ASSESMENT OF THE IMPACTS OF NON-TARIFF MEASURES NTM ON THE COMPETITIVINESS OF THE EU AND SELECTED TRADE PARTNERS

FP7NTM IMPACT

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Index of Heterogeneity of Requirements in International Agri-food Trade [12]

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1. Introduction

Regulations that define the import requirements for foreign products to be sold on domestic markets constitute non-tariff measures (NTMs) and are the focus of the NTM-impact project. The conceptual thinking has progressed in so far as the benefits of such regulations, particularly those aiming at ensuring food safety, plant and animal health, have been acknowledged, but the measurement and systematic analysis is lagging behind. Main challenges are measurement issues as well as data issues. The analysis of the requirements in international trade relies on further advances with regard to the substance of regulation. Advances are necessary because neither the number of requirements nor exporters' complaints about them give sufficient information for analysis. While the comparative analysis across countries, products and measures is a second step in the analysis of NTMs, this paper aims to shed light on the substance of requirements and how to measure them in terms of an index of regulatory heterogeneity.

In order to ensure that the research is feasible we make a number of assumptions:

- The focus is on governmental requirements that foreign producers have to meet in order to sell their products on the markets of respective importing countries.

- Import requirements are considered, and those of the 10 partner countries and the EU are compared in the analysis. Including the EU import requirements, which can be considered to reflect the requirements producers in the EU are subject to, in the comparison is necessary in order to ascertain differences from the EU exporters' perspective.

- The EU is taken as one entity so that possible regulatory differences across member states are not taken into account. That is agri-food trade across the EU member states is assumed free without NTMs.

- Since it is impossible to compare all possible regulations for all agri-food products, some kind of product and measures selection is necessary and thus only a set of products and requirements are considered in the comparative analysis.

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2. Systematic Approach to Regulatory Heterogeneity in Agri-Food Trade

2.1. Regulatory system to control food safety/quality

Standards and regulations in agri-food trade make up a very complex system, and different countries usually have different interpretations. This section briefly presents a general framework of regulatory systems to control food safety and quality in international agri-food trade. Rau et al. (2010) provides a full description of the framework and legal issues. The regulatory framework is based on the EU system and constitutes the backbone of a systematic analysis of regulations, involving the collection of data as well as and the comparison of requirements across countries. Figure 1 presents an overview of the conceptual framework of the regulatory system to control food safety/quality. As shown, we differentiate between the three broad regulatory elements of i) requirements for food business, ii) conformity assessment and iii) requirements for authorities/countries. Requirements for food business can be further distinguished according to what they actually regulate. Obviously there will be requirements that do not or not easily fit into the framework.

As Rau et al. (2010) mention, in the USA requirements on food contact materials, for example, are framed as requirements on the food product: so-called indirect additives, while elsewhere a food contact material is seen as a separate topic.

Figure 1: Structure of regulatory elements in agri-food trade
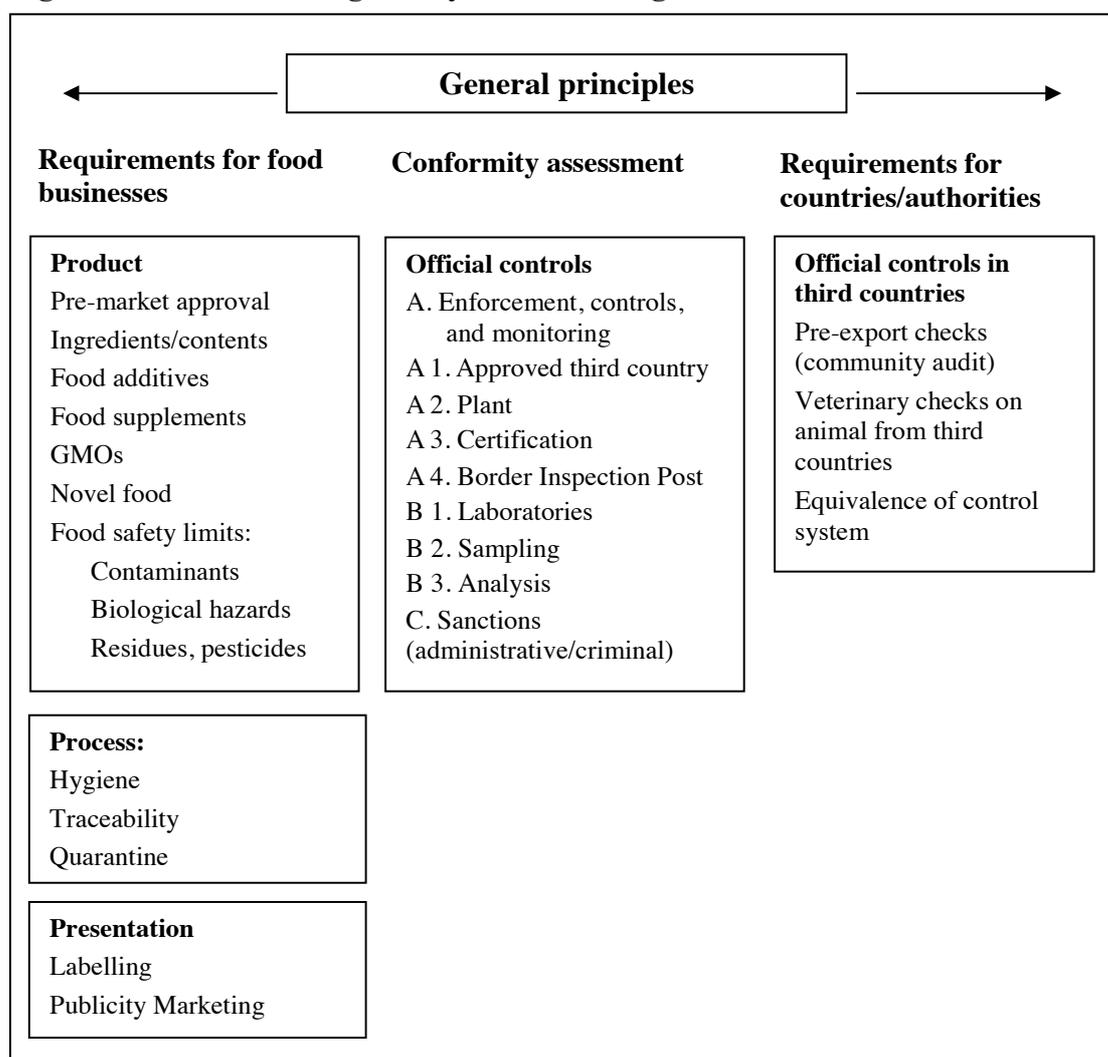
Source: Rau et al. (2010)

2.2. International Perspective on Regulatory Heterogeneity

Standards and regulations in agri-food trade are set within the frame of the regulatory systems for agri-food products in countries, and they are thus first of all domestic affairs, often with international coordination though. The domestic requirements of the importing country constitute the basis for the requirements that foreign products have to meet in order to be sold. Regulations differ across countries for many reasons. On the one hand, standards requirements reflect institutional structures and the national food law, and on the other hand they reflect the prevalent production systems, which depend on local circumstances including natural conditions as well as technical and scientific resources, and consumption traditions such as diets, consumer preferences and acceptable tolerance levels of food safety risks for example. Due to regulatory heterogeneity across countries, the requirements for supplying the domestic market and those for exporting to foreign markets differ.

At the international level, the relation between requirements for domestic and foreign products is organized by the WTO trade rules in the SPS and TBT Agreement. The SPS and TBT Agreement applies to product standards, but production and process requirements also fall under the Agreement if production methods can be used to distinguish final products. The SPS agreement holds for production and process requirements if it can be shown that the final product generated according to a specific method is harmful or risky for human, animal and plant health. While maintaining the sovereign right and obligation of countries to set their own standards, countries are encouraged to base their import requirements on internationally agreed standards such as the Codex Alimentarius Committee of the World Health Organization (WHO)[4] for food safety.

The provisions under the SPS and TBT Agreement aim to ensure that standards are not misused as disguised protectionist measures. Requirements for foreign products are not to be more stringent than those for domestic products and foreign products should be generally treated like corresponding domestic products (with the same use and tariff classification). The SPS Agreement however foresees the possibility of different requirements for foreign food products if they protect human, animal and plant health in the importing country. The TBT Agreement has a similar provision to introduce regulations in order to meet legitimate objectives, including security, human health and safety and the prevention of deceptive practices. In order to impose different and possibly tighter standards on foreign products importing countries are required to provide scientific risk assessments, thereby justifying the necessity of the respective requirements. Furthermore, requirements have to be commensurate with their objectives and least trade-distorting for achieving the objective aimed at. With the SPS and TBT Agreement, domestic standards requirements generally constitute the basis for import requirements but countries can also demand different and possibly tighter standards for foreign products in certain cases. If the criteria for different requirements are fulfilled, importing countries can either uniformly impose stricter standards on imports from all exporting countries or require that products from different countries satisfy different

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4 The Codex Alimentarius refers to food standards, guidelines and codes of practice recommended under the Joint FAO/WHO Food Standards Programme. The International Pant Protection Convention (IPPC) and the World Organization for Animal Health (OIE) respectively promote international standards and guidelines to prevent the introduction and spread of plant and animal pests.

requirements in order to control for export specific risks. In the latter case products from certain countries may need to be specifically treated and checked before importing so as to reduce the risk of introducing pests that are endemic in the particular exporting country but not in the importing country. Therefore regulatory heterogeneity can be considered country-specific and the regulations of two trading partner countries should be compared.

From the exporters' point of view, the requirements for supplying the domestic market and foreign export markets matter.[5] Firms have to satisfy the requirements of importing countries in order to sell their products on foreign markets, and the concept of regulatory heterogeneity looks at the differences of requirements. The emphasis is on the relative difference of requirements. Regulatory heterogeneity between exporting and importing countries means trade costs. At the firm level, meeting stricter import requirements obviously leads to compliance costs, and those firms that wish to sell their products on different foreign markets tend to face even higher costs because they have to comply with several standards according to the export destination. On the other hand, import requirements that are more lenient than domestic requirements also involve costs if changes in products and/or the production process are necessary to comply and if compliance needs to be established by costly conformity assessment. That is, the mere fact that requirements differ between countries causes costs for exporters and this is an important main idea behind the concept of regulatory heterogeneity.

From the EU export perspective, the requirements of the EU and trading partner countries are compared for sets of products and measures selected and subsequently expressed in a corresponding index of regulatory heterogeneity. The heterogeneity index developed gives information not only about if there are differences in import requirements but also about the size of the differences. Looking at the substance of import requirements and how they differ, the heterogeneity index developed stands in relation to the costs for EU exporters to supply foreign markets outside the EU. The following section considers the evidence for regulatory heterogeneity.

2.3.   Evidence of Regulatory Heterogeneity from the EU Exporters' Perspective

Recent studies by Berden et al. (2009) and Sunesen et al. (2009), which were undertaken on behalf of the European Commission, aim at identifying bilateral regulatory heterogeneity or regulatory divergence in a trade and investment context at a sectoral level. Both studies employ business surveys, sector expert interviews and literature reviews to gather data on NTMs and quantify their impact in gravity-type analyses and simulation models; compare Schlueter et al. (2009). The scope of both studies is broad: They consider all non-price and non-quantity restrictions in goods, services and investment, including border measures as well as behind-the-border measures in all sectors. To identify empirical evidence of the effectiveness of policy heterogeneity in the context of the NTM-Impact project, we concentrate on the main findings for the agri-food sector and the relevant regulatory measures.

Berden et al. (2009) examine the EU-US trade relationship. Using a global business survey, they determined the main NTMs in each sector. Companies on both sides of the Atlantic and in third countries were asked to indicate trade and investment barriers and to express their opinion related to the NTMs and regulatory divergence they were facing

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[5] The requirements for selling on the domestic market and those for selling on the foreign market are ideally compared, but in this work's comparative analysis the focus is on import requirements only.

in their exporting activities.[6] The survey was conducted in 2008. Using the answers from 3500 companies Berden et al. (2009) generate a bilateral NTM index that takes values between 0 and 100. For the interpretation of the index, 0 means that regulatory divergence does not exist between the trading partner countries, while 100 means absolute divergence. For the food and beverages sector they compute a divergence level of 45.5 for trade from the EU to the US, and of 33.6 for trade from the US to the EU. Thus, European exporters perceive regulatory divergence stronger than US exporters. This gives evidence to argue that the assumption of symmetric trade barriers (made in several gravity-type applications) is not per se feasible. In comparison to other sectors, the NTM index for food and beverages takes midway values: with regard to EU-US trade the indices range between 20.0 for information/communication technologies and 56.0 for aerospace/ space industry and with regard to US-EU trade the indices are between 17.6 for travel and 55.1 for aerospace and space industry.

Based on a literature review and on exporter interviews, Berden et al. (2009) identify those areas of regulatory heterogeneity that are highly relevant for EU-US and US-EU trade. Table 1 and 2 respectively present a summary for relevant NTMs in trade of food and beverages and also give trends in divergence over time. Those measures which affect all sub-sectors of the food and beverages business are considered more relevant than measures affecting only one sub-sector.

They find that diverging regulations between the two economies result in additional trade and trade-related investment costs of 73% for EU-US trade and 57% for US-EU trade. Tackling the divergence, where possible, and reducing the additional costs associated would boost the US gross domestic product (GDP) by 1.2 billion Euros per year. The annual boost of EU GDP amounts to 5.0 billion Euros. US food and beverages exports to the EU would increase by 2.4 %, and EU exports to the US would grow by 0.8 % per year.

Sunesen et al. (2009) analyze the trade relationship between Japan and the EU by using a similar methodical approach. They take the perspective of businesses that supply the Japanese market and thus only consider the regulatory obstacles that EU companies face when exporting to Japan. Based on 92 survey answers, the heterogeneity index constructed shows a divergence level of 60.0 for EU exporters of food and beverage. In other sectors the divergence level ranges from 44.0 (pharmaceuticals) to 67.0 (medical). According to the survey results, 80% of the participating companies consider Japan as being more or much more difficult to access than other markets. The most important issues raised by European exporters relate to the use of additives in processed foods. Other main NTMs to the Japanese market are related to standards and conformity assessment requirements which are typically laid down for sanitary requirements, maximum residue levels for veterinary drugs, general food labeling requirements and nutrition labeling requirements. Table 3 lists the areas of regulatory heterogeneity for EU-Japanese trade of processed food products and indicates the potential decrease in cost if the respective barriers were lifted.

The companies specify the higher costs of adopting production to Japanese standards, of labeling and packing requirements, and higher costs related to conformity assessment to

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[6] Note that only businesses that were already active in trade participated in the survey. This seems to have caused a bias in the results on the effect of NTMs because measures can be prohibitive and therefore affect businesses that do not export.

be between 20 and 40%. Realizing the cost-reduction potential of reducing policy heterogeneity would boost European processed food exports to Japan by 4.8 billion €.

Table 1: Regulatory Heterogeneity Relevant for Agri-Food Trade, EU-US

NTM	Trend
Container security initiative, causing delays for all sea cargo.	Constant
US product standards that differ from international ones.	Constant
100% container scanning.	Constant
Double certification need caused by the EU's Authorized Economic Operator program and the US Custom's Trade Partnership against Terrorism	Decreasing
Restrictions of imports from third countries on the grounds of national security.	Increasing
Lack of harmonization between federal, state and municipal regulations.	Constant
Bioterrorism Act: extensive documentation and registration.	Constant
Certification of agricultural products as organic.	Constant
Dairy: Grade A dairy Pasteurized Milk Ordinance.	Constant
Specific meat regulations.	Decreasing

Source: Berden et al. (2009)

Table 2: Regulatory Heterogeneity Relevant for Agri-Food Trade, US-EU

NTM	Trend
Traceability and labeling of biotechnology food and feed and the lack of uniform approval process of agricultural biotechnology products.	Increasing
EU product standards which differ from international ones.	Constant
EU labeling requirement laws.	Increasing
Double certification need caused by the EU's Authorized Economic Operator program and the US Custom's Trade Partnership against Terrorism	Decreasing
Maximum limits on mycotoxins for a variety of foodstuffs.	Constant
Organic food labeling.	Constant
Microbial treatments for meat products (poultry).	n/a
Obstacles in the trade of vitamins and health food products.	Constant
Growth promoting hormones in beef.	Constant
Packaging regulations.	Constant

Source: Berden et al. (2009)

Table 3: Regulatory Heterogeneity for Trade of Processed Foods, EU- Japan

NTM	Cost-reduction potential
Absence of a common list of permitted food additives and compositional standards.	high
EU organic products do not have complete access to Japanese market/logo.	middle
Strict sanitary requirements and safety standards impose costs of compliance where standards are incompatible or non-transparent.	high
Packaging and labeling requirements impose additional costs.	middle
High conformity costs as Japanese authorities do not accept evaluations made by the EU or international bodies.	middle
Rigorous border inspection and quarantine regulations cause delays at the port of entry.	middle

Note: High (middle) cost-reduction potential means a contribution to the possible barrier reduction of more than 20% (10 - 20%).
Source: Sunesen et al. (2009)

Divergence of import regulations for different exporting countries

In a study on specific regulatory measures in the meat sector Schlueter and Wieck (2009) analyze detailed regulation-specific data on SPS measures. They identify such types of NTMs for ten major meat importers and exporters.[7] The study differentiates between regulatory measures which are equally applicable to imports from all origins and regulatory measures which are targeted towards specific exporting countries. These two broad categories of measures are further differentiated by trading partner and year for each line of meat product, resulting in a unique data set of regulatory measures which are applied for agri-food safety purposes in the meat sector.

In total, 4203 regulatory measures are found to be imposed on meat trade over the time 1996-2007 and countries considered. These measures are arranged into six classes which describe different agri-food safety purposes: (1) Disease prevention measures; (2) Requirements for microbiological testing for zoonoses; (3) Tolerance limits for residues and contaminants; (4) Production process requirements; (5) Conformity assessment and information requirements; and (6) Requirements for handling of meat after slaughtering. With around 3200 measures, the number of uniform measures across all exporters is four times as high as the numbers of measures that are specifically in place in bilateral trade (see Table 4). Considering uniform regulatory measures, the EU and the US apply the most measures on meat imports, followed by China and Korea that apply much less (see Table 5).

Table 4: Number of Uniform and Bilateral Measures per Regulation Class

Number of measures applied	diese	micr	tole	proc	conf	hand	total
Equal across all exporters	594	163	1006	413	757	335	3268
Bilateral measures	418	64	36	169	202	46	935

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[7] Countries which have the highest average aggregated meat trade flow in value terms of the sample period 1996 to 2007 are included in the analysis. Importers: Canada, China, EU15, Hong Kong, Japan, Republic of Korea, Mexico, Russia, Saudi Arabia, USA. Exporters: Argentina, Australia, Brazil, Canada, China, EU15, Hong Kong, New Zealand, Poland, USA.

Note: diese = disease prevention measures, micr = requirements for microbiological testing, tole = tolerance limits for residues, proc = production process requirements, conf = conformity assessment, hand = handling of meat after slaughtering.
Source: Schlueter and Wieck (2009)

Table 5: Number of Uniform Measures per Importer

Number of measures applied	USA	CAN	CHN	EU15	HKG	JPN	KOR	RUS	SAU	MEX
Equal across all exporters	704	245	547	809	25	267	422	85	4	160

Source: Schlueter and Wieck (2009)

Figure 2 shows the aggregation of uniform regulatory measures into classes for each country. For the EU and a lower extent also for the US, it is noticeable that most of the measures are applied in the area of tolerance limits. Opposite to the highly safety regulated importing markets of US and EU, meat imports into Hong Kong and Saudi Arabia face the fewest uniform SPS measures.

Figure 2: Number of Types of Uniform Measures by Importing Countries
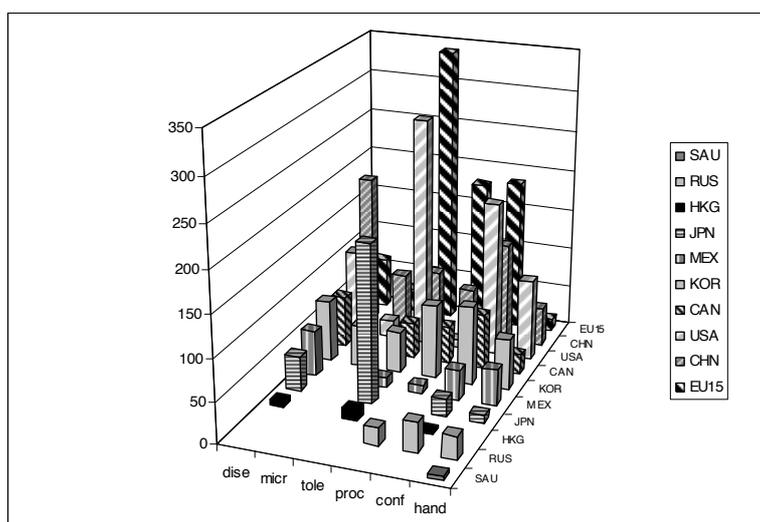
Note: dise = disease prevention measures, micr = requirements for microbiological testing, tole = tolerance limits for residues, proc = production process requirements, conf = conformity assessment, hand = handling of meat after slaughtering.
Source: Schlueter and Wieck (2009)

Considering bilateral/country specific regulatory measures, China and the EU, followed by the US by a wide margin, have implemented the most measures across the sample of analysis (

Table 6). As presented, China and the US mainly require disease and pest prevention measures for exporting meat to their markets. In contrast, most measures of the EU are requirements for production processing and conformity assessment.

Table 6: Number of Bilateral Measures Implemented by Importing Countries

	USA	CAN	CHN	EU15	HKG	JPN	KOR	RUS	MEX
dise	99	50	123	24	8	26	44		44
micr			64						
tole	2		20		14				
proc				169					
conf	16	5	34	102		2	35	6	2
hand			23	1		10	12		
SUM	117	55	264	296	22	38	91	6	46

Note: dise = disease prevention measures, micr = requirements for microbiological testing, tole = tolerance limits for residues, proc = production process requirements, conf = conformity assessment, hand = handling of meat after slaughtering.
Source: Schlueter and Wieck (2009)

Table 7 presents the number of bilateral SPS measures of importing countries imposed on different exporting countries. As shown, both bilateral and country specific uniform regulatory measures can result in the heterogeneity of import conditions that exporters face in their export activities. It is clearly illustrated that most of the US measures are targeted towards the EU whereas the bilateral measures implemented by China target US imports and EU imports almost to the same extent.

Table 7: Number of Bilateral SPS Measures

					Exporter					
Importer		USA	CAN	CHN	EU15	HKG	JPN	KOR	RUS	MEX
	USA	n.p.	14	112	73		3	20		3
	ARG	16	7	8	42		10	2		10
	AUS			10	59			13		
	BRA		2	10	13			4		
	CAN	4	n.p.	8	63	2	1	20		3
	CHN				23		7		6	
	EU15	97	30	99	n.p.	20	17	21		20
	HKG			15	3	n.p.				
	NZL			1	20			9		
	POL		2	1				2		10

Source: Schlueter and Wieck (2009)

The heterogeneity index developed points out differences in requirements across countries, which potentially raise costs for EU exporters that wish to supply the markets of the respective importing countries. For the sets of products and measures selected, the index will show if respective measures are similar or dissimilar. In the interpretation of the index, the regulatory similarities between the EU and its trade partners are

identified and such insights point towards those areas where NTMs may be more effectively addressed and trade opportunities could be improved and/or further explored. While agreements on equivalence, for example, may facilitate trade in the case of similarities, regulatory dissimilarities may be overcome in negotiations, be it in multilateral or bilateral negotiations or on a case-by-case basis, in order to limit their potential trade- restricting impact. The analysis of the index will allow for such policy implications.

2.4. Comparing Requirements to Ascertain Regulatory Heterogeneity

For constructing an index of regulatory heterogeneity, the import requirements relevant in trade between pairs of exporting and importing countries are compared. The regulatory elements identified elsewhere, containing the basic data for the heterogeneity index, are broad and the comparison needs to be on a more disaggregate level with regard to details/mechanisms of the regulatory elements as well as with regard to products or groups of products. Based on the regulatory elements, domestic and foreign requirements would ideally be compared but our comparative analysis across countries, products and measures focuses on import requirements. Taking the EU exporters' perspective, the EU import requirements, which are considered to approximate the requirements applicable in EU member states and the import requirements of its trade partners are compared. The EU is generally taken as one entity in this research so member states are not examined individually. This considerably reduces the demand for information necessary and also simplifies the analysis. Since the large majority of import requirements for products to enter the markets of the EU member states is set at the EU level and is in fact harmonized across member states[8], this simplification seems to be reasonable. Looking forward to the upcoming research, the import requirements of third countries for EU products in general and not for products from individual EU member states however seems to be more critical.

Comparing regulations is a difficult task that involves taxonomy of requirements. Rau (2009) elaborates on the commonly applied methods of measuring standards and regulations and outlines associated challenges. For constructing the index, main challenges have been identified:

- Relevant versus irrelevant/binding versus non-binding,

- Matching of product categories and measures,

- Text versus numerical elements and incidence of no regulation

- Detailed versus aggregate information;

Requirements demanded by governments are formulated in documents of regulations that differ in informational contents and can contain more than one requirement. Listing requirements is involved because there are usually many different requirements applying for products/groups of products that fit into the framework developed in chapter 2. In particular, general horizontal requirements apply to all products, and they should also be considered when looking at requirements at the product level.

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[8] EU requirements are formulated either in regulations or directives. While EU regulations directly apply as law in all member states, EU directives are binding on the member states as to the objectives to be achieved within a certain time limit, and member states must adapt their national laws to meet the stated objectives. That is, for EU directives the member states have the flexibility to choose on the policy measures they use for attaining the goals set at the EU level.

Documents of regulations comprise all possible requirements and do not indicate which ones are economically important and binding. Binding and non-binding requirements are found in the same document, and with regard to both binding and non-binding requirements no information about their actual enforcement is provided. Given the large number of requirements, it seems optimal to focus on those requirements that are actually relevant and matter.

For the comparison, the harmonized coding system for products/or group of products in international trade (HS codes) is taken. While classifying exported and imported products the HS classification may not be sufficient for comparing product-specific requirements that are usually defined according to sector definitions of products. This may therefore require additional consideration of these links.

Regulations describe requirements of product features, processes and procedures (compare Figure 1), sometimes in a rather vague manner and other times in detailed technical specifications. Some requirements that, for example, specify the contents of ingredients and maximum residue levels are usually expressed in numerical terms and comparing them across countries is thus relatively straightforward. However, many requirements are not measurable on an objective scale such that ranking them becomes difficult. The stringency of a measure is not necessary equivalent to its effect. For constructing the index, it has been agreed to first and foremost concentrate on numerical elements. While practical, this focus does not leave out the possibility to define other indicators that provide measurable information about the requirements prescribed in text format. In addition to the numerical elements versus the text format, incidences of one country regulating and other countries not regulating pose a particular challenge when comparing regulations. In particular the question arises about what "no regulation" actually means and how such incidences of "no regulation" can be best identified in the comparison across countries. Incidences of "no regulation" are accounted for in the index (see chapter 4.3).

As already mentioned above, the comparison will necessarily take place on a disaggregated level in order to appropriately identify difference in requirements. Previous attempts to compare standards and regulations shows that the details matter and a comparison at a less detailed level does not seem to bring differences to light. Providing information of requirements at the detailed level however leads to the issues of aggregation at various levels. Given that any weighting for any index is prone to open a debate, we follow the approach by the OECD in their Product Market Reform Index. Wolfl (2009) provides details on the aggregation issues with regard to the index by the OECD and the approach is explained for the heterogeneity index suggested in chapter 4. The rationale is set out here: Where possible equal weights are used for transparency and so as to not be sensitive to the data changes. Though this might not fully reflect the biological, economic or legal importance of neither specific requirements at the detailed level nor types of requirements at the more aggregate level, it does allow the differences in requirements to be reflected in a practical way. Using various levels of aggregation, the index will allow the measures to be compared using a transformation to a similarity measure.

3. Index of Regulatory Heterogeneity

This chapter introduces a measure of differences in requirements relevant in agri-food trade in terms of a NTM heterogeneity index. This approach is taken primarily because the impact of NTMs might be considered as a second stage phenomenon- it is dependent on the heterogeneity of NTMs and other factors such as domestic and

international market structures, exchange rates etc. In this first case it is best to at least have a basic measure of the disparity before looking at its impact which will be part of the second part of WP5 in the NTM-impact project. In the following the index is referred to as the Heterogeneity Index of Trade (HIT).

The HIT will measure the differences of NTM requirements across partners relative to the levels instituted in the EU, though there is no rationale why another base can not be used. It will be necessary to combine elements of various types of data - numerical, ordered and binary in a transparent manner. Many of the problems associated with data of this kind are the sparseness associated with the data matrix once the legal framework has been considered. There are implicit questions about the breadth of grouping similar elements especially when there is little numerical information about the measure. In this light, the index will naturally have to include a number of asymmetric binary variables (where having the relevant measure is seen as more informative than not), ordinal measures where measures relative to a base case are important and the standard interval scaling associated with for example Maximum Levels.

As with any index, the underlying requirement is to take disparate data and to combine them into a single measure. This approach, in essence, requires two forms of data, the raw information and the underlying weighting algorithms. The raw data will depend upon availability and applicability. The selection of the data is governed by 'expertly informed expediency' i.e. expertly guided data selection, with the caveat that the index might be sensitive to that data selection. After all an index is the sum of its parts' (or perhaps the product of its parts in certain cases). In general though we may consider the index as:

$$I_j = \sum_{k=1}^{n} w_k f(i_{jk}) \qquad \text{Eqn(1)}$$

where the weight on a specific element is denoted w_k and term $f(i_{jk})$ denotes the value of the element (perhaps transformed).

This chapter will consider approaches taken in index creation especially in the light of NTM measures and an outline of the approach to be followed with a brief example of the technique.

3.1. Literature of Applications of Heterogeneity Indices

This section will look at two main strands of the literature- the types of indices available to use along with the statistical background for each and an empirical consideration of these in trade policy. The underlying problem is to take a disparate set of data and to reduce their dimensionality to a single measure. This measure must be applicable at all levels of aggregation as it is feasible that the user will wish to analysis both micro and macro level trade flows.

Previous simple approaches are discussed in Deardoff and Stern (1997). These include frequency type models in which the number of NTMs in a specific database is considered. They do not seek to explicitly discover the impact of the NTM just as the measure to be considered here, rather this approach measures the number of regulations in place, irrespective of their importance. Price based measures themselves are not without issues. The price to be used is not always clear cut and simplifications will be based on assumptions that may be less than valid. When considering the use of gravity based models, they point out that the use of a simple measure of NTMs places a

substantial burden on the variable within the model leading to an upward bias in the estimated impacts of the NTMs.

Another approach to dealing with the heterogeneity of the various measures is to consider the Ad Valorem Equivalents (AVEs). This in essence turns the NTM into an equivalent tariff. This approach is standard within much of the literature with a prime example being Kee et al. (2008). This paper builds on the literature to consider what the generalized tariff level would be equivalent to the current level of protection in the country's trading partners to keep export levels the same. As they point out, this will lead to redistributive effects implicitly that might be considered as part of the deadweight loss triangle associated with restricted trade though the redistribution of incomes should be based on the firms importing into the country rather than a domestic effect. These elements would be best captured in a general equilibrium type model with the partial equilibrium second order impact being a rather imperfect proxy for these impacts. Despite this, the AVEs are used to estimate a Trade Restrictiveness Index (TRI), which is based on the sum of the individual Harberger's Triangles in the case of the TRI following Anderson and Neary (1994) and the overall level of the country's protection in other cases. The underlying estimations were based on the HS-6 categories with a total of 4575 cases. The overall situation is that the countries with the most restrictive regimes also face the highest barriers to trade themselves.

Other global indices cover the level of competitiveness explicitly such as the Global Competitiveness Index (GCI) (Schwab and Sala-i-Martin, 2009). This is somewhat different from many other indices as the weighting on the sub-indices change as the economies develop. As with other indices, survey data supplements the economic data used. In the GCI's case the responses take a value of between 1 (worst) and 7 (best). It covers 133 countries and has a total number of respondents of 12614. Outliers are assessed using standard statistical techniques and a moving average is calculated to derive the final sector indices. This allows for relative stability of the index but to allow larger sample sizes to carry more weight than the smaller samples. The index is presented in a number of manners. Both the rank and the score out of 7 are included with the previous outcomes in a number of levels of disaggregation. These are supplemented by a spider/ diamond plot for the specific country allowing the significant elements to be observed. Golub (2003) considers measures of restricting inward investment. This has a number of natural parallels to the work to be carried out here. The study utilizes a simple summation representing whether or not certain characteristics are present. The index is calculated at an industrial level and then aggregated using trade weights. Though not a binary measure like a number of studies the thresholds are taken from Hardin and Holmes (1997) are arbitrary. Indeed Hardin and Holmes' paper performs some sensitivity analysis on their measure with respect to their weights (and implicitly the thresholds) and finds that their measure is very sensitive to the choices made in absolute terms, though the rankings generally remain similar.

The bilateral investigation of EU-US trade by Berden et al. (2009) used a survey generating 5445 data points to generate measures of trade or investment based divergence. Noticeably their measure was an ordinal scale (from 0: no divergence in regulation or NTM measure, to 100: extremely high levels of regulation). For food and beverages they highlight the different approaches of the two partners: the EU uses traceability to ensure food standards throughout the process whereas the US emphasizes

the final product's testing. Many of the requirements for food and drinks are across the board with further complications generated by the state level requirements in the US (though it might be worth considering these as a NTM for even the US producers). Most of the sectoral factors they consider are those based on Dairy and Meat. They emphasize the relatively *ad hoc* approach to especially meat products such as bans in addition to the obvious costs involved in acquiring the approval of US agencies for EU based production facilities. Further SPS specifications of the EU are noted to be higher than the US and high maximum levels of mycotoxins are both seen as an important point of divergence between the EU and US. Indeed the EU's higher SPS requirements are seen as the most important factor for US to EU trade whereas for trade from the EU to US government support to farmers is seen as the most important factor. As with the individual states' powers in the US over food testing, national authorities have power over consumer health and protection. This will lead to difficulties in harmonization of these issues. These issues by their nature suggest to Berden et al. that those NTMs are likely to continue to be a burden on the sector though if harmonization could be achieved the potential gains are significant.

In a similar vein, Vigani et al. (2009) examine the impact of GMO regulations on trade flows. The GMO aspect of their gravity model was represented by an index based upon a normalized score from six categories. The data was acquired from 60 countries and either the overall index or the sub-elements were used in a gravity model based on trade at an HS-2 digit level. The index, labeling, approval and traceability were all seen to be statistically significant and negatively signed as one would expect a priori with the scale that was used in the study.

The Logistics Performance Index, henceforth LPI, (Arvis et al., 2010) deals with many problems that are faced in with measuring NTMs. The LPI is based on a ranking-based response from a survey with approximately 5000 assessments from 1000 respondents. The responses for six core indicators are standardized using the mean and standard deviation approach before the PCA tools are applied. The weights derived from the relevant principal component are used to construct the LPI index. This component in the 2009 study accounted for approximately 88% of the variation in the data and it is noticeable that the loadings for each of the core elements are approximately the same. This can be seen in Figure 3.

Figure 3: Loading for the LPI
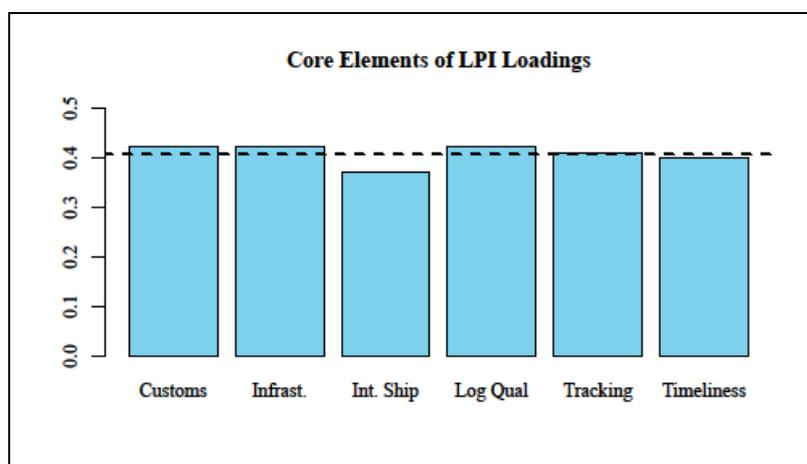
Source: Arvis et al. (2010)

Wolfl et al. (2009) consider the Product Reform Index, which includes an element of non-tariff measures with tariffs being 17% of the 'barriers to trade and investment' part of the overall index, thus the non-tariff type measures make up the remaining portion. The data is gathered using a multiple choice questionnaire (available from OECD, 2007) and other OECD or equivalent sources. Each of the industries is scored on an ordinal scale of between 0 and 6 weighted and combined to give the overall index. Kox and Lejour (2005) consider a simple heterogeneity index for services based on pair-wise comparisons. This is a purely binary indicator based measure with 0 being indicative of identical regulations. The exact calculation is based on Kox et al. (2005). This approach is not very different to the approach considered here with one exception- they consider only data through the binary coding of the regulations. Other approaches are capable of dealing with mixed data types. Though Kox and Lejour (2005) and Nordas and Kox (2008) warn about the impact of subjective judgment in the decision making processes in the index creation; it must be stated that except in the most extreme cases the classification of 'identical' will necessitate a value judgment to ensure that it is the spirit of the regulation that is identical not the wording.

3.2.   Statistical Aspects

As is inevitable in any statistical construction there are a number of different approaches to the calculation. These are discussed in a number of sources with a summary in Nando et al. (2005) with an updated approach in OECD (2008). These handbooks suggest an overall framework for any analysis to create a composite index. The approach needs some modification to be applied to the potentially sparse data set that NTMs tend to generate as regulations in one area are not necessarily mirrored in the other partner. This sparseness implies that many of the multivariate techniques, which would be used in a standard problem, are at best of limited.

Equal Weighting

There are a number of approaches to generating the weights for the index. The simplest approach is that of *equal weighting*. With this method each element is considered as important as any other in the calculation of the next level of aggregation. This can be considered as very simplistic and naïve, missing the relative actual importance of some of the elements of the index. It does have the advantage of being applicable when there are no reasons to move away from this approach. This equal weighting approach will allow any changes in policy to be reflected transparently by the index.

This is the approach taken in the Product Market Reform Index, henceforth PMR (Wolfl et al., 2009). This index was previously calculated using constant weights derived from Principal Components Analysis (PCA). However due to issues of the changing environment weights derived from PCA this approach was no longer seen as the most applicable process. At each level of the index equal weights are applied to the constituents, irrespective of the number of constituents that these have. The overall impact of the change from PCA to a simple equal weighting was slight for the PMR index (between 0 and ±0.4 index points). This use of equal weighting for stability is an important factor in the decision to use a simple weighting for the HIT. Though it may not fully reflect the actual importance in some cases the benefits are great and without specific rationale to move away from these weightings it is unwise to do so.

Principal Component Analysis

With a more complete, purely quantitative data set it is possible to use Principal Component Analysis possibly in conjunction with some form of data imputation to complete the data set. In essence this approach looks to explain as much of the underlying variance of the data by using linear combinations of the data. The technique involves the creation of new variables each of which are uncorrelated with each other.

Each PC contributes some explanatory power to the overall variance of the data. The number of principal components to be included in the composite index is part of the construction decision. There is no one single answer to this question. The most common approach is to use the associated eigen values of each component following the Kaiser-Guttman rule (1960 and 1954). It should be noted however that this criterion is not always supported as a valid technique (Yeomans and Golder, 1982). Other techniques for selecting the number of components such as Scree plots or comprehensibility are somewhat subjective. PCA tends to be most effective when there is some correlation within the variables and there are substantial differences across the individual cases.

PCA and other multivariate techniques are of limited use when the number of cross-sectional units relative to the number of observations per unit is small as the properties of the components are not clearly defined. This is most likely to be the case for NTMs

where the number of potential measures is likely to be a significant multiple of the number of countries.

Cluster Analysis

The aim of cluster analysis is to group multidimensional data into groups that share certain underlying characteristics. Generally a distance measure is used to group the units into coherent groups. Clusters can be sensitive to the distance measure used however, for NTMs the choice is somewhat limited. The Gower distance (see for example Gower, 1971 and Podani, 1999) is able to accommodate quantitative and qualitative data and account for sparsely populated data set, which is a major issue in the NTM data sets.

3.3.   Approach Suggested for NTM index

Given the rather sparse and mixed nature of the available data at present, the options available for the construction of the index are incredibly limited. Despite the obvious desire to use only quantitative data, it is not feasible to construct a data set that is purely quantitative and covering a sufficiently large number of NTM to ensure that the index has any meaning. Likewise at present the data set available is rather limited in terms of the number of countries available.

This suggests that a very simple measure of differences is perhaps the best avenue of investigation; and given the aim is an index of heterogeneity i.e. a measure of difference, the Gower measure (Gower, 1971) appears to be the most suitable candidate for the metric especially when using Podani's Taxonomy (see Podani, 1999) to allow for the use of ordinal values. We can think of the data for the index as falling in to one of three categories, binary, ordered and quantitative[9] as shown in Table 1. If a partner has similar NTMs to the EU, then their similarity will be high, near 1 and their dissimilarity will be near 0.

Table 8: Measure Types for Non-Tariff Measures

Type	Binary	Ordered	Quantitative
Measure	Rule based calculation	Rank based calculation	Calculation
Example	EU has rule (1), Australia has none (0)	EU has tightest label requirements (5), US has average (3) and Mexico least (1)	MRL levels of lysteria in beef.

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[9] Qualitative data, such as colour can also be used but the use of this will be minimized.

The index approach suggested here further satisfies the properties suggested by Kox and Lejour (2005) and Nordas and Kox (2008):

- increasing with differences in regulation
- allowing aggregation and disaggregation across diverse regulations and issues
- specificity to trading pairs
- independence of judgment about levels and types of regulation

With any diverse set of characteristics or elements, it is necessary to bring the data into a common measure for comparison, just as correlation coefficients can be compared. In order to do this, the Gower measure explicitly normalizes the data allowing a mathematical aggregation across heterogeneous elements. The output from the index calculations are (dis-)similarities rather than unit, such as parts per million, based. Thus they have no specific unit so allowing comparison.

The Gower index compares characteristics of two partners j and k:

$$G_{jk} = \frac{\sum_{i=1}^{n} w_{ijk} s_{ijk}}{\sum_{i=1}^{n} w_{ijk}} \qquad \text{Eqn(2)}$$

The measure s_{ijk} measures the level of similarity in the characteristic i.

For quantitative measures the calculation is simply:

$$s_{ijk} = 1 - \frac{\mid x_{ij} - x_{ik} \mid}{\max(x_i) - \min(x_i)} \qquad \text{Eqn(3)}$$

For ordinal data the approach is very similar using rankings and can be found in the Technical Appendix. The use of binary data is identical to that of Kox and Lejour (2005).

Two weighting schemes are considered. These are shown below in It is simple arithmetic to change from one weighting system to another if this is required.

Figure 44 and are important when considering *aggregation* schemes. In the simplest case equal weights are used. This approach parallels that of the PMR. It is possible to change this approach, allowing specific constituents to be weighted in a specific way. In the analyses presented a simple set of weights are used at the lowest possible level.

The first approach to aggregation weighting considers the highest level of aggregation as a sum of the lowest level constituents and equally weights these equally in light of that. Using the example of Figure 3, there are six constituents in the index at the lowest level, each of these is given a weight of 1/6 in the total index which would be equivalent of weighting Sub-Index (a) with a weight of 4/6 and its four constituents each with 1/4 (the sub-index weight is proportionate to the number of constituents within it relative to the number of constituents in total). The weighting of Sub-Index (b) is 1/3 with each of the two elements weighted at ½. The impact of this is that each of the elements of each of the sub-indices are weighted the same.

The second approach weights the sub-indices equally and gives the indicators different weights. The second approach treats the sub-indices as equally important and weights

each of these accordingly with ½. This does not take into account the number of constituents of the sub-indices at all. The first is equivalent to calculating the overall index using all the constituent parts directly, the second is equivalent to using the constituents to calculate the sub-indices and then using these to calculate the overall index. The second is similar to the approach taken in the PMR (Wolfl, 2009). It is simple arithmetic to change from one weighting system to another if this is required.
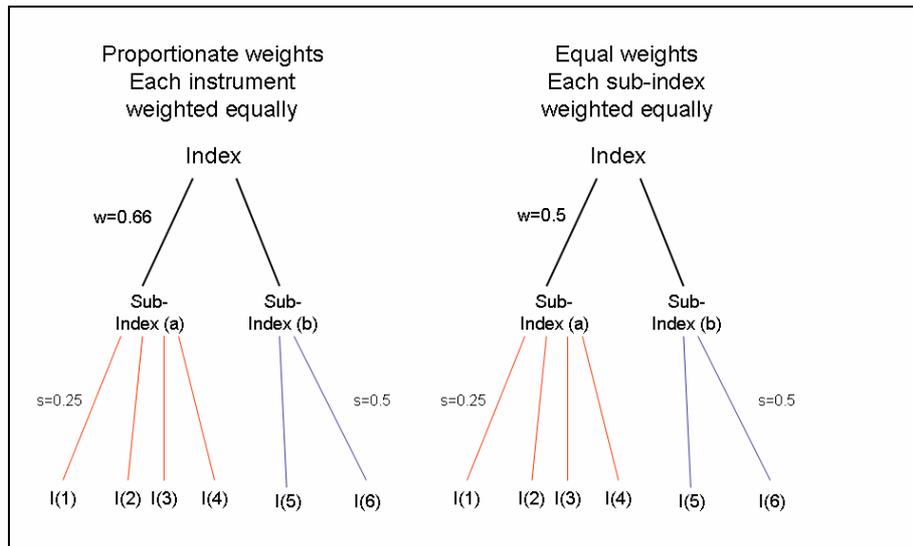
Figure 4: Different Weighting Systems

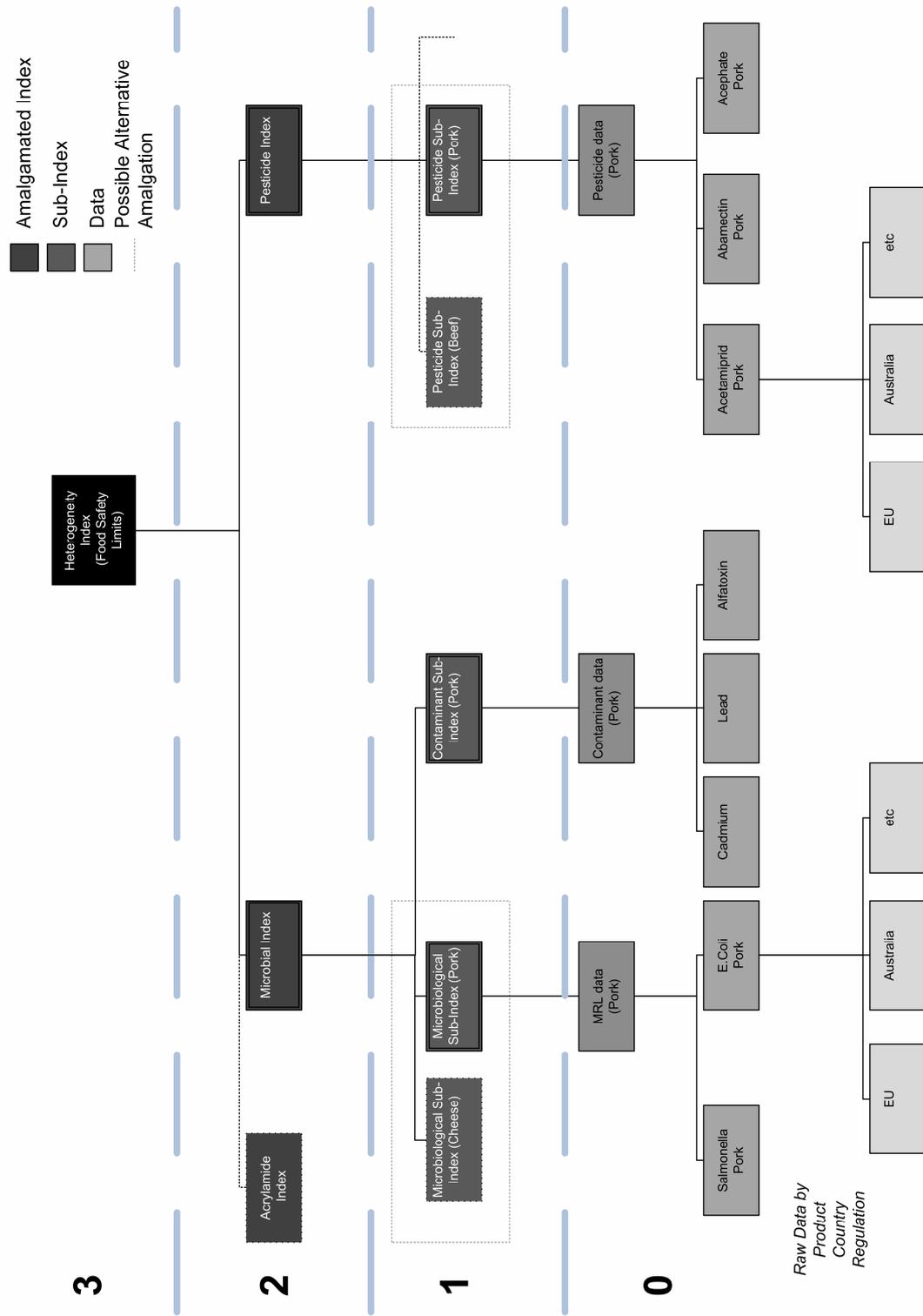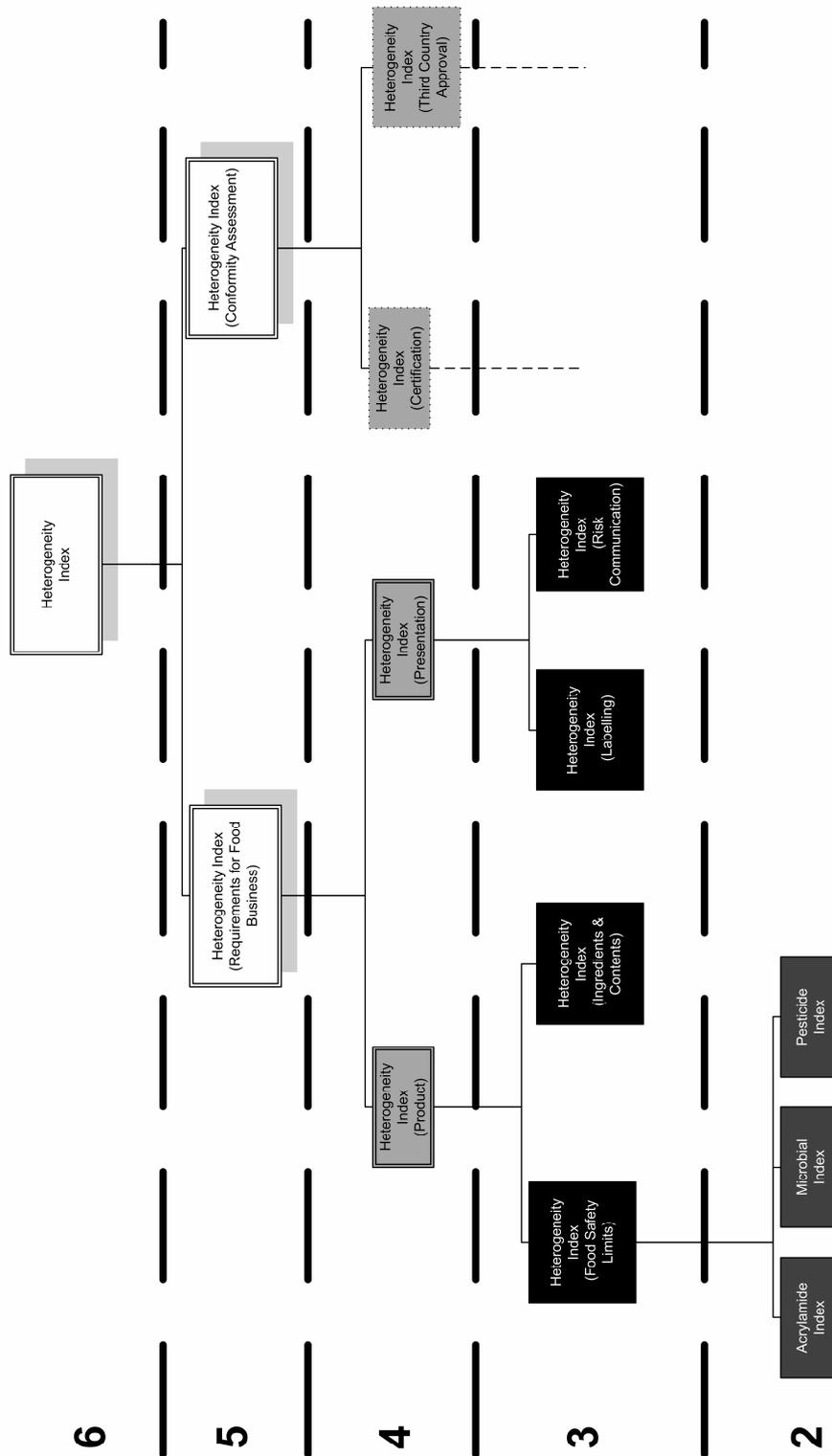**Figure 5: Index Construction from the Lowest Level**

Figure 6: Index Amalgamation at Broadest Levels

3.4.   Practical Application and Output of the Index

This section presents two simple examples of the index. In the first application, the index is calculated for data obtained in a test run on pork and cheese residue levels for contaminants and for microbial agents for a combined 'food safety' index. The second uses hog meat, using the US definitions, pesticide data from the US FAS database. For further work a larger dataset will be created the scope of which is outlined in the Appendix.

Using this approach and the diagrams presented in the previous section, one can easily contemplate different index scales. By combining sub-indices with common elements, be they product or measured regulation, a number of combined indices are possible. The differences become one of focus; is the measure be used to consider a heterogeneity in food safety in pork and so including microbial pork, pork pesticides and acryl-amides sub-indices or microbial levels across a range of products and so including pork, cheese etc microbial sub-indices. This means that how one cuts one's food safety index depends upon the specific point of interest. Care must be taken to be explicit in the weightings used in the new indices; however this is relatively straight forward and can be made consistent across the index as a whole.

Results of Australian and EU Heterogeneity Index

Using the Gower index and data, the Heterogeneity Index between Australian and EU legislation is constructed. The sample for the microbial residues is 23 regulations with contaminants having 11; thus giving an overall sample of 34 individual regulations for specific variables. Of these due to amalgamation and some coinciding of rules 11 cases exist for the microbial regulations and 7 for the contaminants.

Following the processes described in Section 3.3, each of the indicators of the indices is given equal weight. Further we can amalgamate the groups to give an overall index, based on the relative number of indicators. Using this approach we can construct a randomly weighted index centered on the overall index which allows us to see if individual sub-indices can potentially influence the main index. Further we can allow for equal weighting of the sub-indices explicitly, which is in general, different from the relative proportional weightings.

Sub-Indices

The data was sparse for both the microbial and contaminant data sets, for the microbial data set 4 out of 11 were numerical, others included a non-numerical element and were considered as ordered variables (or binary in the EU-Australia case). For the contaminants only 2 out of 7 could be considered as complete and therefore fully numerical. For the microbial measures the dissimilarity index was 0.82[10] for the contaminants this was 0.714. Combining the data sets gave an overall index of 0.78. This

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[10] It should be noted that these numbers might be inflated due to high requirements of Cheese and Pork E.Coli measures in EU relative to Australia. Simple levels rather than logs of the levels were used. This is an area for further consideration.

can be interpreted as the EU and Australia regulations on microbiological aspects are quite different with the contaminants being more similar than the microbial regulations.

Sensitivity

Using the proportions of the microbial to contaminant variables in the overall index as an approximation of the weightings a random weighting procedure was performed using the elemental sub-indices. The results of the sensitivity based on the proportionate weightings are given in Figure 7. This is a basic histogram which demonstrates the impact of various weights. The dashed lines represent the ±1 standard deviation levels.

**Figure 7: Histogram Using Proportionate Weights**
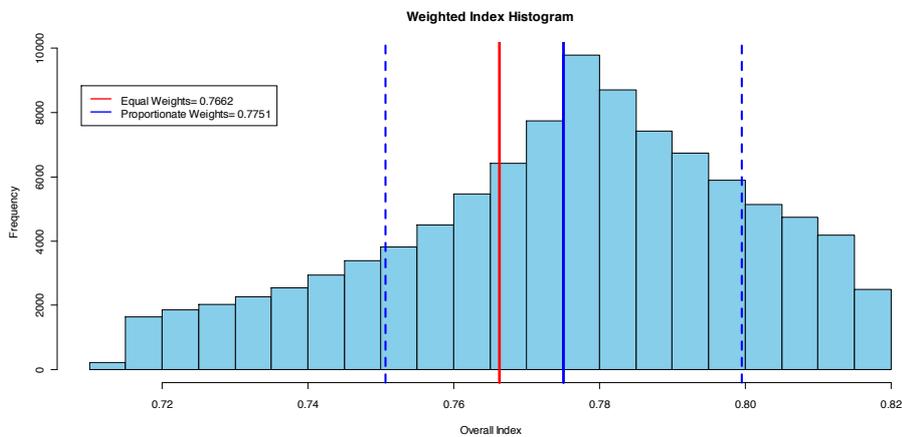
When the weights are assumed to be equal across indices, the mode of the index distribution changes with the distribution considerably less skewed as would be expected. This is the approach favored in the PMR Index. The result is shown below in

Figure 8. As can be seen from the histograms, both approaches to the weighting are close together. This would suggest that in this simple case that the weighting scheme does not have a significant impact on the outcome of the calculations.

The difference in these two figures represents the different points and approaches to aggregation. The proportionate weights treat each constituent element in exactly the same way with exactly the same level of importance. This would in effect mean that a microbial measure on specific food stuff would be given the same level of importance as a labeling requirement on a carcass of pork. The equal weights treat any sub-indices as equally important. So one could imagine that the microbial sub-indices are given the same level of importance as the labeling requirements, or the pork sub-index is as important as that of apples. This weighting is irrespective of the number of constituent parts of each of the sub-indices.

Figure 8: Histogram Using the Equal Weighting System
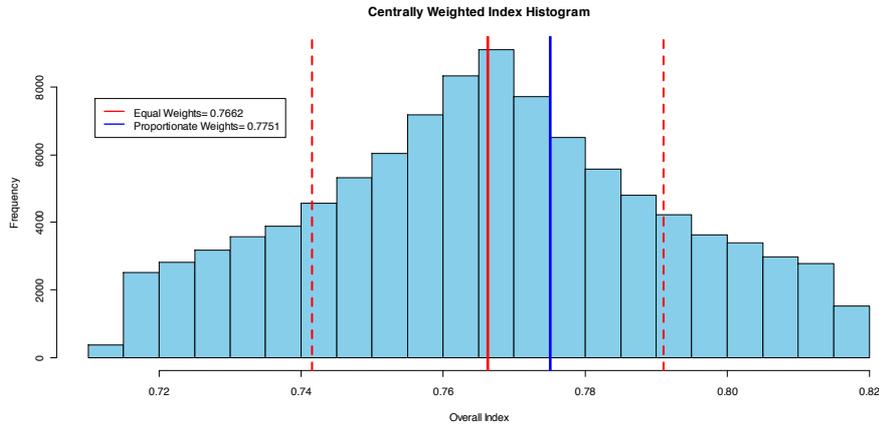
Application to Pesticide Data

Given the sparseness of the EU- Australian data, visualization is difficult. Thus to address this concern, a brief examination of US based Pesticide Data from the FAS MRL database is presented[11]. This involved a data set of 9 countries and 108 different pesticide residual levels. The indices are calculated again forcing any variables with missing values into ordinal variables. This accounted for approximately half the observations. The weighting system is irrelevant here as there is no aggregation beyond the single level. All constituents are weighted the same; the weighting becomes important if there is a combination of the measures.

Considering a naïve measure of dissimilarity as in Kox & Lejour (2005), we can compare exact replications of the levels across a number of countries. In Table 9, the value 1 represents complete dissimilarity in the exact level of the pesticide, i.e. if the EU has a level of 0.01 and Russia has 0.011 this is not a similar level. Clearly this case is extreme however it does demonstrate the necessity of a distance measure. We can see that the EU and all other countries are dissimilar to each other using this set of data. The EU and the US are furthest apart on this measure with EU-Australia being closest. It is necessary to realize that despite being closest Australia and the EU are still more different than similar.

Extending the analysis to the USA, one can see that the US is more dissimilar to all the countries but especially Russia and Brazil. Note that this is with the caveat above. In comparison to the Codex we can see that the New Zealand legislation is almost identical.

Table 9: Count Dissimilarities

	EU	US	Codex
US	0.8056		
Codex	0.6944	0.9074	

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[11] This US data can be considered as a sub-group of sorts as the set of US regulations and those of the EU coincide for some elements but the US and EU regulate different pesticides. The FAS database will not contain information about the pesticides that the EU alone regulates but will contain information about the regulated pesticides of the US irrespective of the EU position.

|			
Aus	0.6667	0.9352	0.6204
Bra	0.7130	1.0000	0.3889
Can	0.7315	0.9630	0.5000
Jpn	0.7407	0.9074	0.7870
NZ	0.6944	0.9815	0.0185
Rus	0.7130	1.0000	0.3796

Using the approach outlined in section 3.3, a dissimilarity matrix was calculated for the same data set. The results are presented in Table 10. It is clear to see that the overall levels of dissimilarity have fallen as would be expected once the distances are taken in to account. The rankings in each of the measures are correlated with a Spearman correlation coefficient of 0.71. There is a relationship between the Gower and the count measures with a R^2 of around 62%. This relationship can be seen in

Figure 9. The EU has become more similar to the other countries as the distance (or perhaps the lack of distance) between the partners becomes important. Thus we can interpret the differences between the Gower and Count approaches as demonstrating the fact that differences in legislation are not as extreme as a naïve approach such as counts would suggest. A clear example of this is the EU-Australia and EU-US pairings. Using the counts only 33% of the legislation is the same between EU and Australia, with a dissimilarity of 66% whereas the EU-US pairing has a dissimilarity of 81%. When the size of the deviations is taken into account using the Gower measure, the EU-US is closer together than the EU-Australian pairing. In essence the differences in the requirements are smaller between the EU and the US where they exist than between the EU and Australia. A further interesting comparison can be made between the US-Brazil and US-Russia pairings. Both of these are equally different from the US, furthermore when the distances are considered this is preserved. In fact according to this data set the Russian and Brazilian legislation is very similar to each other, though this may be due to the limited data set that was used in this example.

Table 10: Gower Dissimilarity

	EU	US	Codex
US	0.4516		
Codex	0.5256	0.6299	
Aus	0.4216	0.4648	0.4659
Bra	0.5955	0.7519	0.2262
Can	0.5545	0.6044	0.3334
Jpn	0.3719	0.2403	0.5776
NZ	0.5141	0.6331	0.0152
Rus	0.6068	0.7708	0.2343

Figure 9: Relationship Between Gower and Count Measures

The Relationship Between Gower & Count Dissimilarities
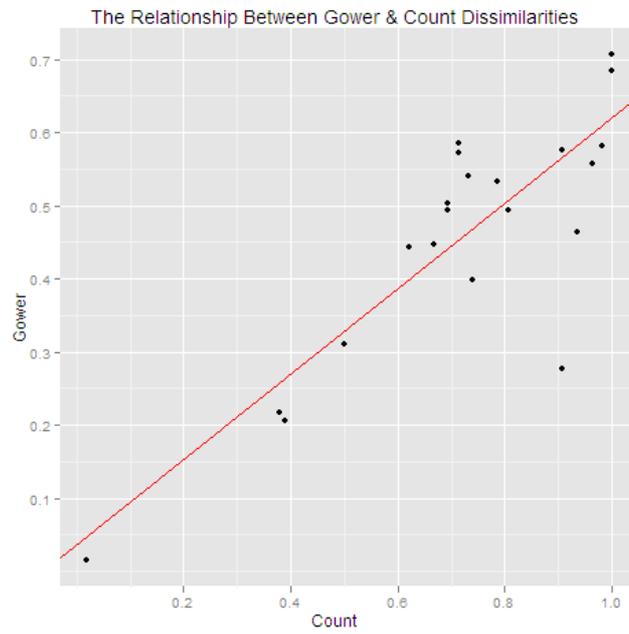
4. Summary and Concluding Remarks

This paper presents a systematic framework consisting of regulatory elements that prescribe requirements relevant in international agri-food trade. There are horizontal requirements, which equally apply to all agri-food products or to the broader groups of plant and animal products, and product-specific requirements, and both of these are areas for extension in future work.

For the comparative analysis, the concept of regulatory heterogeneity in the context of international agri-food trade is introduced. Firms that wish to export to foreign markets have to satisfy the requirements of importing countries, and the concept of regulatory heterogeneity looks at the relative differences of requirements. Regulatory heterogeneity between exporting and importing countries means trade costs, whereby the mere fact that requirements differ between countries causes these costs and consequently affect trade. Requirements relevant for agri-food trade are considered from the EU exporter's perspective. The requirements for firms to supply the EU common market and the markets of third countries are compared in order to identify differences that are expressed in terms of an index of regulatory heterogeneity. Using the data obtained in the comparison of requirements, the heterogeneity index will translate the relevant requirements given by binary, ordered or quantitative pieces of information into a measure of similarities or dissimilarities. As such, the purpose of the heterogeneity index is to reveal differences in requirements. These insights point towards those areas where import requirements are dissimilar and respective trade opportunities could be improved through negotiation and agreements between trading partners. Furthermore, the result of the index can be used for the analysis of the trade impact, which is the topic in the second part of this ongoing research.

With regard to the comparison of requirements, the following issues have been identified as particular challenging: 1) Relevant versus irrelevant/binding versus non-binding, 2) Matching of product categories and measures, 3) Text versus numerical elements and incidence of no regulation and 4) Detailed versus aggregate information. These challenges are specifically addressed in the heterogeneity index. The practical application to a first example of data illustrates what results of the index can be expected and how the analysis with the index will look like. Finally, to define the scope of the comparative analysis and to ensure feasibility, a set of measures and products need to be selected as a focus and the appendix gives suggestions in the product and measures selection.

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6. Appendix

Appendix A1: Similarity Measure

Gower Similarity Index

The similarity measure is defined comparing characteristic *i* for two partners, *j* and *k*:

$$G_{jk} = \frac{\sum_{i=1}^{n} w_{ijk} s_{ijk}}{\sum_{i=1}^{n} w_{ijk}} \qquad \text{Eqn(A.1)}$$

where *w* = 0 if either of the characteristics are unknown and *s* is a similarity measure. This will be changed to a measure of dissimilarity by subtracting this from 1, though this transformation will take place at the end of any measure calculations.

For quantitative data the measure is based on the metric

$$s_{ijk} = 1 - \frac{\mid x_{ij} - x_{ik} \mid}{\max(x_i) - \min(x_i)} \qquad \text{Eqn(A.2)}$$

These measures may then be aggregated across elements. This may also be weighted (the default approach is equal weighting). It is clear that in the quantitative data at either ends of the available data set- the maximum and minimum of the data the measure of similarity, s_{ijk}, will take the value of 0.

For binary data, the presence of similar requirements or the agreement between two partners is given the value 1, otherwise 0. Gower suggests a measure that assesses the possibility of the comparisons. This is used to account for the sparse nature of the data. It also allows the asymmetric analysis of the binary variables where a regulation's presence is seen as more significant than its absence. Further for binary variables $w_{ijk}=s_{ijk}=1$ if $x_{ij}=x_{ik}=1$ else $w_{ijk}=s_{ijk}=0$; for nominal variables $w_{ijk}=1$ is both characteristics are know with the s_{ijk} reflecting the similarity of the variable. It is not possible to use techniques such as multiple or single imputation for missing values (see Schafer, (1999) for details on the techniques) as it does not seem plausible that one regulation can give us much information about any other. This means that the missing data is dealt with using a binary or ordinal approach depending on the element under consideration.

The standard Gower measure does not allow for ordinal data, though it has been used for such. Thus Podani (1999) suggests that the standard Gower measure for quantitative data is modified to use the rank rather than the exact value of the ordinal data. This is a similar approach to Spearman's Rank Correlation coefficient, where the ranking of the observation is important rather than its value.

Podani's measure is given below.

$$s_{ijk} = 1 - \frac{\mid r_{ij} - r_{ik} \mid -(T_{ij} - 1)/2 - (T_{ik} - 1)/2}{\max(r_i) - \min(r_i) - (T_{i,\max} - 1)/2 - (T_{i,\min} - 1)/2} \qquad \text{Eqn(A.3)}$$

T is the number of objects that have either the maximum or minimum rank and $\max(r_i)$ and $\min(r_i)$ are the maximum and minimum ranks respectively. The similarity between two partners is based on the number of places in the ranking that the two partners are apart. The first formulation above adjusts for the possibility of ties and is best used for solely ordinal data. The numerator represents the amount of movement required to change rank to equate the two values, in other words how many ranks would one country need to change to be the same as the EU in the NTM being considered. Where further analysis might be required it is possible to use a simplified version that considers the relative rankings.

$$s_{ijk} = 1 - \frac{\mid r_{ij} - r_{ik} \mid}{\max(r_i) - \min(r_i)} \qquad \text{Eqn(A.4)}$$

This can be further simplified when there are no ties, as $\min(r_i)=1$ in this case and $\max(r_i)=n$ (the number of partners).

This allows for the ordinal variables to be considered although as with most analyses of this type of data the exact distribution of the underlying variable and potentially anchoring issues are ignored[12]. Using an ordinal approach for missing values relies on the assertion that a missing value implies that the partner involved has *no specific desire* to regulate a specific product. In other words, their regulation has no measure and is therefore least stringent. This then puts the regulation at the highest ranking in the data. Though not using all the information available in the calculation of the similarities across partners it does use as much information as is possible to use. It further removes the arbitrary allocation of a value (in the case of quantitative data) to missing values where maxima and minima are critical.

Visualization Data with an Illustration with Pesticide Data

Given the greater breadth and depth of this data it is possible to examine in more depth different visualization approaches. A number of approaches might lend themselves to this type of multivariate dataset. A simple approach to the data is to examine a boxplot.

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[12] The problem of sign is surmountable using a 2 step process when there is a clear 'most' or 'least' tight partner. In this case if two partners are equally dissimilar and one is know to be strictly tighter (or looser), say B than A, then a second comparison B with C can be made. If B is very similar to C then C is stricter than A and will therefore take the sign of A. If B and C are dissimilar then C and A will take opposite signs from B. Note that this will not work if there are some regulations where the strictness of the regulation is not clear. This is foreseen to be the case in many situations. Thus attributing a direction is still an area for further research.

Clearly this gives limited information about the specific groupings of the data, though it does give a feel for the distribution of each of the variables which in itself might be useful. An example is given in Figure A1. The y-axis represents the maximum level of the relevant pesticide in this case.

Figure A1: Simple Boxplot of Pesticide Data
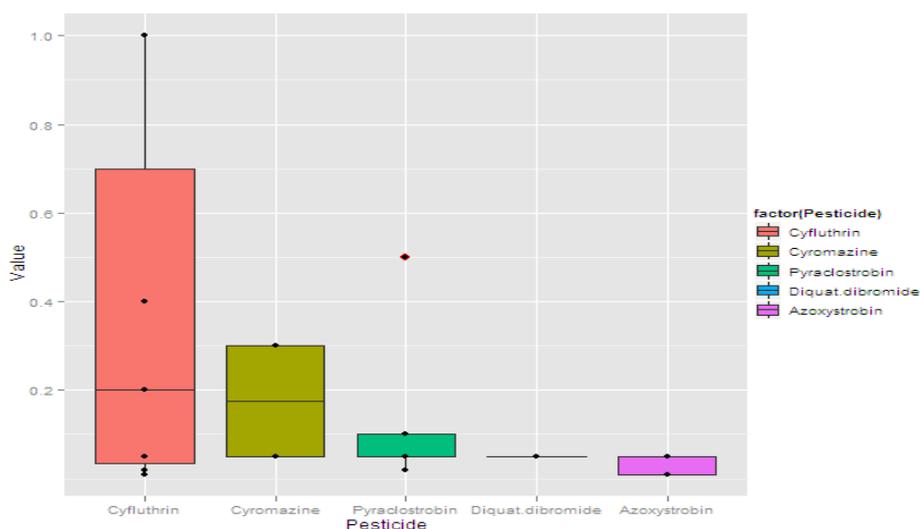
The radar, spider or star chart is common and allows the data to be presented for a number of elements across a relatively small number of observed units (see Figure A2). In this situation, each ray represents a specific measure with the countries lines. A far more interesting application would be the use of the radar to plot indices or sub-indices on each of the axes. This then gives the areas where the partners are different from each other, in essence where there is need of discussion towards reducing various NTMs or where they are very similar and harmonization can be most easily implemented. In this case there would be no EU measure plotted, rather measures are all relative to the levels used by the EU. It can be seen from Figure A2, that the spider can be informative when the values are scaled[13]. The alternative with no scaling can be difficult to see as well as to interpret. In the selection of pesticides below we can see that the Codex is consistently the highest level of each of the pesticides, with New Zealand matching this for all but one indicator, Pyraclostrobin. This is in fact paralleled in most of the pesticides and is reflected in the near zero dissimilarity measure of New Zealand.

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[13] The scaling in the figure is based on proportion of maximum level allowed. There are obviously many others such as the level relative to the Codex or the EU regulations. This however might lead to problems if one or more of the levels are considerably different from that of the base.

Figure A2: Simple Radar Chart of Selected Pesticides
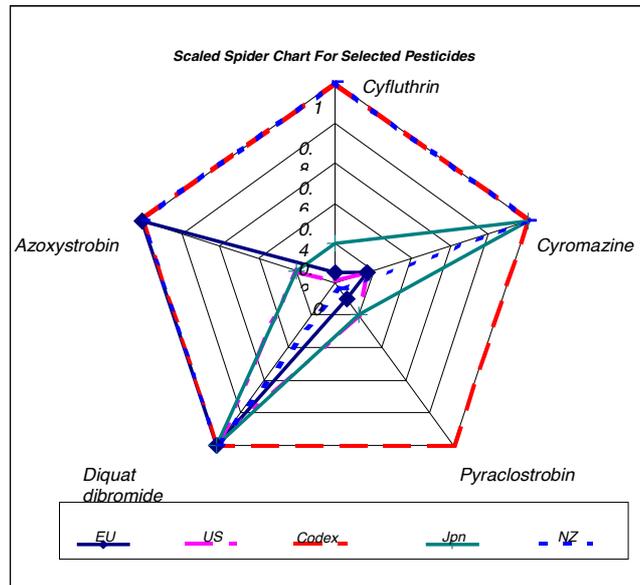
For slightly larger data sets (and especially those with a large number of countries) it is often easier to use parallel co-ordinate plots. These involve a similar approach to the radar chart except that it is 'unwrapped' so it is long and thin with a number of vertical axes. The pesticides are represented on these, with the individual countries being represented by a line across the axes. Two examples are given in Figure A3 and A4, one with unscaled data the other scaled. It is clear that for a reasonable size of data seta parallel plot can give greater intuition than the radar plot due to the relative ease of interpreting the extra dimensions. It further has the advantage of being able to present data with wider ranges, though as with the radar plot scaling is often advantageous.

Again one is able to see clustering and similarities between the various indicators across partners with New Zealand again obviously following the Codex for all indicators except Pyraclostrobin where it has one of the lowest levels. The advantage of the parallel plot approach is that more indicators can be placed on the graph although the ordering of the axes is important for interpretation and identification of similar regulations.

Conclusion

There is no one best way of examine the type of data generated in this type of study. There are a number of different techniques that can be used depending upon the desired emphasis or requirements and the number of countries being considered. Indeed an interactive approach to any of the approaches might be considered the best form of visualization technique where possible with the static version of each being second best. This will allow manipulation of the axes to ease the comparisons across countries as required. For policy use, it might be best to use a combination of these plots on the sub-indices. This was not possible with the current data set. This would give a visual representation of the differences between the partners with respect to certain elements or objectives. Clearly within a policy setting this is more useful than explicit indicators.
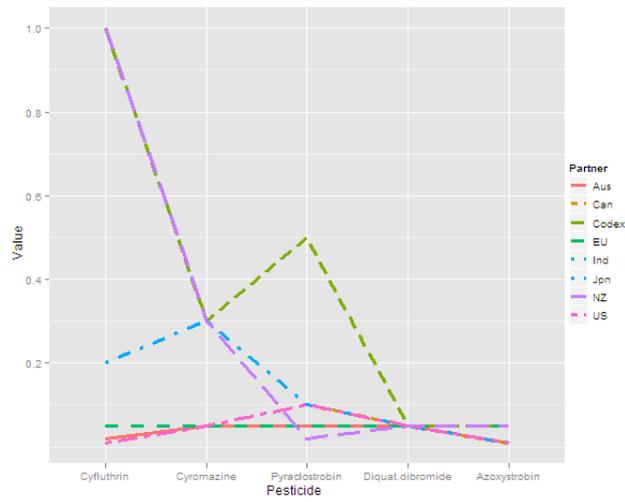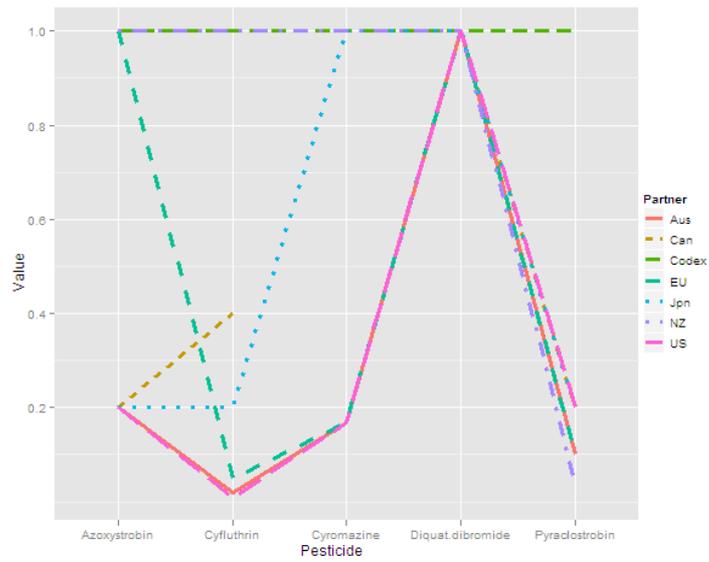
Figure A3: Unscaled Parallel Plot

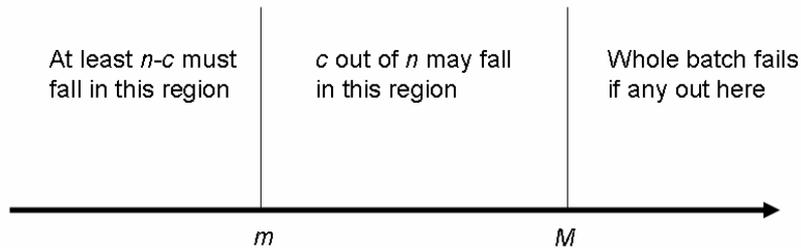

Figure A4: Scaled Parallel Plot

Appendix A2: Specific suggestion for food safety limits (MRLs) and their testing

A simple technique is proposed to deal with the various quantitative measures associated with maximum levels (MLs), maximum residual levels (MRLs) when accompanied by sampling and testing criteria. In the case of no lower bounds then a specification is suggested.

There is a recognized need for scientifically based sampling plans for foods in international trade (Forsythe, 2002). As promoted by the International Commission on Microbiological Specifications for Foods one-, two- or three-stage sampling plans are distinguished for laboratory tests. The simplest form specifies only a sample size (*n*) and a single food safety limit (*M*). An analysis under a one-stage plan results in rejection if any lot, or sometimes the average of lots, in the sample exceeds the maximum limit in the test. Such schemes are common in the regulation on man-made contaminants that can be eradicated completely from the food chain or high-risk pathogens such as carcinogens.

Most microbial pathogens are regulated by a more lenient scheme that accommodates for the ubiquitous presence of microbes and the limited consumer risks of illness or death. A number of regulations concerning the levels of a number of microbes specify a sample size (*n*) and a number of possible failures in the sample (*c*). These failures are not critical in that they are still below a maximum specified level (*M*) but are above a lower bound (*m*).

Figure A5: Food Safety Decision Criterion

| At least *n-c* must fall in this region	*c* out of *n* may fall in this region	Whole batch fails if any out here
	m	*M*

This would suggest a weighted average of the two residual levels would be a reasonable approximation for an effective ML. Thus the effective ML (EML) is given by the following relationship:

$$EML = \left(\frac{c}{n} M + \frac{n-c}{n} m \right) \qquad \text{Eqn(A.5)}$$

The relationship between the sample size and the number of failures allowed on a sample and the EML is given in Figure A6. Clearly *n* cannot be smaller than *c* hence the flat area in the diagram. This gives the effective ML for the item in question. It does however implicitly suggest that the samples are at the boundaries of the regulation, i.e. at the *M* and *m* levels. This is shown in Figure A6 where the Maximum is set to 10 and the

minimum to 5. The impact of the minimum level is to change the intercept level of the measure with measure then being solely determined by the Maximum level and the number of failures allowed.

Figure A6: Relationship of Effective Maximum Levels, Samples and Failure Rates
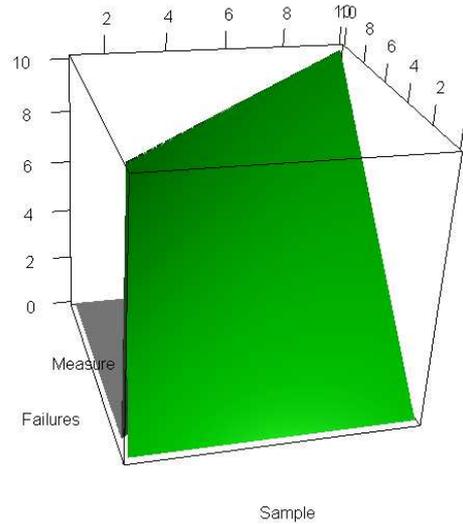
An alternative approach would be to take the mid-points of the range *m, M*. This would give the Midpoint ML as:

$$\left(m + \frac{M-m}{2}\right)\frac{c}{n} + \frac{m}{2}\left(\frac{n-c}{n}\right) = \frac{m}{2} + \frac{Mc}{2n} \qquad \text{Eqn(A.6)}$$

This is a little more realistic in that the midpoint of the critical values specified in the regulation is used for the weighted average. The impact on the measure is illustrated in Figure A7 where the parameters are set up as above for Figure A6.

It is clear that there is no major qualitative difference between these two approaches- the actual maxima are replaced by the relevant midpoints. The second seems to be a more sensible approach as it is unlikely that the maxima of the levels would be the binding factor rather a midpoint might be more reasonable in terms of one's expectations.

In the case of no lower bound then the parameter m takes the value of 0. If there is not an allowed failure rate from the sample then *c* takes the value 0. This allows the measure to be used whether or not a lower testing band is allowed or not. Indeed the only parameter that can not take the value of 0 is that of the sample size, *n*. This would represent a non-testing regime. If this were to be the case then this must logically be equivalent to having no requirements as the product is never tested for the relevant microbe or contaminant.

Other sensitivities are presented in the figures below. These are generated using a sample submitted of (*n=*) 10 and allowing (*c=*) 5 of these to be in the 'at danger' zone. A measure with the value 0 would suggest an extremely tight level of regulation for the

testing and level specification. For implementation the difference of the measures is important and so we need only be concerned with the differences between the case and the specific partner.

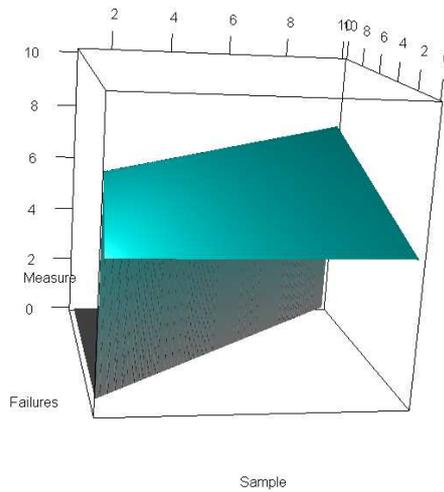Figure A7: Relationship of Midpoint Maximum Levels, Sample and Failure Rates

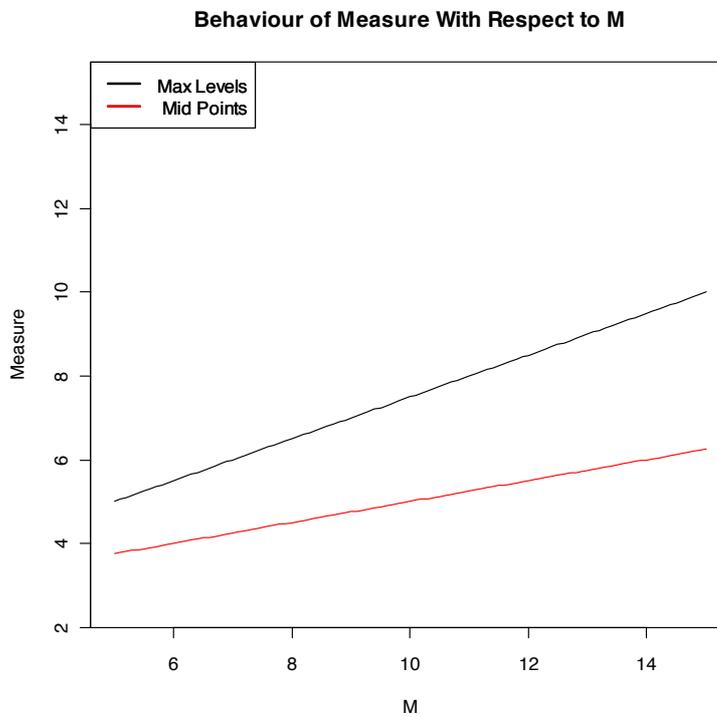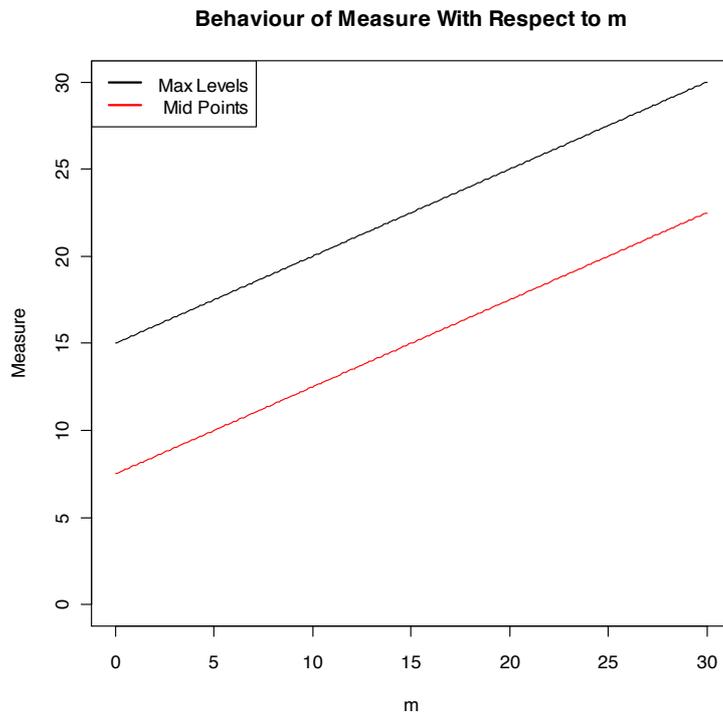**Figure A8: Sensitivity To Maximum Values**

Figure A9: Sensitivity to Lower Bounds

Behaviour of Measure With Respect to m

Appendix A3: Product and Measure Selection

Product Selection

In the product selection for the analysis of the heterogeneity index under WP5 and the data collection under WP4 it is suggested to consider the main trading agri-food products. At the moment, three products have been agreed to be looked at:

- Cheese: HS code 040690, cheese (excl. fresh cheese, incl. whey cheese, not fermented, curd, processed cheese, blue-veined cheese, and grated or powdered cheese).

- Apples: HS code 080810, fresh apples.

- Pork: HS code 0203, meat of swine, fresh, chilled or frozen.

It is suggested to extend the product scope to up to a total of 10 products. Using the HS4 level of aggregation, we consider EU trade to the partner countries and intra-EU trade to include a number of aspects in the product selection. Where necessary, the data collection will specify the products chosen further at the more detailed HS6 code. The trade data comes from Eurostat database and covers the time period 2004-2008. Initially, we look at trade volumes, which isolate currency implications, but cross reference with values at a later stage to ensure that there are no "false" inclusions, e.g. HS 20SS Confidential Trade.

Following Schlueter et al. (2009) a classification is developed. Within the possible areas of selection a classification of "incumbents", "rising stars", whose 4 year growth rate was highest, and "dead dogs", whose 4 year growth was the lowest, as well as "potentials_third countries" with regard to the EU exports to third countries that are not included in the project. In particular, we add "potentials_intraEU", which are derived by comparing extra-EU trade with the countries of the project partners and intra-EU trade. Note that the criteria are primarily relative to the partner countries in the project rather than the overall top ten trading partners as in Schlueter et al. (2009). This of course implies that we for example look at "rising stars" to the countries of the project partners rather than the top ten EU trade partners (though there might be some overlap).

The rationale for including the comparison between EU trade to third countries and intra-EU trade in the product selection is straightforward. Intra-EU trade can be considered to be representative of the products where the EU has a comparative advantage and where no NTMs exist in the common EU market.[14] The latter of course assumes that agri-food trade across the EU member states is free without trade barriers due to NTMs and that the powers of the EU member states to impose temporary restrictions under certain circumstances, as defined in Articles 152 and 153 of the EU treaties, are not used. Intra-EU trade thus represents those products that the EU member states produce and trade within the common EU market but could also export to third countries. The actual traded

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[14] We are aware that the intra-EU data not only covers products that are actually produced in the EU but also those products that are imported by one member state and sold further on the market of other EU member states. This of course weakens the selection criteria of comparing extra-EU and intra-EU trade and, we therefore use the combination of selection criteria based on the trade data available.

products are naturally recorded as the exports from the EU to third countries only (extra-EU trade). The data for extra-EU trade reflects the effects of various NTMs, including the effects of the import requirements that differ from the EU requirements, next to other factors. Products where the intra-EU and extra-EU trade is comparable suggest that there are well exploited trade opportunities with NTMs not having a large impact on the extra-EU trade. It is perhaps those products, for which little extra-EU trade is reported despite relatively high levels of intra-EU trade, where there are restrictions caused in part by NTMs.

Table A8 shows the list of chosen products according to the aforementioned selection criteria, and those products that seem to be particularly relevant with regard to the criteria of "potential_intraEU" are highlighted in the columns. Note that highly processed food stuffs made from several ingredients as well as live animals and plants are discounted from further analysis. Fish and sea food is also not considered. Looking at trade volume, cheese (0406), pig meat (HS 0203), apple and pears (HS 0808) as well as vegetables (0702 and 0709) are the potential "incumbents" to be selected, whereby cheese, pig meat and apples have already been chosen for a test run. Barley (HS 1003), maize (HS1005), rape or colza seeds (HS1205) and live plant (HS 0602) as well as apples and pears (HS 0808), tomatoes (HS 0702), potatoes (HS 0701) as well as bovine meat (HS 0201) are interesting products according to the criteria of "rising stars" on the one hand and "dead dogs" on the other hand. With regard to EU exports to the third countries that do not participate in the project ("potentials_thirdCountries"), possible products are pig meat (HS0230), cheese (0406), barley (HS 1003), potatoes (HS 0701) and vegetables (0709).

As already mentioned, trade within the EU represents trade without NTMs. Figure A10 shows the result of the comparison between intra-EU trade across the member states and extra-EU trade with third countries for which partners are in the NTM-impact project. Following the argument of the "potentials_intraEU", the selection criteria identifies those products for which a relatively low volume of trade with the partner countries but a high volume of trade across the member states is reported in 2008. In addition, the growth rate of EU trade with partner countries is considered. Looking at the "potentials_intraEU", maize (HS 2309), barley (HS 1003), rape or colza seeds (HS 1205) and apple and pears (HS 0808), potatoes (HS 0701), tomatoes (HS 0702), other fresh vegetables (HS 0709) vegetables (0710) and bovine meat (HS 0201) are identified in the product selection, next to the test run products. In Figure A10, the test run products are marked in a different color. We suggest considering these products in the further comparative analysis and data collection.

NTM Selection

The selection of the specific NTMs to be dealt with in the analysis is of utmost importance. This section outlines the broad area for investigation rather than a set of specific regulations. For the comparative analysis of the heterogeneity index it is proposed that both horizontal regulations and product specific regulations are considered. Note that those NTMs that can be associated with political issues between the EU and third countries, such as bans are not considered in the selection and hence excluded in the comparative analyses.

Horizontal requirements

Horizontal requirements equally apply to all products. They are not specifically pointed out in the framework described in chapter 2 but can be found within each regulatory domain. In general, horizontal requirements can be considered to be related to principles behind the respective regulatory system and the associated food law. In the Market Access database (MADB), which collects EU agri-food firms' complaints about NTMs as trade barriers (trade barrier database), 21 complaints out of the 110 total number of complaints are reported for horizontal measures, irrespective of products (compare Schlueter et al., 2009). Amongst them, horizontal measures for sanitary and phytosanitary reasons are most prominent, mainly disease prevention measures. For the data collection in later work, it is suggested to consider horizontal measures, for which the general differentiation between animal and plant products seems to be useful. There is the obvious division between requirements of plant products on the one hand and products of animal origin on the other hand, though there might be areas of overlap.

Table A1: Overview of Relevant Products for the Comparative Analysis

No	Incumbents	Rising stars/dead dogs	Potentials_thirdCountries	Potentials_intraEU
1	Wine	Barley	Spirits And Liqueurs	Soya Beans
2	Spirits And Liqueurs	Live Swine	Food Preparations	Bananas
3	Cheese And Curd	Vegetable Products	Wheat And Meslin	Rape Or Colza Seeds
4	Pig Meat	Palm Oil	Milk Powder	Oil Cake Veg Fat
5	Beer	Maize or Corn	Malt Extract	Oil Cake Soybean
6	Food Preparations	Sunflower Seeds	Wine	Bovine Meats
7	Bread And Cakes	Oil Cakes	Cigars	Milk & Cream
8	Chocolate	Cigars	Cane And Beet Sugar	Sunflower Seeds
9	Olive Oil	Hop Cones	Animal Food	Barley
10	Soft Drinks	Synthetic Sugar	Chocolate	Firewood
11	Animal Food	Bovine Meats	Pig Meat	Potatoes
12	Wheat And Meslin	Carrots, Turnips	Bread And Cakes	Palm Oil
13	Not Frozen Vegetables	Other Oil Seeds	Frozen Fish	Wheat & Meslin
14	Milk Powder	Wheat And Meslin	Soft Drinks	Tomatoes, Fresh
15	Malt Extract	Dates, Figs, Etc.	Cheese And Curd	Duck Meat
16	Cigars	Brassicas	Malt	Live Plants
17	Waters	Pig Fat	Beer	Cane Or Beet Sugar
18	Apples And Pears	Apricots, Cherries	Meat Of Poultry	Maize Or Corn
19	Coffee	Swedes, Mangolds	Seeds	Buttermilk Etc
20	Sugar Confectionery	Glycerol	Wheat Or Meslin Flour	Apples
21	Live Plants	Other Fruit	Butter	Wheat & Meslin Flour
22	Frozen Fish	Apples and Pears	Raw Tobacco	Rape Or Colza Oil
23	Pasta	Rape Or Colza Seeds	Olive Oil	Starch Residues
24	Cut Flowers	Offal Of Bovine	Prepared Tomatoes	Allia
25	Other Fresh Vegetables	Potatoes	Whey	Rice
26	Bulbs, Tubers	Fats Of Fish	Not Frozen Vegetables	Other Fresh Veg
27	Barley	Malt Extract	Vegetable Saps	Fruit Juices
28	Meat Of Poultry	Prepared Vegetables	Barley	Citrus Fruit
29	Sauces	Live Plants	Pasta	Vegetables
30	Live Horses	Grapes	Live Plants	Fruits & Nuts
31	Fish	Soya-Bean Oil	Offal Of Bovine	Animal Feed Preparation
32	Extracts Of Coffee, Tea	Buttermilk	Extracts Of Coffee, Tea	Binders/Foundry moulds
33	Fruit Juices	Margarine	Potatoes	Other Veg
34	Seeds	Fish Flours	Sugar Confectionery	Bread Etc
35	Citrus Fruit	Dried Legumes	Other Prepared Meat	Waters
36	Raw Tobacco	Cocoa Butter	Fruit Juices	Malt Extract
37	Offal Of Bovine	Whey	Sauces	Whey
38	Cane And Beet Sugar	Animal Food	Live Bovine Animals	Cheese & Curd
39	Prepared Tomatoes	Guts Of Animals	Soya-Bean Oil	Chocolate
40	Malt	Rape Or Colza Oil	Live Horses	Food Preparations n.e.s.
41	Vegetable Saps	Birds' Eggs	Manufact. Tobacco	Pig Meat
42	Pig Fat	Pepper	Synthetic Sugar	Other Vegetables
43	Prepared Fish	Tomatoes	Sunflower Seeds	Waters
44	Butter	Melons And Papaws	Coffee	Rough Wood
45	Whey	Milk Powder	Margarine	Sawn Wood
46	Other Prepared Meat	Salted Meat	Roasted Cereals	Prepared Tomatoes
47	Prepared Fruit	Potatoes Flour	Sausages	Pasta
48	Cocoa Powder	Fermented Beverages	Prepared Vegetables	Malt
49	Cocoa Butter	Roasted Cereals	Not Concentrated Milk	Wine
50	Tomatoes	Coffee	Prepared Fruit	Beer

Source: Eurostat data on agri-food products, including processed food, HS4 level

Figure A10: Comparison Extra EU-Trade and Intra EU-Trade
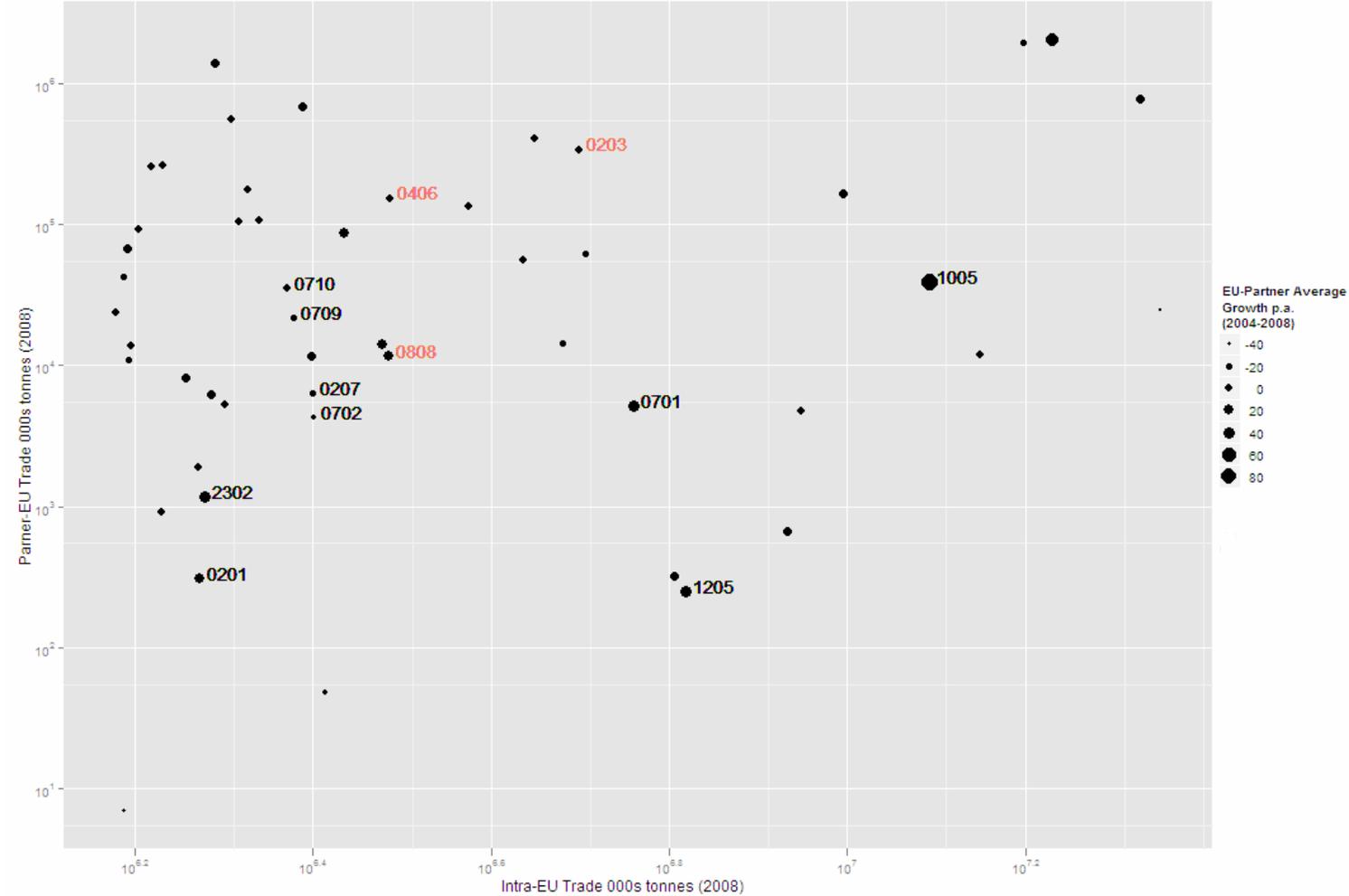
Source: Eurostat data on agri-food products, including processed food, HS4 level

Product specific requirements

The choice of the specific requirements for the agri-food products or product groups selected is based on communication with a number of product experts to suggest a number of key areas to focus on. Interviews with EU agri-food exporter to obtain first hand information about NTMs are not foreseen and thus the selection of product-specific requirements relies on other sources. The export opinion is combined with the consideration of the relevant NTM complaints analysis in Schlueter et al. (2009) and the existing questionnaire-based studies where EU firms are asked about the NTMs they face in their exporting activities. Dehousse et al (2002) identifies issues of labeling from the EU exporters' perspective in general. With regard to specific agri-food products, the MADB reveals that the large majority of EU complaints are about SPS measures to prevent diseases/pests and their importation (Schlueter et al., 2009). These are on the one hand requirements of the treatment of end-products and on the other hand requirements at the country level, often related to regionality issues.

The EU Commission's Local Market Access Teams (MATs) and the two SPS Working groups (respectively for plant and animal products), both of which were established under the EU's strategy to improve market access for European exporters, are excepted to provide further guidance. These groups are part of the EU Commission's delegation in a number of countries and have specific scopes covering the requirements for EU exporters to supply different partner countries. In the information available so far, there appears to be two main foci for the MATs: horizontal market access issues (including labeling) and SPS measures relating to conformity assessment procedures (European Commission, 2009). The importance of the latter is further highlighted by the existence of the aforementioned two Working Groups for SPS measures of animal and plant products.

The product specific elements will be focused on these areas with specific requirements for the selected products requested for data collection. The list presented in Table A2 is thus only indicative of the areas that should be further considered.

Table A2: Product Specific Requirements

Product   • Quality classes   • Food safety limits (combined with sampling)   • Biological hazards (pests, diseases)   • Contaminants, e.g. lead or cadmium levels   • Veterinary drugs   • Microbiological criteria   • Pesticide levels
Processes   • Irradiation   • Quarantine
Labeling   • Country of Origin labeling   • Possibilities of re-labeling
Conformity assessment   • Sampling & Testing   • Certification/veterinary certification