The impact of technical barriers on US-EU agro-food trade

Michele Nardella [a] and Stefano Boccaletti[b]
[a]Ph.D. student, Dept. of Ag. Econ., University of Guelph, Ont., Canada
mnardell@uoguelph.ca
[b]Associate professor, Università Cattolica del S. Cuore, Piacenza, Italy
stefano.boccaletti@unicatt.it

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Introduction

In the last decade, government involvement in the regulation of agro-food products' quality attributes has increased and it is still an issue whether such provisions are implemented to correct market failures or rather instruments for a new era of agricultural protectionism. There are several reasons for such government involvement: to provide safer food to consumers, to ensure the health of animals, to preserve the environment, to help consumers in determining quality characteristics of products, to protect consumers from fraud and deceptive practices and finally to create trade barriers (Schmitz, Furtan and Baylis, p. 435).

At the end of Uruguay Round, negotiators underlined the importance of common procedures to set and evaluate safety and non-safety quality attributes of agro-food products. Further, several WTO members auspicated a process of harmonization of product standards to reduce current and future disputes. To achieve these objectives, member countries signed three new agreements dealing with quality product attributes (SPS, TBT and TRIPS agreements). These agreements have provided the legal framework to set new product standards and to solve trade disputes. Despite these efforts, from January 1995 to January 1999 there have been 25 trade disputes concerning quality product attributes, 13 of which concerned agro-food products (Wilson). Furthermore, EU and US were often the countries involved. In 1999, US agro-food exports to the EU amounted to $ 5,882 million –10,5% of the total EU agro-food imports–, whereas EU agro-food exports to the US were $ 9,638 million –19.3% of the total US's agro-food import– (UNCTAD data).

A previous research (Roberts and DeRemer) identified the presence of questionable European technical regulations negatively affecting the US agro-food export. In particular, alleged European regulations were 67 with an estimated trade impact of $ 900 million in 1996. Even though Roberts and DeRemer's research represents the first comprehensive study on the trade impact of European technical regulations, Weyerbrock and Xia argue that those results should be carefully interpreted. In fact, the economic impact of each trade measure was obtained interviewing a panel of FAS experts who could have been biased, because they were aware that US producers groups could use the results to claim a WTO intervention.

Technical barriers fit within the broader category of Non Tariff Measures (NTMs). In particular, they belong to "Trade Restricting Regulations", together with other trade restraints such as Government Procurement, Domestic Content Regulations and Foreign Direct Investment Regulations. Several authors agree on the definition of technical barriers[1], but a definite approach to evaluate the economic impact of those regulations does not exist yet (Maskus, Wilson and Otsuki; Beghin and Bureau). The assessment of the economic impact of quality product attributes on trade is crucial for two main reasons. First, the demand of product standards will raise over time, because consumers' income and awareness of technological and safety issues are increasing. In this circumstance, the efficient provision of food quality characteristics will critically depend on the assessment of the costs deriving from the implementation of those regulations. Second, it is necessary to quantify the economic impact of technical barriers in order to solve trade disputes.

This study intends to offer an evaluation of the trade impact of both non-technical and technical NTMs on the US-EU bilateral trade, the two major players in WTO negotiations. Therefore, the objectives of this paper are:

(a) to describe number, type and distribution across products of NTMs affecting the US and EU agro-food trade, by using an inventory approach;
(b) to evaluate the elasticity of agro-food exports with respect to the number of NTMs implemented at both EU and US borders, by estimating gravity type models using UNCTAD data. Results will provide an indication on whether NTMs increase trade, because of lower transaction costs, or reduce trade, because foreign producers face higher costs of compliance in order to meet regulations in the importing country;

(c) using the same gravity models, to appraise whether the elasticity of agro-food exports with respect to the number of NTMs varies across agro-food products or not. There are two main reasons to believe that the estimated elasticities might change across agro-foods products. First, the number, type and distribution of NTMs among agro-food products can reflect rent-seeking behaviors of agribusiness interest groups. Thus, the magnitude and the sign of estimated export elasticities may depend on the degree of protection granted to a particular sector. Second, number, type and distribution of NTMs could depend on the severity of market failures characterizing each agro-food industry.

The organization of this paper is the following: first, we provide a description of the data used in this investigation; second, we describe the structure of agro-food NTMs implemented at both US and EU borders. Third, we present the estimated gravity models. Empirical results on two different sets of gravity models and concluding remarks end the paper.

Data

The UNCTAD TRade Analysis and INformation System database (TRAINS) is a good source of information on the tariff and non-tariff barriers applied by most developed and developing countries. It reports information on imports (i.e. exporting country, value, volume), classifying traded goods according to the main International Classification Systems such as the Harmonized System (HS) or the Standard Industrial Trade Classification Codes (SITC); 6-digit level is the most detailed level of product differentiation. Instead, information on Tariff Measures or NTMs applied at the border of an importing country, refer to goods classified according to a national system of tariff lines. This national system may classify products with a level of differentiation detailed more than the 6-digit level. Thus, it is possible that within a product category (6-digit level) there will be one or more tariff lines. In order to match UNCTAD figures on trade values, for which the most detailed level of product differentiation is 6-digits, with UNCTAD figures on NTMs, for which the level of product differentiation may be higher than 6-digits, we have reclassified UNCTAD data on NTMs using the HS system at 6-digit level. We exclude the duplications (i.e. when the same measure is applied to several tariff lines within the same 6-digit category) and therefore consider only the effective number of NTMs applied to each agro-food product. Moreover, we took into account that the number of Tariff Lines within the same 6-digit category may be different between US and EU, we standardized the number of NTMs dividing it by the number of Tariff Lines, therefore obtaining the average number of NTMs applied to the Tariff Lines in that product category. Another necessary conversion was about the type of NTMs. In fact, UNCTAD reports that the US declared 28 different types of NTMs in 1999, whereas EU for the same year declared only 23 types. We have reclassified both into 11 common categories. For the categories not concerning quality product attributes, we followed the UNCTAD classification[2], while for NTMs on quality product attributes (technical measures) we have specified 5 categories[3]. In this way, for each agro-food product and at each border (US and EU), we have information on the import value in thousands of US dollars and on the number and type of NTMs enforced.

Structure of Non-tariff Measures affecting the US-EU bilateral agro-food trade

Ndayisenga and Kinsey recently conducted a descriptive analysis on NTMs in the international agro-food trade. Employing an inventory approach, they evaluated the distribution of NTMs, calculating simple descriptive statistics. Their source of data was the UNCTAD Trade Control Measures which reports imposed, modified and removed trade restrictions from 1980 to 1991.

Focusing our attention on US and EU borders and employing the same approach, we analyzed the structure of NTMs assessing the various types of measure adopted and their distribution amongst agro-food products. We focused on the number of NTMs and calculated the stacking index, as defined by Ndayisenga and Kinsey[4].

The aim of this assessment is to provide a basis to compare and rank countries with respect to the use of NTMs. Figure 1 shows the distribution of NTMs implemented at both the US and EU borders. At the US border, agro-food exports face 970 NTMs; 30% are non-technical. Among non-technical NTMs, the category *Import Authorization & Non-Automatic License* is the most frequent measure implemented at the US border. On the contrary, *Testing, Inspection and Quarantine requirements* and *Technical Requirements for Safety Matters* are the most common technical measures. At the EU border, number, type and distribution of NTMs differ completely from the US ones. On one hand, the number of NTMs is approximately three times less, only 301. On the other hand, non-technical measures represent over 90% of NTMs. *Prior Surveillance* and *Import License and Non-Automatic License* are the most common NTMs implemented, accounting respectively for 50% and 29% of the total. Among technical measures, *Technical Requirements* and *Labeling Requirements*, both for safety matters, are the most frequent measures, each accounting for 8% of the European NTMs.

The percent distribution of NTMs among agro-food products at both borders is displayed in figure 2. From a graphical inspection, we can see the discrepancies between the two borders. However, there is a similarity: on average, 50% of all NTMs is applied to product categories which account for less than the 40% of total agro-food imports. At the US border, 54% of all NTMs are applied to agro-food product categories, HS 03, 02, 20, and 08, in order of importance (see table 1 for a description of the categories) accounting for only 37% of total US agro-food imports. At the EU border, 57% of NTMs are applied to five different agro-food product categories, HS 02, 11, 03, 19, 08, that account for the 37% of EU's agro-food exports. According to these results we can see that agro-food product categories HS 02 and HS 08 receive particular attention from policy makers in both countries.

Figure 3 indicates the distribution of the stacking index across agro-food products. From this distribution, we can see how the US applies more NTMs than the EU. The average stacking index for agro-food imports is 13% in the US and only 5% in the EU, which means that agro-food imports in the US are subject to more regulations than those in the EU.

These results show the two main structural differences between the EU and US borders. First of all, technical NTMs are preferred in the US (70% of all NTMs), while in the EU the opposite is true (9% of NTMs). Second, agro-food imports in the US face a number of NTMs more than double that of the EU.

Methodology

A definitive approach to assess the quantitative impact of both technical and non-technical NTMs -as suggested by some authors- does not exist yet and the chosen approach depends essentially on the objectives that one wants to achieve (Maskus, Wilson and Otsuki; Beghin and Bureau). However, gravity type models -mostly applied to evaluate the effects of international integration (Anderson; McCallum; Swann, Temple and Shurmer; Wall; Cheng and Wall)- seem also to be a suitable approach to evaluate the effects of NTMs on trade (Otsuki, Wilson and Sewadeh; Zahniser *et al.*).

Tinbergen is quoted as the first author using gravity model to explain bilateral trade flows as a function of trading partners' GDPs and geographical distance. The simplest form of gravity model is:

$$\ln (1 + exp_{ijt}) = a + ß_1 \ln Y_{it} + ß_2 \ln Y_{jt} + d \ln D_{ij} + ?\, \boldsymbol{B'}_{ij} + e_{ijt} \qquad (1)$$

where exp_{ijt} is the value of export in a common currency from country *i* to country *j* in year *t*, Y_{it} is the GDP of country *i* in year *t*, Y_{jt} is the GDP of country *j* in year *t*, D_{ij} is the distance between country *i* and country *j*, and $\boldsymbol{B'}_{ij}$ is a vector of variables characterizing the border of importing country j [5]. Model 1 is regressed on panel data. In the presence of cross-sectional data, as in our case, the gravity model reduces to:

$$\ln (1 + exp_{ij}) = a_{ij} + ?\, \boldsymbol{B'_{ij}} + e_{ij} \qquad (2)$$

where the new element a_{ij} represents the specific 'country-pair' effect between the trading partners. The country-pair intercepts measure the effect of "all omitted variables that are cross-sectionally specific but remain constant over time, such distance, contiguity, language, culture" (Cheng and Wall, p.11). In our case, the fixed 'country-pair' effect will account for differences in GDP, population, distance, transaction costs, custom duties and administrative procedures between the EU and US borders in 1999. Vector **?** contains the estimated impacts of additional NTMs on the log of agro-food export values.

Since our dependent variable can assume a value equal to zero, but we do not know whether this is the effect of NTMs or different factors, we estimate eq. (2) using a Tobit model. Therefore, the econometric specification becomes:

$$y_{ij}^{*} = a_{ij} + ?\, \boldsymbol{B'_{ij}} + e_{ij} \qquad (3)$$

where y_{ij}^{*} is a latent variable; $y_{ij} = 0$ if y_{ij}^{*} £ 0, or $y_{ij} = y_{ij}^{*}$ if $y_{ij}^{*}>0$ (Zahnizer *et al.*). Thus, y_{ij} has a normal truncated distribution and e_{ij} is distributed with zero mean and variance σ^2. Tobit specifications estimate the vector of parameters g and σ^2 (Maddala, p.339).

Country-specific export elasticities

To evaluate the effect of technical measures on agro-food, we estimated the following version of the gravity model:

$$\ln (1 + exp_{ij}) = \alpha_{ij} + \gamma_1 \text{NTEC} + \gamma_2 \text{TRns} + \gamma_3 \text{TRs} + \gamma_4 \text{Ls} + \gamma_5 \text{Lns} + \gamma_6 \text{TIQ} + \varepsilon_{ij} \qquad (4)$$

where exp_{ij} is the export value of agro-food products in thousands of US dollars at the HS 6-digit level; NTEC is the number of non-technical NTMs; TRns and TRs are the number of non-safety and safety *Technical Requirements* respectively; Lns indicates the number of *Labeling Requirements* for non-safety issues, Ls for the safety ones; TIQ is the number of *Testing, Inspection and Quarantine Requirements*. ε_{ij} is the standard error.

Non-nested tests indicate that there are structural differences between the US and the EU borders. Table 2 reports the results, where $\hat{g}$ are the estimated parameters of eq.4 and $\hat{h}$ are the estimated agro-food export elasticities with respect to different NTMs.

The model on the European agro-food exports in US indicates that the estimated export elasticities for the safety provisions have a negative sign, as Roberts *et al* (2001) predict (p.18). The positive export elasticity with respect to the number of technical requirements for safety matters is the only exception. It is most likely that the standardization of safety product attributes reduces information, search and enforcement costs supported by both US custom authorities and importing firms.

The estimated economic impact of this measure is equal to +$108 millions. Results for the other two technical measures for safety matters indicate that the negative impact on trade of TIQ is greater than for Ls. In particular, agro-food imports from the EU decline by 1.67% ($160 millions) for a 1% increase in the number of TIQ measures. Instead, the value of European agro-food exports to the US decreases marginally given a 1% increase in Ls (–0.14%, -$14 millions).

A possible interpretation of this result may be that while Ls requirements affect only the production costs of both domestic and foreign firms, TIQ requirements have an additional economic impact. In fact, TIQ effects are less predictable and transparent than those from Ls: import flows slow down, transaction costs increase and administrative procedures become more complex. Finally, the impact of non-technical NTMs on trade is negative; the estimated elasticity is –0.43 (-$41 millions). The model of US agro-food export to the EU indicates that European technical NTMs do not affect trade; all estimated elasticities are not statistically different from zero.

On the other hand, increasing by 1% the number of non-technical NTMs at the EU border, agro-food exports from US decline by 0.83%, almost twice the value for the US border. However, quantifying the impact in dollars, the negative effect is comparable (–$49 millions). The relative scarce use of technical NTMs could be the explanation. In fact, according to UNCTAD data on NTMs for 1999, technical NTMs at the EU border represent only 9% of all NTMs implemented.
Finally, comparing the country specific fixed effects ($\alpha_{i,j}$) from both models (table 2), gravity models predict that US agro-food imports from the EU are less than the EU imports from the US, regardless of the number, type and distribution of NTMs. Differences in GDP per capita, tastes and consumer's preferences can be adduced as an explanation.

Commodity-specific export elasticities

To appraise whether the effect of both technical and non-technical NTMs depends on the agro-food products to which they are applied, we estimated the following model using a Tobit procedure for the 22 agro-food product categories listed in table 1:

$$\ln (1 + exp_{ij}) = \alpha_{ij} + \gamma_1 \text{ NTM} + \varepsilon_{ij} \quad (5)$$

where NTM is the number of NTMs faced by that particular agro-food product, ε_{ij} is the estimated error. Further, we tested whether there are structural differences between the US and EU borders.
Table 3 reports the results. Non-nested tests indicate that there are structural differences between the US and the EU borders for some groups of agro-food products (HS 02, 04, 07, 08, 09, 16, and 20). Thus, the border effect is relevant on the estimated export elasticities. For other products this hypothesis was rejected (HS 01, 03, 05, 06, 11, 12, 13, 14, 15, 17, 19, 21 22). Moreover, for cereals (HS 10), it was not possible to estimate a model because of collinearity between the constant and the vector of NTMs. We encountered similar econometric problems for the US export of *coffee, tea and spices* (HS 09) to the EU.
Among the agro-food products for which there are not structural differences between the two borders, only for 5 of them the estimated elasticities are statistically significant (HS 03, 06, 11, 12 and 22). Moreover, the estimated impact of NTMs appears to be controversial. In fact, the estimated elasticity of NTMs is negative for *fish & crustacean* (HS 03), *milling products* (HS 11) and *oils seeds* (HS 12). On the contrary, for the categories *live trees & other plants* (HS 6) and *beverages, spirits and vinegar* (HS 22) the estimated export elasticities display a positive sign. This puzzling result may be explained considering that the incidence of technical regulations for safety matters in these two product categories is low (31% for HS 06 and 0% for HS 22).
Considering only those models where the hypothesis of structural changes between the two borders was not rejected estimated elasticities are significant at both borders only for HS 04 (*dairy products; bird's eggs, natural honey*). On the contrary, commodity-models for HS 07, 08, 09 and 16 present agro-food export elasticities significant either at the US or EU border.
At the EU border, the estimated export elasticities are negative and significant at the 10% and 5% level for the agro-food categories HS 04 (*dairy product; bird's eggs; natural honey*) and HS 06 (*edible fruits and nuts*) respectively. Increasing the number of NTMs applied to category HS 04 by 1%, the US export value declines by 5.12%. On the contrary, for the same increase in the number of NTMs, the decline for US edible fruits and nuts export is only – 0.83%.
At the US border, among the models with a statistically significant EU export elasticity, the sign is negative for 3 (HS 04, 09, and 16) out of 4 products. Considering the type, number and distribution of NTMs, a clear pattern emerges. The EU export elasticity ranges from –6.0 (HS 16) to +2,8 (HS 07) as the prevalence of safety technical measures and the magnitude of stacking index diminish. In fact, 96% of NTMs applied at the US border to European exports

of *preparation of meat and fish* (HS 16) are safety technical measures; in addition, to this agro-food product category, the US border applies 40% of all technical measures available. Instead, 21% of NTMs applied to *edible vegetables* (HS 07) are safety technical measures and on average only 5% of all technical measures is applied to this product category. The EU exports of *coffee, tea and spices* (HS 09) constitutes an exception to this behavior. In fact, the export elasticity is –0.47 despite the fact that 21% of NTMs applied are safety technical measures and that on average the products within this category face 5% of all available technical measures.

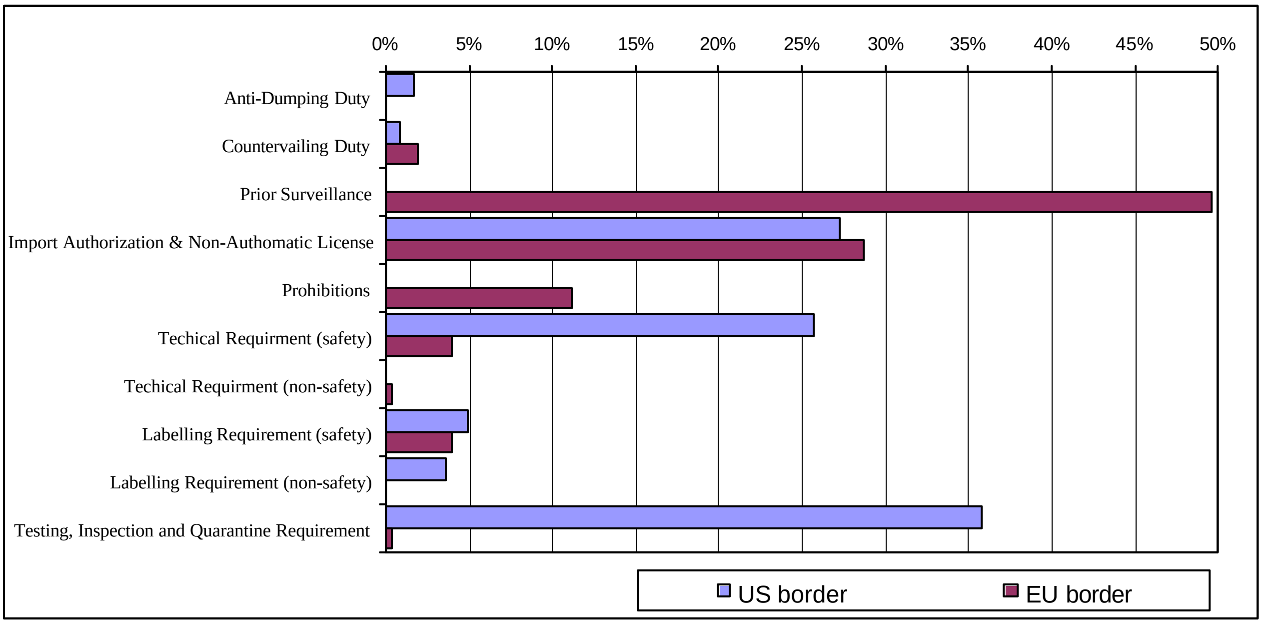
Concluding Remarks

Controversial aspects exist in the current debate over the application of technical trade measures based on quality product attributes of agro-food products. On one hand, an importing country adopts such provisions to correct market failures arising from the production, distribution and consumption of agro-food products. On the other, they may also result from the rent-seeking behavior of domestic agro-food industries. At the end of Uruguay Round WTO member countries, aware of the growing importance of NTMs and of potential conflicts among trading partners, signed three important multilateral agreements (TBT, SPS and TRIPS), each dealing with a different set of quality product attributes, with the aim to provide the legal framework necessary to set new standards and to solve trade disputes. Despite these efforts, more than half of the trade disputes after the Round concerned agro-food product standards, with US and EU often involved.

From the analysis of the data contained in the UNCTAD TRAINS database, substantial differences emerge in the structure and distribution of NTMs at the US and EU borders. US authorities prefer to adopt technical measures rather than non-technical ones, the former representing 70% of all NTMs. Instead, at the EU border non-technical measures dominate, being 91% of all NTMs. Another interesting difference is in the number of NTMs that are applied to agro-food products: on average, the stacking index is 13% for the US and only 5% for the EU. This means that agro-food imports in the US are subject to a higher number of regulations than in the EU. The differences between the two borders are confirmed in the estimated economic impact, obtained employing gravity models, of NTMs on the agro-food bilateral trade between EU and US. In fact, at the US border the export elasticity with respect to the number of non-technical NTMs is approximately half of the correspondent effect at the EU border. Further, technical regulations do not affect European agro-food imports from the US, while the picture for the US border is more complex: US *Technical Requirements for safety matters*, contrary to what we could expect, show a positive export elasticity (+1.12), while *Testing, Inspection and Quarantine Requirements* and *Labeling Requirements* for safety matters have a negative impact on agro-food exports, respectively –1.67 and -0.14. Results from commodity gravity models indicate that agro-food imports decrease as the number of NTMs as a whole and the stacking index increase.

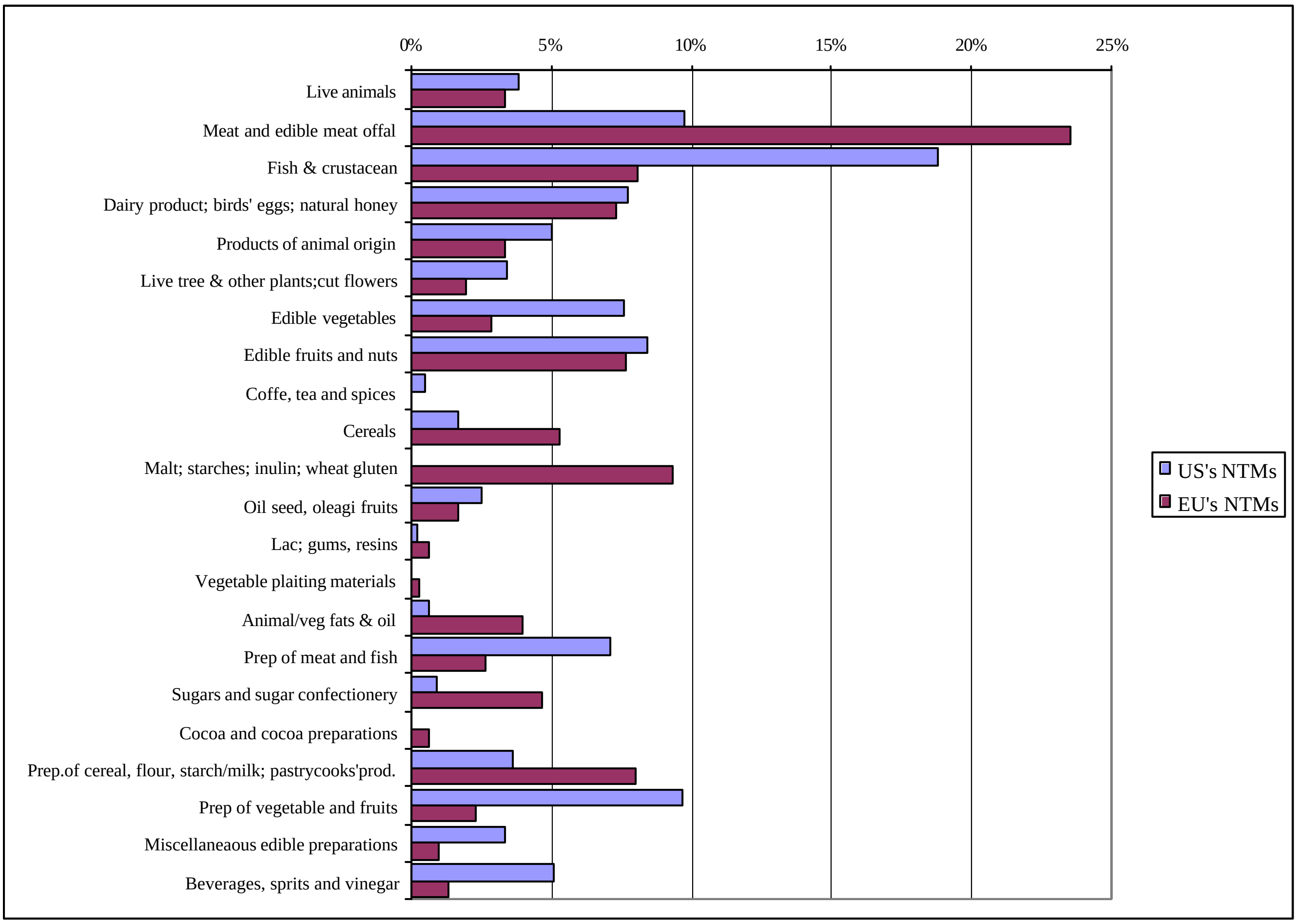
TABLES AND FIGURES

Figure 1. Percent Distribution of NTMs at the US and EU borders.



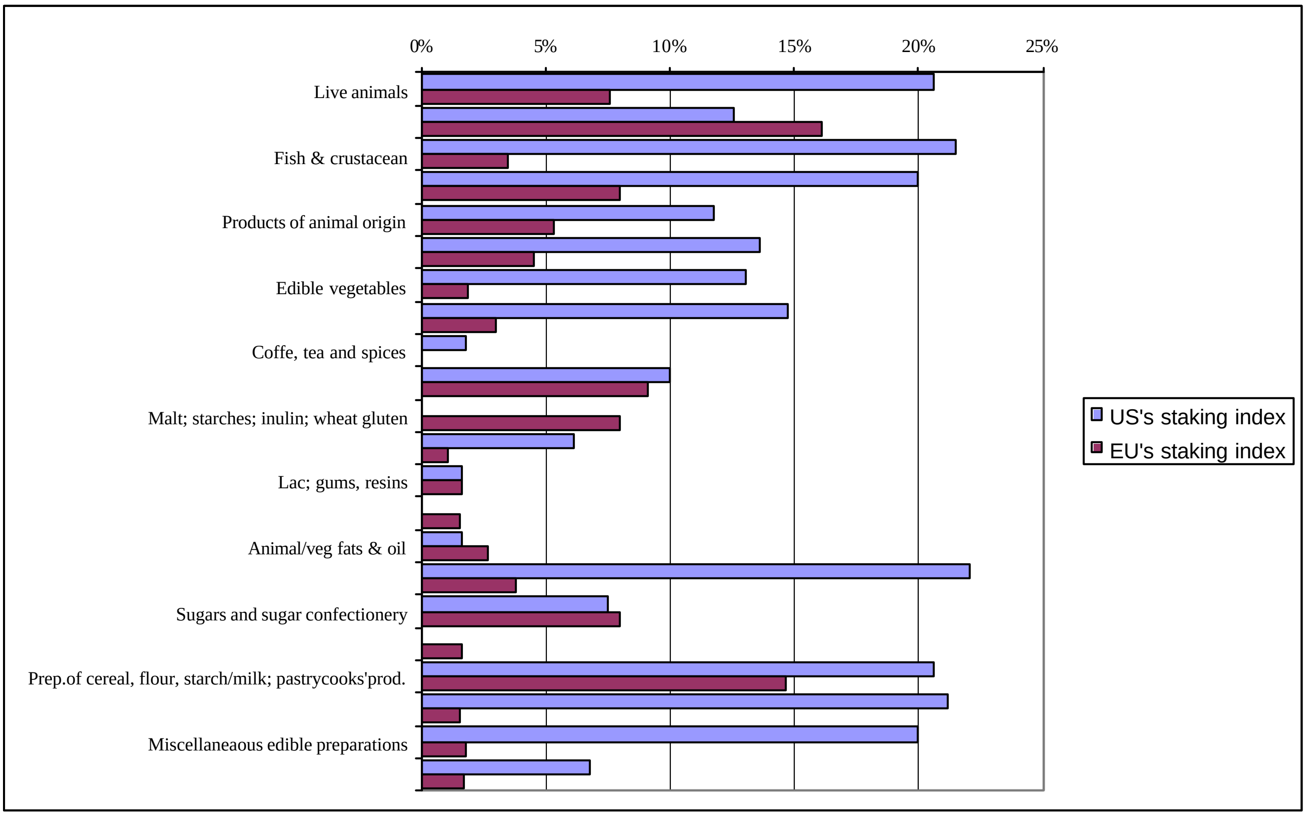
Source: elaboration from TRAINS dataset (UNCTAD).

Figure 2. Percent distribution of NTMs among agro-food products (HS 02) at the US and EU borders.



Source: elaboration from TRAINS dataset (UNCTAD).

Figure 3. Percent distribution of the stacking index among agro-food products (HS 02) at the US and EU borders.



Source: elaboration from TRAINS dataset (UNCTAD).

Table 1. Agro-food product categories (Harmonized System at 2-digit level).

Description	HS (2-digit)
Live animals	01
Meat and edible meat offal	02
Fish & crustacean	03
Dairy product; birds' eggs; natural honey	04
Products of animal origin	05
Live tree & other plants;cut flowers	06
Edible vegetables	07
Edible fruits and nuts	08
Coffe, tea and spices	09
Cereals	10
Malt; starches; inulin; wheat gluten	11
Oil seed, oleagi fruits	12
Lac; gums, resins	13
Vegetable plaiting materials	14
Animal/veg fats & oil	15
Prep of meat and fish	16
Sugars and sugar confectionery	17
Cocoa and cocoa preparations	18
Prep.of cereal, flour, starch/milk; pastrycooks'prod.	19
Prep of vegetable and fruits	20
Miscellaneaous edible preparations	21
Beverages, sprits and vinegar	22

Table 2. Estimated gravity models to evaluate the effect on NTMs on the EU and US agro-food trade.

Parameters	EU export to US			US export to EU		
	$\hat{g}$	$\hat{h}$		$\hat{g}$	$\hat{h}$	
$\alpha_{i,j}$	5,443		***	6,802		***
NTEC	-0,939	-0,427	***	-1,730	-0,827	***
TRs	2,841	1,118	***	-0,107	-0,002	§
TRns	n.a.	n.a.		0,121	0,000	§§
Ls	-1,839	-0,140	***	-0,107	-0,004	§
Lns	2,738	0,152	***	n.a.	n.a.	
TIQ	-3,044	-1,666	***	0,121	0,000	§§
σ	4,264		***	3,070		***
obs.	628			575		
Log Likelihood	-1512,2			-1387,52		

$\hat{h}$ is the estimated elasticity.

One, two or three asterisks indicate significance at the .10, .05 or .01 level respectively.

§ Since vector TRs is equal to vector Ls, we have dropped one of them and the estimated coefficient has been divided by 2.

§§ Since vector TRns is equal to vector TIQ, we have dropped one of them and the estimated coefficient has been divided by 2.

Table 3. Commodity gravity models.

HS	Bilateral trade				EU exports in US				US exports in EU			
	$\hat{g}_{NTM}$	$\hat{h}_{NTM}$	**obs**	**Log Likelihood**	$\hat{g}_{NTM}$	$\hat{h}_{NTM}$	**obs**	**Log Likelihood**	$\hat{g}_{NTM}$	$\hat{h}_{NTM}$	**obs**	**Log Likelihood**
01	-2,71	-4,40	29	-524	-	-	-	-	-	-	-	-
02	-		-	-	-0,19	-0,34	53	-714	-1,61	-2,86	40	-805
03	-1,42	-1,96***	148	-349	-	-	-	-	-	-	-	-
04	-		-	-	-1,42	-4,35**	27	-648	-5,12	-4,50*	25	-533
05	-0,40	-0,68	34	-834	-	-	-	-	-	-	-	-
06	0,75	1,23*	24	-557	-	-	-	-	-	-	-	-
07	-	-	-	-	2,12	2,77**	56	-130	0,22	0,05	42	-895
08	-	-	-	-	-1,15	-1,69	55	-121	-0,83	-0,37**	51	-121
09	-	-	-	-	-2,66	-0,47***	28	-603	n.a		27	-524
10	n.a.	n.a.	32	n.a.	n.a.	n.a.	16	n.a.	n.a.		16	n.a.
11	-2,49	-1,22***	57	-131	-	-	-	-	-	-	-	-
12	-2,01	-0,76***	77	-186	-	-	-	-	-	-	-	-
13	-0,93	-0,16	23	-541	-	-	-	-	-	-	-	-
14	2,08	0,17	12	-254	-	-	-	-	-	-	-	-
15	-0,31	-0,07	77	-176	-		-	-	-	-	-	-
16	-		-	-	-2,31	-6,05***	26	-567	0,56	0,24	19	-416
17	0,02	0,02	28	-676	-	-	-	-	-	-	-	-
18	-		-	-	n.a	0,00	11	-233	0,21	0,04	11	-206
19	0,67	1,25	32	-731	-	-	-	-	-	-	-	-
20	-		-	-	-0,77	-1,62	44	-112	0,62	0,11	40	-850
21	-0,01	-0,01	31	-675	-	-	-	-	-	-	-	-
22	0,66	0,81**	43	-107	-	-	-	-	-	-	-	-

$\hat{h}$ is the estimated elasticity calculated on the aggregate number of NTMs.

One, two or three asterisks indicate significance at the .10, .05 or .01 level respectively.

References

Anderson, J. E. (1979). "A Theoretical Foundation for Gravity Equation". *The American Economic Review*. Vol. 69, No. 1, pp. 106-116.

Beghin, J. C., and Bureau, J. (2001). "Measurement of Sanitary, Phytosanitary and Technical Barriers to Trade". *Briefing Paper, Center for Agricultural and Rural Development*. Dept. of Economics, Iowa State University.

Cheng, I. H., Wall, H. J. (2002). "Controlling for Heterogeneity in Gravity Models of Trade and Integration". *Working Paper 1999-010C. Federal Reserve Bank of St. Louis.*

Maddala, G. S. (1992). *Introduction to Econometric*. MacMillan Publishing Company. 2th ed.

Maskus, K. E., Wilson, J. S., and Otsuki, T. (2001). *Quantifying the Impact of Technical Barriers to Trade. A Framework for Analysis.* World Bank, Washington D.C.

Ndayisenga F. and Kinsey J. (1994). "The Structure of Nontariff Trade Measures on Agricultural Products in High-Income Countries". *Agribusiness*, Vol. 10, No. 4, pp. 275-292.

McCallum, J., (1995). "National Border Matters: Canada-US Regional Trade Patterns". *The American Economic Review*. Vol.85, No. 3, pp. 615-623.

Otsuki, T., Wilson, J. S. and Sewadeh, M. (2001). "What Price Precaution? European Harmonization of Aflatoxin Regulations and African Groundnut Exports". *European Review of Agricultural Economics*. Vol. 28, No. 2, pp. 263-283.

Roberts, D., and DeRemer, K. (1997). "An Overview of Foreign Technical Barriers to US Agricultural Exports". *Staff Paper AGES-#9705, Economic Research Service*. USDA. Washington.

Roberts, D., Josling, T. and Orden, D. (1999). "A Framework for Analyzing Technical Barriers to Trade in Agricultural Markets". *Technical Bulletin No. 1876*. Economic Research Service, USDA.

Roberts, D., Unnevehr, L., Caswell, J., Sheldon, I., Wilson, J., Otsuki, T., and Orden, D. (2001). "The Role of Product Attributes in the Agricultural Negotiations". *The International Agricultural Trade Research Consortium*. IATRC Commissioned Paper Number 17.

Schmitz, A., Furtan, H., and Baylis, K. (2002). *Agricultural Policy, Agribusiness, and Rent-Seeking Behaviour*, University of Toronto Press, Toronto.

Swann, P., Temple, P., and Shurmer, M. (1996). "Standards and Trade Performance: The UK Experience". *The Economic Journal*. Vol. 106, no. 438, pp.1297-1313.

Tinbergen, J. (1962). *Sharing the World Economy: Suggestions for an International Economic Policy*. New York: Twentieth Century Fund.

Wall, H. J. (2000). "Gravity Model Specifications and the Effects of the Canada-U.S. Border". *Working Paper 2000-024A. Federal Reserve Bank of St. Louis*.

Weyerbrock, S., and Xia, T. (2000). "Technical Trade Barriers in US/Europe Agricultural Trade". *Agribusiness*. Vol. 16, No.2, pp. 235-251.

Wilson, J. S. (1999). *The Post-Seattle Agenda of WTO in Standards and Technical Barriers to Trade: Issues for Developing Countries*. World Bank, Washington D.C.

Zahniser, S. S., Pick, D., Pompelli, G., and Gehlhar, M. J. (2002). “Regionalism in the Western Hemisphere and its Impact on U.S. Agricultural Exports: A Gravity-Model Analysis”. *American Journal Agricultural Economics*. Vol. 84, No. 3, pp. 791-797.

Footnotes

[1] Roberts, Josling, and Orden define technical barriers as: "regulations and standards governing the sale of products into national markets that have as their prima facie objective the correction of market inefficiencies stemming from externalities associated with the production, distribution, and consumption of these products" (p.3).

[2] We consider 6 types of non technical NTMs: Antidumping Investigations and Duties, Countervailing Duties, Prior Surveillance, either Import Authorization or Non-Automatic License, Quota Control and Prohibitions.

[3] Technical Requirements, for both safety and non-safety matters, Labeling Requirements, safety and non-safety, Testing, Inspection and Quarantine requirements.

[4] This index indicates the share of NTMs simultaneously applied to a product on the total number of NTMs imposed.

[5] Following Wall, it has been used ln (1+exp_{ij}), rather than ln exp_{ij} in order to include observations of zero measurable trade.