Gravity estimation of non tariff measures (NTMs) on EU-USA agri-food trade:

Implications for further analysis

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Abstract

This year marks the formal opening of trade negotiations between the world's two largest trading partners – the European Union (EU) and the United States of America (USA). It is expected that the transatlantic partnership negotiations will face significant obstacles on both sides, which in turn places the burden on economists to provide plausible impact assessments to inform policy makers. Unfortunately, modelling databases whilst rich with detailed disaggregated representations of tariff barriers, still underperform in the case of non-tariff measure counterparts. Indeed, unlike conventional tariff measures, NTMs do not have a transparent price effect which can be readily inserted into an economic model. Over the last decade, the usage of gravity models has received recognition as one such tool for understanding the 'part-worth' of NTM measures on trade restrictiveness. This paper also employs a gravity approach, whilst the explorative nature of the research restricts the current focus to four agro-food sectors.

Preliminary results suggest that NTMs impose a relatively equivalent ad valorem equivalent (AVE) trade cost on trade flows of cattle meat and processed rice in both directions. In the case of cattle meat, this appears to be consistent with the retaliatory nature of NTM instruments employed by US importers on EU bans. In beverages and tobacco and dairy products, however, the AVE of the NTM is higher on EU imports of US goods. In the case of beverages and tobacco, this finding appears to be consistent with the qualitative survey work conducted in ECORYS (2009), whilst the result for US dairy imports from the EU remains at first sight, counterintuitive and deserving of further research.

Key words: non-tariff measures, gravity equation, residual approach, agri-food

[1] The views expressed in this paper do not represent those of the European Commission.

1. Introduction

Since the Second World War, the transatlantic partnership forged between the EU and the USA has traditionally carried considerable economic and political weight, which has indelibly shaped the course of world events. Over the last two decades, however, the political and economic landscape has shifted in large part due to the continued emergence of the 'BRICs' and the continued fallout of the financial crisis, which has saddled many western economies with heavy national debts, high unemployment and sluggish growth. From a trade perspective, both factors played a role in the Doha multilateral trade negotiations under the auspices of the WTO. Trade negotiators from crisis ridden developed countries faced mercantilist pressures from their own politicians which curbed the ambition of the talks, whilst the enhanced presence of the developing country lobby sought to attain an improved negotiating position (particularly on agricultural trade), which had hitherto been largely absent in previous multilateral negotiations.

As the Doha talks reached a deadlock, both the EU and USA actively pursued 'second best' preferential trade agreements (PTAs). For example, the USA has actively forged PTAs with the Republic of Korea and Colombia, whilst the EU has recently signed accords or is close to doing so with the Republic of Korea and Singapore. Finally, in 2011 the seeds were planted for a potential EU-USA PTA at a high level working group meeting on jobs and growth (HLWG). Under the auspices of this initiative a final report was released in February 2013[2] in which it was concluded that the sheer weight of the bilateral trade volumes under consideration rendered potentially attractive economic gains to both partners from liberalisation, even with low initial levels of tariff protection. Taking a broader perspective, it is envisaged that bilateral regulatory integration on issues relating to phyto-sanitary (SPS), technical barriers to trade (TBT) and intellectual property rights (IPR) could even pave the way for a set of corresponding global trading standards in sanitary and, leading to concomitant positive spill-over effects for third countries.

A review of the literature reveals two reports (ECORYS, 2009;CEPR, 2013) on US-EU trade, both of which converge on the notion that the economic gains reaped by each partner from the harmonisation of non-tariff measures (NTMs) far outweigh those expected from 'conventional' tariff reductions. Given that the GTAP database lacks any estimates of NTMs, both studies turn to (inter alia) the gravity approach to enumerate their trade restrictiveness. Accordingly, the current paper also employs a gravity specification, although the methodological approach employed attempts to address some of the perceived weaknesses in the aforementioned studies in an attempt to present more accurate estimates of NTMs for further policy analysis.

The rest of this paper is structured as follows: Section two provides a revision of the relevant gravity literature with recommendations for the approach adopted here. Section three describes the

[2] See the link: http://ec.europa.eu/enterprise/policies/international/cooperating-governments/usa/jobs-growth/index_en.htm.

gravity model, the methodological choice followed and the dataset. Section four presents and discusses the results, whilst section five concludes.

2. Literature review

UNCTAD provides a comprehensive classification of NTMs that distinguishes up to 14 types (WTO, 2012) although only for half of them official information is collected. These categories include SPS, TBT, but also price and quantity controls (licenses, quotas, bans)[3]. Some of the regulations may pursuit legitimate domestic objectives such as guarantee food safety and citizens' health, in which case, trade frictions arise due to lack of harmonization of national regulations. Some other NTMs, however, may be put in place to deliberately impose a barrier to trade. Nevertheless, the literature aiming at quantifying and evaluating the impact of Non-Tariff Measures (NTMs) usually refer only to non-price and non-quantity trade restrictions measures, either at the border, such as red-tape bureaucracy, and behind the border, in which case, more attention is paid to SPS and TBT (ECORYS, 2009).

The gravity equation has become a common approach to analyse the trade cost of NTMs, whilst two approaches, direct and indirect methods, are identified. On the one hand, direct methods quantify NTMs using inventories of standards and regulations per industry and country, notifications by importer countries to the WTO about the implementation of new regulations and their accordance with international rules (UNCTAD TRAINS Database), or complaints by traders (WTO Trade Policy Reviews, CoreNTM), from which either dummy variables (to reflect the presence or not of an NTM), frequencies or coverage ratios (percentage of products or of trade within a sector affected by NTMs) are calculated. A common criticism is that these methods neglect the relative importance of each measure in restricting trade, while countries more transparent in reporting their regulations appear to be more restrictive (Chen and Novy, 2012). Given the pervasiveness of sanitary standards in agri-food products, there are several applications in the agri-food sectors that, however, tend to be sector specific. For instance, Grant and Anders (2010) analyse the reorientation of seafood trade following stricter food safety measures imposed by the US, using the number of detentions or refusals for a particular exporter as an additional explanatory variable; and Disdier and Marette (2010) focus on regulations on the maximum antibiotic residues limit on crustaces in main importing countries.

Additional direct methods involve the collection of exhaustive databases on specific NTMs, usually, technical barriers and SPS, in specific countries and sectors. Winchester et al. (2012) build up a database with sanitary, phytosanitary and conformity measures in the EU and 9 trading countries,

[3] Categories for which there is not an official collection of data by UNCTAD are distribution restrictions; restrictions on post-sales services; subsidies (excluding export subsidies); government procurement restrictions; intellectual property; rules of origin; export related measures. The rest of categories cover: sanitary and phytosanitary measures; technical barriers to trade; pre-shipment inspection and other formalities; price control; licences, quotas, prohibitions and other quantity control measures; charges, taxes and other para-tariff measures; finance measures; anti-competitive measures; and trade-related investment measures.

applied in the agri-food sectors, from which, several indexes are constructed representing the degree of regulatory heterogeneity across countries, which further feed a gravity equation to evaluate their impact on trade for the pool of fruits, vegetables and grains sectors. The above method, however, faces the limitation of the sector and time coverage of the measurements.

ECORYS (2009) and Sunesen et al.,(2009) use scores based on perceptions of business about difficulties of market access as a proxy for the NTM indicator in a gravity equation; then, the NTM-tariff equivalent is input in a CGE model to simulate the economic impact of a trade agreement between the EU and the US, and the EU and Japan, respectively. Although the sector coverage is wide, including 12 manufacturing sectors and 6 services sectors, agri-food is collapsed to a single "processed food" industry. Results of the gravity estimation on the food sector suggest that divergence in regulations imply a trade cost increase of 73% for food exports from the EU to the US, and 57% on the opposite direction, and 25% for EU exports into Japan. Nevertheless, the NTM approach based on surveys can be subject to criticisms due to the limitation of the sample (of firms) representativeness and the subjectivity of the measurement.

As an alternative, either borders (eg. Chevassus-Lozza et al., 2008; Winchester, 2009) or fixed effects (Fontagné et al., 2011) have also been used in the gravity literature as proxies for NTMs. To date, Kee et al. (2009) provide the most comprehensive quantification of NTMs impact across sectors (they use H6 disaggregation) and countries, estimating restrictiveness indexes from a dummy type variable that account for the presence of any type of non-tariff barrier to trade plus domestic support, using an import equation (no bilateral trade as in the gravity equation). Results on agricultural products, report a mean NTM ad-valorem equivalent (AVE) of 27%, significantly higher than the 10% found for manufacturing goods, with dairy products reaching a maximum of 46%. The authors also find that the contribution of NTMs and agricultural domestic support of the overall level of protection (that is, including tariffs) increases with GDP per capita.

Recently, Li and Beghin (2012) conducted a meta-analysis to explain the variation of trade effects of health, safety and sanitary regulations and standards, encountered by the previous literature (27 papers are considered), and accounting for different estimation techniques, NTM measurement, data disaggregation and size, and different approaches to deal with zero-trade data. The study finds that the impact of NTMs on agriculture is likely to be more negative than in manufacturing sectors, and in this effect is reinforced when trade is flowing from developing to developed countries.

Alternatively, the gravity model can be used as an indirect method to estimate the overall impact of NTMs on trade rather than the specific effect of a particular NTM. The gravity equation belongs to the "quantity gap" indirect approach by opposition to the "price gap". Indirect methods start by acknowledging that NTMs (imposed by the importer country) are likely to cause distortions in trade, reducing imports and/or increasing import prices. Quantity methods are recommended when either prices do not exist because NTMs are prohibitive and preclude trade altogether (Ferrantino, 2006), or when prices are difficult to measure and compare, as in the case of sectors that embed highly differentiated products. In any case, the relatively more abundance and degree of disaggregation of trade data has favoured the use of the quantity gap approach, while the use of price wedges is very scarce (Bradford, 2003).

The "quantity gap approach" compares the value of observed imports, constrained by NTMs, with the normal value of imports that would have prevailed in the absence of NTMs. The gravity model allows the estimation of what this normal value of imports would be (Ferrantino, 2006). This is also called the "residual gravity approach", as the NTM ad-valorem equivalent is obtained from the residuals of the gravity equation.

The residual approach has been more extensively applied in services sectors. Earlier applications include Park (2002), and more recently Francois et al. (2005) and Guillin (2011). An application to the agri-food sectors is conducted by Philippidis and Sanjuán (2007a, 2007b). Most of the aforementioned applications have as a common denominator that the tariff equivalent for NTM feeds into a General Equilibrium Model to better ascertain the impacts of trade liberalization on particular bilateral trade agreements. With the exception of Guillin (2011) who uses a two-stage Heckman model, none of the previous literature using the residual approach has addressed the issue of zero trade values.

To summarise, no gravity approach is exempt of criticisms. Tariff equivalents derived from NTMs variables or indexes are very sector and NTM specific, and depend crucially on the quality of the measurement of the NTM under consideration. The accuracy of the NTM calculation in the residuals-gravity approach, on the other hand, depends heavily on the estimation technique and the quality of the model specification (Ferrantino, 2006).

In this paper, the residual gravity approach is favoured, as we are interested in a common framework for a large coverage of disaggregated sectors. Besides, the residual approach provides a combined estimate of all potential NTMs trade costs while it is flexible enough to allow the computation of bi-directional NTMs trade costs. In particular, we aim at estimating tariff equivalents for NTMs, on agri-food sectors using the GTAP database as the main data source, and we will address the zero trade value issue by using the Pseudo Poisson Model (PPML) as recommended by Santos Silva and Tenreyro (2006).

3. The gravity specification

3.1 Model development

In its simplest form, the gravity model posits that trade between two countries is a positive function of GDP (i.e., ‘mass’) and a negative function of trade costs (i.e., distance) (Tinbergen, 1962, Pullianen, 1963). Empirical applications have extended this specification to encompass (*inter alia*) preferential trade (Kandogan, 2008; Foster et al., 2011; Hayakawa and Yamashita, 2011), contiguity (Bergstrand, 1985; Thoumi, 1989), common language and/or ex-colonial ties (e.g. Rose and van Wincoop, 2001), or even to cater for the effect of distance along different hemispheres as well as remoteness (Melitz, 2007). Other developments (Arnon et al., 1996; Hallack, 2006) account for the so called 'Linder' hypothesis (Linder, 1961), which posits that countries with similar *per capita* incomes have a greater tendency to engage in mutual trade. This is seen as a test of the monopolistic intra-industry hypothesis, whilst the polar opposite that differences in per capita incomes (which proxy for differing factor intensities) promote trade can be interpreted as support for the HO hypothesis.

Thanks to successive underpinnings in the economic theory (Anderson, 1979; Bergstrand, 1985, 1989; Helpman and Krugman, 1985; Helpman, 1987) the gravity equation has regained credibility. More recently, Anderson and van Wincoop (2003, 2004) formalised a paradigm for subsequent econometric gravity work, providing an explicit treatment of prices (first raised by Anderson (1979) and Bergstrand (1985, 1989)) whilst accommodating the empirical observation of 'cross-hauling' of differentiated products. Expressed as a CES preference function of the form:

$$X_{ij} = \frac{Y_j Y_i}{Y_w} \left(\frac{t_{ij}}{P_j \Pi_i} \right)^{1-\sigma} \tag{1}$$

where X_{ij} are exports from country i to country j; Y_i and Y_j represent GDP, Y_w is world GDP, t_{ij} are trade costs, expressed as "iceberg cost" i.e. $t_{ij} = 1 + \tau_{ij}$[4] (i.e. no trade costs imply $t_{ij}=1$); and σ is the elasticity of substitution between varieties (i.e. countries). The variables Π_i and P_j are price indices, denominated as 'multilateral resistance' terms which are dependent of trade barriers (t_{ij}). Anderson and van Wincoop (2003, 2004) stress the importance of controlling for these multilateral resistance terms arguing that trade between two regions depends on the bilateral barrier between them relative to the average trade barriers that both regions face with all their trading partners. Empirically, these unobserved multilateral resistance terms are proxied with country specific dummies (Feenstra, 2004; Anderson and van Wincoop, 2004).

In attempting to quantify policy induced trade gains, it is acknowledged (Vollrath et al., 2009) that gravity studies need to accommodate measures of trade protection on a commodity by commodity basis. Although there exist a number of recent gravity studies which explore this issue (e.g., de Frahan and Vancauteren, 2006; Vollrath et al., 2009; Ghazalian et al., 2009; Tamini et al., 2010; Raimondi and Olper, 2011), in all cases (except the latter) the commodity coverage is limited to two or three sectors, whilst none of the above extends the definition of protectionism to explicitly account for export refunds.

[4] The concept of iceberg cost was developed by Samuelson (1952), who suggested that some fraction of a commodity 'melts' away as a necessary cost of transportation over a unit of distance. This construct is equally applicable to trade costs, which inhibit the effective flow of goods and services from one region to another.

From an econometric standpoint, earlier studies favoured the use of an Ordinary Least Squares (OLS) log-linear specification. Subsequent literature (Santos Silva and Tenreyro, 2006; 2011) demonstrates that this estimator does not adequately cater for zero value observations, whilst the expected value of the log-linearized error will in general depend on the covariates and therefore lead to problems of heteroskedasticity. This leads Santos Silva and Tenreyro (2006; 2011) to recommend the Poisson estimator, which belongs to the category of count models.

3.2. Methodology: the Poisson model

Trade observations are not pure count-, but rather non-negative continuous data. Notwithstanding, the Poisson Maximum Likelihood estimator still provides consistent estimates (Woolridge, 2002), in which case it is referred to more precisely as the Poisson Pseudo-Maximum Likelihood (PML) estimator (Gourieoroux *et al.*, 1984). The model assumes that the observed volume of trade between countries *i* and *j*, X_{ij} follows a Poisson distribution with a conditional mean (μ_{ij}) which is an exponential function of the explanatory variables $\boldsymbol{z}$: $\mu_{ij} = exp(\boldsymbol{\beta}'\mathbf{z})$ [5].

Extensions to the Poisson model include the Negative Binomial, which allows for over-dispersion (i.e. the conditional variance exceeds the conditional mean), and Zero Inflated Poisson (ZIP) and Zero Inflated Negative Binomial (ZINB), that account for an excess of zeros in the dependent variable. Previous applications of these larger variety of count models to the gravity equation can be found in Burger et al.(2009), and Philippidis et al.(2013). Nevertheless, we will keep the simplest form, the Poisson model, as a first approach to quantify NTM AVEs, for simplicity.

3.3. Data and final model specification

Although the final intention is to derive NTM specific to each of the 20 agri-food sectors in the GTAP database, we initiate this work with four sectors: cattle meat, dairy products, processed rice and beverages and tobacco (descriptions included in Table 1).

Table 1. Description of the analysed sectors and accompanying codes

Sector code	Name of the sector	Definition
cmt	Meat of cattle	Meat of cattle, sheep, goats and horses
mil	Dairy products	All dairy products
pcr	Processed rice	Milled rice
b_t	Beverages and tobacco products	Cigarettes, cigars, wines and spirits, beer

[5] See Cameron and Trivedi (1998) for a detailed discussion of count models.

The final form of our gravity specification is presented in equation (2), where the sub-index *i* and *j* refer to the exporter and importer, respectively, whilst *t*, refers to the year:

$$E[X_{ijt}] = \mu_{ijt} = exp[\beta_0 + \beta_1 M_{ijt} + \beta_2 Dist_{ij} + \beta_3 NoSo_{ij} + \beta_4 Remote_{it} + \beta_5 Contig_{ij} + \beta_6 Lang_{ij} + \beta_7 Col_{ij} + \beta_8 SqIncome_{ijt} + \beta_9 Gdp_{ijt} + \beta_{10} Y2004_t + \sum_{i=2}^{N} \theta_i F_i + \sum_{j=2}^{N} \theta_j F_j + \varepsilon_{ijt}] \quad (2)$$

The distance variable (*Dist*) is complemented by contiguity (*Cont*), the North-South hemispheres distance (*NoSo*) and remoteness (*Remote*). In terms of historical and cultural linkages, we include both common language (*Lang*) and colonial ties (*Col*) dummies. Additionally, the squared difference (*SqIncome*) (Linder hypothesis) and the product of GDPs (*Gdp*) in *per capita* GDPs are incorporated[6]. Finally, bilateral import tariffs (*Mt*) are inserted into the gravity regression. The gravity equation includes fixed effects for both time (*Y2004*) and country (exporter and importer) (F_i and F_j). The country fixed effects proxy the unobserved theoretical multilateral resistance terms posed by Anderson and van Wincoop (2003, 2004), while both, country and year fixed effects control for correlation between omitted and observed variables (Greene, 2002). A full description of the explanatory variables is presented in Table 2. The econometric software STATA 12.0 has been applied in the estimation.

Data for 2004 and 2007 on bilateral trade flows, *ad-valorem* applied tariffs by commodity and GDP for 128 regions are taken from release 8.0 (Aguiar et al., 2012) of the GTAP database. The population data needed to calculate *per capita* income is obtained from the World Bank (2011). Bilateral distance, contiguity, common official language, colonial linkages data, and the latitudes needed to calculate the variable *NoSo* are taken from CEPII (2011).

A cursory glance at the data shows that the application of export refunds has been incidental in both years, reducing even more its applicability in 2007. As an example, 93% of the bilateral trade routes do not apply any export refund in dairy products, with this percentage going up to 96% in beverages and tobacco, 99% in cattle meat and 100% in processed rice.

[6] The *Gdp* coefficient is restricted to a value of 1 according to the theoretical model derived by Anderson and van Wincoop (2003). From an estimation perspective, the use of the bilateral product of GDP and the difference in per capita income reduces collinearity problems that may emerge between individual GDP (or per capita GDP) with country fixed effects. The Linder hypothesis posits that countries with similar per capita incomes have a greater tendency to engage in mutual trade.

Table 2. Variable descriptions in the gravity equation

Variable	Description
X_{ijt}	Value of imports into country *j* from country *i* at world prices in year t
Mt_{ijt}	Power of the import tariff rate ($AdvRate_{ijt}$) applied by importer *j* on imports from *i* in year *t*, measured in *ad-valorem* equivalents, in logs: $$Mt_{ijt} = ln\left(1 + \frac{AdvRate_{ijt}}{100}\right)$$
$Dist_{ij}$	Great circle distance between the capitals of country *i* and *j*, in logs
$Contig_{ij}$	Dummy variable that values 1 when countries *i* and *j* share a border, and 0 otherwise
$Lang_{ij}$	Dummy variable that values 1 when countries *i* and *j* share the same official language, and 0 otherwise;
Col_{ijt}	Dummy variable that values 1 when countries *i* and *j* have or have had a colonial linkage
$NoSo_{ij}$	Difference in latitudes between countries *i* and *j*, in logs: $\ln(latitude_i - latitude_j)$
$Remote_{it}$	Indicator of remoteness of country *i* in year *t*, calculated as a GDP weighted average of distance to the countries with which country *i* trades: $$Remote_{it} = ln\left(\sum_{j}^{T(i)} \frac{GDP_{jt}}{GDP_{Wt} - GDP_{it}} \times Dist_{ij}\right)$$ where $Dist_{ij}$ is the distance between *i* and *j* (defined as above), GDP_{Wt} is the world GDP in year *t*, and *T(i)* is the number of the destination countries of exports from *i*. *T(i)* can vary for each *i*, for instance, when *i* is a composite, the number of destination countries is 95, while when *i* is an individual country, *T* is 94
Gdp_{ijt}	Product of GDP in country *i* and country *j* in year *t*, in logs: $\ln(GDP_{it} \times GDP_{jt})$, with GDP measured in million US $ (in nominal terms)
$Sqincome_{ijt}$	Square of the difference in per capita income in countries *i* and *j*, in logs: $\ln((GDPpc_{it} - GDPpc_{jt})^2)$ with GDPpc measured in US$ per habitant (in nominal terms)
$Y2004_t$	Dummy variable that values 1 when the year *t* is 2004
F_i (F_j)	Fixed effects for exporter (importer) country *i* (*j*). $F_i(F_j)$ are dummy variables, that value 1 when the exporter (importer) is *i* (*j*), and 0 otherwise

3.4. The NTM ad-valorem equivalent

Discrepancies between actual (AX_{ij}) and predicted (PX_{ij}) values of trade are taken to be indicative of trade barriers, as the prediction by the gravity equation is assumed to reflect potential trade under frictionless conditions. Given that applied tariffs are included explicitly in the model, trade barriers implied by the residuals are considered to be due to non-tariff measures. Thus, the trade cost t_{ij} in equation (1), is assumed to reflect the NTMs proxied by the residuals. After linearizing taking logs:

$$\left(t_{ij}^{NTM}\right)^{1-\sigma} = \left(1 + \tau_{ij}^{NTM}\right)^{1-\sigma} = {AX_{ij}}\Big/{PX_{ij}} \qquad (3)$$

where τ_{ij}^{NTM} is the bilateral *ad valorem* (or tariff) equivalent (AVE) of all the NTMs imposed by country j to imports coming from country i.

Following Francois et al (2005) and Park (2002), however, AVEs are not calculated for each pair of countries engaged in trade but for each importing country. Thus, for each country j, actual and predicted imports are summed over all its trade partners: $AX_j = \sum_{i=1}^{N} AX_{ij} \;\; i \neq j$ and $PX_j =$

$\sum_{i=1}^{N} PX_{ij} \;\; i \neq j$ (in our application N=128). Predicted imports larger than observed imports are indicative of the existence of trade barriers. In order to quantify how big these trade barriers are, we need to compare this ratio with some benchmark, which as in Francois et al.(2005) and Park(2002) is chosen as the largest value of the observed to predicted ratio, and which is interpreted as a free-trade benchmark ratio (AX_b/PX_b):

$$\left(t_j^{NTM}\right)^{1-\sigma} = {}^{AX_j/PX_j}\Big/_{AX_b/PX_b} \tag{4}$$

Solving for the tariff equivalent (τ_{ij}^{NTM}) of non-tariff measures imposed by country j:

$$\tau_j^{NTM} = \left(\frac{AX_j/PX_j}{AX_b/PX_b}\right)^{1/_{1-\sigma}} - 1 \tag{5}$$

At the benchmark, there are not any non-tariff measures affecting trade, and the ad-valorem equivalent is zero.

As our interest lies in the specific trade restrictions that may be in place between the EU and US, we modify the calculus of the NTMs AVE to account for the direction of trade and the specific routes. To do so, we differentiate between three different origins for the EU imports: US, EU and the rest of the world (RoW); and three different origins for the US imports: EU, NAFTA and RoW[7]. Then, the sum of observed and predicted trade in (4) refers to the countries within each group. For instance, the AVE NTM of imports into the EU coming from the US is:

$$\tau_{US\rightarrow EU}^{NTM} = \left(\frac{AX_{US\rightarrow EU}/PX_{US\rightarrow EU}}{AX_b/PX_b}\right)^{1/_{1-\sigma}} - 1 \tag{6}$$

Where $AX_{US\rightarrow EU}$ ($PX_{US\rightarrow EU}$) adds up observed (predicted) imports coming from the US to any country in the EU: $AX_{US\rightarrow EU} = \sum_{j=1}^{27} AX_{US\rightarrow j}$ and $PX_{US\rightarrow EU} = \sum_{j=1}^{27} PX_{US\rightarrow j}$. Given that the sample used in the estimation includes two years of data, 2004 and 2007, actual and predicted trade is averaged across years. Sectorial substitution elasticities (σ) across importing sources are taken from the GTAP database.

4. Results

4.1. Estimation results

The estimation results obtained with the Poisson model for each of the four agri-food sectors analysed are presented in Table 3.

Focusing on tariff variables, we observe that in all regressions *ad-valorem* tariffs (Mt) have the expected negative sign and the impact is significant. The mean elasticity for tariffs is reported as -

[7] Note that the country composition of the Rest of the World differs depending which destination, EU or US, is considered.

0.473, such that, on average, trade increases by 0.473% when the tariff rate falls by 1%. This result masks the heterogeneity across sectors, where dairy (mil) trade is found to be the most elastic to tariff rate falls.

Our tariff results are close to those obtained by Philippidis et al. (2013), using also the GTAP database (but referred to 2001 and 2004 and 95 regions), whilst they represent an improvement on previous cross sectional studies using the GTAP database (Kuiper and van Tongeren, 2006; Philippidis *et al.*, 2007a, 2007b), which found examples of non-significant and positive tariff parameter values across agro-food sectors. Vollrath et al. (2009) greatly reduce the number of (spurious) positive tariff parameter estimates, although the statistical significance of tariff impacts on trade volumes is limited (including aggregate agricultural trade across three years, 1995, 2000 and 2005). In contrast, in a further cross section study for 2005 employing a random parameter probit estimation procedure (Ghazalian et al., 2009), tariff parameters are found to be statistically significant in the chosen sample of three meat sectors[8]. Finally, employing a two stage Heckman estimation procedure with average trade values for the years 2002-2004, Raimondi and Olper (2011) find insignificant tariff parameters in six of their 18 agro-food sectors considered, as well as their aggregated agro-food sector.

The results suggest that transportation costs (proxied by 'distance') have a negative and highly significant impact in all sectors; a result that is supported by the majority of (agro-food) gravity studies. Comparing with trade protection across all sectors, distance is found to have a stronger (absolute) impact on trade flows with a mean elasticity of -1.163. The most sensitive trade changes due to distance occur in cattle meat and processed rice, with values larger than 1.2 in absolute value, whilst in dairy and beverages, the response of trade is slightly less elastic, with values, nevertheless close to unity. Interestingly, when measuring distance along the North-South axis, our results appear to support the notion of a mitigating impact of North-South trade (NoSo) on distance (Melitz, 2007), where we find a positive and significant parameter estimate in two sectors, cattle meat and beverages (Table 3). Surprisingly, in dairy products we discover a statistically significant negative impact which may simply be due to the fact that differences in production opportunities along the North-South axis are not so relevant for this sector. Importantly, our elasticity estimates for 'distance' and 'North-South' variables lie within the range of estimates in the empirical literature. Moreover, we find that the constraining effect that distance plays on trade is considerably stronger than the promoting effect caused by the differences in latitudes between countries, which is consistent with the findings of Melitz (2007).

[8] Employing trade data for the same year (i.e., 2005), the significance of tariffs for 'bovine meat' in Ghazalian et al.,(2009) is not supported by Vollrath et al. (2009). This may be due to either the estimation procedure employed, and/or the degree of aggregation of the red meat sector.

Table 3. Estimated coefficients of the gravity equation with the Poisson model [a,b,]

	cmt	mil	pcr	b_t	Mean [c]
Mt_{ij}	-0.452* (0.262)	-0.899*** (0.041)	-0.260*** (0.043)	-0.282***(0.025)	-0.473
$Dist_{ij}$	-1.259***(0.091)	-1.078*** (0.006)	-1.346*** (0.016)	-0.970*** (0.004)	-1.163
$Contig_{ij}$	+0.580*** (0.157)	+0.678*** (0.011)	+0.563*** (0.034)	+0.408*** (0.009)	75.42%
$Lang_{ij}$	+0.305 (0.216)	+0.284*** (0.012)	-0.307*** (0.028)	+0.303*** (0.009)	19.35%
Col_{ij}	+0.196 (0.193)	+0.357*** (0.014)	+0.347*** (0.048)	+0.522*** (0.009)	43.64%
$NoSo_{ij}$	+0.152*** (0.057)	-0.026*** (0.004)	-0.009 (0.008)	+0.158*** (0.003)	0.071
$Remote_{i}$	-5.301 (6.422)	+2.215*** (0.824)	-3.103* (1.655)	-1.590*** (0.415)	-0.620
$Sqincome_{ij}$	-0.018 (0.020)	-0.060*** (0.002)	-0.067***(0.003)	-0.068*** (0.001)	-0.049
LL	-49009.4	-52552.4	-20986.3	-101879.1	
Wald Chi^{2} [d]	19549.5	375800.0	197835.2	374702.6	
% zero trade values	2.0%	2.5%	22.0%	0.3%	
N obs.	32546	32546	32546	32546	

[a] Standard errors in parentheses. Results for the year, and country-specific fixed effects are not reported for space saving reasons; ***, ** and * stand for significant coefficients at 1, 5 and 10% of level of significance, respectively.

[b] The sector codes are described in Table 1 and the variable abbreviations in Table 2

[c] Mean across sectors of percentage change in expected value of bilateral trade following 1% change in the explanatory variable or elasticity (in continuous variables); and the mean of the sectoral percentage change in expected value of bilateral trade when the dummy variable equals 1: $100 * \lfloor \exp(\beta_j) - 1 \rfloor$ (Cameron and Trivedi, 1998). Non-significant (at 10%) coefficients are replaced by zero in the computation.

[d] Statistic that tests for the general significance of the model

Comparing across continuous explanatory variables, 'remoteness' exerts the strongest (absolute) influence over bilateral trade with a mean of -0.620, where in the current study this effect is statistically significant and positive (as expected) only in one sector (mil). On the other hand, a statistically significant counter-intuitive (negative) impact is found in two sectors (pcr and b_t, although the first one only at 10%). Further inquiries are needed to find an explanation for this result.

Comparing between categorical variables, contiguity (common border) is found to have the most notable impact, with statistically significant effects in all four agri-food sectors. Examining the mean impact on trade (Table 3), the border-sharing effect increases bilateral trade by 75.42% with respect to those countries which are not contiguous. As expected, a common language exhibits a positive (albeit weaker) impact on bilateral trade, and this effect is found to be positive and statistically significant in two sectors (mil and b_t). Colonial links are also found to encourage bilateral trade in 3 out of the 4 sectors, with an important mean trade increase of 43.64%.

Finally, the results of the gravity model offers some evidence of a Linder effect (sqincome) across our agri-food sectors; that is, a smaller difference in partner per capita incomes results in larger trade flows (negative coefficient). Statistical significance and correct negative signs are found in three sectors (mil, pcr and b_t).

4.2. The Ad-valorem equivalent results

In Table 4 bilateral trade between the selected regions (EU, US, NAFTA and Rest of the World) in the computation of NTMs is shown. Total agri-food trade from the US to the EU amounts to 9933 million $, while this figure duplicates in the opposite direction (18940 million $) (panel a, Table 4). Therefore, any potential reduction in costs derived from the reduction of NTMs may be of significant relevance especially for the EU.

Among the four sectors considered, beverages and tobacco is the most important, accounting for 12.63% of imports to the EU from the US and 56.94% in the opposite direction (panel b, Table 4). The second most important sector for the bilateral trade between US and EU (among the four considered in this preliminary study) is dairy products. Imports to the EU from US account for 115 million $ (1.16% of total agri-food trade in this route and direction), while in the reverse direction, imports to the US from the EU amount to 1119 million $ (5.91% of total agri-food trade). The least important sector is processed rice, with shares in agri-food trade remarkably less than 1%. Cattle meat, although of not a high importance compared to beverages, still accounts for 80 million $ of trade from the US to the EU, and 41 million $ in the opposite direction (panel b, Table 4).

In terms of trade shares, intra-EU trade accounts for almost 72% of all agri-food trade, where only 2.40% comes from the US (panel c, Table 4). On the contrary, the EU trade share in US imports is significantly higher, accounting for almost 20% of US imports. Intra-NAFTA trade accounts for 34% of agri-food trade, while RoW accounts for a significant 46% of total US agri-food imports. Among sectors, extra-EU imports are marginally more important in processed rice and cattle meat, where imports coming from the US account for 1.93 and 0.49% of total EU imports, respectively. By contrast, equivalent market shares in the US for EU imports, account for 58% in beverages, 47% in dairy, 2.6 % in rice and 1% in cattle meat. Therefore, currently, the EU is a much important provider of food for the US than the other way round, and accordingly, consumers in the US could benefit from a reduction of NTMs that would make imports from the EU cheaper.

Table 4. Bilateral trade between the EU and US in 2007

a) Trade value (million $)

	Imports to the EU			Imports to US		
	US	EU	RoW	EU	NAFTA	RoW
cmt	79.99	12557.71	3839.88	40.61	1089.78	2632.08
mil	115.00	33570.44	1812.70	1119.79	203.50	1052.23
pcr	27.79	842.41	567.52	11.88	6.68	442.85
b_t	1254.22	42235.50	5887.21	10784.18	3738.10	3873.23
Total agri-food	9933.86	297472.89	106698.44	18940.26	33002.45	44822.34

b) Sectorial weight with respect to total trade in the agri-food sector

	Imports to the EU			Imports to US		
	US	EU	RoW	EU	NAFTA	RoW
cmt	0.81	4.22	3.60	0.21	3.30	5.87
mil	1.16	11.29	1.70	5.91	0.62	2.35
pcr	0.28	0.28	0.53	0.06	0.02	0.99
b_t	12.63	14.20	5.52	56.94	11.33	8.64
Total agri-food	100.00	100.00	100.00	100.00	100.00	100.00

c) Trade shares of exporting regions

	Imports to the EU			Imports to US		
	US	EU	RoW	EU	NAFTA	RoW
cmt	0.49	76.21	23.30	1.08	28.96	69.96
mil	0.32	94.57	5.11	47.14	8.57	44.29
pcr	1.93	58.59	39.47	2.57	1.45	95.98
b_t	2.54	85.54	11.92	58.62	20.32	21.06
Total agri-food	2.40	71.84	25.77	19.57	34.11	46.32

Source: own calculations based on the GTAP v.8.0 database

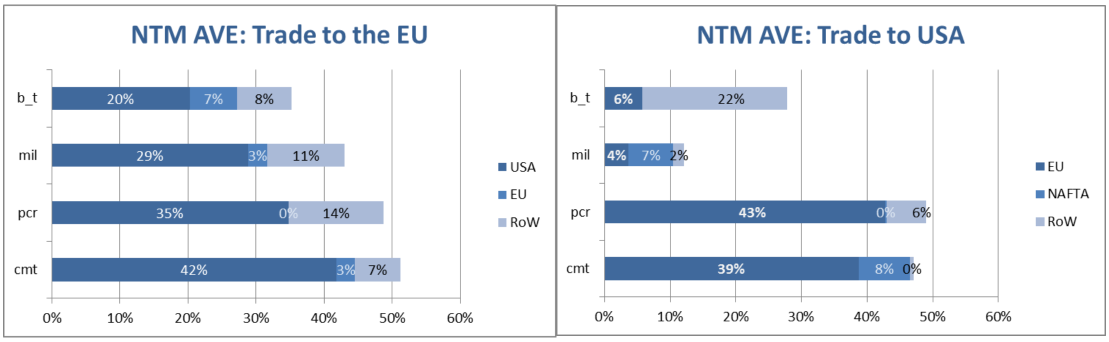
Graph 1, panel a, shows the ad-valorem equivalent of the non-tariff measures imposed by the EU to imports coming from US, other EU countries and the rest of the world, for each of the sectors analysed. Panel b shows the ad-valorem equivalent imposed by the US to imports coming from the EU, rest of NAFTA and rest of the world, calculated as explained in section 3.4.

Tentative estimates of the ad valorem tariff equivalents of NTMs imposed by the EU (including divergences in regulations, standards) on imports coming from the US are 42% in cattle meat, 35% in rice, 29% in dairy and 20% in beverages. As expected, the AVE of NTM is minimum for intra-EU trade, while the trade cost induced by NTMs applied to imports from the rest of the world are intermediate, with a minimum impact in cattle meat and beverages and tobacco (7-8%), intermediate in dairy (11%) and maximum in processed rice (14%). Compared to the trade cost induced by NTMs on extra- in intra-EU trade (Graph 1, left hand side). The EU's AVE calculated on cross-Atlantic trade are clearly larger for each sector, where the difference is largest in the cattle meat (42% versus 3%), processed rice (35 versus 0%) and dairy (29% versus 3%) sectors.

The notable result for cattle meat is perhaps expected, particularly given the degree of regulatory schemes relating to the long serving EU import restriction on beef from cattle treated with growth promoting hormones, whilst EU NTM restrictions on rice imports have been identified in the past by the Office of the United States Trade Representative (2007) as a source of frustration for US exporters. In the dairy sector, the EU imposes considerable administrative burdens relating to (*inter alia*) milk quality requisites (somatic cell counts), tariff rate quota usage and the usage of generic name (i.e., parmesan, feta etc.) (US DEC, 2013). In the case of wines and spirits, EU labelling (particularly geographical indicators (GI's)) and packaging regulations, coupled with EU derogations on US wine making practice restrict the free flow and trade of these products, although care should be taken when interpreting a single aggregate AVE for this sector given the broad sectorial aggregation employed in the underlying GTAP database (i.e., this sectors covers all soft drinks; alcohol, wines, spirits etc.).

Graph 1. Ad-valorem equivalents of Non-tariff Measures

a) **b)**



Interestingly, AVEs of NTMs imposed by US in its trade with the EU on cattle meat and processed rice are of a similar magnitude to those imposed by the EU to imports coming from the US. The estimated US AVE on imports of cattle meat and processed rice from the EU is 39% and 43%, respectively. This compares with corresponding sector figures on trade running from the US to EU of 42% and 35%. This in part reflects the retaliatory nature of sectoral trade relations between the two traders. For example, the result for cattle is due to the US sanction on EU origin beef which serves as a retaliatory measure for the EU's ban on hormone induced beef.

In this bilateral EU-US comparison, however, big differences emerge in dairy and beverages, with trade costs imposed by the US much lower than the equivalent by the EU. Thus, 20% (29%) of AVE imposed by the EU in beverages and tobacco (dairy) coming from the US reduce to 6% (4%) imposed by the US on imports coming from the EU. At least in the case of dairy, the estimate presented in our study is perhaps slightly low, given that the US (like the EU) also imposes cumbersome administrative regulations on EU producers such as the "Grade A dairy safety document for pasteurised milk ordinance" (PMO) which is, according to a detailed survey conducted by ECORYS (2009), of a highly prohibitive nature. As for alcoholic beverages, the US imposes cross state retailing and distribution red tape restrictions on EU products, whilst the geographical indicator which receives much attention within the EU, is not given due consideration by US authorities. In both cases, neither NTM is considered to be highly trade prohibitive (ECORYS, 2009), which appears to be consistent with the AVE estimate presented in the current study.

As a final observation, the results presented here are reasonably consistent with the average AVE estimate presented by Kee et al. (2009) for agricultural products (27%). On the other hand, this study presents lower estimates compared with those reported by ECORYs (2009), who estimate for the 'total of processed food sector' an AVE of 56.8% for imports coming from the US to the EU, and 73.3% for imports coming from the EU to US. Apart from the different sectorial coverage and disaggregation, the differences are most likely related to the choice of data, but may also be linked with methodological considerations (choice of estimator).

5. Conclusions

This year signals the opening of negotiations between the world's two largest trading partners, the European Union (EU) and the United States (US). Unfortunately, conventional trade impact assessments employing computable general equilibrium (CGE) models are ill equipped to properly deal with the potential economic gains from such a deal due to the lack of any coherent and consistent database relating to non-tariff measures (NTMs). Indeed, unlike conventional tariff measures, NTMs do not have a transparent price effect which can be readily inserted into an economic model. Over the last decade, the usage of gravity models has received recognition as one such tool for understanding the 'part-worth' of NTM measures on trade restrictiveness. This paper also employs a gravity approach, whilst the explorative nature of the research restricts the current focus to four agro-food sectors.

Preliminary results suggest that NTMs impose a relatively equivalent trade cost on trade flows of cattle meat ant processed rice in both directions. In beverages and tobacco and dairy products, however, the AVE of NTM is significantly higher for trade running from the US to the EU. Accordingly, substantial gains could be obtained by both countries reducing divergences in regulations and standards in cattle meat and processed rice, while further gains would be allocated to the US producing sector of beverages and tobacco and dairy.

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