The Transatlantic Trade and Investment Partnership and Agriculture: A Quantitative Analysis

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Abstract

The Transatlantic Trade and Investment Partnership (TTIP) is a proposed free trade agreement between the United States and the European Union (EU) that could address several important barriers facing agricultural trade, including tariffs, tariff-rate quotas (TRQs), and non-tariff measures (NTMs). TRQs and NTMs are particular relevant in a potential TTIP agreement, as there are several agricultural sectors with these trade barriers in place. Using a computable general equilibrium (CGE) model to analyze two core hypothetical market liberalization scenarios, the objective of this study is to quantify the potential effects of the TTIP agreement. Results from the first scenario, where tariffs are removed and there is a 50 percent increase in TRQ quota amounts, indicate that total U.S.-EU agricultural trade increases by $4.9 billion. The second scenario, a more expanded market access scenario that also includes the removal of NTMs, results in an increase in total U.S.-EU agricultural trade by an additional $2.1 billion; although, binding TRQs limit some of the potential gains. Across all scenarios, results indicate that expansion in agricultural exports is greater for the United States; however the EU generates larger welfare gains.

Keywords: Agricultural trade, trade agreement, Transatlantic Trade and Investment Partnership, TTIP, computable general equilibrium (CGE) model, non-tariff measures (NTMs), gravity model, United States, European Union, tariff rate quotas (TRQs)

Introduction

The formation of the World Trade Organization (WTO) and increase in free trade agreements (FTA) has led to a reduction in tariffs globally. For example, for manufacturing industries Hayakawa and Kimura (2014) estimate that WTO membership reduces tariffs by 0.5 percent, and FTAs reduce tariffs by 1.9 percent. However, agriculture has remained a sensitive issue, especially for developed countries that tend to protect agriculture with a combination of trade barriers and domestic support (Keeney and Beckman, 2009). For example, both the EU and the United States have low tariffs on goods; with higher simple tariffs on agricultural products. For example, the U.S. simple average tariff is 3.5 percent, but 4.7 percent for agricultural sectors. The difference is even greater for EU tariffs; 5.5 percent for all goods, 13.7 percent for agriculture (Akhtar and Jones, 2014). In addition to imposing higher tariffs, the EU has been more selective in including agricultural products in FTA negotiations than the U.S., which has been more comprehensive in its level of liberalization in FTAs (Grueff, 2013).

With the reduction in global tariffs, research focus has shifted to better understanding the impacts of NTMs.[1] NTMs can be defined as all non-price and non-quantity restrictions on trade in goods, services and investment, at the federal and state level. Unfortunately, NTMs have proven difficult to measure, especially compared to relatively transparent tariffs (Womach, 2005). In addition, estimating the potential impacts of NTM removal has also proven difficult. The proposed Transatlantic Trade and Investment Partnership (TTIP) is a free trade agreement under negotiation by the United States and the European Union (EU) that seeks to reduce tariffs, but also has an ambitious goal of targeting NTMs. NTMs are especially prevalent in agriculture,

[1] In addition, the United States Trade Representative (USTR) notes that the President's Agenda recognizes that "behind the border" measures and other non-tariff barriers have grown in significance for U.S. exporters seeking access to foreign markets.

with fruits, vegetables, and meat sectors heavily protected. Indeed, Li and Beghin (2012) conclude that trade flows in agriculture tend to be impeded more by NTMs than other sectors.

Recent studies examining the economic gains from TTIP suggest that reducing NTMs could bring about equal or greater benefits than tariff removal (Table 1). For example, CEPR (2013b) concludes that reducing NTMs could account for as much as 80 percent of the potential economic gains from TTIP. Unfortunately, these TTIP-based studies have generally aggregated agricultural sectors into one overall sector. Thus, they are unable to detail impacts to specific commodity sectors. This is despite using a computable general equilibrium (CGE) model, which is capable of giving results across a wide range of sectors. CGE-based studies of TTIP have not, however, considered possible TRQ scenarios; although FTAs recently concluded by the EU (e.g., Canada, Chile, South Africa) have mainly increased the quota portion of TRQs for agriculture goods, rather than completely removing the tariff.

This paper uses an agriculture-focused, multi-country, CGE model to analyze the potential effects of a TTIP agreement. Our study pays particular attention to the role of TRQs and NTMs, explicitly modelling these barriers across individual agricultural sectors. In contrast to typical "broad-brush" approaches that calculate estimates of NTM impacts across every sector and do not distinguish among different types of measures, we apply a tailored strategy that combines market analysis with econometric tools. We focus only on sectors that contain NTMs which have been raised as significant concerns by exporters. We then apply individual gravity models to econometrically estimate the levels of forgone trade that may be due to NTM concerns. The partial effects of NTMs estimated from our gravity model are decomposed into a different type of ad-valorem trade costs and incorporated into the CGE model, which can deal with the general equilibrium effects. Non-linear effects of TRQs are properly dealt with in model simulations using mixed complementarity methods.

Two core hypothetical scenarios are envisioned to highlight the range of possibilities that could result from TTIP negotiations. We first consider a market access scenario, where tariffs are removed, and there is a 50 percent increase in TRQ amounts. The second scenario describes a more expanded market access, where NTMs are removed on top of the increased market access from the first scenario. Along with the United States and EU, we also investigate the impacts to the other North American Free Trade Agreement (NAFTA) regions (Canada and Mexico), and other major agricultural trade markets (Brazil, China, and India).

Background

The United States and EU are major producers of most products and agricultural goods. For trade, they are each other's largest trading partners for overall goods and are among the world's largest traders of agricultural goods. However, while agricultural trade with other partners has increased over time, agricultural trade between the United States and EU has decreased. This decline is due in part to the proliferation of regional trade agreements (e.g., NAFTA), and emergence of other countries in agricultural trade (e.g., Brazil).

The U.S. and EU are each other's largest trading partners for all goods (mainly industrial products). Global Trade Analysis Project (GTAP) data indicates that the U.S. had a $95 billion deficit in trade with the EU in 2011. In terms of exports to the U.S, the EU was the second largest source (following China); for U.S. exports, the EU was again the second largest destination (following Canada). For imports to the EU, China was also the largest source (the U.S. was third); however, the percentage of total EU exports to the U.S. was almost double that to the next largest region. In total the EU was responsible for 16.9 percent of trade for the United

Table 1. CGE-based Quantitative Analyses of TTIP

Authors	Type of CGE Model	Food and Agriculture Coverage	NTM Estimation	TTIP Scenario	Impact on U.S. & EU	Results
This study	Static GTAP model, with GTAP-E and AEZs, V9 (2011) database	Comprises 38 of 47 sectors	Gravity model for notified, selected NTMs	1) Market access (tariffs & TRQs) 2) Market access expanded (select NTM removal added)	% Δ in exports value: U.S.-[0.41,0.55] EU-[-.01,0]	GDP gains are larger for tariff removal scenario, compared to NTM removal
ECORYS (2009)	Limited information provided, beyond a 10-year analysis used	Food & beverages sector only	Gravity model using business survey and literature	2 main scenarios: -Limited (25% NTMs eliminated); -Ambitious (50% NTMs eliminated)	% Δ in exports value: U.S.-[1.74,3.97] EU-[0.74,2.07]	GDP gains from ambitious scenario more than double of limited
CEPR (2013b)	Imperfect competition GTAP model, V8 (2007) projected to 2027	Agriculture, forestry, fisheries aggregated, processed foods	NTM estimates from ECORYS (2009)	2 comprehensive scenarios: -10% NTMs, 98% tariffs elimiated; -25% NTMs, 100% tariffs	% Δ in GDP: U.S.-[0.04,0.39] EU-[0.10,0.48]	NTMs account for as much as 80% of gains from TTIP
EP (2014)	MIRAGE model, with GTAP data	Comprises 17 of 31 sectors	Gravity model for notified NTMs	5 scenarios Reference is primary: tariffs removed, 25% NTMs removed	% Δ in exports: U.S.-120 EU-60	Gains to agriculture are largest; Sectors w/ largest impacts: beef, sugar, dairy
Erixon & Bauer (2010)	GTAP model, V7 (2004) extrapolated to 2010, projected to 2015	Comprises 8 of 32 sectors	None	Tariff removal w/ various trade facilitation and productivity assumptions	% Δ in GDP: U.S.-[0.15,1.33] EU-[0.01,0.47]	Potential gains are larger than most FTAs, including a potential Doha agreement
Francois & Pindyuk (2011) CEPR (2013a) Kimman & Hagsberg (2012) Semerak (2013)	Focus on EU countries: Austria; UK; Sweden; Czech Republic	No agriculture specific results or agriculture is highly aggregated	Unknown ECORYS (2009) ECORYS (2009) None	NTM & FTAs NTMs & tariff removal NTMs & tariff removal Tariff removal	Focus is on EU specific countries	NTMs account for the largest trade gains
Mavus et al. (2013) Rollo et al. (2013) Aslan et al. (2014)	Focus on 3rd countries: Turkey; Developing countries; China	No info	CEPR (2013b) Qualitative CEPR(2013b)	Spillover scenarios	Greater trade and macro impacts than 3rd countries	NTM spillovers lead to smaller benefits than those to U.S. and EU
Fontage, Gourdon, and Jean (2013)	MIRAGE model, projected to 2025	Comprises 6 out of 34 sectors	Gravity model for notified NTMs	1) Tariffs removal 2) 25% NTMs 3) Harmonization spillovers 4) Ecorys NTMs	% Δ in ag exports: U.S.12.6% EU-7%	TTIP will boost bilateral trade w/ no trade diversion. Similar impacts on GDP
Egger et al. (2014)	Monopolistic competition	Comprises 2 of 22 sectors	Gravity model	1) Tariffs removal 2) NTMs-Goods 3) NTMs-Services	% Δ in real consumption: U.S.:0.40; EU:1.07	GDP gains from NTM removal greater than tariff removal

States and the U.S. accounted for 14.2 percent of EU trade (EC, 2014b).

For agriculture[2], trade between the two was $35 billion in 2011 (Table 1); U.S. exports were $13.85 billion, while the EU exported $21.19 billion. The importance of agricultural trade between the two has changed over time. For example, in 1992 the United States was responsible for 21 percent of EU agricultural imports; by 2012 this had decreased to 8 percent (EC, 2014b). This is due in part to a result of the emergence of trade from other countries (e.g., Brazil), EU expansion, and an increase in free-trade agreements with other countries (e.g., EU-Mediterranean countries). Note that the United States has had a trade deficit in agricultural products with the EU since around 2000, this deficit reached $12 billion in 2012 (EP, 2014).

Table 1. Trade Values ($ Million), 2011

	Bilateral Trade		Total Exports		Total Imports	
Sector	U.S. to EU	EU to U.S.	U.S.	EU	U.S.	EU
Cereals	151	1	2,654	294	188	1,123
Wheat	491	22	13,610	14,709	747	10,663
Coarse grains	519	23	16,363	9,827	1,076	10,748
Fruits	317	110	4,521	19,547	10,824	31,129
Vegetables	355	189	3,400	15,475	10,182	21,182
Nuts	1,734	27	4,709	3,062	2,458	6,933
Oilseeds	1,886	888	29,414	27,402	9,168	47,613
Other agriculture	857	755	13,317	21,739	14,347	41,463
Other meat	433	361	6,408	27,694	4,597	26,850
Dairy	34	103	2,062	23,756	1,339	19,240
Beef	217	45	6,754	18,687	4,431	22,159
Pork	178	468	6,589	14,232	1,531	10,599
Poultry	1	0	4,153	22,277	663	23,243
Powdered milk	2	6	1,565	1,917	162	940
Butter	73	34	371	5,193	170	4,702
Cheese	8	1,068	511	20,508	1,026	17,373
Processed sugar	33	18	302	6,105	3,840	9,443
Processed rice	54	23	1,491	1,218	785	2,119
Processed foods	5,669	16,943	42,461	244,584	71,969	231,302
Biofuels	841	100	3,322	584	570	4,309
Services	121,893	138,747	378,677	1,535,669	311,519	1,201,298
Manufacturing	259,443	1,611,498	1,159,296	4,467,642	2,100,507	4,838,969

Source: GTAP v.9 Base data

[2] This is classified as food products, excluding fish and natural resources.

The composition of trade in agricultural products differs across the two regions. The majority of U.S. exports to the EU are raw agricultural goods, while the EU tends to export processed agricultural goods. However, U.S. exports of raw agricultural goods to the EU have fallen over time, from a high of almost $12 billion in 1996 to less than $6.5 billion since 2000. At the same time, EU exports of processed goods to the United States have increased over time, reaching a high of $20 billion in 2012 (EP, 2014).

Examining GTAP data for agricultural sectors, Table 1 indicates that processed foods are the leading agricultural category exported by the United States to the EU (41 percent of the total), followed by oilseeds and nuts. Almost 37 percent of total U.S. nut exports are to the EU, while only 6 percent oilseed exports are to the EU. For EU exports to the United States, processed foods (principally, wine) has the largest share, responsible for more than 80 percent of total agriculture trade. Apart from processed foods, the EU also exports a large amount of cheese to the United States ($1 billion).

Tariffs and Tariff-rate Quotas (TRQs)

The GTAP database provides an ad-valorem equivalent (AVE) for regular tariffs, specific tariffs, compound tariffs, and TRQs.[3] This total tariff allows for complete market liberalization experiments. However, recent FTAs recently concluded by the EU have mainly increased TRQs for agricultural goods, rather than completely removing the tariff. Separating TRQ regimes from tariff-only regimes allows for a more accurate representation of possible TTIP scenarios.

Tariffs

Tariffs between the U.S. and EU are in general relatively low by global standards. In addition, 37 percent of all tariff lines in the United States and 25 percent in the EU are already duty-free (Seshadri, 2014). However, agriculture sectors tend to have larger tariffs than non-agriculture

[3] More information is available at: http://www.macmap.org/

sectors (Akhtar and Jones, 2014). Generally, the EU has often been more selective in including agricultural products in free trade agreements (FTA) negotiations, while the United States has been more comprehensive in its level of liberalization in FTAs (Grueff, 2013).

Tariffs on agricultural trade in the model's agricultural trade categories between the United States and the EU are presented in Figure 1 (see Appendix 1, Table 2). Note that AVEs for several sectors are quite large, for example the tariff on U.S. beef is 61 percent. Figure 1 indicates that the EU does place higher tariffs on its agricultural sectors than the United States. The tariff estimates from the GTAP database are examined and corrected for any inconsistencies with other data sources.

Tariff-rate quotas (TRQs)

TRQs are separated from the total tariff calculation in the data and explicitly specified in the CGE model. To disentangle TRQs from the total tariff calculation, we need accurate data on TRQ quota amounts, in- and out-of-quota tariff rates, and fill rates. Data from the European Commission Taxation and Customs Union (TARIC, 2014) provide detailed TRQ information for each TRQ line in the EU; U.S. TRQ notifications to the World Trade Organization (WTO) are used for U.S. TRQs. Table 2 indicates that there are ten model sectors with greater than 30 percent of trade under TRQ lines for the EU, and Table 3 indicates that there are five for the United States.[4]

[4] The CGE model we use has GTAP version 9, base 2011 at its heart, thus sectors are much more aggregated than those given in the TARIC data base and U.S. notifications. The aggregation scheme to represent TRQs is explained in Appendix 1, TRQs.

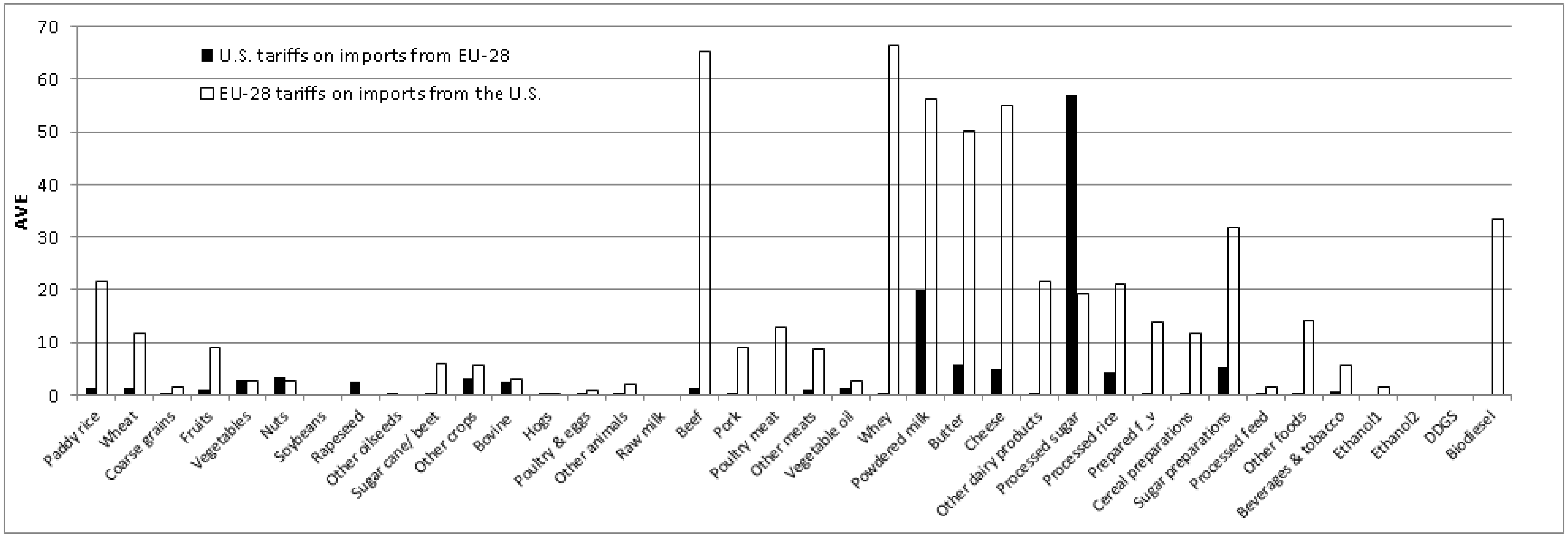

Figure 1. Total Tariffs (including AVEs of TRQs) on Agricultural Trade between the United States and EU

Table 2. EU TRQs on U.S. Sectors

Sector	Percent of trade under TRQs	Quota (Metric Tons)	Estimated TRQ fill rate	Tariff AVE	
Beef	100	48,200 [1]	>90%	In-quota	0
				Out-of-quota	34.23
Butter	100	11,360	17%	In-quota	50.60
				Out-of-quota	110.97
Cheese	100	83,748	20%	In-quota	22.04
				Out-of-quota	59.85
Wheat	95	3,462,030	>90%	In-quota	6.74
				Out-of-quota	60.09
Powdered milk	84	68,537	~0%	In-quota	32.10
				Out-of-quota	80.27
Coarse grains	82	3,437,283	82%	In-quota	6.57
				Out-of-quota	69.81
Nuts	55	90,000	+100%	In-quota	2.00
				Out-of-quota	4.55
Processed rice	45	82,285 [2]	91%	In-quota	0
				Out-of-quota	32.10
Pork	30	82,112	<5%	In-quota	9.86
				Out-of-quota	28.70
Poultry	-	16,665	~0%	In-quota	18.48
				Out-of-quota	37.37

[1] Shared between Argentina, Australia, Canada, New Zealand, United States, and Uruguay

[2] 41,109 Metric tons are strictly for the U.S.

All others are for all WTO members

Source: TARIC

Table 3. U.S. TRQs on EU Sectors

Sector	Percent of trade under TRQs	Quota (metric tons)	Estimated TRQ fill rate	Tariff AVE	
Powdered milk	100	14,415	49%	In-quota	3.19
				Out-of-quota	49.45
Butter	95	3,089 [1]	>90%	In-quota	4.15
				Out-of-quota	98.84
Cheese	66	136,420	57%	In-quota	9.94
				Out-of-quota	56.63
Processed sugar	59	619	+100%	In-quota	12.20
				Out-of-quota	24.70
Beef	-	64,805	0%	In-quota	4.80
				Out-of-quota	26.40

[1] 154 Metric tons are strictly for the EU

All others are for all WTO members

Source: U.S. notifications to the WTO

TRQs are in place on several meat and dairy sectors for both the U.S. and EU. For U.S. exports to the EU, the quota is more than 90 percent filled for several sectors, indicating that an increase in the quota amount would likely induce additional exports. Beef, wheat, nuts, and processed rice are all filled more than 90 percent, while coarse grains is 82 percent filled. For all of these sectors, the out-of-quota rate is substantially larger than the in-quota rate, except for nuts. The relatively small out-of-quota tariff rate for nuts led to exports that were greater than the fill rate. There is a TRQ for U.S. poultry; however, NTMs effectively prohibit exports to the EU.

For U.S. TRQs, processed sugar is the sector with a fill rate greater than 100 percent; although, the quota amount for the EU is relatively small, as the United States allocates most of its quota to cane sugar producers, while the EU largely produces sugar beets. Despite the TRQ allowance for beef, the EU does not export any beef to the United States due to BSE restrictions.

Non-tariff Measures (NTMs)

To estimate the effects of NTMs in EU-U.S. agriculture we employ a gravity model. In its basic form, the gravity model predicts that bilateral trade flows increase as the size of the trading partners increases, and decreases 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, its theoretical foundation is mostly guided by the work of Anderson and van Wincoop (2003) who explicitly model multilateral resistance terms. The gravity model has been employed extensively to estimate NTMs (Disdier and Marette, 2010; EP, 2013; ECORYS, 2012).

Following Anderson and van Wincoop (2003), to estimate sector-level bilateral trade flows a CES specification with sector-level expenditure shares may be expressed by the following gravity equation:

$$X_{ij}^{k} = \frac{Y_i^k E_j^k}{\sum_i Y_k^i} \frac{t_{ij}^k}{P_i^k \Pi_j^k}^{1-\sigma_k} \qquad (1)$$

where X_{ij}^{k} is exports from country *i* to country *j* for sector *k*, Y_i^k is the total production of sector *k* for country *i*, E_j^k is the total expenditure on sector *k* by country *j*, t_{ij}^k are iceberg trade costs, and σ_k is the elasticity of substitution parameter. P_i^k and Π_j^k are price index terms. They reflect the level of inward and outward multilateral resistance terms that arise from trade costs.

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 sub-expenditure function allow the estimation of the partial effect of changes in trade barriers where supply and expenditure are taken as given. In estimating the effects of NTMs, the gravity model only calculates the loss of forgone trade holding other factors held constant. This partial effect ignores demand-side issues and other welfare effects that may result from removing the NTM. Furthermore this partial effect does not account for general equilibrium issues related with adjustments in other markets and supply constraints.

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 $E_j^k\left(P_i^k\right)^{1-\sigma_k}$ (Feenstra, 2004). By exploiting bilateral variation in trade flows, this approach effectively controls for exporter competitiveness characteristics (comparative advantage forces, agricultural natural endowments) embedded in $Y_i^k\left(\Pi_j^k\right)^{1-\sigma_k}$ and demand potential (market size, demand structure) embedded in

$E_j^k \left(P_i^k\right)^{1-\sigma_k}$ as well as dealing with the multilateral resistance terms. Taking the natural logarithm of equation (1) we arrive at:

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

Such that

$$t_{ij}^k = \beta_1^k NTM_{ij}^k + \beta_2^k Dist_{ij} + \beta_3^k \left(1 + tariff_{ij}^k\right) + \beta_3^k PTA\_dum_{ij} + \beta_4^k EU\_dum_{ij} + \beta_5^k contig\_dum_{ij} + \beta_6^k common\_lang_{ij} \qquad (3)$$

where α_i^k and b_j^k are the fixed exporter and importer effects respectively. We specify trade cost equation 3 and substitute it for t_{ij}^k in equation 2. Trade costs t_{ij} are proxied by a set of control variables that include tariffs ($tariff_{ij}^k$), preferential trade agreements (PTA_dum_{ij}), distance ($Dist_{ij}$), contiguity or land borders ($contig\_dum_{ij}$), and common language ($common\_lang_{ij}$). NTM_{ij}^k is a dummy variable that equals one when there is a specific NTM concern raised by import country *i* on export country *j* for sector *k*. Unlike other approaches which apply a country level NTM indicator—one NTM for each commodity for an importing country, rather than an NTM imposed by an importing country that can vary by exporting country, for each commodity--(Kee et al. 2009, and EP 2014), our measure of the NTM is bilateral. This is more appropriate for NTMs that are country-specific in nature which is the case for many of the NTMs of concern in TTIP, e.g., beef hormone and ractopamine restrictions, which are largely specific to U.S. exporters. Secondly, the NTM coefficient, β_1^k, is estimated individually to calculate a specific effect for each measure. 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, such as size, income level, comparative advantages in agriculture, and demand structure that would affect trade. We also include a binary variable that takes the value of one when both countries are members of the EU.

Following Silva and Tenreyro (2006) we use a Poisson estimator that is able to include zero trade flows and correct for certain biases that occur in the logarithmic specification. 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. The coefficients are interpreted as elasticities.

The effect captured by NTM_{ij}^{k} will include the border effect net of tariffs. As the border effect is simply the residual above and beyond expected trade it will estimate any other unobservable barriers. Data for exports is from UN Comtrade; distance, contiguity, common language, preferential trade agreements are from CEPII; and tariffs are from MacMaps. As MacMaps' tariff measure includes an AVE of TRQs, the NTM effect will partially account for the TRQ effect.

Table 4 summarizes the estimated forgone levels of exports that may be attributed to EU and U.S. NTMs. Across most of the measures examined we find that U.S.-EU trade in sectors with significant NTMs is much lower than our model would predict. We see that relative to the EU, the United States stands to increase exports by a larger margin if these set of measures are removed. The forgone levels of U.S. exports attributed to EU NTMs were estimated to be between $4 and $9 billion. U.S. fruit and nut exports were found to be the largest sources of trade losses; corn and meat exports were also significant sources of forgone trade. The forgone levels of EU exports attributed to U.S. NTMs were estimated to be between $1.7 and $2.5 billion. EU fruit and vegetable exports were found to be significant sources of lost trade.

Table 4. NTMs on Agricultural Sectors

Sector	Example of NTM in sectors	NTM statistically significant?[a]	Exports $Mill (2010-2012 average)	Estimated level of forgone trade (in 2011, mil. $)	
				low	high
EU sectors with NTM concerns raised by U.S. exporters					
Beef	Growth hormones, PRTs	Yes	166	382	510
Poultry	PRTs	Yes	566	96	110
Pork	Ractopamine, Trichanae, PRTs	Yes	18	104	247
Corn	Biotech Restrictions	Yes	158	509	1,058
Soy	Biotech Restrictions	Yes	1,300	247	249
Fruits	Maximum residue limits	Yes	374	1,371	2,531
Vegetables	Maximum residue limits	No	225	0	0
Nuts	Maximum residue limits	Yes	1,580	998	3,823
Wheat	Karnal Bunt testing	Marginal	374	0	653
Total			4,761	3,707	9,181
U.S. sectors with NTM concerns raised by EU exporters					
Beef	BSE	n/a[b]	0	31	58
Fruits	PRA process	Yes	110,000	587	910
Cheese	Marketing of raw cheese requirements	No[c]	852,115	0	0
Other dairy	Grade A requirements	No	131	0	0
Vegetables	PRA process	Yes	189,000	1,142	1,468
Total			1,151,246	1,760	2,436

[a]Significant at the 1 or 5% level; marginal significance is at the 10% level only.

[b]Coefficient may not be estimated due to zero EU beef exports to U.S. Estimated gain predicted with beef gravity model.

[c] NTM coefficient was statistically significant but of the wrong expected sign.

The above estimates do not exhaust NTM issues, but attempt to capture a subset of tangible NTM issues that have been prominent in trade discussions thus far. While we attempted to cover a broad range of SPS and TBT measures, many measures were not covered. Due to data and modelling limitations we did not consider other critical NTMs such as geographical indicators, administrative and custom requirements, rules of origin issues, taxes discriminatory on exporters, state-specific requirements, government procurement policies, or other regulations. The NTM analysis is meant to be a hypothetical assessment of costs. It is possible that the level of regulatory convergence or reform could include far more NTMs than examined, under-predicting the full possible gains from TTIP. Alternatively, the future actual agreement may not deal with all of the NTMs examined here, and even for these cases, only partially relax requirements, leading to over-predictions from the gravity model.

Finally, it is important to recognize that our estimates of forgone trade due to NTMs are not equivalent to the predicted gains from removing these barriers. First, since our model only identifies the level of bilateral resistance with sectors with specific NTMs concerns, the results should be interpreted as upper-bound estimates. The level of aggregation of the sector also neglects important product level differences. Second, the estimates only reflect the "partial effect" of NTMs and would only be equivalent to the gains of removing all NTMs if all other factors were held constant. As NTMs are known to carry many secondary and external welfare effects (Beghin et al, 2012; Deardorff and Stern, 1998) these partial effect estimates likely overestimate the gains from NTMs. In particular, the following three factors are likely to restrain the levels of estimated effects found in this study.

1. Estimates do not account for general equilibrium effects. Any change in market access has secondary effects on other markets (factor markets and other commodity markets).

The estimates are likely to over-predict the gains, since they do not account for supply constraints and inter-sector 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 removal of EU NTMs on nuts, a dramatic expansion of exports would likely put pressure on U.S. nut production, raising prices and restraining supply. 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. Modeling the general equilibrium effects would be critical for these cases.

2. 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), non-linear effects of TRQs are not effectively captured in a gravity model. For many cases in TTIP, 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 NTM and TRQ framework.
3. The estimates focus purely on the cost side and ignore other potential welfare implications. NTMs, notably SPS measures, may deal with externalities or change perceived product quality and thus lead to demand-shifting effects. In some of these cases EU or U.S. preferences may affect the predicted gains from removal. In such cases, modelling demand side changes in addition to the supply side changes would be necessary.

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 partial effects of NTMs estimated from our gravity model are decomposed into a different type of ad-valorem trade costs and incorporated into the CGE model, which can deal with the general equilibrium effects. Non-linear effects of TRQs are properly dealt with in model simulations using mixed complementarity methods. The study also attempts to address possible demand side effects of NTMs.

CGE Model

Given the complex links and interactions between agricultural sectors, competition among these sectors for limited economic resources, as well as interactions between the production, consumption, and trade activities, an economy-wide computational general equilibrium (CGE) modeling approach provides an appropriate framework to analyze the impacts of TTIP. The value of a global, CGE approach in analyzing the impacts of trade policy has previously been demonstrated in the work of several TTIP studies (e.g., CEPR, 2013b; ECORYS, 2009; EP, 2014). For both the CGE data and model we rely on the publicly available GTAP resources. As one of our goals is to determine the impacts of TTIP from tariffs and TRQs, we have to take steps to explicitly specify TRQs in our model as they are not available in a standard model. NTMs also need to be explicitly accounted for in our model.

We utilize a version of the GTAP model built by Beckman et al. (2012), which encompasses all the standard features mentioned above, along with some critical updates for agricultural sectors. In particular, the model incorporates biofuels and biofuel co-products into GTAP-E model (Beckman et al., 2011); and also incorporates the livestock/feed nesting structure from Keeney and Hertel (2009). In addition, the model utilizes the detailed land-use module

(GTAP-AEZ) which captures heterogeneous land quality and allows a better representation of agricultural production. GTAP-AEZ disaggregates land into 18 agro-ecological zones (AEZs) that share common climate, precipitation and moisture conditions (Hertel et al., 2008). Alternative agricultural and forestry land uses then compete for lands with heterogeneous quality.

With the base model established, we turn to modeling tariffs, NTMs, and TRQs for TTIP. Implementing a tariff removal scenario is relatively straightforward in the GTAP model; one only has to specify the size of the shock on the variable '*tms*', the tax on imports into a country. This variable is defined as the tax introduced by the importer on the exporter for a given sector. Conducting a NTM removal scenario is also straightforward, as the variables used are all exogenous price shocks: *tms*[5], *txs* (the tax on exports from a country), and *ams* (a tax on production efficiency). TRQ scenarios; however, require substantial work to implement them in our model.

To implement TRQs in our model we begin with the pioneering work of Elbehri and Pearson (2000) who first implemented TRQs in the GTAP model. Although they do not imbed the TRQ module directly in the program (rather it uses a companion program called TRQmate), the program code provides a useful basis for the treatment of TRQs in our model. To begin with, we define several variables:

$$TMS3_{i,r,s} = TMSINQ_{i,r,s} * TMSTRQ_{i,r,s} \quad (4)$$

where *TMS3*, the total power of the tariff in sector i, exported from region r to region s, is equal to the in-quota power of the tariff (*TMSINQ*) multiplied by the actual *extra* power of the tariff due to TRQs (*TMSTRQ*);

[5] Note that *tms* is already used in the tariff removal scenario, thus we must specify a *tms2* variable that is also applied on the import price. Further, the TRQ modeling also makes use of *tms*, so we also specify a *tms3* variable.

$$TMSOVQ_{i,r,s} = TMSINQ_{i,r,s} * TMSTRQOVQ_{i,r,s} \quad (5)$$

TMSOVQ, the total power of the of the tariff on over-quota imports is equal to *TMSINQ* multiplied by the *full* extra power of the out-of-quota tariff;

$$TMSINQ_{i,r,s} = VIMSINQTRQ_{i,r,s}/VIWS\_TRQ_{i,r,s} \quad (6)$$

so *TMSINQ* is equal to the value of the quota volume (*QMS_TRQ*) of imports at world prices plus the in-quota rate (*VIMSINQTRQ*) divided by the value of *QMS_TRQ* at world prices (*VIWS_TRQ*);

$$QXSTRQRATIO_{i,r,s} = VIWS_{i,r,s}/VIWSTRQ_{i,r,s} \quad (7)$$

where *QXSTRQRATIO*, the ratio of actual imports (*QXS*) to *QMS_TRQ* is equal to the value of imports at *cif* prices (*VIWS*) divided by *VIWSTRQ*.

External data for *VIWS_TRQ*, *VIMSINQ_TRQ*, and *TMSTRQOVQ* are necessary for the model; from these pieces of information any other necessary variable can be computed. We collect the data for those three variables from TARIC and GTIS, and use the programs provided by Elbehri and Pearson (2000) to populate our base data. From these data, actual quota volume can be backed out:

$$QMS\_TRQ_{i,r,s} = VIWS\_TRQ_{i,r,s}/CIF_{i,r,s} \quad (8)$$

Finally, to implement the module into our GTAP model, we use the advances first made by Bach and Pearson (1996) and Harrison et al. (2004) to introduce MCP into GTAP. This ability was recently used by Hertel and Beckman (2011) and Beckman et al. (2012) to model the Renewable Fuels Standard and blend wall for U.S. biofuels, and the Renewable Energy Directive for EU biofuels. To utilize MCP for TRQs we specify the complementary equation:

$TMSTRQ \perp 1 \leq (1 - QXSTRQRATIO) \leq TMSTRQOVQ$ which implies that

$TMSTRQ = 1 \; and \; (1 - QXSTRQRATIO) > 0$ and imports are in-quota (9)

$1 \leq TMSTRQ \leq TMSTRQOVQ\ and\ (1 - QXSTRQRATIO) = 0$ and imports are on-quota

$TMSTRQ = TMSTRQOVQ\ and\ (1 - QXSTRQRATIO) < 0$ and imports are over-quota

The state of the quota volume will determine what quota tariff rate the sector is under. This specification allows a switching regime, when exports are under the quota amount they will be taxed with the in-quota rate; once they exceed the quota the out-of-quota rate will be applied.

CGE Model Results

To better understand the effects of TTIP on agricultural production, prices, and trade, as well as country-specific macroeconomic impacts, such as GDP and welfare, we make use of a global CGE model that details inter-industry linkages. A mixed-complementarity problem (MCP) setup is used to explicitly model the non-linear effects of TRQs on trade. Gravity model estimates from Arita et al. (2015) are used to model NTM costs in our CGE model (see Appendix 3). Two hypothetical scenarios are explored. We first simulate a market access scenario, where tariffs are removed, and there is a 50 percent increase in TRQ quota amounts. The second scenario includes the market access of the first scenario, but also removes NTMs. Finally, in the appendix we consider demand sensitivities that may arise from changes in the NTM regime. Along with the United States and EU, we also investigate the impacts to the other NAFTA regions, to other major agricultural trade markets (Brazil, China, and India), and the rest of the world.

Market Access

The first hypothetical and stylized TTIP scenario considers the removal of tariff, except where there is a 50 expansion of TRQs for those sectors in Tables 2 and 3 (with in-quota rates set to zero). This market access scenario does not consider NTMs. Aggregate macro results are presented, then detailed trade results are discussed. The focus of the trade section is on the United States and EU, although trade impacts to all other regions as a whole are presented.

Finally, production and price changes resulting from our trade policy simulation are discussed. The focus of these sections is on agricultural sectors.

Macro Impacts

A market access scenario would lead to an increase in real GDP for the two treaty partners, while the other NAFTA countries (Canada and Mexico) have a small decrease in GDP (Table 5). Changes in GDP for the other regions are effectively zero. These increases in U.S./EU GDP are similar to those estimated in other studies (see Table 1). As Table 5 indicates, the model estimates a larger increase in GDP for the EU compared to the United States. This is largely a result of an increase in EU exports of manufactured products and services.

Table 5. Macro Impacts from a Market Access Scenario (% change)

		Value of Agriculture		Land Cover		
Region	GDP	Imports	Exports	Forestry	Crops	Livestock
U.S.	0.09	1.08	1.61	-0.01	-0.01	0.02
EU	0.23	0.61	-0.10	0.04	-0.07	0.02
Canada	-0.02	-0.26	-0.09	-0.01	-0.01	0.04
Mexico	-0.03	-0.27	-0.01	0.00	0.01	0.00
China	0.00	-0.06	-0.40	-0.02	-0.01	0.02
India	0.00	0.00	-0.37	0.06	-0.01	0.11
Brazil	0.00	-0.06	-0.46	0.00	-0.02	0.00
ROW	0.00	-0.08	-0.47	0.00	0.00	0.00

Source: ERS TTIP Model

For aggregate agricultural trade, both the United States and EU have increases in imports. The United States increase is a little more than one percent, and is largely a result of increasing imports of dairy products. The EU has more than a ½ percent increase in imports, again largely from dairy products as well as pork. All other countries have a decrease in global trade. Bilateral tariffs on agricultural goods are in general higher for the EU than for the United States (Figure

2), thus, a tariff removal scenario leads to larger bilateral export gains in the United States than for the EU.

Trade Impacts

Detailed agricultural sector trade impacts to the U.S. and EU trade are presented in Table 6. The United States has an increase in export value to the EU for most agricultural sectors; although there is a decrease in raw milk and raw oilseeds, e.g., soybeans. This is mainly because tariffs in these sectors are small (Figure 1). U.S. export values to all other countries decline, as the increase in exports to the EU displaces these exports. The increase in U.S. bilateral export value of butter to the EU is much larger than the 50 percent TRQ quota increase; however, overall exports from the United States are still under the quota due to the low initial fill rate (Table 7). U.S. exports of beef to the EU hit the new 50 percent quota increase, then are fully restrained by the high out-of-quota tariff. U.S. bilateral wheat and nuts exports do not reach their new quota limit. For these two sectors, the initial quota allocation was fairly large and initial in-quota tariff rate was low, with the United States already exporting a large share. However, the cheese sector expands, completely filling the TRQ.

Table 6. Bilateral Trade Values from a Market Access Scenario (% change)

Sector	U.S.to EU	U.S.to All Others	All Others to U.S.	EU to U.S.	EU to All Others	All Others to EU
Cereals	65.10	-1.75	2.50	12.22	1.35	-14.86
Wheat	23.43	-1.49	0.87	5.27	0.42	-5.75
Coarse grains	1.79	-0.47	0.56	1.20	0.58	-0.60
Fruits	29.96	-0.87	0.53	5.21	0.46	-0.76
Vegetables	16.08	-0.48	0.43	8.12	0.33	-0.62
Nuts	1.65	-0.77	0.62	7.35	0.82	-1.21
Oilseeds	2.93	-0.71	-0.29	10.63	0.15	-0.21
Other agriculture	35.78	-1.74	0.19	9.24	0.75	-1.13
Other meat	41.16	-1.13	0.63	0.95	0.18	-3.63
Dairy	198.31	-2.13	-0.06	3.92	0.25	-5.01
Beef	50.00	-1.33	1.09	1.30	0.14	-2.19
Pork	266.00	-1.61	0.59	1.96	0.37	-21.78
Poultry	362.20	-1.42	1.03	14.74	0.09	-0.15
Powdered milk	58.33	-1.62	0.32	3.50	0.00	-2.28
Butter	206.66	-3.83	-6.29	11.40	2.69	-92.96
Cheese	650.07	-1.64	-24.41	29.94	0.18	-8.51
Processed sugar	154.55	-1.08	0.75	38.38	-0.17	-0.84
Processed rice	64.49	-1.26	0.39	7.85	1.36	-3.50
Processed foods	39.08	-0.73	-0.09	1.24	-0.01	-4.08
Biofuels	5.30	-0.48	-0.68	30.30	0.06	-0.58
Services	-0.83	-0.83	0.57	0.39	-0.01	0.23
Manufacturing	5.15	5.15	-0.78	4.25	0.13	-1.29

Source: ERS TTIP Model

Table 7. Changes in TRQ Fill Rates across Scenarios

	Base	Tariff & TRQs	Tariffs, TRQs & NTMs
EU TRQs on U.S. Sectors			
Beef	100	100	150
Butter	17	35	35
Cheese	20	100	100
Wheat	91	75	74
Powdered milk	1	13	13
Coarse grains	82	57	100
Nuts	100	68	115
Processed rice	91	100	100
Pork	5	12	47
Poultry	1	3	97
U.S. TRQs on EU Sectors			
Powdered milk	49	38	34
Butter	100	74	75
Cheese	57	49	50
Processed sugar	100	92	93
Beef	1	8	54

The changes in U.S. global export values are mixed (Table 8). There are decreases in wheat, coarse grains, oilseeds, powdered milk, and poultry meat; however, there are increases in many other categories of exports, including fruits, vegetables, and all other meats. U.S. global import values increase across agricultural sectors, especially cheese. This increase is entirely due to EU exports, as cheese imports from all other countries declines. The EU has an increase in export value to all other countries for most agricultural sectors, as they replace some of the U.S. decline. Export values from all other countries to the EU declines for almost all agricultural sectors, again the reverse of the U.S. result. In general, all other country export values decline for many agricultural sectors, while import values decline for all but a few sectors.

Table 8. Trade Values from a Market Access Scenario (% change)

	Exports			Imports		
Sector	U.S.	EU	All Others	U.S.-	EU	All Others
Cereals	2.06	-3.62	-3.83	2.74	0.56	-0.88
Wheat	-0.59	-0.40	-0.23	1.24	0.57	-0.14
Coarse grains	-0.40	0.00	0.09	0.58	-0.10	-0.19
Fruits	1.30	-0.13	-0.06	0.57	0.06	-0.08
Vegetables	1.24	0.05	-0.06	0.61	0.08	-0.04
Nuts	0.12	-0.37	-0.01	0.70	0.10	-0.19
Oilseeds	-0.48	0.31	0.01	0.83	0.04	-0.08
Other agriculture	0.67	0.18	-0.23	0.72	0.22	-0.19
Other meat	1.73	-0.48	-0.50	0.71	0.41	-0.05
Dairy	1.15	-0.18	-0.85	2.12	0.59	0.14
Beef	0.32	0.00	-0.09	1.10	0.55	-0.15
Pork	5.61	-0.15	-3.97	1.43	8.70	-0.13
Poultry	-1.35	0.13	0.08	1.03	-0.02	-0.23
Powdered milk	-1.53	0.00	0.05	1.74	0.14	-0.08
Butter	37.68	-7.22	-7.06	9.56	12.40	1.58
Cheese	8.11	1.50	-2.66	29.41	0.58	0.11
Processed sugar	15.93	-0.69	-0.06	0.93	0.59	-0.07
Processed rice	1.13	-1.52	-0.12	0.65	0.66	-0.11
Processed foods	4.59	-0.11	-0.81	0.91	0.44	-0.06
Biofuels	0.98	5.26	-0.38	3.41	1.19	-0.31
Services	-0.84	0.01	0.13	0.49	-0.02	-0.12
Manufacturing	0.65	-0.01	-0.40	0.61	0.23	-0.06

Source: ERS TTIP Model

Production and Price Changes

Due to expansion of exports to the EU, prices for all agricultural sectors in the United States slightly increase. Prices for EU agricultural sectors decrease, on the other hand, due to the increase in imports from the United States. Changes in production for U.S. agricultural sectors largely follow export changes (Table 9), although there is a small increase in coarse grain production compared to the decline in exports. The largest decreases in U.S. production are in oilseeds (soybeans, rapeseeds, and other oilseeds), powder milk, cheese, and wheat. For the EU, there is a decline in production for many agricultural sectors, although there are increases in oilseeds, poultry, and cheese. Assessing market price changes for all other countries is not possible due to aggregation issues. However, changes in production are measured. These changes are relatively small, except for the large decrease in butter and cheese production (0.60 percent and 0.29 percent). This is a result of the large increase in U.S. butter exports and production, which displaces all other country production and trade.

Table 9. Production Values from a Market Access Scenario (% change)

Sector	U.S.	EU	All Others
Cereals	0.51	-1.30	-0.02
Wheat	-0.41	-0.31	-0.04
Coarse grains	0.01	-0.08	0.00
Fruits	0.16	-0.10	-0.01
Vegetables	0.11	0.00	-0.02
Nuts	0.07	-0.27	0.01
Oilseeds	-0.20	0.14	0.00
Other agriculture	0.05	-0.06	-0.04
Other meat	0.20	-0.26	-0.01
Dairy	-0.03	0.08	-0.04
Beef	0.06	-0.02	0.01
Pork	0.88	-0.50	-0.22
Poultry	-0.12	0.14	0.04
Powdered milk	-0.53	0.06	0.01
Butter	2.79	-0.87	-0.60
Cheese	-1.16	0.52	-0.29
Processed sugar	0.44	-0.31	-0.01
Processed rice	0.37	-0.90	0.00
Processed foods	0.37	0.04	-0.08
Biofuels	0.01	0.15	-0.03
Services	0.00	0.03	0.05
Manufacturing	0.02	-0.09	-0.11

Source: ERS TTIP Model

Finally, land cover changes (Table 5) are largely a result of total production changes. The U.S. has an increase in primary livestock production and exports (Table 6), thus there is a shift of land from the other two land types -- forestry and crops -- to livestock. Our CGE model does, however, contain the increase in crop yields from Keeney and Hertel (2009), thus less land is needed for crop production. The EU also has a similar shift of land to livestock, at the expense of cropland.

Market Access with NTM removal

The next hypothetical TTIP scenario involves combining the market access experiment with the removal of NTMs presented in Table 4. How NTMs are allocated in our CGE model is discussed in Appendix 3. This scenario is labeled as “NTM removal scenario”.

Macro Impacts

An NTM removal scenario would lead to an increase in real GDP for the two trading partners (Table 10), while the other NAFTA countries (Canada and Mexico) have a (small) decrease in GDP. These GDP changes are similar to those reported in the market access scenario. The increase in GDP is slightly larger for the United States (0.10 percent compared with 0.09); the EU has a larger increase (0.28 percent compared with 0.23) from the market access expanded scenario as consumers benefit from lower market prices in the sectors where NTMs are removed.

Table 10. Macro Impacts from a Tariff/TRQ & NTM Removal Scenario (% change)

		Value of Agriculture		Land Cover		
Region	GDP	Imports	Exports	Forestry	Crops	Livestock
U.S.	0.10	1.91	3.17	-0.02	0.00	0.02
EU	0.28	1.77	-0.21	0.30	-0.44	0.14
Canada	-0.02	-0.30	-0.46	0.03	-0.13	0.07
Mexico	-0.03	-0.43	-0.50	0.02	-0.02	0.00
China	0.00	0.05	-0.88	-0.02	-0.03	0.02
India	0.00	0.05	-0.99	0.18	-0.04	0.28
Brazil	0.00	-0.15	-1.19	0.08	-0.06	-0.05
ROW	0.00	-0.07	-0.97	0.02	-0.05	0.01

Source: ERS TTIP Model

For aggregate agricultural trade, both the United States and EU have increases in import values that are larger than the changes from market access alone. The value of U.S. imports grows by 1.91 percent, which is largely a result of increasing cheese and beef imports. The EU has a 1.77 percent increase in the value of its imports, largely pork and butter. All other countries globally have a decrease in trade, except for China and India, which have small increases in agricultural imports. In addition to the larger imports, the United States has a larger increase in exports with the NTM removal scenario: double that of the market access scenario.

Trade Impacts

Detailed agricultural sector trade impacts to U.S. and EU trade are presented in Table 11. U.S. export value to the EU increases for most agricultural sectors; especially, in those agricultural sectors where NTMs are removed. U.S. exports to all other countries decrease for all sectors, as exports are diverted to the EU market. The changes in U.S. global export values are mixed (Table 12). There are decreases in the value of global exports for wheat, oilseeds, and powdered milk; however, there are large increases in exports for butter, fruits, nuts, and pork. Under this experiment, U.S. exports of beef to the EU exceed the 50 percent increase in the TRQ; indicating that the removal of the NTM lowers costs such that U.S. beef exports are competitive at the out-of-quota tariff rate. Indeed, U.S. beef exports are 150 percent of the fill rate. This scenario also brings coarse grains and nuts to the TRQ fill rate (Table 9); in the case of nuts the fill rate is past 100 percent. There are also large increases in the pork and poultry fill rates, such that poultry almost fills their TRQ.

U.S. import values generally increase across agricultural sectors, from both the EU and from all other countries. The increases in import values from the EU are, in general, much larger than from all other countries. The only decrease in imports from the EU is from *ethanol2*, however, the increase in biodiesel outweighs those declines; while there are only import decreases in fruits, vegetables, beef, vegetable oil, butter, cheese, processed food, and biofuels from all other countries. The EU has an increase in exports to all other countries for most agricultural sectors (only processed sugar has a decrease in the aggregated sector composition (Table 12). Exports from all other countries to the EU decline for almost all agricultural sectors. In total, all other country imports and exports decline for all but a handful of agricultural sectors.

Table 11. Bilateral Trade Values from a Tariff/TRQ & NTM Removal Scenario (% change)

Sector	U.S.to EU	U.S.to All Others	All Others to U.S.	EU to U.S.	EU to All Others	All Others to EU
Cereals	57.15	-2.58	3.26	16.67	3.11	-15.09
Wheat	21.36	-2.82	1.25	7.52	1.95	-6.23
Coarse grains	82.93	-1.20	0.94	5.68	4.79	-16.88
Fruits	358.99	-3.16	-0.50	251.57	4.01	-8.76
Vegetables	14.87	-1.06	-2.55	248.13	1.87	-1.12
Nuts	72.52	-5.71	3.44	27.13	19.50	-47.84
Oilseeds	1.96	-1.32	-0.24	11.94	1.30	-0.36
Other agriculture	32.57	-2.86	0.33	12.59	3.70	-2.26
Other meat	38.07	-1.95	0.81	1.87	1.04	-4.27
Dairy	196.86	-2.80	0.15	4.51	0.55	-5.08
Beef	125.67	-1.87	-6.36	542.44	0.41	-6.15
Pork	1,308.07	-2.25	0.47	2.89	0.96	-73.18
Poultry	13,785.37	-2.00	1.24	31.39	0.56	-3.58
Powdered milk	57.92	-2.06	0.32	4.33	0.14	-2.28
Butter	206.52	-4.44	-6.27	12.05	2.90	-92.93
Cheese	650.07	-2.39	-24.63	30.91	0.45	-8.44
Processed sugar	152.77	-1.62	0.92	38.82	-0.03	-0.86
Processed rice	64.47	-1.96	0.65	7.85	1.08	-3.40
Processed foods	38.85	-0.90	-0.06	1.40	0.10	-4.07
Biofuels	5.22	-0.61	-0.30	30.34	0.22	-0.37
Services	-0.85	-0.85	0.58	0.41	0.01	0.24
Manufacturing	5.14	5.14	-0.77	4.27	0.14	-1.27

Source: ERS TTIP Model

Table 12. Trade Values from a Tariff/TRQ & NTM Removal Scenario (% change)

	Exports			Imports		
Sector	U.S.	EU	All Others	U.S.-	EU	All Others
Cereals	0.82	-2.02	-3.87	3.52	-0.83	-1.47
Wheat	-1.95	0.75	-0.53	1.78	-0.26	-0.01
Coarse grains	0.71	-9.39	-1.25	1.05	9.07	-0.30
Fruits	18.51	-2.30	-2.38	2.78	0.89	-0.15
Vegetables	0.60	4.08	-0.82	3.48	-0.46	0.00
Nuts	19.81	-33.16	-9.70	3.71	8.37	-1.08
Oilseeds	-1.11	1.45	0.07	1.00	-0.20	-0.10
Other agriculture	-0.58	2.49	-0.59	1.04	-0.99	-0.19
Other meat	0.75	-0.36	-0.66	1.07	-0.34	0.18
Dairy	0.46	0.00	-1.01	2.47	0.61	0.35
Beef	1.76	0.71	-1.84	9.16	1.64	-0.17
Pork	25.65	-1.97	-13.73	1.96	57.64	0.04
Poultry	0.24	0.13	-0.39	1.24	0.69	-0.16
Powdered milk	-1.97	0.13	0.03	2.16	0.15	-0.05
Butter	37.18	-7.08	-7.19	10.13	12.39	1.70
Cheese	7.28	1.72	-2.93	30.37	0.64	0.32
Processed sugar	15.25	-0.60	-0.02	1.09	0.57	-0.03
Processed rice	0.46	-1.69	-0.16	0.90	0.76	-0.24
Processed foods	4.41	-0.02	-0.84	1.02	0.41	-0.02
Biofuels	0.87	5.40	-0.16	3.75	1.35	-0.32
Services	-0.87	0.02	0.12	0.51	-0.02	-0.12
Manufacturing	0.64	0.01	-0.39	0.62	0.24	-0.05

Source: ERS TTIP Model

Production and Price Changes

Prices for all agricultural sectors (except for wheat) in the United States increase as there is increased competition for goods from the increase in exports. Prices for EU agricultural sectors decrease (except for *ethanol1*, which is zero), on the other hand, as they experience an overall increase in imports. Changes in production for U.S. agricultural sectors largely follow the changes in exports (Table 13). The largest decreases in U.S. production are to wheat, vegetables, and cheese. For the EU, there is a decline in production for many agricultural sectors; although there are increases in cheese, wheat, oilseeds, vegetables, and other agriculture. Changes in market prices for all other countries are not reportable due to aggregation issues; however, changes in production are available. These changes are relatively small, except for the large decreases in pork, nuts, and butter. This is a result of the decrease in exports, as U.S. exports and production displace all other country production and trade.

Table 13. Production Impacts from a Tariff/TRQ & NTM Removal Scenario (% change)

Sector	U.S.	EU	All Others
Cereals	0.32	-0.82	0.02
Wheat	-1.47	0.10	-0.11
Coarse grains	0.08	-4.06	-0.09
Fruits	1.74	-2.09	-0.22
Vegetables	-0.76	1.58	-0.05
Nuts	5.11	-24.61	-0.93
Oilseeds	-0.59	0.89	0.03
Other agriculture	-0.62	0.72	-0.09
Other meat	0.23	-0.95	-0.06
Dairy	-0.07	0.18	-0.03
Beef	-0.07	-0.03	-0.13
Pork	2.22	-3.67	-0.78
Poultry	0.08	0.13	0.00
Powdered milk	-0.69	0.13	0.02
Butter	2.73	-0.79	-0.60
Cheese	-1.23	0.66	-0.33
Processed sugar	0.33	-0.23	0.01
Processed rice	0.05	-0.97	0.03
Processed foods	0.36	0.10	-0.07
Biofuels	-0.05	0.27	0.07
Services	0.00	0.05	0.05
Manufacturing	0.02	-0.07	-0.11

Source: ERS TTIP Model

Conclusions

This study provides a quantitative assessment of the potential effects of a hypothetical and stylized TTIP agreement using two scenarios that consider tariff, TRQ, and selected NTM barriers. First, we consider a market access scenario, where tariffs are removed and there is a 50 percent increase in TRQ quota amounts. A second, more expanded market access scenario that includes NTM removal is then considered. Trade barriers between the TTIP countries and other partners remain unchanged in this analysis.[6]

Our analysis shows that there is significant scope for agricultural trade expansion in the TTIP regions if intraregional tariffs are eliminated and TRQs are expanded, despite the fact that tariffs between TTIP countries are already relatively low. We find that the market access experiment (scenario 1) would generate small increases in GDP for both the United States and EU; although the increase is greater for the EU. For agriculture, we find that U.S.-EU agricultural trade expands, with larger increases for U.S. exports. As a result, prices of U.S. agricultural goods slightly increase, while prices of EU agricultural goods fall. There is some trade diversion with third countries, but most effects are limited. A second scenario that in addition removes NTMs scenario would lead to even larger expansion in bilateral agricultural exports. For our base period (2011, the latest GTAP basedata available), the EU had a trade surplus in agricultural (and biofuels) goods with the United States of $7.3 billion. This surplus is reduced to $4 billion in the market access scenario and $3.1 billion when NTMs are also removed.

Impacts to individual commodities differ across the scenarios as well. Under the market access scenario, U.S. exports to the EU increase for most agricultural commodities; when NTMs are also removed, these increases are even greater. While TRQs limited U.S. beef exports to the EU, the removal of the NTM lowers production costs such that the U.S. exports some beef at the much higher out-of-quota tariff rate. The largest gains for most agricultural sectors under all scenarios occur to those governed under TRQs, but where the quota is not currently filled. For example, U.S. pork exports to the EU increase by more than 1,000 percent (albeit from a small

[6] Pending trade agreements such as the EU-Canada Comprehensive Trade and Economic Agreement could affect the gains from TTIP.

base) when NTMs are removed. For the EU, there are increases in exports to the United States for most agricultural sectors, and only exports of ethanol produced from grains have a decrease. Again, the largest gains are those which have TRQs or NTMs.

Changes in total U.S. or EU trade also differ across the scenarios; removal of NTMs generates the largest trade growth. Overall U.S. and EU exports do not increase in all agricultural commodities, as reductions in trade with all other countries and supply constraints balance the increased trade between the TTIP partners. For the United States, there are large gains in pork and cheese exports, while the EU has gains in wheat and oilseeds exports. The bilateral changes to the United States and EU are enough, however, to lead to decreased exports by all other countries as a whole. The United States tends to have an increase in imports across all agricultural sectors, while results are mixed for the EU and all other countries.

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Appendix 1 – The GTAP Data for the CGE Model

We utilize the most recent GTAP database for our TTIP experiments, v. 9 which has a base of 2011. The disaggregated GTAP base data contains over 130 regions and 57 sectors; researchers often aggregate these to make the results easier to comprehend and interpret. For TTIP we aggregate the regions to 8: Brazil, Canada, China, EU, India, Mexico, the United States and a rest of the world (ROW) region that contains all other regions (Table 1). Our regional aggregation includes those most likely to be impacted by TTIP: the other NAFTA regions, and other major agricultural trade markets. Indeed, 5 of our regions were the top agricultural exporters in 2013 (EU, United States, Brazil, China, and Canada). Our aggregation set includes the top 6 agricultural importers, except for Japan and Russia.[7]

Table 1. Region Aggregation Scheme

No.	Country/region	Included GTAP country/regions
1	Brazil	bra
2	Canada	can
3	China	chn, hkg
4	European Union (EU)	aut, bel, cyp, cze, dnk, est, fin, fra, deu, grc, hun, irl, ita, lva, ltu, lux, mlt, nld, pol, prt, svk, svn, esp, swe, gbr, bgr, hrv, rou
5	India	ind
6	Mexico	mex
7	United States	usa
8	Rest of World (ROW)	aus, nzl, xoc, jpn, kor, mng, twn, xea, brn, khm, idn, lao, mys, phl, sgp, tha, vnm, xse, bgd, npl, pak, lka, xsa, xna, arg, bol, chl, col, ecu, pry, per, ury, ven, xsm, cri, gtm, hnd, nic, pan, slv, xca, dom, jam, pri, tto, xcb, che, nor, xef, alb, blr, rus, ukr, xee, xer, kaz, kgz, xus, arm, aze, geo, bhr, irn, isr, jor, kwt, omn, qat, sau, tur, are, xws, egy, mar, tun, xnf, ben, bfa, cmr, civ, gha, gin, nga, sen, tgo, xwf, wcf, xac, eth, ken, mdg, mwi, mus, moz, rwa, tza, uga, zmb, xec, bwa, nam, zaf, xsc, xtw

[7] Japan and Russia are not disaggregated from the ROW because Japan is only a major agricultural importer, not an exporter or producer; and GTAP data for Russia is notoriously poor.

Our sector aggregation scheme is heavily weighted towards agricultural sectors (Table 2). To that end, we keep any GTAP base data agricultural sector disaggregated, e.g., wheat and processed rice. Unfortunately, there are only twenty sectors that can be considered as agricultural sectors in the base data; thus we use the SplitCom utility to create several sectors of interest in TTIP. As a result our final aggregation is 38 agricultural and biofuel sectors, with 47 total sectors. Agricultural sectors 1-16 are raw products in agricultural production; sectors 21-38 are the processed products of these raw products; and sectors 41, 45-47 are biofuels and their co-products. This aggregation scheme allows analysis for meat products, a focus of both NTMs and TRQs; nuts, a large source of U.S. exports to the EU; and details the results to processed food sectors (33-37), which in aggregate are the largest agricultural sector by a wide margin. Energy products (18-20, 39, 43) keep their original disaggregation as is required for use of the specific GTAP model we employ.

SplitCom

We completely disaggregate six of the GTAP-defined sectors into subsectors using the SplitCom utility developed by Horridge (2008). In addition, we break out the respective amounts for biofuels from their previous aggregate sector, e.g., Ethanol1 is split from sector P_C, but the P_C sector remains. SplitCom is a matrix balancing program that allows the user to subdivide the rows and columns of a sector from a balanced social accounting matrix (SAM). The user provides data to disaggregate a GTAP sector's input demands, uses in intermediate and final demand and trade, and tax and tariff payments. SplitCom then uses methods similar to minimum entropy to balance the disaggregated SAM and to satisfy accounting identities. The utility manipulates only the disaggregated sectors, which can be re-aggregated to restore the original values in the GTAP SAM. We ultimately use SplitCom to disaggregate 24 grain, animal, meat

Table 2. Sector Aggregation Scheme

No.	Name	Description	GTAP sector code	Aggregation of Sectors for Results
1	Paddy rice	Paddy rice	pdr	Cereals
2	Wheat	Wheat	wht	Wheat
3	Coarse grains	Barley, corn, oats, sorghum	gro	Coarse grains
4	Fruits*	Fruits	v_f	Fruits
5	Vegetables*	Vegetables	v_f	Vegetables
6	Nuts*	Tree nuts	v_f	Nuts
7	Soybeans*	Raw soybeans	osd	Oilseeds
8	Rapeseed*	Raw rapeseed	osd	Oilseeds
9	Other oilseeds	All other oilseeds	osd	Oilseeds
10	Sugar cane/ beet	Raw sugar cane and beet	c_b	Other agriculture
11	Other crops	Plant-based fibers and other crops	pfb, ocr	Other agriculture
12	Bovine	Cattle, sheep, goats, horses	ctl	Other meat
13	Hogs*	Hogs	oap	Other meat
14	Poultry & eggs*	Poultry	oap	Other meat
15	Other animals*	Wool and all other animals	oap	Other meat
16	Raw milk	Raw milk	rmk	Dairy
17	Natural resources	Fishery, forestry	frs, fsh	Manufacturing
18	Coal	Coal	coa	Manufacturing
19	Oil	Oil	oil	Manufacturing
20	Gas	Natural gas	gas, gdt	Manufacturing
21	Beef	Beef	cmt	Beef
22	Pork*	Pork and pork products	omt	Pork
23	Poultry meat*	Poultry meats and products	omt	Poultry
24	Other meats	Other meat products	omt	Other meat
25	Vegetable oil	Vegetable oils and fats	vol	Oilseeds
26	Whey*	Whey	mil	Dairy
27	Powdered milk*	Powder milks	mil	Powdered milk
28	Butter *	Butter, fats, oils and substitutes	mil	Butter
29	Cheese*	Cheese	mil	Cheese
30	Other dairy products*	Fluid milk and products	mil	Dairy
31	Processed sugar	Processed sugars	sgr	Processed sugar
32	Processed rice	Processed rice	pcr	Processed rice
33	Prepared f_v*	Processed fruits and vegetables	ofd	Processed foods
34	Cereal preparations*	Processed cereal products	ofd	Processed foods
35	Sugar preparations*	Processed sugar products	ofd	Processed foods
36	Processed feed*	Livestock feed products	ofd	Processed foods
37	Other foods*	Other food products	ofd	Processed foods
38	Beverages & tobacco	Beverages and tobacco products	b_t	Processed foods
39	P_C	Petroleum, coal products	p_c	Manufacturing
40	L_Mfg	Labor-intensive manufacturing	tex, wap, lea, lum, ppp, fmp, mvh, otn, omf	Manufacturing
41	Ethanol1*	Corn-based ethanol	p_c	Biofuels
42	Ethanol2*	Sugar-based ethanol	crp	Biofuels
43	H_Mfg	Capital-intensive manufacturing	crp, nmm, i_s, nfm, ele, ome	Manufacturing
44	Ely	Electricity	ely	Manufacturing
45	Other services	All other services	wtr, cns, trd, otp, wtp, atp, cmn, ofi, isr, obs, ros, osg, dwe	Services
46	DDGS*	Dried distiller's grains with solubles	ofd	Cereals
47	Biodiesel*	Biodiesel	crp	Biofuels

Note: * represents a sector split using SplitCom

dairy, and biofuel sub-sectors. Those with an asterisk in Appendix 2, table 2 are split; the original aggregated sector is represented in the fourth column. For example, the original GTAP data base has a sector referred to as: f_v. This sector is split into three components: fruits, vegetables, nuts.

Data for the SplitCom procedure are drawn from multiple sources. Bilateral trade and tariff data are disaggregated using TASTE (Tariff Analytical and Simulation Tool for

Economists), a software developed by Horridge and Laborde (2010) and based on the Market Access Maps (MacMap) HS-6 trade and tariff database (Guimbard et al., 2012). We use the version from October 2012, which is compatible with the GTAP v. 9 database, with some adjustments to tariff rates based on multiple sources. TASTE disaggregates the GTAP sectors into HS-6 data for trade and tariffs. These disaggregated data are then re-aggregated into the sectors defined in the ERS TTIP CGE model, using the HS2002 concordance developed by Hutcheson (2006). Data for the disaggregation of subsectors' inputs and demands for their output are drawn from multiple sources, including FAOSTAT, USDA's Production, Supply and Distribution (PS&D) Database, USDA's Global Agricultural Information Network (GAIN) reports, and Energy Information Administration energy statistics, and national statistics.

TRQs

GTAP tariff protection data is provided by the MacMap database (more information is available at: http://www.macmap.org/), providing an ad-valorem equivalent (AVE) for regular tariffs, specific tariffs, compound tariffs, and TRQs. To estimates the impacts of TTIP from both tariff and TRQ components, we have to separate TRQs from the total tariff calculation in the GTAP database and explicitly specify TRQs in the model. To separate tariffs/TRQs, we obtain external data on TRQs for the EU and United States. Note that the GTAP base data is much more aggregated than our TRQ sources: the Taxation and Customs Union (TARIC) data base and Global Trade Information Services (GTIS). To overcome this, we examine each possible TRQ line in each HS 6 code for a given sector, noting if the TRQ is bilateral or if it is available to everyone in a most-favored nation (MFN) allocation (for rent allocation). Then we calculate fill rates, and in- and out-of-quota rates.

To calculate fill rates we examine the amount of the quota and the amount of imports across each TRQ line. As TRQs might be bilateral, we need to examine each allocation for a region. For example, in EU cheese, there is a TRQ specifically allocated to New Zealand and Australia (two lines), and one for Canada. The Canadian fill rate is the total minus the New Zealand and Australian lines. Finally, the fill rates for all other countries will be the total minus the Australian, Canadian, and New Zealand lines. To calculate in-quota and out-of-quota rates, we need a weighting scheme. Using a trade-weighted measure ignores zero trade in TRQs, so we construct a 'quota-weighted' measure. To construct this we calculate the final quota across each TRQ line, then take the amount of the quota for each trade line and divide by the total quota. The in-quota rate is the weighted sum of the rates across each line, as the fill rates and trade are the same in each category. This average in-quota rate by share, summed up, is the total in-quota rate. Care must be taken to account for specific allotments in each country. Out-of-quota rates are calculated the same way.

Lips and Rieder (2002) discuss aggregating TRQs in the case of several TRQ lines, and make an important suggestion. They note that if at least one tariff line exceeds its quota quantity, the assumption should be made that the sector-wide TRQ also exceeds the aggregated quota quantity. This will bring the TRQ information more in-line with real world behavior. As an example of how this is used, U.S. beef is exported to the EU under several TRQ lines (see Arita et al., 2014 for detailed information). The memorandum of understanding (MOU) TRQ allows high-value U.S. beef to enter quota free, then there is the Hilton quota, again allowing high-value beef, but there at an in-quota rate of 20 percent. Finally, there are two additional quotas, also with in-quota rate of 20 percent, but this is for lower-value beef. The MOU quota is filled most years, the Hilton quota is partially filled, and the U.S. exports no beef under the other 2 additional quotas. Using some aggregate of the four quotas would be misleading; any additional quota given in TTIP would likely be similar in effect to the expanding MOU quota.

Quota rents are also a necessary data component; otherwise the TRQ specification assumes that all rents are accumulated by the importer. For U.S.-EU bi-or multilateral TRQs, we allocate the rents equally among exporters and importers. For sectors (e.g., butter, cheese) where all TRQs are MFN, we specify all rents to accrue to the importer.

Tariffs

Once TRQ-affected tariff lines are treated as discussed above, the remaining tariff lines are aggregated. Note that if a sector is deemed to be a 'TRQ sector', the CGE model treats all trade for that sector as occurring under TRQs. Thus there is no need to worry about tariff AVEs attributable to tariffs or TRQs, the model only uses one specification or the other. We use external data from multiple sources and ERS expert reviews, as documented in Burfisher, et al. (2014) to validate the remaining tariff rates; to estimate a tariff rate for sectors that were disaggregated using SplitCom; and to review and update country tariffs. Note that the SplitCom program will allocate the original tariff value to all newly split sectors, e.g., if the tariff for the f_v sector is 20, the new fruits, vegetables, and nuts sectors will all have a tariff of 20. We use GTAP's Altertax utility to update the model to redefine tariffs on split commodities, tariff rates net of the TRQ tariffs, and to correct or update various tariff rates.

Appendix 2 – U.S. and EU Specific Trade Concerns

Specific Trade Concern	Type of NTM	Products affected
U.S. Concerns on EU NTMs		
EU restricts the use of pathogen reduction treatments (PRTs) commonly used to reduce microbes on meat	Food Safety	Poultry, Beef, and Pork
EU policies restrict the importation and use of U.S. agricultural commodities derived from agricultural biotechnology; approval process is lengthy and costly	Biotechnology	Various Products
EU prohibits beef and beef products raised with growth-promoting hormones	Food Safety	Beef and Beef Products
The EU limits the number of somatic cells permitted in raw milk	Food Safety	Milk and Milk Products
Low level of maximum residue limit (MRL) tolerances; MRLs not established for some products	Food Safety	Fruits, Vegetables, Nuts
EU prohibits pork and beef products produced with ractopamine	Food Safety	Pork and Beef Products
EU prohibits tallow not intended for human consumption over BSE concerns	Animal Health	Animal By-Products
Costly testing of wheat shipments for karnal bunt spores	Plant Health	Wheat
EU requires cherries to be free of brown rot	Food Safety	Cherries
Honey containing pollen derived from biotechnology must be labeled	TBT	Honey
Bans U.S. molluscan shellfish (other than scallops)	Food Safety	Shellfish
Imposes detailed rules regarding designations of origin and geographical indication	TBT	Wine
EU Concerns on U.S. NTMs		
Restrictions on beef products due to Bovine Spongiform Encephalopathy (BSE concerns)	Animal Health	Beef and beef products
Slow procedures on applications to allow import of new types of plant products	Plant Health	Plants and Plant Products
Grade A requirements on some dairy products which is difficult to obtain approval	Food safety	Dairy products
Water testing requires for bivalve mollusks	Food Safety	Fishery
Restrictions in cross-state sales	TBT	Wine

Sources: United States Trade Representative SPS and TBT reports; European Commission Market Access Database; WTO specific trade concerns

Appendix 3 - Allocating NTM Costs for the CGE Model

An NTM can affect trade by influencing the economic decisions of multiple agents, including exporters, importers and consumers, in exporting and importing countries. The gravity results give us an aggregate estimate of NTM costs, however, there is no information regarding how these costs should be allocated across agents in our CGE model (see Box). We examine the incidence of costs using a detailed supply-chain, price-gap approach. As described by Ferrantino (2012), this method can decompose the costs of the NTM, providing more appropriate allocations for our CGE model. Following the supply-chain analysis for beef from Arita et al. (2015), we conduct a similar exercise for biotech crops, using corn as our example. The production of biotech-free crops entails higher costs of export production and higher "rents," or price mark-ups, by exporters and/or importers as a result of the scarcity of a product. These costs and markups cumulatively lead to price premia observed at the retail level. Decomposing these costs is the goal of this section.

There is a large literature on how to appropriately specify NTM costs in CGE models. That is, CGE-based analyses simulate the effects of removing NTMs after drawing on external studies for estimates of the NTMs' trade impacts. In these studies, the price or quantity gaps are converted into AVEs of surcharges on import tariffs that would have the same effect on prices or trade volumes as the NTM measure. The AVEs are then allocated in a CGE model across three mechanisms: surcharges to import tariffs (*tms*) or export taxes (*txs*), or production inefficiencies (*ams*).

Approaches to allocating NTM costs (Table 1) range from assigning all NTM costs to one of the three mechanisms (e.g., Andriamananjara et al., 2003) to differentiating between rents versus costs (e.g., ECORYS, 2009) where rents are modelled, in effect, like export and import taxes (depending on where the price mark-up occurs) and any actual costs in production are allocated to production inefficiencies. Our NTM costs decomposition follows this rent/cost approach.

Table 1. Literature Review of CGE Approaches to Modeling NTMs

Author	Case	Source of NTM measure	Allocation across mechanisms			Interpretation
			Export tax	Import tax	Efficiency	
Andriamananjara et al. (2003)	Footwear	Price gaps	100			Allocation based on implementation of specific NTM. Footwear quantitative import restrictions create quota rents.
	Apparel			100		Apparel voluntary export restriction create quota rents
	Processed food				100	NTMs have a sand in the wheels type of effect.
ECORYS (2009)	TTIP	Gravity model	26.6	13.3	60	Resource-using "waste" is modeled as an efficiency loss; rent-seeking distortions are modeled as import or export taxes. Allocation is estimated.
EP (2014)	TTIP	Gravity model	33	33	33	NTMs represented either as a pure efficiency loss (sand in the wheels) or as a tax, which may affect the importer and/or exporter.
Fox, Francois and Londono-Kent (2003)	U.S. Mexico trucking case	Secondary source: Empirical study of time and costs for cross-border shipments		40-66	33-60	Indirect trade costs are time spent and costs paid by shippers for non-essential border-crossing services, divided into efficiency (time lost) effect and import tariff equivalent (border costs for which rent can be captured).
Fugazza (2008)	Global	Secondary source: Kee et al. (2009)	0	<25%	>75%	Allocation depends upon sector. Rent-creating NTBs modeled as import tariffs; technical NTBs modeled as trade productivity shocks.
Hertel, Walmsley, Itakura (2001)	Japan and Singapore	Multiple secondary sources	0	0	100	Productivity shock includes reduction in direct border costs, time saved and wholesale-retail margins of due to customs automation and increased B-2-B
Minor and Tsigas (2008)	Global	Secondary source: Hummels et al. 2007.			100	Hummels et al.'s tariff equivalents of trade delays counted time in three stages of transit: inland transport, customs processing, and port handling.
Winchester (2009)	Australia-New Zealand	Gravity model			100	AVE of the NTM Includes all border costs excluding transport costs, trade taxes

********End Box***

Supply-chain Analysis

Estimates of added costs of export production for agricultural producers begin with the cost of preserving seed purity. They also include the cost of cleaning planters, foregone benefits of not using biotech varieties (including increased pesticide use) and monitoring. Bullock et al. (2000) estimate the monitoring costs for corn at an average of $0.09 per bushel. Exporters must clean containers, but much of this is done as a matter of course, so the cost is not additional. They also do quite a bit of testing to make sure that varieties are non-biotech. Bullock et al. (2000) estimate this cost at $.056 per bushel. Maltsberger and Kalaitzandonakes (2000) estimate total identity preservation (IP) costs at $0.265 per bushel for high-oil corn, which, they note, has lower level testing than that required for genetically modified foods. The per bushel testing requirements to the IP requirements is $0.32 per bushel, which is about a 14 percent price increase.

Premia paid for non-biotech corn are very low in the EU, as they are largely self-sufficient in corn and can get any excess needed from Ukraine and India (Varacca, 2008). The premia offered are generally 1-3 percent (United Soybean, 2005). At a price of $88 per ton in 2000, this is a figure of about $.04 per bushel. This does not exceed the increased costs of non-biotech corn, in dollar or percentage terms. In total, we assume that production inefficiencies represent 1/3 of the NTM and export taxes 2/3. No NTM costs are allocated to the importer.

All NTM costs for meats are assumed to follow the beef supply-chain structure of Arita et al. (2015), field crops are assumed to follow the corn breakout. Constructing a similar supply-chain breakout for any other agricultural sector is time-prohibitive; thus we allocate NTM costs across the three mechanisms in equal proportions. Note this was the approach followed by EP (2014).