Non-Tariff Measures in Agri-Food Trade: What Does the Data Tell Us? Evidence from a Cluster Analysis on OECD Imports

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1. Introduction

Non-tariff measures (NTMs) are widely believed to assume an increasingly important role in determining international trade, especially between developed and developing economies. The use of NTMs other than quantity control, finance and price control measures increased from 55% of all NTM measures in 1994 to 85% in 2004, and agri-food products are extensively affected. These products are the ones with the largest number of NTM complaints relative to the sectoral export value (UNCTAD, 2005).

NTMs are used for a variety of reasons. These include the correction of information asymmetries and other market failures, but also possibly protectionist purposes. The relevance of these motivations will clearly differ across products. In some products only a few NTMs may be found, while other products might have a proliferation of NTMs. Such differences in incidence of NTMs may also imply differences in potential trade frictions between countries. A cluster analysis can help to class products into coherent groups, taking a multitude of product characteristics into account.

There is no shortage of estimates of the trade effect of NTMs, but despite the increasing number of papers investigating NTMs, assessments of their trade impact by product or at least by sector tend to be rather scarce. This paper fills this gap by conducting a quantitative analysis of the trade incidence of NTMs initiated by governments in OECD countries on 777 agri-food products and groups these products into different clusters. Three criteria are used to evaluate the trade effect, namely the occurrence of NTMs, their trade coverage and the NTM-related trade frictions amongst countries.

Our cluster analysis provides 6 robust groups of products, significantly different in terms of NTM trade incidence. Such differences pose an important unsolved puzzle. They cannot be solely explained by differences in health and food safety concerns and where international trade acts as a vector to transmit undesired product attributes. We therefore review additional reasons proposed in the "protection for sale" literature to explain these differences. In this literature, based on the political economy model of endogenous protection developed by Grossman and Helpman (1994), NTMs are the result of lobbying by domestic firms and industries. The existing works, while providing some useful explanations, are not however completely satisfying in resolving the puzzle of cross-product differences in the occurrence of NTMs. They rely on crude definitions of protection and do not account for the complex forms of NTMs. Efficiency costs of such measures are much less evident than the welfare losses associated with tariffs and quantity non-tariff barriers.

We envision several uses for the results contained in this paper. First, it establishes a formal statistical grouping of products. The clusters can be used to design representative case studies on the incidence of regulations, types of measures and affected countries. Second, our results could be the starting point for new theoretical developments trying to explain governments' motivations to implement NTMs on agricultural products. Third, the cluster results can provide guidance in focusing policy efforts to reduce the trade limiting impacts of NTMs.

The paper is structured as follows. Section 2 describes the construction of the combined database and provides summary statistics. Section 3 implements the cluster analysis and reports the results.

Section 4 links our results to recent contributions of the political economy literature on protection. Section 5 concludes.

2. Data

Three pieces of publicly available information are used to group agricultural products. Our dataset covers the 1996-2006 period: (i) information on the occurrence of NTMs, coming from the UNCTAD/TRAINS database, which itself relies heavily on notifications of measures to the WTO SPS and TBT committees. This cluster analysis focuses on 'quality NTMs' and excludes trade measures that directly impact on prices or quantities such as such as tariffs, para-tariffs, and price control measures, and direct quantity control measures such as quota. The following motives for NTMs are singled out for this study: protection of human health, animal health and life, plant health, environment, and wildlife; (ii) information on trade flows comes from UN/COMTRADE; (iii) information on NTM-related trade frictions amongst countries is obtained from the record of Specific Trade Concerns raised at the WTO SPS committee.[1]

The sample in the database covers 777 products, of which only eight products do not face any NTM in any OECD country. All of those are hardly processed fibres (Silk, Cotton, Flax, Hemp). For all other products, NTMs are notified by at least one OECD country. Column (1) of Table 1 reports the number of affected products by HS 2-digit chapters, while column (2) presents the distribution of notifications at the 2-digit level. Not surprisingly there is a higher concentration of NTMs around fresh products, with fish and other aquatic products topping the list. However processed products are also well represented. Column (3) investigates the trade coverage ratio by HS2 chapter. Fish and meat are again at the top of the ranking. The share of affected trade is also quite high for products of animal origin (HS05), meat, fish and seafood preparations (HS16) and live animals (HS01). Columns (4) and (5) report the number of SPS trade concerns raised by and against OECD countries. In column (4), if a concern is raised simultaneously by several OECD countries, we create a separate record for each country. Furthermore, many concerns involve different HS 2-digit chapters, and a separate record is therefore created for each of the chapters. Similarly, in column (5), a separate record is created for each OECD country against which a concern is raised, as well as for each HS 2-digit chapters affected. Most of the SPS trade concerns are on meat (HS02), fruits (HS08), vegetables (HS08), dairy products (HS04), live animals (HS01), and products of animal origin (HS05).

[1] http://spsims.wto.org/web/pages/search/stc/Search.aspx

Table 1: Product chapters by NTM count, STC count and trade coverage (1996-2006)

HS2	Number products notified by OECD countries	Number NTMs notified by OECD countries	Share OECD imports affected by NTMS (%)	Number SPS concerns raised by OECD countries	Number SPS concerns raised against OECD countries
01- Live animals	17	286	72.23	27	14
02 – Meat, edible meat offal	53	1,340	84.09	57	42
03 – Fish, crustaceans, molluscs, other aquatic invert.	87	1,573	78.32	15	14
04 - Dairy products, eggs, honey, edible animal pduct.	27	624	71.57	26	24
05 - Products of animal origin	17	317	74.28	23	19
06 - Live trees, plants, bulbs, roots, cut flowers	12	278	69.66	13	16
07 - Edible vegetables, certain roots, tubers	56	1,207	66.15	28	18
08 - Edible fruit, nuts, peel of citrus fruit, melons	55	1,248	62.23	32	35
09 - Coffee, tea, mate, spices	32	630	33.51	8	14
10 – Cereals	16	379	65.47	14	14
11 - Milling products, malt, starches, inulin, wheat gluten	34	609	58.37	9	8
12 - Oil seed, oleagic fruits, grain, seed, fruit	44	804	55.33	8	7
13 - Lac, gums, resins, vegetable saps, extracts	12	118	36.43	8	7
14 - Vegetable plaiting materials, vegetable products	10	69	37.04	8	8
15 - Animal, vegetable fats & oils, cleavage products	46	616	46.23	12	9
16 - Meat, fish & seafood preparations	26	670	72.88	12	11
17 – Sugars, sugar confectionery	16	242	48.68	8	8
18 – Cocoa, cocoa preparations	11	178	44.65	8	7
19 - Cereal, flour, starch, milk preparations & products	17	367	67.88	8	7
20 - Vegetable, fruit, nut, food preparations	44	1,085	68.23	8	9
21 - Miscellaneous edible preparations	16	378	68.33	9	17
22 - Beverages, spirits, vinegar	22	502	67.76	9	7
23 - Residues, wastes of food industry, animal fodder	25	175	51.58	13	12
24 – Tobacco, manufactured tobacco substitutes	9	58	6.27	8	7
29 - Organic chemicals	2	8	35.31	8	7
33 - Essential oils, perfumes, cosmetics, toiletries prep.	14	52	16.03	10	9
35 - Albuminoids, modified starches, glues, enzymes	10	54	24.69	8	7
38 - Miscellaneous chemical products	1	3	3.23	8	7
41 - Raw hides & skins (other than furskins) & leather	12	139	38.35	8	7
43 – Furskins, artificial fur, manufactures thereof	9	199	39.42	8	7
50 – Silk	1	5	0.34	8	7
51 - Wool, animal hair, horsehair yarn & fabric thereof	10	75	15.61	8	7
52 – Cotton	4	8	15.40	8	7
53 - Vegetable textile fibres, paper yarn, woven fabric	2	2	0.00	8	7
Total	*769*	*14,298*	*61.1*		

Note: Twelve concerns are not reported in column (4): 6 deal with GMOs and for the 6 other concerns, the WTO SPS-STC database does not provide information on the products. Similarly, eight concerns are not reported in column (5) (4 deal with GMOs and for the 4 others, information is not provided).

3. Cluster analysis

The cluster analysis uses three criteria, one from each of the underlying datasets described in section 2, to provide a statistically sound grouping of agri-food products. The clustering is done on data for the year 2006. That is to say, COMTRADE trade data for 2006 for 12 OECD importing countries (counting the EU15 as 1), 212 exporting countries and 777 HS6 agricultural products[2] are merged with TRAINS data on NTM notifications until 2006 by OECD countries and with concerns brought to the SPS Committee until 2006 and in which OECD countries maintained the measure.

The cluster analysis is conducted at the HS6 product level, using 777 observations, and the cluster criteria are as follows:

- Share of affected trade for each product: imports of each product in OECD countries affected by at least one NTM relative to total imports of that product in OECD countries;
- NTM notifications for each product: total number of NTMs applied by all OECD countries on each product (if two countries apply the same NTM, it is counted as two NTMs, because the NTM code assigned by UNCTAD could in practice coincide with different import requirements imposed by these two countries);
- Number of SPS concerns by HS6 product.

Because the three variables are measured in different units they are standardized to zero means and unit variance before clustering. The grouping is obtained by a partitional cluster analysis using the mean of the observations as cluster centers. The distance is measured using the Euclidean distance. Using the Calinski and Harabasz (1974) stopping rule, the optimal number of clusters (based on *k*-mean clustering) is found to be six.

Table 2 presents the number of observations within each cluster and information on their homogeneity. Cluster 1 is much smaller than other clusters. All clusters show high internal cohesion: small within cluster standard deviation, short average and maximum distances from cluster center. Clusters 2 and 3, followed by cluster 4, are the most homogeneous, with low dispersion around their centers. On the other hand, cluster 1 is the least homogeneous. Clusters 5 and 6 are in-between, cluster 6 being slightly more compact than cluster 5.

Table 2: Clusters characteristics

	Number observations	Within Cluster Standard Deviation	Average Distance from Cluster Center	Maximum Distance from Cluster Center
Cluster 1	25	0.54	1.01	2.84
Cluster 2	131	0.24	0.61	1.23
Cluster 3	195	0.27	0.54	2.13
Cluster 4	216	0.31	0.64	1.65
Cluster 5	116	0.40	0.84	2.12
Cluster 6	94	0.36	0.79	1.71

[2] We kept missing and zero trade flows as these observations could be subject to NTMs or specific trade concerns.

Table 3 provides the mean of each criterion for each cluster and the whole sample. To ease the interpretation of results, the means reported in table 3 are calculated using non-standardized variables. Strong differences exist between clusters. A high share of imports of products included in clusters 1-4 faced NTMs, while this share is only 38.6% for products of cluster 5 and 21.6% for those included in cluster 6. Furthermore, the average number of notifications on products of clusters 1-3 is high. By comparison, this number is only 15.4 for products of clusters 4, 16.7 for products of cluster 5 and 5.3 for those of cluster 6. Finally, the number of SPS trade concerns is very high for products of cluster 1, high for products of cluster 2 but low for all other clusters.

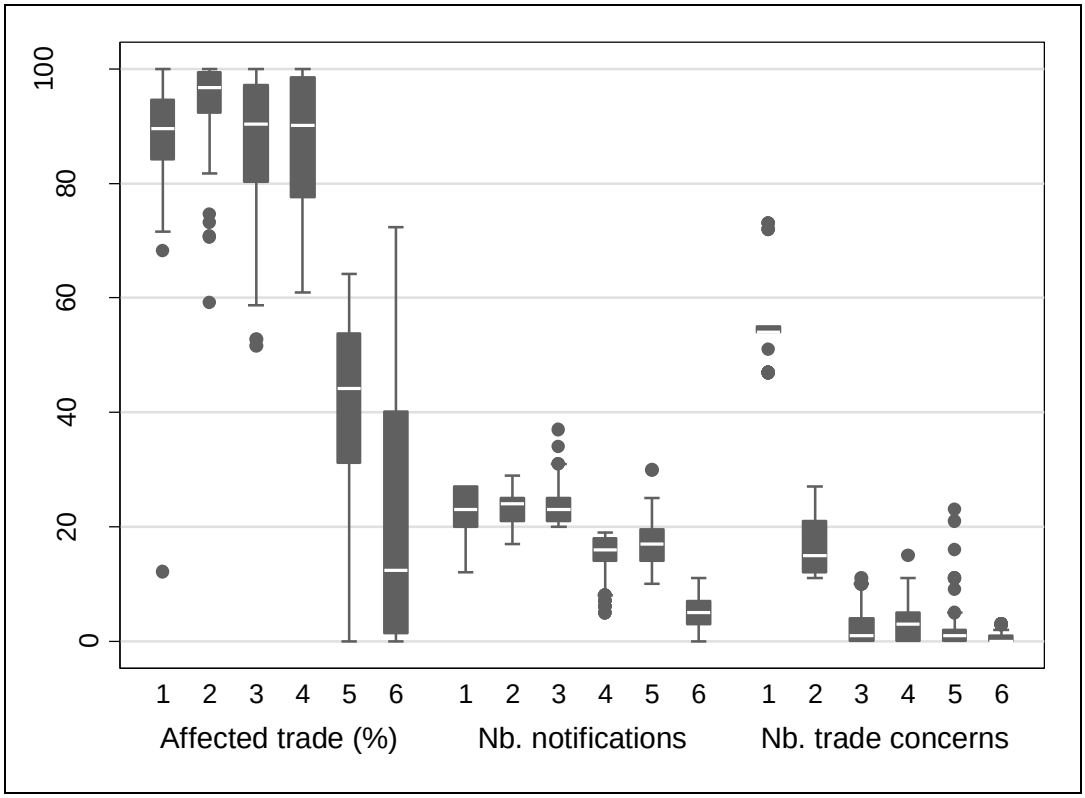
Table 3: Mean for each criterion, by cluster and for the whole sample

	Share notified imports (%)	Nb. notified NTMs	Nb. SPS trade concerns
Cluster 1	85.7	23.2	57.1
Cluster 2	94.6	22.9	16.5
Cluster 3	87.3	23.2	2.2
Cluster 4	87.6	15.4	3.4
Cluster 5	38.6	16.7	2.1
Cluster 6	21.6	5.3	0.7
Whole sample	*73.3*	*17.9*	*6.5*

Figure 1 shows the box plot representation of each of the criteria within each cluster. The lower (upper) limit of a box represents the first (third) quartile of the distribution. The median is shown at the 50^{th} percentile. The whiskers extend the box to the lowest and highest adjacent values, excluding extreme values (those are represented with round markers). This figure gives information on the distribution of each criterion. Share of affected trade is the most dispersed criterion both between and within the clusters. The distribution of the two other criteria exhibits much more similarity both between and within the clusters.

Three tests were performed to check the robustness of the clusters. Tests for robustness to outliers, for stability over time and a test for sensitivity to product aggregation reveal that the clustering obtained is very stable.

Figure 1: Box plots for each criterion, by cluster



The product content of each cluster is as follows:

Cluster 1 (High trade coverage, high number of notifications, very high number of concerns) is the smallest in terms of size and includes two types of products: bovine meat (HS0201-0202) and many dairy products: milk, cream, buttermilk and butter (HS0401-HS0403, and HS0405), cheese (HS0406) and edible products of animal origin (HS0410).

Cluster 2 (High trade coverage, high number of notifications, high number of concerns) consists of:

- All meat products (HS02), except bovine meat and HS020732;
- Many vegetables products (HS07), i.e. potatoes, (HS0701), tomatoes (HS0702), onions, shallots, garlic, leeks (HS0703), cucumbers and gherkins (HS0707), leguminous vegetables (HS0708), dried vegetables (HS0712), dried and shelled vegetables and leguminous (HS0713), Manioc, row root, salep (HS0714 except 071490), and part of vegetables provisionally preserved, not ready to eat (HS0711);
- Products of HS08 "Edible fruit, nuts, peel of citrus fruit, melons" (except HS081050 and 081220).

Cluster 3 (High trade coverage, high number of notifications, low number of concerns) contains:

- Live trees, plants, bulbs, roots (HS06 except flowers);

- Cereals (HS10 except HS100640);
- Related to cereals, several products of HS19 "Cereal, flour, starch, milk preparations" (HS1901, 1903-1905);
- Meat, fish and seafood food preparations (HS16 except HS160210 and 160232);
- Most of the HS20 "Preparations of vegetables, fruit, nuts or other parts of plants";
- ¾ of HS21 "Miscellaneous edible preparations";
- Most of HS22 "Beverages, spirits, vinegar".

Cluster 3 also consists of some specific sectors: Live non-farm animals (HS0106), Fish fillets (HS0304), Crustaceans (HS0306 except 030623), birds eggs (HS0407-0408 except 040899), and natural honey (HS0409).

Cluster 4 (High trade coverage, low number of notifications, low number of concerns) includes:

- Live farm animals products (HS01 except 0106);
- Two-third of fish products (HS03);
- Many products of animal origin (all products of HS0501 "Human hair, waste", HS0502 "Bristle, pig, badger's hair, brush making hair, waste", HS0503 "Horsehair, waste", HS0504 "Guts, bladders and stomachs of animals except fish", HS0508 "Coral, shell, cuttle bone, waste", HS0509 "Natural sponges of animal origin", and HS0510 "Ambergris, civet, musk, for pharmaceutical use");
- Cut flowers (HS0603);
- Almost all vegetables products (HS07) which are not in cluster 2;
- All products included in HS1201 "Soya beans", HS1203 "Copra", HS1204 "Linseed", HS1208 "Flour, meal of oleaginous seed or fruit except mustard", HS1213 "Cereal straw and husks", and HS1214 "Animal fodder and forage products";
- Half of cocoa products (HS1801 "Cocoa beans", HS1802 "Cocoa shells, husks, skins and waste", and HS180310 "Cocoa paste, not defatted").

Cluster 5 (Low trade coverage, low number of notifications, low number of concerns) contains:

- Two-third of the HS11 products "Milling products, malt, starches, inulin, wheat gluten" (except HS1105 and 1107);
- Half of the animal and vegetable fats and oils (mostly products from HS1502 "Bovine, sheep and goat fats", HS1503 "Lard stearin, oleostearin, oils, natural tallow oil", HS1509 "Olive oil", HS1510 "Other olive oils", HS1512 "Safflower, sunflower, cotton-seed oil", HS1515 "Other fixed vegetable fats and oils", HS1518 "Processed animal and vegetable fats and oils");
- Half of sugar products (most products of HS1701 "Solid cane or beet sugar and chemically pure sucrose", HS1702 "Other sugars" and HS1703 "Molasses");
- Remaining cocoa products (HS18).

Cluster 6 (Very low trade coverage, very low number of notifications, low number of concerns) mainly includes products of chapters 24 and higher: tobacco products (HS24), mannitol and sorbitol (HS2905), essential oils, perfumes, cosmetics (HS33 except 330190), albuminoids and modified starches (HS35 except 350211), amylaceous finishing agents and dye carriers (HS380910), silk products (HS50), wool, animal hair products (HS51), cotton products (HS52), vegetable textile fibres (HS53).

4. Discussion

The statistical analysis resulted in six rather robust clusters. But the clusters are heterogeneous in terms of products contained in them, and some product groups are spread over several clusters. How can such cross-product diffrecnes be explained?

The political analysis of Kono (2006) emphasizes that politicians in more democratic societies tend to be more sensitive to public concerns about health, product safety and the environment, which reinforces the tendency to use complex measures and suggests that cross-industry differences could be observed in the degree of NTM coverage. Kono's empirical analysis, cross-country as well as cross-sectoral lends support to this hypothesis. Kono's sectoral analysis highlights that NTMs will be more frequent in those agro-food subsectors where consumer interest groups voice concerns relating to food safety, animal welfare and the environment. A coalition of producers and consumers can successfully demand NTMs to address profound health and food safety concerns, where international trade acts as a vector to transmit undesired product attributes. Fresh fruits and vegetables as well as certain animal products can be seen as falling into that category, and our cluster analysis tends to put those into the groups with high NTM coverage and high trade coverage.

The 'protection for sale' literature proposes some additional reasons to explain cross-product differences. The political economy model of endogenous protection developed by Grossman and Helpman (1994) postulates rent maximizing lobbying activities in return for political support contributions and takes both import elasticities and industry stakes into account. It predicts that the lower the price elasticity of imports, the higher the level of protection afforded to the industry, because the deadweight loss from import protection increases with the price elasticity of imports. In addition, a low ratio of imports to output favours larger lobbying contributions, and will tend to raise protection in the political economy equilibrium, because low imports volumes mean a low of social cost of protection.

Gawande and Bandyopadhyay (2000) test this theory empirically using US non-tariff barriers and lobbying spending and find indeed that protection decreases with the import penetration ratio if the sector is organized, while protection increases with import penetration if the sector is not organized. The proportion of consumption sourced internationally is typically quite small across all agricultural sectors and across countries, but there are some differences across the products included in our sample. For example, the international dairy market is very 'thin' with small trade volumes relative to domestic absorption. The cluster analysis squarely puts dairy products into the group with the highest NTM coverage. A more serious testing of the inverse relationship between the import penetration and NTM coverage can be done using trade data in conjunction with domestic consumption figures.

Extending the Grossman-Helpman framework into a heterogeneous firm model, Bombardini (2008) explains why larger firms are more likely to lobby and makes a link between the size distribution of firms and protection. If lobbying involves fixed costs, then the lobbying will be concentrated amongst the larger firms. The more concentrated industry is more effective in its lobbying, as the benefits are kept inside a smaller group. In contrast the marginal benefits of increased protection are declining, and may not outweigh the costs of lobbying, if more firms enter the club. These predictions are not refuted empirically for data on the US. The implication

for agri-food is that we would observe higher protection and more NTMs in more concentrated sub-sectors.

Another possible cause of differences in NTMs occurrence could be governments' support to ailing sectors. Baldwin and Robert-Nicoud (2007) address the question why declining industries account for most of the protection granted in all industrialized nations. Their framework rests on sunk entry costs, and predicts that in expanding industries rents would attract new entry that would eventually erode the rents generated by protection. In declining industries that is not true, as protection can raise profits sufficiently high, but below the normal return on capital, to make lobbying for protection a rewarding activity. The implication of this approach for agri-food is that we would expect to see relatively more tariff- and non-tariff barriers in sub-sectors that are on the decline in the OECD countries, while we would observe less protection in growing sub-sectors. This pattern is to some extent present in the clustering results, which tends to put the more dynamic processed products (HS24 and higher) mainly in cluster 6.

The theories briefly sketched above are useful to further understanding the patterns of protection across broadly defined industries, e.g. high level of protection in aircraft manufacturing versus low protection in computer manufacturing. But can they also be helpful in understanding differences in protection within agriculture? We have made some attempts above to relate the theoretical insights to our clustering results, but this is necessarily sketchy and should be subjected to further statistical scrutiny.

One problem that the theories discussed above do not tackle sufficiently is the question when a measure can be considered protectionist. They have a relatively straightforward definition of protection: either a tariff or quantitative border measure (both rising behind the border price of imported goods) or a domestic subsidy (lowering the domestic price of domestically produced goods). The NTMs analyzed in this paper are considerably more complex and their efficiency costs are much less evident than the welfare losses associated with tariffs and quantity barriers. NTMs do not necessarily embody the economic inefficiencies that are associated with classical trade barriers and they may be the least trade-restricting policies available in the face of market imperfections. It is therefore not clear a priori that the removal of NTMs affecting trade would achieve efficiency gains that would exceed the losses from weaker regulation. A fuller theory of NTMs to explain differences across products should therefore take into account also consumer benefits (and concomitant incentives to engage in lobbying for regulation) as well as producer incentives to lobby for protection.

5. Conclusion

This paper investigates the variation in the trade incidence of NTMs across agri-food products. The cluster analysis suggests that the 777 products of our sample can be classified into six robust groups. Only a slight portion of the cross-product variance could be explained by differences in health, food safety, and environmental concerns. The remaining variance is partially explained by the literature on endogenous protection. However, the justifications provided in this literature are not fully satisfying and invite further research.

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