries in Li and Beghin's (2014) index with a stringency score more lax than the international Codex average may also be affected by EU NTMs on fruits, vegetables, and nuts. These countries include Malaysia, Mexico, India, New Zealand, and South Africa.

EU NTMs on U.S. vegetables are found to be significant at the 1-percent level and are equivalent to a tariff of 42 to 53 percent (table 8). However, MRLs have the potential to enhance fruit and vegetable demand by European consumers, which could affect the potential gains to exporters from the relaxing of MRL standards (Xiong and Beghin, 2014). We do not find statistical evidence of EU NTMs significantly affecting U.S. nut exports (table 9). Specification 2 estimates a significant effect of EU NTMs; however, the other two specifications are not significant.

Effects of U.S. NTMs on EU Fruit and Vegetable Exports

The EU has raised concerns over the U.S. approval process for new types of plants and plant products. EU exporters have raised concerns over the "positive list" approach, whereby the United States allows imports of new horticulture products only from countries that have been specifically approved. To obtain approval, exporters must apply for entry for new plants and plant products. Application includes a pest risk analysis and pest risk management analysis. EU exporters have stated that the overall process may take a few years and can be costly.

Table 8
Effects of EU NTMs on vegetable agricultural trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-1.14 ***	-1.00 ***	-0.94 ***
	(0.26)	(0.25)	(0.25)
U.S. NTMs	-0.85 **	-0.79 **	-0.72 **
	(0.39)	(0.36)	(0.36)
ln(1+tariff)	-12.02 ***	-8.63 ***	
	(2.62)	(1.73)	
EU	-0.66		0.48
	(0.44)		(0.34)
FTA	-0.20		0.41 *
	(0.27)		(0.23)
ln(Distance)	-1.25 ***	-1.18 ***	-1.23 ***
	(0.12)	(0.10)	(0.13)
Shared border	0.03	0.06	0.06
	(0.12)	(0.12)	(0.13)
Common language	0.14	0.18	0.23
	(0.16)	(0.15)	(0.16)
Number of observations	611	611	611
R^2	0.92	0.91	0.91

Notes: Robust standard errors reported in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement.

Effects on U.S. and EU exports			
EU NTM ad valorem tariff equivalent	**53%**	**45%**	**42%**
U.S. NTM ad valorem tariff equivalent	**37%**	**34%**	**31%**

Note: Elasticity of substitution used to calculate ad valorem tariff equivalent is from Hertel et al. (2007).

Source: USDA, Economic Research Service.

Table 9

Effects of EU NTMs on nut trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-0.53 (0.35)	-1.10 *** (0.32)	-0.23 (0.39)
ln(1+tariff)	-17.09 *** (5.22)	-19.25 *** (5.15)	
EU	2.35 *** (0.59)		2.48 *** (0.59)
FTA	0.79 (0.53)		0.54 (0.51)
ln(Distance)	-0.30 (0.21)	-0.71 *** (0.17)	-0.33 (0.25)
Shared border	-0.21 (0.27)	-0.21 (0.28)	0.04 (0.33)
Common language	-0.55 (0.42)	-0.49 (0.43)	-0.15 (0.43)
Number of observations	493	493	493
R^2	0.77	0.79	0.75

Notes: Robust standard errors reported in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement.

Effects on U.S. nut exports

EU NTM ad valorem tariff equivalent	**n.s.**	**50%**	**n.s.**

Note: Elasticity of substitution used to calculate ad valorem tariff equivalent is from Hertel et al. (2007).
n.s. = NTM effect not significant.

Source: USDA, Economic Research Service.

Gravity model results indicate a statistically significant level of U.S. NTMs for EU fruit and vegetable exports (see tables 7 and 8).[26] The U.S. NTM effect on EU fruit exports is significant at the 1-percent level and estimated to be equivalent to a 29- to 45-percent tariff; for U.S. NTMs on EU vegetables, the result is significant at the 5-percent level and equivalent to a 31- to 37-percent tariff.

Effects of EU NTMs on U.S. Wheat Exports

U.S. wheat exporters have raised concerns over several EU SPS measures, such as the requirements for karnal bunt tests. Karnal bunt is a fungal infection that affects wheat. The distribution of the disease is limited in the United States; however, some EU countries require imported wheat to be tested on arrival. USDA issues phytosanitary export certificates stating that a wheat shipment is from an area where karnal bunt is not present (Vocke et al., 2010). Gravity model results do not show statistically significant evidence of impediments due to EU NTMs on U.S. wheat across any of the specifications (table 10).

[26]In addition to the EU, Argentina, China, and India have also raised SPS concerns to the WTO on the U.S. approval process for fruits and vegetables. We model U.S. fruit and vegetable NTMs raised as concerns by the EU to also affect these countries as well.

Table 10

Effects of EU NTMs on wheat trade

Gravity results: (dependent variable: exports from country *i* to country *j*)

	(1)	(2)	(3)
EU NTMs	-0.73 (0.57)	-0.84 (0.56)	-0.73 (0.57)
ln(1+tariff)	0.57 (1.93)	-1.46 (1.91)	
EU	0.58 (0.48)		0.49 (0.46)
FTA	-0.13 (0.44)		-0.14 (0.43)
ln(Distance)	-2.2 *** (0.22)	-2.2 *** (0.2)	-2.2 *** (0.22)
Shared border	-0.31 (0.26)	-0.30 (0.26)	-0.31 (0.26)
Common language	1.18 *** (0.35)	1.12 *** (0.32)	1.17 *** (0.35)
Number of observations	1,287	1,278	1,278
R^2	0.88	0.88	0.88

Notes: Robust standard errors reported in parenthesis. *,**,*** significant at the 10-, 5-, and 1-percent level, respectively. All specifications include importer and exporter fixed effects. Constant and fixed effects are not reported. NTM = non-tariff measure. FTA = free-trade agreement.

Effects on U.S. wheat exports

EU NTM ad valorem tariff equivalent	**n.s.**	**n.s.**	**n.s.**

Note: Elasticity of substitution used to calculate ad valorem tariff equivalent is from Hertel et al. (2007).
n.s. = NTM effect not significant.

Source: USDA, Economic Research Service.

Summary of Estimated Effects of NTMs

Table 11 summarizes the results for all cases examined. It reports AVEs estimated for the baseline specification (full model); low and high estimates are derived from the 95-percent confidence interval estimates of this specification. In 9 of 11 cases examined, NTM effects on EU and U.S. exports were found to be statistically significant; EU NTMs on U.S. exports of nuts and wheat were not found to be statistically significant. The table compares the estimated AVE effects of the NTMs to existing tariff rates. The tariff rates are from MAcMaps and include TRQs (AVE estimates). The AVE estimates of NTMs are significantly larger than existing tariffs for all but one case (EU NTMs on U.S. beef). EU NTMs on U.S. poultry, pork, and corn were found to have the most trade-impeding effects, with estimated AVE effects of 102, 81, and 79 percent, respectively. The AVE effect of EU NTMs on U.S. vegetables (53 percent) and fruits (35 percent) were also found to be considerable. EU NTMs on U.S. beef were found to be equivalent to a 23-percent tariff, a lower barrier than the tariffs imposed under the current TRQ regime. We estimated an AVE effect of EU NTMs on soy (17 percent) but caution that the effect may reflect both policy barriers and private retailer standards. The AVE effects of U.S. NTMs on EU fruits (45 percent) and vegetables (37 percent) were also found to be significantly higher than current tariff rates.

Table 11

Summary of estimated effects of NTMs

	NTM concerns	NTM significant?	Applied tariff rate	NTM AVE estimate		
				Point estimate[1]	Low	High
EU NTMs on U.S. exports				*Percent*		
Beef	Growth hormones, PRTs	Yes	70	23	12	35
Poultry	PRTs	Yes	21	102	81	126
Pork	Beta agonists, trichanae, PRTs	Yes	25	81	63	101
Corn	Biotech restrictions	Yes	0	79	44	123
Soy	Biotech restrictions	Yes	0	17	10	25
Fruits	Maximum-residue limits	Yes	10	35	19	53
Vegetables	Maximum-residue limits	Yes	14	53	39	68
Nuts	Maximum-residue limits	No[2]	1	n.s.	n.s.	n.s.
Wheat	Karnal bunt testing	No	19	n.s.	n.s.	n.s.
U.S. NTMs on EU exports						
Fruits	Import approval process	Yes	2	45	31	61
Vegetables	Import approval process	Yes	5	37	19	59

NTM = non-tariff measure. AVE = ad valorem tariff equivalent. PRT = pathogen-reduction treatment. n.s. = NTM effect not significant.

[1]Estimations are from specification 1 (full model). Low and high estimates are derived from 95-percent confidence intervals.

[2]One of the three specifications was found to be significant.

Source: USDA, Economic Research Service. Applied tariff data from MAcMaps.

Conclusion

This study provides a quantitative assessment of selected SPS/TBT measures affecting U.S.-EU agricultural trade. In contrast to typical approaches that seek broad-based estimates of NTMs that do not distinguish among different types of measures, we estimated specific NTMs. Using SPS and TBT concerns raised by U.S. and EU exporters, we econometrically tested a broad range of exports of individual commodities using appropriately specified gravity models and estimated the tariff-equivalent effects of EU and U.S. NTMs.

In 9 of 11 cases examined, NTMs were found to be a significant impediment to trade. Estimated AVEs of these NTMs were found to be considerably higher than existing tariffs and TRQs. The estimates reflect only the partial effect of NTMs. As NTMs are known to carry secondary and external welfare effects (Beghin et al., 2012; Deardorff and Stern, 1997), these partial-effect estimates likely overestimate the gains from removal of NTMs. Furthermore, the model only identifies the level of bilateral resistance for cases with specific SPS/TBT concerns. While we attempt to control for trade cost measures and importer- and exporter-level characteristics, other unobserved policy and nonpolicy factors could be captured in the estimates. Finally, the level of aggregation of the commodities also neglects important product-level differences.

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Appendix 1—Other NTMs in U.S.-EU Agricultural Trade

We focused our study on specific SPS and TBT concerns and did not examine other NTM issues, such as tariff-rate quotas (TRQs), price control measures, licensing, administrative and customs requirements, rules-of-origin issues, taxes discriminatory on exporters, geographic indicators, State-specific requirements, and Government procurement policies that may also be addressed through a T-TIP agreement. Furthermore, due to data and modeling limitations, several specific SPS/TBT concerns raised by U.S. and EU exporters were also not examined. A brief discussion of several of these measures and other NTM concerns that were not included in the analysis follows.

EU Geographic Indicators

Geographic indicators (GIs) have been much discussed in the T-TIP negotiations. In the EU, many well-known products associated with a particular geographic area can only use the name of that area if they are produced there. Thus, cheese using the label "Parmigiano Reggiano" in the EU must come from the region around Parma, Italy. In some countries, manufacturers produce certain products in the style of some of these European products (like Parmesan or Asiago cheese), and the associated geographic names have functioned as generic terms for decades. The EU does not import products that do not recognize these GIs. Countries outside the EU have been reluctant to grant protection to the GIs for fear of restricting the established brands of domestic producers and those of producers in third countries.

Economists have outlined the potential costs and benefits stemming from markets that are covered by GIs (Menapace and Moschini, 2011; Moschini et al., 2008; Marette, 2009; Schussler, 2009). Measuring these costs and benefits requires understanding the degree of monopoly rights over the GI, whether there is free entry and exit of producers within the geographic area, the price premium enjoyed by producers of "knockoffs," the size of farms, and consumers' tastes and awareness of a particular GI characteristic and their awareness of a good.

Estimating the costs and benefits in a market for a single GI would therefore be a large data-intensive task. The data needs would also be applicable for every GI in question. In the agreement between the EU and Canada, for example, Canada agreed to enforce about 140 GIs for the EU. Applying such calculations to a large, aggregated gravity model would also be difficult. The EU offers GI protection to hundreds of cheeses, many different kinds of olives, cured meats, etc. Cheeses are aggregated together in the model, and olives are part of the oilseeds category. Trade data are not collected on many of the individual categories at the level of the GI. The cost of researching each of these goods, therefore, would be quite high and may only yield a small effect on each category within the model.

EU Restrictions on U.S. Tallow Exports

Tallow is a byproduct of beef production. It is classified by four degrees of quality: that which is fit for human consumption; that which can be used for animal feed, cosmetics, and pet food; that which can be used for soil enhancement; and that which can only be used for energy purposes (ECOFYS, 2013). Total U.S. tallow exports, mostly to North American Free Trade Agreement (NAFTA) partners, were valued at $431.5 million in 2013. Tallow is used in the EU partly as an animal feed and as an input in biodiesel production; however, the EU imposes restrictions on the importation of tallow products that exceed World Organization for Animal Health (OIE) recommendations.

U.S. BSE Restrictions on EU Beef Exports

Since 1998, EU beef products to the United States have been restricted due to concerns over bovine spongiform encephalopathy (BSE). As a result, the EU exports virtually no beef to the United States. In 2013, the United States revised its BSE regulations to permit imports from countries that the OIE has determined to be of "negligible risk," "controlled," or "undetermined" risk status for BSE (Federal Register, 2013). Before EU beef producers may begin exporting to the U.S. market, USDA's Food Safety and Inspection Service (FSIS) must approve the country's food safety inspection system for beef establishments. In early 2015, Ireland was the first country to secure approval and began supplying the U.S. market, with other European countries making efforts to gain approval. Because the EU exports no beef to the United States, we cannot identify an NTM effect or tariff AVE. Using our beef gravity model, however, we may predict the amount of beef the EU would be exporting to the United States given market conditions and observable trade costs. Our model predicts the EU would export beef valued at between $31 million and $58 million.

EU Somatic Cell Requirements for Dairy Product Imports

U.S. dairy exporters have expressed concern about somatic cell count (SCC) restrictions on dairy exports to the EU (U.S. Dairy Export Council, 2015). These restrictions require U.S. dairy exporters to gain certification that SCCs fall below a certain threshold. SCC requirements apply to exported milk and to the milk used as a primary ingredient in dairy products. U.S. dairy producers apply through a USDA program for certification to meet theEU SCC requirement.

Identifying the effects of SCC requirements on EU imports of the same goods presents both data and modeling limitations beyond the scope of this study. A data limitation stems from the time period involved in our study. SCC requirements were not enforced until 2012, outside the period of study. A further identification problem arises due to all EU dairy imports being affected by the NTM. Our gravity model exploits bilateral variation in NTMs whereby some countries are affected by the NTM, and others are not. As the SCC requirements affect all foreign exporters, we are unable to adequately identify the effects of this NTM from the other characteristics that are unique to the EU as an importer.

U.S. Dairy Standard Requirements

EU dairy exporters have expressed concerns about the time and effort required to receive Grade A certification, which is necessary to export certain dairy products to the United States (EC, 2015). The U.S. Grade A requirements generally cover milk, whey, cream, and all other milk products, with the exception of manufactured products. The requirement grants specific exemptions to butter, cheese, ice cream, and infant formula. It does cover cottage cheese and casein (unless the Grade A version is unavailable) and nonfat dry milk (FDA, 2009; 21 CFR 131, 1999). European producers perceive that revisions to the Grade A requirements in 2000, and further 2007 revisions moving the scope of the law beyond pasteurized products, have made it difficult to be in compliance with the law (Food-Drink Europe, 2012). Similar to the case of the EU's SCC requirements, U.S. dairy requirements are not confined to EU exporters and may not be effectively captured through the identification strategy employed by this study.

In addition to Grade A requirements, the United States has some restrictions on the sale of raw milk cheeses that have been raised as concerns for EU cheese exporters. Specifically, for the

period under study, the United States required that raw milk cheese be aged 60 days before it could be sold (Eucolait, 2014). The EU has no age requirements, and the U.S standard may limit some EU traditional cheese products from being traded. However, perceived quality differences across different cheeses and different producers may make it difficult to estimate the effects of restrictions on cheese trade.

Appendix 2—Estimates of Forgone Trade Due to NTMs

In addition to estimating the tariff AVE of NTMs, we may also use the gravity model to estimate the forgone levels of trade due to NTMs. The forgone levels of trade may be calculated as the difference between the gravity model's predicted value of trade without the NTMs present and the actual observed value of trade under the NTMs.[27] These forgone estimates (2011 base year) are provided in appendix table A2-1. EU NTMs on soy, pork, and corn products were found to be the largest sources of forgone U.S. exports, with estimated effects of approximately $1.1 billion, $1.8 billion, and $0.6 billion, respectively. Although our gravity model estimated a fairly low AVE for the EU NTM on soy products, predicted gains are extrapolated off a relatively large base of U.S. soy exports, translating to significant levels of forgone trade. The estimated forgone levels of U.S. exports due to EU NTMs on beef, poultry, fruits, and vegetables ranged from $150 million to $500 million. The forgone levels of EU exports due to U.S. NTMs on fruits and vegetables were estimated at approximately $650 million and $825 million, respectively.

Appendix table A2-1

Estimates of forgone trade due to NTMs

Sector	NTM concerns	NTM statistically significant?	Estimated level of forgone trade[1]		
			Point estimate	Low	High
EU NTMs on U.S. exports			*Million $, 2011*		
Beef	Growth hormones, PRTs	Yes	497	190	1,067
Poultry	PRTs	Yes	145	61	343
Pork	Beta agonists	Yes	1,829	787	4,271
Corn	Biotech restrictions	Yes	612	269	1,233
Soy	Biotech restrictions	Yes	1,117	582	1,803
Fruits	Maximum residue limits	Yes	467	224	807
Vegetables	Maximum residue limits	Yes	479	317	687
Nuts	Maximum residue limits	No	n.s	n.s.	n.s.
Wheat	Karnal bunt testing	No	n.s.	n.s.	n.s.
U.S. NTMs on EU exports					
Fruits	Import approval process	Yes	646	396	772
Vegetables	Import approval process	Yes	824	359	1,510

[1]Estimations are from specification 1 (full model). Low and high estimates are derived from 95-percent confidence intervals.
NTM = non-tariff measure. PRT = pathogen-reduction treatment. n.s. = NTM effect not significant.

Source: USDA, Economic Research Service.

[27]The estimated levels of forgone trade may be calculated by $\left(\frac{v_{ij}^{k}}{exp\beta_{1}^{k}}\right)-v_{ij}^{k}$.

It is important to recognize that these estimates of forgone trade due to NTMs are not equivalent to the predicted gains from removing these barriers. First, the gravity estimates do not account for general-equilibrium effects. Any change in market access has secondary effects on other markets (input markets and other commodity markets). The estimates are likely to overpredict the gains because they do not account for supply constraints and intersectoral changes that readjust following the removal of the NTM. These secondary effects may be a trivial issue when changes in market access are small. However, if the changes are sufficiently large or occur across a broad range of sectors, the secondary effects may be significant. For the case of meats, an across-the-board removal of NTMs could lead to secondary effects on land and feed prices crowding out production in one or more subsectors.

Second, the estimated gains in trade may be restrained by TRQs. While our estimates attempt to control for tariffs (estimated tariff AVE of TRQs are included), nonlinear effects of TRQs are not effectively captured in a gravity model. For many cases in T-TIP, SPS measures and restrictive TRQs coexist. For the case of U.S. beef exports, with the current quota filled at critical levels, removal of the beef hormone ban is unlikely to generate significant gains unless the TRQ is expanded or removed. Appropriate examination of these cases requires a joint SPS/TBT and TRQ framework.

Third, the gravity estimates do not model the potential welfare benefits of NTMs. SPS/TBT measures may deal with externalities or change perceived product quality and thus lead to demand-shifting effects. In some of these cases, U.S. or EU preferences may affect the predicted gains from removal. Without addressing the demand-side issues, the gravity model may overestimate the results of eliminating NTMs.

In a complementary ERS study, *Agriculture in the Transatlantic Trade and Investment Partnership: Tariffs, Tariff-Rate Quotas, and Non-Tariff Measures* (Beckman et al., 2015), a computable general equilibrium (CGE) analysis is used in conjunction with the gravity estimates provided in this study to assess the gains of removing NTMs in a fully integrated framework. The study generates quantitative estimates of removing tariffs, TRQs, and the selected SPS/TBT measures estimated in this study.[28] The partial effects of NTMs estimated from our gravity model are decomposed into a different type of ad valorem trade cost and incorporated into the CGE model, which can deal with the general equilibrium effects. The study also attempts to address possible demand-side effects of NTMs.

[28]The quantitative estimates of removing the selected SPS/TBTs generated by this CGE study are lower than the forgone levels of trade estimated through our econometric study. Accounting for general equilibrium effects and demand side sensitivities reduces the potential gains estimated with our gravity model.