MEASURING COSTS AND BENEFITS OF NON-TARIFF MEASURES IN AGRI-FOOD[1]

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1 Introduction

Regulations in the food and agriculture sector are put in place and enforced by governments in order to address societal interests where unregulated markets are not yielding the desired outcome. Many of the regulations address human health issues; others address environmental and animal welfare problems associated with agricultural production. As long as the regulation concerns a non-tradeable good (or service) the optimal design of the regulatory measures need not take the interest of foreign parties into account. However, when the product is tradeable across national borders, border measures and behind-the border measures are usually taken to assure that the imported varieties meet domestic requirements. Research on non-tariff measures (NTMs) is thus at the interface between domestic regulations and international trade.

With increased international integration, trade is increasingly becoming a vector of external effects, and governments have responded with a wide array of NTMs to the need to safeguard domestic concerns. Imports can carry invasive species such as pathogens, pests, or weeds, foreign to an economy's ecology Different trade partners may have different food safety standards and institutional capacity to enforce these standards. This may lead to imports of food that do not meet domestic requirements. Imperfect and incomplete monitoring at the border where it occurs compounds the health or environmental risk. In countries with ill-defined property rights, trade may also encourage unsustainable production of some goods for the export market, leading to a deterioration concerning global-commons issues (Chichilnisky, 1994).

In some instances in which trade is the direct conduit of significant external effects, it may be an option to restrict trade, but some policies are more effective at addressing external effects than others. Many technical barriers to trade may restrict trade but improve welfare in the presence of negative externalities or informational asymmetries. Other measures can expand trade as they enhance demand for a good through better information about the good or by enhancing the good's characteristics.

These features of NTMs are not very well recognized in most of the existing literature, which tends to have a narrow mercantilist focus on foregone trade. Clearly, the different forms of NTMs carry different costs and benefits for different parts of society, and a systematic accounting of economic costs and benefits of NTMs should start by considering the different market failures that these measures attempt to address. OECD(2009) distinguishes three broad classes of market failures: 1) failures affecting consumers, such as imperfect information related to food safety, but also consumer concerns relating to production methods; 2) failures affecting producers, such as animal disease outbreaks; 3) global commons issues, usually related to the conservation of valuable eco-systems.

This paper proposes a framework that allows the assessment of economic effects of NTMs designed to address these different types of market failures, and to empirically measure the benefits and costs associated with NTMs. The challenge is to recognize regulatory autonomy to address domestic policy issues – mainly dealing with market failures- while avoiding obstacles to trade. By providing a basis

to quantitatively compare different approaches to address a given regulatory problem, this paper contributes to seeking least-cost and trade-friendly solutions.

The framework incorporates different types of consumers distinguished by their concern for negative and positive external effects and product attributes. Their concerns may depend on the information they have on those product attributes. If domestic and foreign products have different product characteristics, some NTMs, such as compulsory labelling, can reveal the missing information and lead to a differentiation of consumer demand between domestic and foreign varieties. Foreign supply may also be a source of negative externalities in production, such as the introduction of invasive species. The proposed framework captures those effects and the associated NTMs through their effects on cost of production of affected domestic producers. The proposed framework also addresses NTMs related to global commons issues.

The paper is structured as follows: Section 2 provides some statistics on the incidence of NTMs in agri-food. Section3 discusses the main types of market failures and it discusses the associated NTM policy instruments. Section 4 presents a modular framework to assess costs and benefits of NTMs. Section 5 discuss data sources and other issues related to operationalizing the proposed method. Section 6 concludes.

2 NTMs in agri-food: what do available data tell us?

This section provides a brief summary of the incidence of NTMs in agri-food in OECD countries. Statistics are provided across products and across countries, and on the stated motivations behind those measures. Furthermore, information on trade frictions related to NTMs is presented. The section concludes that there is no obvious correlation between the number of notified measures and the occurrence of trade frictions. Where a high level of NTM notifications coincides with a low degree of trade frictions those measure may be trade facilitating rather than impeding trade.

Measuring the incidence of NTMs on a country and commodity basis is not easily done because no comprehensive databases exist that register all the measures in place in an internationally comparable way. Table 1 provides some information, based on publicly available data, on the incidence of NTMs, their trade coverage and information on trade frictions related to NTMs that derive from sanitary and phytosanitary (SPS) measures. The data sources are described in more detail in section 5 below. The comparative statistics in Table 1 cover OECD countries for the period 1996-2006, and the sample covers 769 products that are subject to at least one NTM[2].

[2] Only eight of the total 777 products for which positive trade flows are observed do not face any NTM in any OECD country (HS 500200 - Raw silk; HS 500310 - Silk waste, not carded or combed; HS 500390 - Silk waste, other; HS 520300 - Cotton, carded or combed; HS 530121 - Flax, broken or scotched; HS 530129 – Flax hackled or otherwise processed, but not spun; HS 530130 - Flax tow and waste; HS 530290 - True hemp, other).

Column (1) reports the number of notified products by HS 2-digit chapter, while column (2) presents the distribution of NTMs. By comparing those two columns, it is clear that any given product is subject to several measures put in place by OECD countries. Not surprisingly there is a higher concentration of NTMs around fresh products (fish, meat, etc.), with fish and other aquatic products topping the list. However processed products are also well represented. The trade coverage ratio by HS2 chapter in column (3) shows that a high proportion of the value of imports is subject to NTMs. Fish and meat are again at the top of the ranking. The trade coverage ratio is also quite high for products of animal origin (HS05), meat, fish and seafood preparations (HS16) and live animals (HS01).

Columns (4) and (5) report the number of SPS trade concerns raised by and against OECD countries in the SPS committee of the WTO. This is an indicator of the degree to which (a subgroup of) NTMs leads to trade frictions that are significant enough for countries to bring them to the level of the WTO. Between 1996 and 2006 a total of 233 specific trade concerns dealing with agri-food products were raised. Out of these 233 cases, 150 were raised by OECD countries. In 139 cases raised, the measure was maintained by at least one OECD country.[3] Most of the SPS concerns are on meat (HS02), fruits (HS08), vegetables (HS08), dairy products (HS04), live animals (HS01), and products of animal origin (HS05).

Table 2 illustrates that concerns related to SPS measures are global concerns. Developed countries raise concerns about measure put in place by other developed countries, but 40% of their concerns relate to measures in developing countries. Developing countries are increasingly active in raising concerns at the WTO SPS committee, taking about one third of the concerns raised for their account, and 31% of their concerns relates to measures put in place by other developing countries. These statistics indicates that NTMs are not exclusively a North-North issue and they are not exclusively a South-North issue.

[3] The count of the number of cases from the original WTO SPS-STC data requires some explanation. In column (4), if a concern is raised by several OECD countries, we create a separate record for each country. Furthermore, many concerns involve different HS 2-digit chapters. A separate record is created for each of the chapters. Similarly, in column (5), a separate record is created for each OECD country against which a concern is raised, as well as for each HS2 chapter affected.

Table 1: Product chapters by NTM count, concern count and trade coverage, 1996-2006

HS2 Chapter	Number products notified by OECD countries	Number NTMs notified by OECD countries	Share OECD imports subject to NTMs (%)	Number SPS concerns raised by OECD countries	Number concerns raised against OECD countries
01- Live animals	17	286	72.2	27	14
02 – Meat, edible meat offal	53	1,340	84.1	57	42
03 – Fish, crustaceans, molluscs, other aquatic invert.	87	1,573	78.3	15	14
04 - Dairy products, eggs, honey, edible animal pduct.	27	624	71.6	26	24
05 - Products of animal origin	17	317	74.3	23	19
06 - Live trees, plants, bulbs, roots, cut flowers	12	278	69.7	13	16
07 - Edible vegetables, certain roots, tubers	56	1,207	66.2	28	18
08 - Edible fruit, nuts, peel of citrus fruit, melons	55	1,248	62.2	32	35
09 - Coffee, tea, mate, spices	32	630	33.5	8	14
10 – Cereals	16	379	65.5	14	14
11 - Milling products, malt, starches, inulin, wheat gluten	34	609	58.4	9	8
12 - Oil seed, oleagic fruits, grain, seed, fruit	44	804	55.3	8	7
13 - Lac, gums, resins, vegetable saps & extracts	12	118	36.4	8	7
14 - Vegetable plaiting materials, vegetable products	10	69	37.0	8	8
15 - Animal, vegetable fats & oils, cleavage products	46	616	46.2	12	9
16 - Meat, fish, seafood preparations	26	670	72.9	12	11
17 – Sugars, sugar confectionery	16	242	48.7	8	8
18 – Cocoa, cocoa preparations	11	178	44.7	8	7

19 - Cereal, flour, starch, milk preparations & products	17	367	67.9	8	7
20 - Vegetable, fruit, nut, food preparations	44	1,085	68.2	8	9
21 - Miscellaneous edible preparations	16	378	68.3	9	17
22 - Beverages, spirits, vinegar	22	502	67.8	9	7
23 - Residues, wastes of food industry, animal fodder	25	175	51.6	13	12
24 – Tobacco, manufactured tobacco substitutes	9	58	6.3	8	7
29 - Organic chemicals	2	8	35.3	8	7
33 - Essential oils, perfumes, cosmetics, toiletries prep.	14	52	16.0	10	9
35 - Albuminoids, modified starches, glues, enzymes	10	54	24.7	8	7
38 - Miscellaneous chemical products	1	3	3.2	8	7
41 - Raw hides, skins (other than furskins), leather	12	139	38.4	8	7
43 – Furskins, artificial fur, manufactures thereof	9	199	39.4	8	7
50 – Silk	1	5	0.3	8	7
51 - Wool, animal hair, horsehair yarn & fabric thereof	10	75	15.6	8	7
52 – Cotton	4	8	15.4	8	7
53 - Vegetable textile fibers, paper yarn, woven fabric	2	2	0.0	8	7
Total	*769*	*14,298*	*61.1*		

Source: Columns (1), (2) calculated from UNCATD TRAINS, Column (3)calculated from UNCTAD TRAINS and UN COMTRADE; Columns (4) and (5) calculated from WTO SPS-Specific Trade Concerns (STC) databases. See Section XX for more discussion of these data sources.

Note: 12 concerns are not reported in column (4). 6 deal with genetically modified organisms (GMOs) and for the 6 other concerns, the WTO SPS-STC database does not provide information on the products. Similarly, 8 concerns are not reported in column (5) (4 deal with GMOs and for the 4 others, information is not provided). In columns (4) and (5), total calculation does not make much sense since some concerns are not reported and since we create separate records to account for all HS2 sectors and OECD countries involved in trade concerns.

Table 2: Countries raising a SPS concern and countries maintaining the measure, 1995-2007

	Countries maintaining the measure		
	Developed Countries	Developing Countries including CIS	Grand Total
Countries raising the issue:			
Developed Countries	60%	40%	66%
Developing Countries including CIS	69%	31%	33%
Least-developed countries	100%	0%	1%
Grand Total	63%	37%	100%

Source: WTO-SPS STC, author's calculations

Based on the three sets of data used in table 1, Disdier and van Tongeren (2009) compute 6 robust clusters of products, calculated at the HS 6-digit commodity level, in order to investigate the correlation between NTMs and the occurrence of trade frictions. Table 3 summarizes the results from this analysis. If a high number of NTMs coincides with a high number of trade concerns, it suggests that the NTMs on products included in this cluster have a protectionist effect (typically products of clusters 1 and 2). On the other hand, if a high number of notifications is registered but at the same time a low number of concerns occurs, this would suggest that NTMs are put in place with a shared understanding of sanitary or environmental concerns: exporters do not consider that these NTMs are protectionist (although the share of notified exports could be high) and do not raise a concern at the SPS Committee (typically products of cluster 3).

The most dynamic trade growth, and the highest import penetration rates are observed in processed products (HS24 and higher), but they are mostly found in cluster 6 which registers relatively low levels of NTM notifications and low levels of concerns. Much of the trade in processed products occurs in multinationally operating supply chains, and this suggests that there would be less domestic producer pressure stemming from those chains to erect trade barriers.

Table 3: Clusters of products

	Number of cluster members	Trade coverage	NTM notifications	SPS concerns	Typical product
Cluster 1	25	High	High	High/ Very high	Cheese
Cluster 2	131	High	High	Medium/ High	Poultry
Cluster 3	195	High	High	Low	Vegetables
Cluster 4	216	High	Low	Low	Cut flowers
Cluster 5	116	Low	Low	Low	Vegetable oil
Cluster 6	94	Very low	Very low	Low	Oil cakes & other vegetable material

This section illustrates that NTMs are an important reality of international trade, even when bearing in mind that the TRAINS data source used has many limitations. Its coverage of measures is incomplete and its country coverage may be biased. There is no obvious way to correct for the representation biases, as the true occurrence of NTMs across countries and products is unknown.

The available statistics show that NTMs are important in all trade in agriculture and food products. All countries apply them, often putting several measures on a given product. Trade frictions, as they emerge in the WTO SPS committee, arise between exporters and importers from all corners of the world, but there is not a one-to-one relationship between the occurrence of NTMs and trade frictions. In some cases these measures may form a market access barrier, especially if applied in non-transparent ways which leads to high transaction costs for the exporter. In other cases, the measures may actually facilitate trade.

2.1 Research on trade effects of NTMs

Trade effects of NTMs have been extensively analyzed with the gravity-equation approach. Many gravity analyses tend to be broad in scope (multi commodity/sector, countries, and policies), which allows for a broad-brush investigation of general hypotheses such as the trade-restricting or expanding effects of NTMs or the impact of harmonization. The gravity equation has also been used to look at specific policy issues such as the EU aflatoxin policy (Otsuki *et al*., 2001). Most studies find some evidence of trade-impeding effects associated with technical measures using various indicators (levels, counts, AVE, price wedges). Beyond the well-established trade impeding effects of many SPS and TBT measures, trade expanding effects also have been identified, often through harmonization and shared standards, in customs unions, and for some goods and policies (Disdier *et al*., 2008; Fontagné *et al*., 2005; Henry de Frahan and Vancauteren, 2006; and Moenius, 1999, 2006). A few studies found an absence of trade effects from technical measures in some sectors (*e.g.* Fontagné *et al*., 2005) and for harmonized measures (Czubala *et al*., 2007). Effects of NTMs have also been studied with partial and general equilibrium simulation models, usually by parameterizing them as tariff-equivalent in the import demand (or export supply) functions. See OECD (2008b) for a review of quantitative approaches.

The prevailing economic approaches to analyze NTMs often provide a one-dimensional effect of trade losses without a clear delineation of the link between forgone trade and welfare. However, many NTMs may restrict trade but improve welfare in the presence of the negative externalities or informational asymmetries. Other NTMs can expand trade as they enhance demand for a good through better information about the good or by enhancing the good's characteristics. (Maertens *et al.* (2007); Maertens and Swinnen (2009)). In the presence of disease risks, well designed NTMs may allow for some limited amount of trade, while in the absence of measures, such as strict border inspections or restricting imports to products from a specific country or region within a country, no trade might take place at all. Several papers have looked at import bans with animal disease outbreaks (Wilson and Anton, 2006; Lee and Paarlbergh, 1998; Pendell *et al*., 2007 among others).

There is an implicit presumption in much of the existing literature that harmonization of NTMs is welfare improving. When harmonized, these regulations can reduce unit cost of production via

economies of scale and can guarantee free movement of goods on a unified market, such as has happened in the EU. But consumer choice might also be reduced if the goods being harmonized are initially differentiated and if tastes differ across countries (Moenius, 2006). The case for harmonization is not settled yet with no consensus on policy prescriptions emerging from the analytical literature (Barrett and Yang, 2001; Casella, 1996 and Gandal and Shy, 2001). Much tension exists between theory and applied work in the literature on harmonization of NTMs. Many of the empirical assessments have been mercantilist focusing on forgone trade (e.g., Otsuki *et al*., 2001) rather than considering their potential welfare-enhancing effects.

3 Market failures and policy instruments

Trade effects of NTMs provide but a partial view on NTMs. From an economic perspective the welfare effects of regulations are more interesting, but also more difficult to ascertain. Regulations are designed to correct for market failures and market imperfections. This section discusses market failures and the associated NTM policy instruments to address them.

3.1 A taxonomy of market failures and imperfections addressed by NTMs

Imperfect and failing markets lead to outcomes that are not efficient, and this is an important rationale for government intervention. A large proportion of NTMs attempt to remedy external effects. Externalities occur when some agent's utility or production depends on the choices made by other agents, who do not factor these external effects into their decision making. As a consequence, there are costs, or benefits, associated with the externality that fall on some agent but are not reflected in market valuations. It is useful to characterize an externality by its point of impact in order to organize the discussion. When the external cost or benefit arises in consumption it will be referred to as a consumption externality, while those where the impact arises in production will be called production externalities. As an example, consider harmful chemical residues that arise in production, but their possible health impact occurs on the consumption side; this type of externality will therefore be referred to as a consumption externality.

Other market imperfections addressed through NTMs relate to the consequences of asymmetric information (one partner in a transaction knows more than the other) or imperfect information (not all consequences can be known). The informational problems can also conveniently be located as occurring at the consumer or producer side. They can also play a role in the context of monitoring of rules and regulation by governments.

The taxonomy starts with failures affecting the utility of consumers; then the reports looks at their counterparts in production, i.e., failures linked to production. This is followed by a discussion of global commons issues, and finally by a treatment of some issues related to imperfect monitoring.

3.1.1 Market failures affecting consumers

Externalities affecting consumers: This case involves the creation of a negative externality on agents not associated with production or consumption of the good. Consumers are affected by the external effect which is independent from their own consumption basket. If a good releases pollution during either its production or its consumption it may affect other persons who are not at all involved in producing or consuming that good. Consumer concerns about animal welfare is another example;

here some consumers (or rather 'citizens') are concerned about the production methods, their welfare is affected regardless their own decisions to consume or not to consume meat produced from animals produced under certain conditions.[4] Consumers could be disaggregated into consumers in the importing country and those in the exporting country as they may be affected differently.

Asymmetric information and health, safety, or nutritional value: This type of imperfection is associated with the purchase or the consumption of the good by a final consumer. The consumer derives a benefit from consuming the good but also bears a cost or benefit not exactly known to him via a health impact. Hence the perceived and true social costs of the good differ. If the producer is well-informed about the characteristics of the good, a situation of asymmetric information prevails. Some attributes, either experience or credence attributes, are unknown or uncertain to the consumer at the time of purchase and may decrease (as in the case of unhealthy ingredients) or increase (as in the case of nutritional benefits) the value of the good. There are also attributes that are unsafe to consume and could harm consumers. Recent examples of cases where asymmetric information can be associated with an undervaluation of health risks are outbreaks of E-coli and salmonella unknown to some consumers, in either the importing or the exporting country

3.1.2 Market failures affecting producers

Externalities impacting producers: external effects arise when the production process of a good is altered by external forces other than prices. Water pollution may impact fishery production for example. The pollution is generated either by consumption, production, or trade elsewhere or by the environment itself as in the case of soybean rust brought to the US by hurricanes. The resulting impact is a decrease in production or an increase in the cost of production either by loss of efficiency (farm yields fall) or by trying to abate the external effects (fungicide applications to eliminate some fungus). These occurrences may be non-rival (a whole region is hit by a FMD outbreak) or private (a single producer hit by pollution). Occasionally, externalities can be positive, such as new imported technological knowledge which is non-rival in the sense that it is available to most domestic producers.

Asymmetric information in production: producers, like consumers, may also suffer from asymmetric information and purchase inputs with unsafe attributes (*e.g.* seed-borne disease transmitted to a farmer may induce losses).

3.1.3 Global-commons issues

Global commons or common-pool resources refer to resources perceived as belonging to the (global) community and requiring collective stewardship. They are open access or common pool resources, for which property rights are not well defined or not defined at all. Examples of such global commons problems include unsustainable resource use in forest products, depletion of fish stocks through over-fishing, and agricultural production with negative ecological impacts. Consumers do not need to consume a

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4. This case corresponds to damages from the externality which are "separable" from the market consumption. The externality affects the representative consumer's welfare but not directly her market consumption decision. By convention economics treats citizens as consumers whenever citizens are not producers.

specific good themselves to suffer the externality. However, consumers may benefit from consuming products certified as respecting the commons. Eco-labels and fair trade are well known examples of measures providing perceived benefits to consumers with global-commons concerns.

Although the analytical treatment of global commons cases will often be closely related to the treatment of externalities affecting consumers, it is worth distinguishing the former as an increasing number of trade frictions between OECD and developing economies are based on global commons issues and as interest in sustainable practices expands. Trade is often central: a good is imported from a source characterized by global commons issues or unsustainable practices. A NTM in the importing country may attempt to alleviate the global commons problem in the sourcing country.

3.1.4 Imperfect monitoring and other government failures

In practice, the implementation of existing regulatory policies can only be imperfectly monitored and incompletely enforced. In this sense governments are failing by not doing enough, and consequently this is sometimes called failure by omission. The limited institutional capacity to monitor and enforce regulations sometimes calls for additional interventions, or may necessitate policies that would not be welfare-optimal if monitoring were perfect. Mitigating the institutional deficiencies can have strong trade implications and bring costly policies. A failure to detect and contain FMD or BSE early can induce a collapse of trade if partners are closing borders as an emergency measure. If institutional capacity for border inspection is limited, a country might chose to designate just one port of entry for imports of certain food products, and this measure can lead to an additional trade cost. Other policy responses may be more cooperative when they can be planned, especially in the North-South context. For example, coordination of policies such as certification of South exporters by importing countries in the North providing the additional capacity missing in the exporting country (*e.g.* the EU assisting Latin American meat packers to meet EU food safety and phytosanitary standards).

In many countries, full traceability and monitoring may elude the authorities. Even the highly developed regulatory frameworks in OECD countries cannot completely prevent salmonella and E-coli outbreaks. Theoretically, optimum monitoring should equate expected cost and benefits of monitoring activities, and this often means that complete monitoring and total prevention would be excessively costly. The ability to effectively regulate the agri-food sector is generally more limited in low income countries that lack institutional experience as well as financial resources. If there is limited capacity to inspect and monitor the resulting "failure of omission" (the government is not doing enough) will exacerbate the issue of food safety and global-commons externalities, as consumers do not have information on process and product characteristics of the imported food they buy. In this context, private standards have emerged to pick up some of the tasks. (Fulponi 2006, Garcia Martinez *et al*., 2007).

3.2 Associated policy instruments

The market imperfections discussed above can be addressed through a wide range of policies, but this report concentrates on those policies that have a potential impact on international trade flows,

singling out non-tariff measures. In a recent initiative the Multi-Agency Support Team (MAST)[5] that provides the technical work on behalf of a group of eminent persons that has been charged by the directors general of UNCTAD and the WTO with advancing work on non-tariff barriers has developed the following definition of NTMs:

> *Non-tariff measures (NTMs) are policy measures, other than ordinary customs tariffs, that can potentially have an economic effect on international trade in goods, changing quantities traded, or prices or both. (MAST, 2008)*

This definition is broad and to a large extent uninformative as was the older nontariff barrier category (NTBs), as both NTMs and NTBs are defined residually by policies that are not tariffs.

This broad definition of NTMs does not imply a prior judgment as to their actual economic effect, appropriateness in achieving various policy goals, or their legal status under the WTO legal framework or other trade agreements. For the purposes of OECD work on NTMs, this has further been narrowed down by excluding measures that directly impact on prices and quantities (quotas, tariff rate quotas (TRQs), State Trading Enterprises (STEs), import licensing and anti-dumping measures), and to concentrate on the less researched group of measures that indirectly affect price and/or quantity through addressing other attributes of the goods being sold, typically through regulatory measures. The next section illustrates what kind of policy measures fall into this category.

3.2.1 The enlarged MAST classification of NTMs

The MAST group has developed a new classification system of NTMs, which considerably extends the original TRAINS classification used by UNCTAD to inventorize trade measures. A particular feature of this new classification is the separate inclusion of categories for SPS and TBT measures as well as provisions to include procedural obstacles (related to the implementation of measures, not the measures themselves). The classification has been tested by UNCTAD and ITC through pilot studies in seven countries, and the classification is likely to be revised in light of the experience gained in the pilot studies[6]. The classification system is primarily designed to accommodate the exhaustive cataloguing of existing policies; it is therefore as much as possible free of prior assumptions about potential effects of measures and it is in that sense not an analytical scheme. The main groups of the new MAST classification are the:

A. Sanitary and phytosanitary measures

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5 Institutional members of MAST as of July 2008 are: Food and Agriculture Organization of the United Nations (FAO), International Monetary Fund (IMF), International Trade Centre UNCTAD/WTO (ITC), Organization for Economic Cooperation and Development (OECD/TAD), United Nations Conference on Trade and Development (UNCTAD), United Nations Industrial Development Organization (UNIDO), World Bank (WB), World Trade Organization (WTO). Observers: European Commission (EC). United States International Trade Commission (USITC), United States Department of Agriculture (USDA). The MAST is jointly coordinated by UNCTAD and World Bank. MAST reports to the Group of Eminent Persons, which is convened by the director general of UNCTAD. MAST submitted a final report in November 2009.

6. They case study countries are Brazil, Chile, India, Philippines, Thailand, Tunisia and Uganda.

B. Technical barriers to trade

C. Other technical measures

D. Price control measures

E. Quantity control measures

F. Para-tariff measures

G. Finance measures

H. Anti-competitive measures

I. Export related measures

J. Trade related investment measures

K. Distribution restrictions

L. Restriction on post-sales services

M. Subsidies

N. Government procurement restrictions

O. Intellectual property

P. Rules of origin

The main headings of the classification of procedural obstacles are:

- Arbitrariness or inconsistency
- Discriminatory behaviour favouring specific producers or suppliers
- Inefficiency or obstruction
- Non-transparency
- Legal issues
- Unusually high fees or charges (e.g. for stamp, testing or other services rendered)

The subset of measures under categories (A) through(C) is most relevant for the current paper. They have a relatively clear relationship with the market imperfections discussed previously. These broad categories also form the core of interventions which are on the rise worldwide (Beghin, 2006) and have common allocative effects. They increase cost of production via higher marginal cost or larger fixed cost, and they tend to affect industry structure. These types of instruments can also enhance consumer demand for goods by increasing quality attributes or by reducing informational asymmetries about the targeted good. Some of these policies jointly affect both producers and consumers. Many of the policies covered by categories (A) through (C) involve considerations of institutional capacity. Sometime they address capacity failures of trade partners (failure of omission by the exporting country); sometimes they imply an extensive domestic institutional capacity to

implement policies. Although different types of requirements affect different inputs and stages of production, most of these policies increase cost of production either at the margin or via fixed cost.

The effects of price control measures under (D) are relatively well understood, and instruments types included in (E) have been extensively discussed with the analysis of quotas, tariff rate quotas and their administration (see for example OECD, 2002a, 2002b; Boughner, de Gorter, and Sheldon, 2000). Para-tariff measures included in (F) can be analyzed as conventional tax instruments and their incidence is straightforward to derive. The latter types of instruments could easily be added to the framework proposed below. The remaining categories (G) through (P) are also important but cannot easily be integrated in the proposed modelling framework. Procedural obstacles can, however, be translated into trade-cost which could be expressed as tariff equivalents in most cases, and could in principle be incorporated in to the framework proposed below.

3.2.2 SPS measures

Some SPS measures included in category (A) address asymmetric information between producers and consumers of products with credence attributes to ensure that buyers know what they buy and that it is safe either for human health or the environment. The standards and requirements target process and product attributes. SPS measures also address potential externalities in production via invasive species or infectious diseases. Most of the SPS policies under category (A) imply a shift in the marginal cost of production because additional costs are incurred to meet the requirements. In addition, some SPS measures may also increase and enhance demand by providing information to consumers.

Some SPS policies are directly linked to trade as the vector of the externalities. For example some interventions target foreign suppliers on a geographical basis. The category of geographical restrictions is basically an import ban based on origin. Regulatory heterogeneity, i.e. the case where the exporter's standards are not in line with the importer's requirements, leads to a number of SPS measures. Certification requirements address the institutional setting either domestically or abroad to ensure standards are met. A series of subcategories addresses the lack of reciprocity in certification and regulation when some standards, including international ones, are not.

3.2.3 TBT measures

These are regulations and standards targeting technical characteristics of products. As in the case of SPS, there are voluntary standards for both process and product attributes. Both process standards and product standards shift cost curves by increasing cost of production, and they can impact positively on demand through reduction of asymmetric information between suppliers and consumers. Safer products are presumably more attractive to some or all consumers. Unlike SPS measures, TBT measures do not include explicit bans on imports from specific countries or regions.

Technical regulations cover compulsory standards and requirements. Again these concern product standards as well as process standards, presumably shifting supply leftward and demand to the right. These regulations address asymmetric information and opportunistic behaviour of suppliers regarding credence attributes. Traceability and origin of material are included in this category, as are limits on residues and restrictions on some substances. GMO regulations are another subcategory,

and so are identity preservation and environment-specific requirements, addressing either production-based externality and/or commons issues.

A further subcategory covers conformity assessment, certification, and testing of products and the cases in which lack of recognition of certification procedures may hinder exchange. The latter is more in the realm of institutional or policy failures as discussed above.

3.2.4 Other technical measures

The third category of NTMs covers policies and requirements which somehow did not fit in the two previous ones but look quite similar to them for analytical purposes with some qualifiers. A special sub-category covers pre-shipment inspections to check conformity of the products, potentially addressing the above mentioned failure of omission.

3.2.5 Procedural obstacles

The inclusion of procedural obstacles is a novelty in this new classification. These obstacles can potentially apply to all of the explicitly mentioned measures, and their importance derives from the recognition that a trade barrier may arise from the way a given regulation is implemented. Lack of transparency, for example, leads to information costs. By increasing the transparency of its regulations, a government may considerably reduce the prior information hurdle that foreign exporters face and hence increase the access to its markets. Conversely, by reducing regulatory transparency a government increases the cost of gathering information about its regulations which may hinder entrance to its market by foreign firms. As such, lack of transparency can reduce competition from the outside and protect domestic producers – provided that the regulations are more transparent, and hence less costly to obtain for domestic producers.

3.3 Compliance cost and market entry

Compliance with NTMs has a bearing on producer costs, both variable (through additional activities) and fixed (through additional investments), and this can have important consequences for the industry structure. If compliance with standards and regulations implies large investments that are sunk once undertaken, economies of scale become an important characteristic of the industry. Sunk costs related to NTMs may become an entry barrier and a decisive determinant of industry structure. Not all firms will meet the new standards and the structure of an industry can profoundly change because of the new production requirements to satisfy in the export market. This is leading to concerns regarding market participation in low-income countries in particular. Often this unequal ability to meet standards causes dualism in the industry affected by the new regulatory environment. A modern and successful segment emerges, whereas smaller producers are marginalized and serve an informal domestic market, exit the market or become employees in larger firms (Rau and van Tongeren 2007; Maertens and Swinnen 2006, and others). Sunk entry costs can also relate to acquiring information about the relevant regulations in the export market, leading to the recognition of the importance of transparency in regulations.

The precise effect of the NTM on fixed and variable cost is important: changes in variable costs translate into changes in prices, and if all firms have to incur the same variable cost change in order

to meet the NTM there is no obvious competitiveness effect. However, sunk investments do not figure in firms' optimal pricing decisions and have more indirect effects on market prices through entry and exit of firms. Only firms that are sufficiently productive to "jump the hurdle" of fixed market entry costs will be able to export (Melitz, 2003).

Measuring cost of compliance is far from straightforward. Various methods have been used: firm-level surveys (*e.g.* Wilson and Otsuki 2004b), price comparisons (Yue *et al.*, 2006; Ferrantino 2006), cost accounting (*e.g.* Grothe *et al.*, 2000), econometric estimations (Antle, 2000; Maskus *et al.*, 2005).

The principal problem that needs to be addressed when measuring cost of compliance is the question of the correct baseline, or point of reference. In some cases producers would have made the production changes required to meet importer requirements even without standards being in place, or producers make further changes not directly necessary to achieve compliance. In these instances it is questionable whether the direct costs of such changes can be considered as compliance costs. Additional difficulties arise if exporters serve different markets with different requirements, perhaps leading to differing compliance costs across markets, and higher total compliance costs Harmonization can potentially reduce those costs.

4 Cost-benefit framework: a modular approach

This section presents a framework that allows the assessment of economic effects of NTMs designed to address different types of market failures mentioned above. A central notion in this framework is to distinguish those consumers (or producers) that are affected by the market failure from those who are not, and to derive a method to empirically measure the benefits and costs associated with NTMs for these different groups. On the consumer side, this approach rests on insights from modern empirical consumer economics and on the producer side it incorporates insights from epidemiological studies.

The framework is modular, essentially a partial equilibrium model. New elements with detailed side calculations can be attached or removed from the main structure without the necessity to alter the general logic of the approach.

The theoretical framework is designed to be applied with empirical data to facilitate a quantitative cost-benefit analysis. The objective of this section is to outline a common approach and its intuition. Not each and every potential effect is discussed here, as the framework may be easily extended in many directions to analyze particular trade problems. One element not elaborated here, but which can be important in practice, concerns costs related to administration, monitoring and enforcement.

The proposed framework is geared towards welfare analysis that can be calibrated and quantified based on information on real policy situations. The framework allows for a comparative analysis of welfare effects of different alternative ways, different NTMs, to address the same type of market imperfections. This is illustrated here by looking at only three polar cases: free trade; a prohibitive standard or an import ban; and free trade with labelling.

The framework comprises "modules" for calculation of cost and benefits affecting (a) domestic consumers, (b) domestic producers, (c) domestic government, and (d) foreign producers. For

simplicity, foreign consumers and governments are not included here. In addition, the different actors in the supply chain (farmers, processors, retailers etc.) are collapsed into a single production stage representing supply. These abstractions influence results in many cases but are maintained here to preserve clarity in exposition. The framework distinguishes the external costs and benefits to various agents induced by failures and then cost and benefits to the same agents induced by policies imposed to remedy the failures.

A key feature of the framework is to distinguish those agents who are concerned by a given market imperfection from those that are not. On the consumer side, this involves distinguishing those consumers who have a preference for certain characteristics of the good in question (or a preference for avoiding certain undesirable characteristics) from those who are not concerned. This distinction may be difficult to make in practice, but will be vital in achieving an accurate outcome. Recent advances in consumer economics, and in particular experimental economics, offer ways to partition consumers into various groups by observing their choice behaviour. Similarly, on the producer side, a distinction is made between those who are affected by a producer based externality from those who are not. The exposition introduces a minimum of technical detail. The full derivations and calculations of welfare effects can be found in OECD (2009).

An important simplification is made in order to keep the exposition as straightforward as possible. In the discussion below it is assumed initially that the only source of the market failure is foreign and that the domestic economy is free of all production and consumption failures. Implicit in this approach is the assumption that domestic producers and consumers have fully adjusted their behaviour to internalize all externalities that might previously have existed, perhaps in response to domestic regulation. This simplification is merely introduced in order to keep the exposition tractable. It is relaxed later to analyze the more common case where both domestic and foreign producers are subject to production requirements (mandatory or voluntary standards), but domestic and foreign suppliers have to make different efforts to meet the different requirements on different markets. It is of course conceivable that the externality could originate domestically and be exported by the domestic country. Positive externalities are also possible, such as technology transfers. These cases are not considered here but could be accommodated in the framework. The following table summarizes the cases distinguished and highlights the main results.

Table 4: Cases of NTM Analysis

Market failure	Policy and regulatory regime	Key feature and major likely outcomes
Consumption-based externalities	1) Prohibitive standard or import ban	No competition from foreign producers Autarky but high quality. Unconcerned consumers buy "too much quality". Price paid is high with no imports.
	2) Free trade (no label)	Foreign producers enter; larger supply, product is undifferentiated. Consumers benefit from unique lower price; domestic producers lose from competition and lack of label. Concerned consumers lose from imperfect information, lower average quality.
	3) Free trade and mandatory label	Goods and demands are differentiated; 2 equilibrium prices. Each consumer type can consume preferred product. Consumers benefit from competition in supply. Domestic producers have higher profit with higher price thanks to label. Issues: who pays for labelling/certification, sunk or marginal cost of label, protectionist level of the label? Possible free-riding for separable externalities.
Production-based externalities	4) Prohibitive standard or import ban	The prohibitive standard or import ban precludes imports of foreign units that can contaminate domestic supply. No externality in production. Demand is independent of the externality.
	5) Free trade (no label)	Foreign supply (imports) contaminates domestic production. Pivot of the domestic supply curve from higher cost of production induced by externality. Total supply meets demand at lower price. Consumers gain as the price is lower than under autarky. Domestic producers lose from lower price and higher cost.
	6) Free trade & mandatory label	Not analyzed here. A non-prohibitive standard could eliminate the externality, would increase the unit cost of foreign suppliers. Consumers would benefit from the competition in supply. Producers would lose from competition but not from higher cost. The price would be lower than under autarky

Global commons, separable, non-rival externalities	7) Prohibitive standard	Conceptually similar to case one when consumers do not have the information on the negative attributes. No feedback effect on demand because externality is separable from consumption. The prohibitive standard eliminates the domestic part of the externality but not the part generated outside of the country. Welfare improves as the externality is smaller. Price paid is relatively high.
	8) Free trade (no label)	Concerned consumers are not informed about the link between consumption and externality. Externality expands. No feedback from the externality on demand. Free trade lowers the price paid but expands the externality. Domestic producers lose; domestic consumers gain from lower prices but some consumers lose from expanded externality.
	9) Free trade & mandatory label	Not analyzed in this report. No feedback on demand but separable externality decreases as unit purchases have to meet the standard linked to the label. If label is costly at the margin, supply pivots leftward and equilibrium price is higher. Potential free-rider problem.
Additional cases		
Non-rival global commons	10) (not analyzed in this report)	Conceptually similar to consumer-based externalities (case 1) but even with proper policy and fully informed concerned consumers, externality remains as some goods purchased by unconcerned consumers or in other countries will contribute to the global externality. Potential free-rider problem.
Non-prohibitive standard and costly effort	11)	Firms exert effort to abate the negative externality with some sunk and marginal cost of effort. Higher marginal cost is passed on to consumers. A relatively large sunk cost influences the number of domestic and foreign firms (via entry and exit).

4.1.1 Market failures affecting consumers

The market good being analyzed is assumed to be homogenous (i.e., same quality attributes) except for a specific characteristic that differs according to the country of origin. We assume that foreign producers offer a good with a specific characteristic (an environmental or safety risk or a specific process of production) that some domestic consumers do not want or do not favour, while the other domestic consumers are indifferent. This assumption matches the prevailing practice in which a regulation is supposed to protect some concerned domestic consumers regarding a characteristic conveyed by foreign products. This is clearly a simplification, as it is likely the case that both domestic and foreign producers are subject to mandatory standards in their home economies. However, this analytical simplification allows a sharper focus on the implications of differing requirements between countries, reflecting differences in what is considered appropriate product characteristics. Given these differing requirements, different levels of effort are required by domestic and foreign firms to comply with production requirements in different markets.

It is assumed initially that foreign producers are not able to correct this characteristic or to reduce the externality linked to the good they offer. Except for the one special characteristic, all consumers have the same preferences regarding the direct utility linked to the product. The characterization of preferences largely follows Polinsky and Rogerson (1983). Demands are derived from quadratic preferences, and supply is derived from a quadratic cost function. Turning first to consumer preferences, demand of each consumer *i={1,…,N}* is derived from a quasi- linear utility function that consists of the quadratic preference for the market good of interest and an additive numeraire:

$$U_i(q_i, w_i) = aq_i - \bar{b}q_i^2/2 - Ir_i\, q_i + w_i \qquad (1)$$

where the term $aq_i - \bar{b}q_i^2/2$ is the immediate satisfaction of consumer *i* from consuming a quantity q_i of the good and w_i is the numeraire good consumed by *i*. For simplicity $a, \bar{b}$ are the same for the *N* consumers.

The effects of externalities and information are captured by the term $-Ir_i\, q_i$. The parameter *I* represents the knowledge and/or externality context regarding the specific characteristic brought by the foreign product. If consumers are not aware of the specific characteristic or if there is an unaccounted externality linked to the specific characteristic, then *I*=0.Conversely, *I*=1 means that consumers are aware of the specific characteristic and can unambiguously identify the foreign product or they internalize the externality and reduce their consumption. The perceived damage associated with the consumption of the good with the specific characteristic is denoted $-r_i\, q_i$.

The maximization of the utility function under a budget constraint yields a demand function for each consumer. Aggregate demand for the good is obtained by summing individual demand functions over all *N* consumers. However, total demand can be partitioned into two groups: those who are indifferent and those who are concerned about a specific characteristic of the good (see appendix 2 for details). Let the proportion $\beta=N_1/N$ of consumers be completely indifferent to the specific characteristic, with $r_i = 0$ for every $i=1,..,N_1$. In other words, they attach no damage value to consuming the good. The remaining proportion $(1-\beta)= 1-N_1/N$ of

concerned consumers is reluctant to consume the specific characteristic and associates a damage per unit consumed equal to $r_i = r_2$ for every $i = N_1+1,..,N$ [7]. With $b = \bar{b}/N$, the (inverse) demand functions for the two subgroups become:

$$\begin{cases} p_1^D(Q) = a - (b/\beta)Q & \text{indifferent consumers} \\ p_2^D(Q,I) = a - Ir_2 - [b/(1-\beta)]Q & \text{concerned consumers} \end{cases} \quad (2)$$

Note that this specification is a mixed version of horizontal product differentiation (at the same price consumers are indifferent between a product with the characteristic and a product without the characteristic) and vertical product differentiation (at the same price concerned consumers unanimously choose the product without the negative characteristic). For food safety, if consumers unanimously prefer safe food, the specification can be captured with a full vertical product differentiation model where the proportion of indifferent consumers is β=0. [8]

On the supply side, a perfectly competitive industry with price taking firms is assumed for both domestic and foreign supplies. There are M_O domestic firms and M_F foreign firms. Firms' cost functions are quadratic in output, and they are choosing output to maximize profits:

$$\pi_{sj} = pq_{sj} - \tfrac{1}{2}c_s q_{sj}^2 - K_s \text{ for } j=\{1,...,M_s\};\ s=\{O,F\} \quad (3)$$

where c_s is the variable cost parameter and K_s is the sunk cost linked amongst others to the firm's market entry and compliance with regulations. The profit maximization yields individual firm supply functions which can be added up to yield industry supply Q [9]:

$$\begin{aligned} p_O^S(Q_O) &= c_O Q_O / M_O && \text{inverse domestic supply} \\ p_F^S(Q_F) &= c_F Q_F / M_F && \text{inverse foreign supply} \end{aligned} \quad (4)$$

The total inverse supply defined by the sum of foreign and domestic supply is

$$p_{O+F}^S(Q_O) = \frac{c_O c_F Q_O}{c_O M_F + c_F M_O} \quad \text{inverse overall supply} \quad (5)$$

For the rest of the analysis it is assumed that $c_O > c_F$, which means that domestic producers incur higher marginal cost than foreign producers. This reflects a situation where domestic production incurs a costly effort to eliminate the specific characteristic (an

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7. The case where consumers attach a positive value to the characteristic is completely symmetric. It is captured by taking a negative value for r_2.

8 The demand functions given by (2) are linear, which is obviously a simplification. An alternative specification could be to consider non-linear demand with $p_2 = \left[\frac{Q}{\beta(1+Ir_2)^{\phi}}\right]^{\frac{1}{\varepsilon}}$, where ϕ is the information elasticity and ε is the price elasticity of demand. The welfare estimations under both specifications are close when the price elasticity of demand is relatively low, which is often the case for food.

9. Individual supply functions are only defined for prices exceeding average costs, because otherwise firms would obviously cease production.

environmental/safety risk or a specific process of production) that some domestic consumers do not want, while foreign producers do not have to bear these addition al costs. Alternative assumptions are easy to accommodate in the framework. To simplify further it is assumed initially that sunk costs K_O and K_F are equal to zero; this means that firm exit and entry can be ignored. This assumption will be relaxed subsequently.

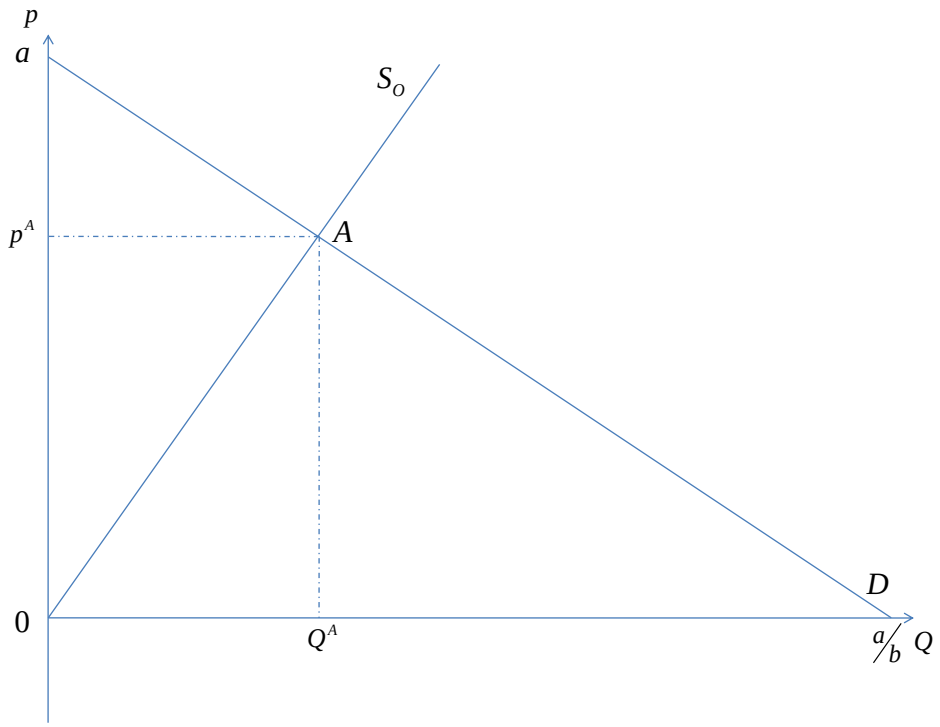
Three regulatory configurations are compared in the sequence: (*i*) a prohibitive standard impeding foreign products with the given characteristic (equivalent to an import ban), (*ii*) a free trade situation and (*iii*) a free trade situation with a mandatory labelling regarding the negative characteristic offered by foreign firms. The case with a positive label on the domestic product to signal the absence of the undesired characteristic is not detailed here, but the results would be technically similar to the situation (*iii*) where only the foreign product is labelled.

4.1.2 Prohibitive standard

The autarky situation brought about by a prohibitive standard is the easiest case to analyze. In this case, the overall domestic demand collapses to just one function, since the foreign product is simply not available. Figure 1 shows domestic demand (D) and domestic supply (S_O). The price is located on the vertical axis and the quantity is shown along the horizontal axis. With zero imports, there is a single equilibrium price p^A clearing the market by equalizing demand and supply with an equilibrium quantity Q_A (such that $p^D(Q^A, 0) = p_O^S(Q^A)$).

The profits of all domestic producers correspond to area OAp^A in Figure 1, and the surplus of domestic consumers corresponds to area Ap^Aa. Total domestic welfare is the sum of consumer and producer surplus and given by area OAa. Full analytical expressions for equilibrium values of prices and quantities as well as for all the components of welfare are provided in Appendix 2.

Figure 1. Consumption externality, prohibitive standard

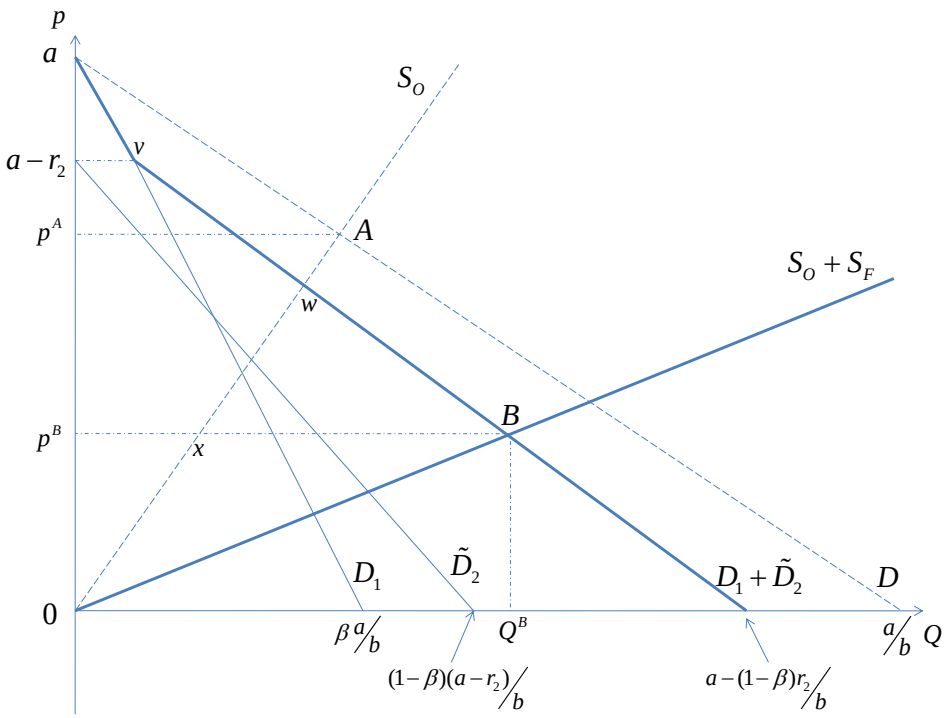


4.1.3 Free Trade

The case opposite to prohibited imports is free trade. This situation is represented in Figure 2, where the previous situation under autarky is now represented with dashed lines. Opening borders to foreign products (with a supply denoted S_F,) changes the market allocation. The overall supply is represented by S_O+ S_F in Figure 2.

On the demand side, recall that a proportion β of consumers is completely indifferent between domestic and foreign products, since these consumers are not concerned by the additional characteristic brought by the foreign producer. This subgroup has an overall demand D_1. A proportion (1-β) of consumers is concerned by foreign products (for instance for safety/environmental, ethical, social reasons). Their willingness to pay for a given quantity decreases by r_2 for products with the given negative characteristic.[10] Therefore, the demand by concerned consumers becomes $\tilde{D}_2$ (defined by $p_2^D(Q,1)$).

Figure 2. Consumption externality, free trade



For this free trade configuration without labels, the overall demand is $D_1+\tilde{D}_2$ in Figure 2. The per-unit damage r_2 implies a kink in the aggregate demand schedule at the point *v* in figure 2. Under this configuration, there is a single market clearing price, since the absence of information about the product characteristic makes it impossible to distinguish the two

10. Consumers' knowledge is simplified: we abstract from search or experience strategies. We also abstract from quality/safety signaling (via brand investment or guarantee) and/or firm's reputation in a context of repeated purchases under imperfect information. Rational expectations about quality require consumers to know all parameters (common knowledge) in signaling models. This requirement is unrealistic when technical expertise is required to know some attributes.

qualities and to segment the market. Market clearing leads to the equilibrium price p^B such that demand equalizes supply and determines equilibrium quantity Q^B.

The profits of domestic producers correspond to area Oxp^B in Figure 2. Clearly, domestic firms earn less profits compared to autarky: $Oxp^B < OAp^A$. The surplus of domestic consumers corresponds to area p^BBva, and total domestic welfare is given by area $OxBva$. The profit for foreign producer is OxB. Clearly, foreign producers benefit from trade liberalization compared to autarky with zero profit.

Figure 2 also depicts the changes in domestic welfare when shifting from autarky to free trade. Two opposite effects can be identified. The first one is caused by imperfect information for the proportion ($1-\beta$) of concerned consumers who are reluctant to buy foreign products. Since these consumers cannot differentiate between the two types of goods, they decrease their demand at any given price and their surplus decreases. The second effect is the decreasing price effect coming from the supply increase linked to the foreign producers' entry.

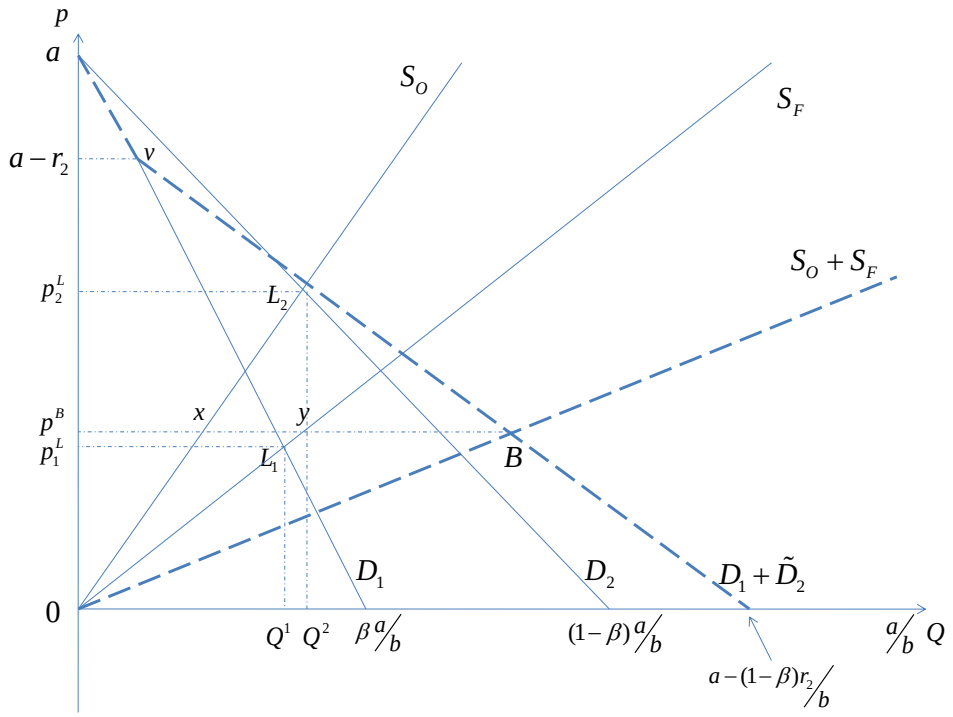
The effect of trade liberalization on the domestic country, i.e., the comparison between the welfare OAa under autarky and the welfare $OxBva$ under free trade is ambiguous. If area xBw is larger than area $vaAw$, the decrease in price is large enough for trade liberalization to be beneficial to the domestic country. Alternatively, area xBw could be lower than area $vaAw$, when trade liberalization involves a relatively large decrease in the demand by the proportion ($1-\beta$) of concerned domestic consumers. In this case trade liberalization would result in welfare losses, for the domestic country, and a trade ban linked to a standard that impedes foreign products with the specific characteristic would be preferred from a domestic point of view. Foreign producers will be injured by such a decision with a loss equal to OxB.

4.1.4 Free trade with a mandatory label

The free trade option may lead to a decrease in domestic welfare if the proportion of concerned consumers is large enough and, because of imperfect information about the good's characteristics, they reduce their demand sufficiently to offset the benefits obtained through cheaper imports. The third configuration combines free trade with a mandatory label that perfectly signals the negative characteristic linked to the foreign product. For simplicity, this label is understood by all consumers and fully transmits the relevant information to consumers.[11] To simplify further, it is assumed here that labelling is costless; an assumption that can easily be relaxed. Labelling makes it possible to segment the market into two varieties: one foreign variety that contains the characteristic that is disliked by some consumers and the domestic variety that is free of the characteristic. It is assumed that the segmentation is perfect and that no arbitraging sales between the two segments can occur. The foreign supply S_F is now represented in Figure 3. The previous situation under free trade without label is now represented with dashed lines (with the previous equilibrium situation at point B).

11. Wansink *et al.* (2004) analyze the limitations of labels to convey information. Some quality characteristics described in labels may be difficult for consumers to understand. Some labels may confuse consumers and tarnish the credibility of "better" labels.

Figure 3. Consumption externality, mandatory label



With labelling there are two prices clearing the market, since the label makes it possible to identify the two qualities by segmenting the market. The proportion (*1-β*) of concerned consumers may now turn to the domestically-produced product without the negative characteristic, so that the demand D_2 is the same as under autarky with $p_2^D(Q,0)$.

The first equilibrium price p_1^L equalizes $p_1^D(Q)$ and $p_F^S(Q)$, where foreign products are bought by the proportion β of indifferent consumers searching for the lowest price. The indifferent consumers' surplus is $p_1^L L_1 a$ and the foreign producers' profits are $0\,p_1^L L_1$. The second equilibrium price p_2^L equalizes $p_2^D(Q,0)$ and $p_O^S(Q)$, where the domestic products are bought by the proportion (1-*β*) of concerned consumers who avoid foreign products. The concerned consumers' surplus is $p_2^L L_2 a$ and the domestic producer's profits are $0\,p_2^L L_2$. Domestic producers increase their profits compared to the free trade situation without label (the profit was $0\,p^B x$).

Domestic welfare is area $p_1^L L_1 a + 0 L_2 a$ in Figure 3. Under this third policy scenario, welfare is greater than that obtained under free trade without labelling measured by *OxBva.* The labelling policy allows higher profits for domestic firms and more product diversity for consumers. The latter is welfare improving compared to the free trade situation without the label. From the consumers' point of view, this situation is the best one, since a label provides information and trade liberalization helps to decrease prices.

The profit for foreign producers with labelling is $0p_1^L L_1$, which is clearly lower than the welfare $0p^B y$ obtained under free trade without a labelling requirement. Imposing a mandatory label is controversial between the two countries as foreign producers would lose some profits.

The welfare conclusions emerging from the above analysis depend obviously on the configuration of parameters. Demand elasticities and the size of the consumer's valuation of the externality (r_2), determine the final assessment, and these will have to be determined empirically. Also, if domestic firms happen to have lower marginal cost then foreign suppliers, and can hence offer their product at lower prices than foreign suppliers, even non-concerned consumers will be tempted to buy domestic. Such cost differences can also be the result of the policy itself.

Obviously, the label enforcement leads to private and public costs related to the certification of products and production facilities, identity preservation and the promotion of the label (see Bureau *et al*., 1998). Labelling also increases production costs, as production and packaging processes have to be altered (for the example of costs and benefits of country of origin labelling for fruit juices see Centre for International Economics (2006)). If these costs are not "too" high (not prohibitive), the government will find it optimal to impose the label.

The incidence of labelling costs is a complicating factor. The optimal partitioning of costs between consumers, taxpayers, producers and the government depends on the nature of inspection and certification costs (see Crespi and Marette, 2001). If both domestic and foreign firms incur the same inspection and certification costs that depend on quantities, economic theory suggests that they are factored into consumer price. In this case, there is a parallel upward shift of both supply curves S_0 and S_F in Figure 3. In contrast, if firms incur inspection and certification costs that are sunk, these costs are not directly incorporated in the price and firms cannot pass them on to consumers. Some firms may exit the market until the remaining firms break even with a higher market price at the new equilibrium. In this case, both supply curves S_0 and S_F rotate towards the vertical axis in Figure 3. In this case the analysis should track the respective number of domestic and foreign firms. Whatever the type of cost, the higher the cost of certification and inspection is, the lower the benefit of imposing a mandatory label.

The potential for controversy between countries when considering policy options is exacerbated when investment costs are borne by foreign producers. Indeed, as these costs are not passed on to consumers directly in the price, it is optimal for a government to shift the sunk costs of labelling to foreign producers. A prohibitive cost may deter foreign producers from entering the domestic market and may become a trade barrier.

The labelling policy analyzed in this example did not discuss the type of label. Information about product characteristics can be provided in the form of 'negative' labelling that marks a product as containing characteristics that are not desired by some consumers. Alternatively, 'positive' labelling highlights in an affirmative way the compliance with a production standard. For the logic of the analysis pursued here the distinction does not matter, as long as the consumer is able to fully distinguish between different product varieties, but in terms of implementing a labelling policy there may be important differences between the two approaches. Consumers may react differently to a negative signal compared to a positive one.

4.1.5 Market failures affecting producers

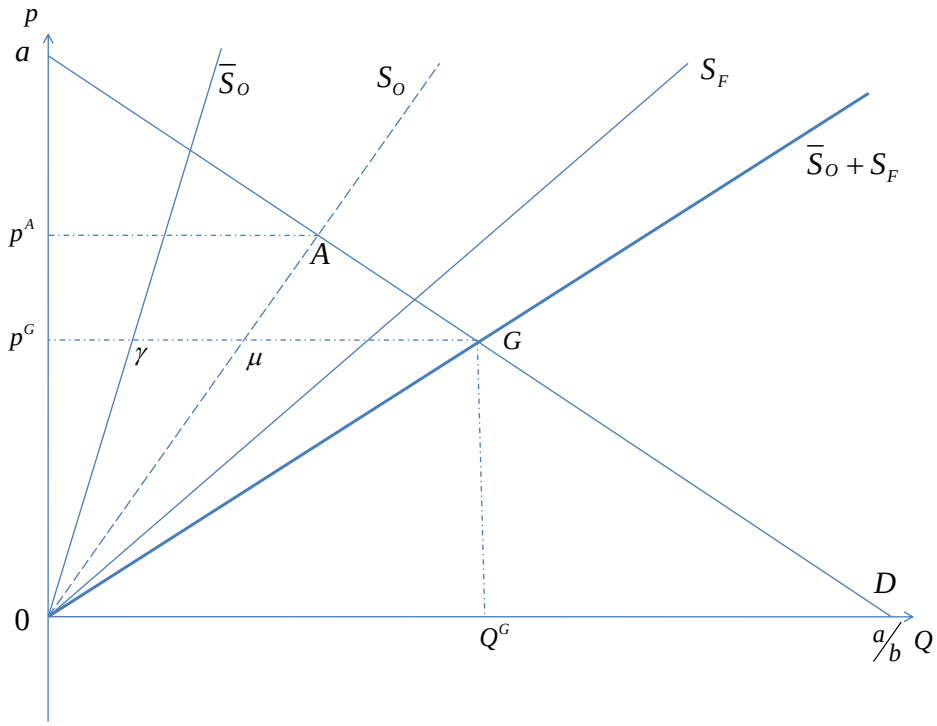
Production-based failures, such as animal or plant disease outbreaks, can be conceptualized as a negative shock on supply as shown in figure 4, inducing a shift or a pivot of the marginal cost curve. This follows Orden and Romano (1996), Wilson and Anton (2006), and Peterson and Orden (2008). The initial supply S_O under autarky is represented by the dashed line in Figure 4. Consumer demand *D* is assumed unaffected by the trade regime.

With the import of foreign products, the externality is transmitted to the domestic market and negatively impacts domestic supply with a shift from S_O to $\overline{S}_O$. This change in domestic supply after opening to trade in the face of a potential production loss through the introduction of some disease can be represented rather straightforwardly. Call λ the probability of losing the production following the appearance of the externality. Assuming risk-neutral domestic producers, the maximization of individual profits involves choosing output such that $\overline{\pi}_{Oj} = p(1-\lambda)q_{Oj} - \frac{1}{2}c_O q_{Oj}^2$ is maximized. $\overline{\pi}_{Oj}$ is the expected profit before the realization of the loss, since the output decision is taken before the likely realization of the loss. Solving the individual maximization problem and summing over producers the total domestic supply obtained is: $\overline{S}_O(p) = \sum_{j=1}^{m} \overline{q}_{Oj} = m(1-\lambda)\,p / c_O$. The higher λ, the greater is the pivotal shift of the inverse supply $\overline{S}_O$ to the vertical axis in Figure 4.[12]

Under free trade, the expected equilibrium price is p^G and the total expected domestic welfare is given by area $0\gamma Ga$. The welfare comparison between autarky and free trade consists in comparing areas $0\gamma\mu$ and μGA *(*recall from above that welfare is *OAa* under autarky*)*. The welfare effect is ambiguous *a priori*. If μGA is larger than $0\gamma\mu$ the domestic welfare increases under free trade compared to the situation with a policy that impedes foreign imports. This case corresponds to a situation with a small probability λ of losing production following trade liberalization.

[12]. Note that one extension of the framework could consider a case where the foreign supply S_F is affected by some externalities.

Figure 4. Production externality, free trade



Note that a dynamic approach can be introduced by taking into account time-varying probabilities. Flows over several periods can be taken into account with a discount factor applied to welfare measures presented in figure 4. Further sophistication can be added but ultimately the likelihood of the externality increases with trade.

4.1.6 Global-commons externality

In the context of global-commons externalities two cases can be distinguished. As will become clear, the market consumption decisions and the public bad are separable in both cases.

In a first and simple case, consumers suffer a welfare loss from the externality, independent of their consumption decision. For example, biodiversity is being undermined even if they do not contribute to this failure with their consumption. The loss from this non-rival externality is separable from the utility derived from consumption and does not influence the demand for a good. Although this may seem counter-intuitive, this situation is conceptually equivalent to the situation where the "concerned" consumers do not factor the additional negative characteristic into their demand (with I=0 in equation 1). The concept is similar to the analysis of consumer–based externalities, with one important difference: concerned consumers cannot fully internalize the externality through their individual consumption decisions. The externality should be accounted for in the welfare calculations, but does not feedback in the demand.

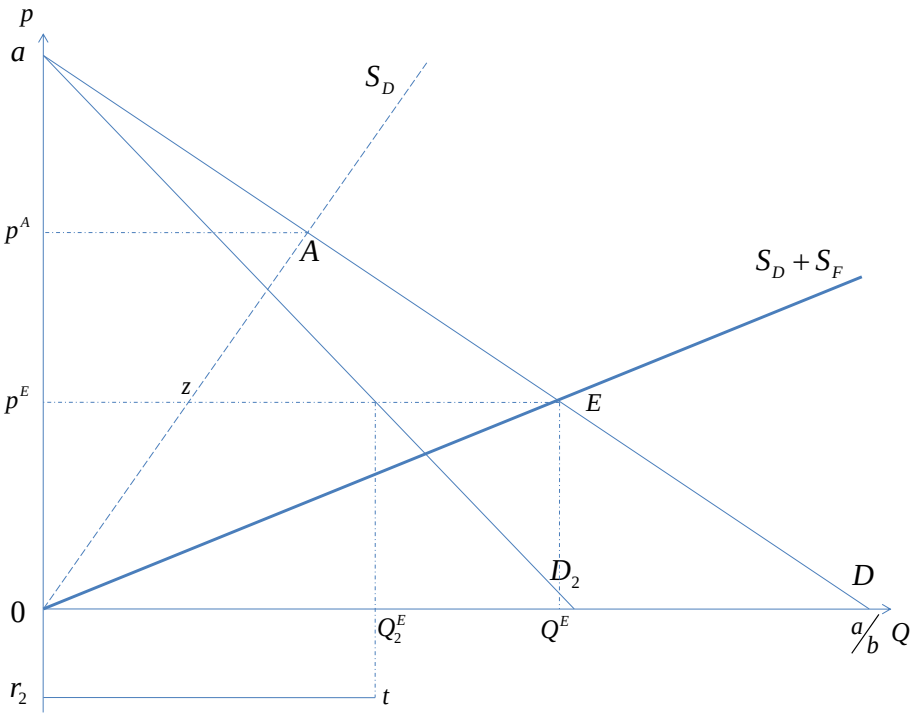
In Figure 5 free trade leads to an equilibrium price p^E that equalizes demand and total (domestic plus foreign) supply. Because their atomistic consumption decision does nothing to abate the global externality, it does not impact the demand of concerned consumers when the market opens to foreign producers (in equation (2) the demand is $p_2(Q,0)$). However, the externality should be accounted for in the welfare calculations, but exactly how the externality should be

measured is not entirely clear. One approach is to take the amounts imported and consumed and to multiply this by the unit damage that concerned consumers attach to the global commons externality. This would yield the value of the externality as $r_2(1-\beta)Q^E = r_2 Q_2^E$, where Q_2^E is the consumption by the proportion (1-β) of concerned consumers at the price p^E. This approach to accounting for global commons externalities as separable from consumption follows (Foster and Just, 1989 and Teisl *et al.*, 2001). Adding the usual consumer surplus (area $p^E Ea$) and producer surplus (area $0zp^E$) to the externality (area $0r_2tQ_2^E$) yields overall domestic welfare under free trade as the area $0zP^E + P^E Ea - 0r_2tQ_2^E$.

Imposing an import ban eliminates foreign supply from the domestic market. The welfare comparison between autarky and free trade consists in comparing areas $0r_2tQ_2^E$ and *zEA* (the combined consumer and producer surplus under autarky yields total welfare as area OAa). The area *zEA* represents a welfare gain under free trade, while area $0r_2tQ_2^E$ is the loss value that concerned consumers attach to negative global externality. Welfare under a prohibitive import ban is increased if the per-unit damage r_2 is relatively large so as to outweigh the benefits of lower domestic prices under a free trade regime.

The above analysis has taken as the basis for valuation the imported and consumed quantities of the good that is linked to the global commons externality. Alternatively, if the externality comes from the production side (as in the case of rainforest destruction) its size could also be measured based on the total quantity of foreign production, and not just on the amount imported and consumed domestically. This approach would yield a value of the externality that depends on total foreign production, and would increase with the total amount of production (the more rainforest is destroyed, the higher the value attached to the remaining rainforest). Although this alternative measurement of the externality does not lend itself easily to graphic exposition in Figure 5, its principle is not fundamentally different from the welfare accounting based on imports. As before, consumer and producer surpluses will have to be amended by a valuation of the global commons externality to obtain a measure of total welfare under alternative policy settings.

Figure 5. Global commons externality



A second case, not fully developed here, includes global commons when concerned consumers reduce their consumption to feel better, although their individual impact on the non-rival externality is small. In this latter case, the externality feeds back into demand decisions of concerned consumers but the externality can typically not be fully internalized. The consumption decrease is too marginal to induce suppliers, whose supply causes the adverse effect on global commons, to change their behaviour. Concerned consumers will decrease the consumption of goods linked to the global commons problem to feel better. They may switch to a sustainable good with an eco-label if such good is available. This latter situation corresponds to the case of the concerned consumers being informed (I = 1) in equation (2), even though the consumers do not fully internalize the externality as the global commons tragedy continues to develop. This second case combines elements of the case where concerned consumers adjust their own consumption because of the negative externality or they would switch to a "sustainable" substitute fulfilling the eco-label standards. Nevertheless, the externality is not fully internalized because other unconcerned consumers purchase the regular good which contributes to the global commons problem. The externality can be reduced but not eliminated unless all consumers globally consume the eco-labelled good.

4.1.7 Extensions

4.1.7.1 A non-prohibitive standard

In the previous exposition of the cost-benefit framework the standard was taken to be prohibitive, leading to an effective import ban. A more realistic approach should consider a standard impacting both domestic supply and foreign supply. Such a standard will increase production costs and it will reduce the impact of the specific characteristic that the concerned consumers want to avoid. To introduce a non-prohibitive standard consumers' utility and producers profit are re-formulated as follows:

$$U_i(q_i, w_i) = aq_i - \bar{b}q_i^2/2 - I \times (1-\rho) \times r_i\, q_i + w_i,$$

$$\pi_{Oj} = pq_{Oj} - \tfrac{1}{2} c_O q_{Oj}^2 - k_O(\rho) q_{Oj} - K_O(\rho), \text{ and}$$

$$\pi_{Fj} = pq_{Fj} - \tfrac{1}{2} c_F q_{Fj}^2 - k_F(\rho) q_{Fj} - K_F(\rho).$$

Firms bear an effort ρ, scaled such that $0 \le \rho \le 1$, that reduces the damage $r_i\, q_i$ for consumers. With this specification, the effort increases domestic and foreign firm's marginal costs $k_O(\rho)$ and $k_F(\rho)$, along with sunk costs $K_O(\rho)$ and $K_F(\rho)$. Firms now face two interdependent decisions: the level of effort to comply with a standard and the level of production. The optimal choice will depend on market structure and on the kind of strategic interaction between firms. In equilibrium, the marginal costs of effort are passed on to consumers through the price. When firms incur compliance costs that are sunk, these costs are not passed on directly to consumers in the price.

For the cost-benefit assessment of a standard, its level may be taken as given. Alternatively, an optimal level of the standard can be determined by letting domestic, or international regulators take a welfare measure into account (Fisher and Serra, 2000). For example, a domestic regulator may select a standard that maximizes domestic welfare (defined as the sum of the domestic agents' surplus). This level may hurt foreign producers if it imposes prohibitive costs, $k_F(\rho)$ and $K_F(\rho)$. On the other hand, an international regulator would choose a standard that maximizes global welfare. One can also consider a combination of several instruments as a standard and a label (see Marette, (2007) and (2008)).

4.1.7.2 Industrial organization considerations, firm entry and exit

Initially it was assumed that sunk costs K_O and K_F were equal to zero. This assumption implies that firm exit can be ignored. However, if sunk costs are non-zero, profits may be become negative, leading to exit by some firms. If sunk cost depends on the compliance efforts a standard may lead to exit by some firms. Some foreign firms may exit the market until the other firms offering products break even. This issue is particularly sensitive if the fixed compliance costs are higher for foreign suppliers than for domestic firms. Rau and van Tongeren (2007) show the impact of fixed and variable compliance costs on market structure, in a context with complying and non-complying Polish suppliers to EU safety standards for meat.

In his path-breaking analysis Sutton (1991) shows that demand shifting activities, such as a standard, may also be used by a firm or a regulator against rivals, in particular foreign firms. A key insight from this work is that concentration increases as market size increases, for example through trade liberalization, if the demand shifting attribute is produced at an endogenous set-up cost, as outlined above. Although Sutton's analysis looked into R&D and marketing, his insights pertain equally to food safety or food quality standards. By selecting a relatively high level of quality and safety standard that involves a significant set-up cost, potential foreign competitors can be driven out of the domestic market. Since incumbents do not pass the sunk cost to consumers they can choose an aggressive pricing strategy, thus eliminating potential rivals. As a result, concentration at the producer level increases and product variety could decrease. This latter mechanism is also found in trade models with heterogeneous firms. Chaney (2005) and Rau and van Tongeren (2009) show that higher fixed cost of exporting lead

to shrinking extensive trade margin (less varieties) through exit of less productive exporters. In contrast, rising variable trade cost lead to a shrinking extensive margin as well as a shrinking intensive trade margin (less exports by all incumbent firms).

4.1.7.3 Supply chain

The framework developed here focused on the end-product, ignoring the upstream and downstream effects of NTMs. These could be included by modelling the successive processing stages. In particular, a market for input factors could also be introduced, which would make variable costs c_O and c_F endogenous. This would allow the relative impact of a standard imposed on the input versus a standard imposed on the output to be measured.

The introduction of vertical relationships between suppliers in the supply chain raises the issue of private standards. Reardon *et al*. (2003), Fulponi (2006), OECD (2006 a), Smith (2008) and Korinek et al. (2008) underscore the rising importance of private standards. The development of private standards raises important issues regarding the future direction of food safety and quality regulation. Private standards represent a shift in responsibility from public agencies to private industry. This raises questions over the degree to which regulation is driven by private rather than public considerations. The recent growth of private regulation also increases the range of standards with which firms must comply. This could significantly increase the total regulatory burden on the food system and consumers.

5 Measuring the valuation of market failures and global commons

The objective of quantifying the economic effects of non-tariff measures can be addressed as a systematic assessment of costs and benefits of a hypothetical policy change. The question asked is: 'what are likely costs and benefits from changing the current policy?' The current policy may be a situation of no regulation or no interference with the market (do-nothing). The typical problem facing such an assessment is that some of the relevant cost and benefit items cannot be estimated with great precision – simply because the policy change is hypothetical and there are no empirical observations available that could reveal reactions of consumers and producers to the new policy set.

The literature on cost-benefit analysis has developed a number of approaches to deal with this particular measurement problem, and they are frequently used as a tool in policy making. Several OECD countries, such as Canada, some EU Member States and the US, provide official guidelines on how to carry out an exhaustive cost-benefit analysis for policy making, especially in the area of regulatory reforms. At the level of the EU official guidelines exists for cost- benefit assessments in a number of policy areas that are relevant across the entire EU.

Being deeply rooted in the theory of welfare economics the cost-benefit analysis takes individual preferences into account.[13] It translates the theoretical notion of preferences into an applied measurement of consumer choices through the willingness-to-pay (or willingness to accept) concept. The crucial challenge is the assessment of consumers' valuation when a market for the good does not exist. This is typically the case when dealing with externalities and

[13]. Some may see this as a weakness rather than strength of cost-benefit analysis, because it implies that preferences should count, even if the holders of these preferences are not well informed. For full discussion see OECD, 2006c.

information asymmetries, but also when current trade policies exclude imports. It is beyond the scope of this paper to provide an exhaustive overview of valuation methods, and the treatment here focuses on recent developments, including experimental economics. An excellent overview of theories and methods is provided in OECD (2006c).

5.1 Consumer valuation of failures

Numerous methods exist for eliciting people's values for both market and non-market goods (such as externalities or environmental goods). Many of them are potentially tailored to the analysis of NTMs, since they capture heterogeneity in consumers' preferences. The quality of a cost-benefit analysis critically depends on these measures.

The *preventive expenditure* method seeks to measure agents' willingness to pay by observing the efforts made to avoid illness. With this method, a money evaluation of the disutility of being ill is added to the estimated cost of illness, together with an estimate of the preventive expenditure that an individual is willing to commit according to a given pathogen level (Harrington and Portney, 1987).

Contingent valuation methods involve asking individuals directly about their willingness to pay in order to reduce the risk of an illness, or more generally to obtain higher quality in a good.

Choice experiments indirectly determine WTP by econometric estimation based on various choices made by consumers. Experimental economic*s* (including lab, field or natural experiments) brings a group of individuals into a situation, where their real behaviour is simulated (in the lab) or influenced (in the field) to reveal their willingness to pay for particular qualities (see Lusk and Shogren, 2007a, for an exhaustive presentation). One advantage of the experimental method is the precise control of the information revealed to consumers, including a measure of their initial knowledge via ex ante and ex post questionnaires. Note that a price premium for differentiated products that are already sold on a given market may be estimated by some econometric method based on hedonic prices. This is for instance the case for the eco-label valuation (see Nimon and Beghin, 1999, and Teisl *et al*., 2002).

The robustness of these methods is much debated, in particular the incentives of respondents to over- or underestimate their WTP (see Shogren, 2006). Different WTP methods have been compared in order to elicit biases (see a survey in Levitt and List, 2007). From a comparison with a field experiment, Blumenschein *et al*. (2008) showed that the hypothetical bias linked to contingent valuation can be removed by a certainty statement at the end of the questionnaire. List (2007) notes that field experiments, despite their limitations, may be useful bridges between lab experiments and real situations. While still being relatively nascent, the use of experimental economics methods can be seen as a major breakthrough to obtain more robust estimates of consumer WTP. Several papers have directly compared the results of lab experiments with other experiments (including field experiments in stores) or market data from supermarkets (eliciting a demand via econometric estimations). Among them, Shogren *et al*. (1999) showed that lab evaluations and market behaviour coincide at high price valuations, supposedly selecting the truly interested consumers. Lusk and Fox (2003) and Marette *et al*. (2008c) have shown that field valuations were close to but exceeded laboratory valuations. Chang *et al*. (2008) showed that for ground beef and wheat flour the results from lab experiments, where participants have to make real pecuniary commitments, outperformed the contingent-valuation approaches experiment in predicting retail sales. Huffman *et al*. (2003,

2007) show the sensitivity of WTP to the source of information (NGOs, Multinationals or public health authorities). Despite their limitations, experimental results can be considered as a good approximation of consumers' or citizens' reactions, once some biases have been overcome. A main advantage of this method over other approaches is that it allows choice situations to be controlled more precisely, and hence allows in principle for transferring the results into other contexts.

Despite its appeal, various constraints may impede the measurement of willingness to pay. These constraints range from the efforts necessary to collect information to the occurrence of effects that have an unclear or indirect impact on consumer preferences. But the main constraint is clearly the difficulty to monetize policy impacts that save lives. Individuals may be reluctant to place a monetary value, or express their willingness to pay, on a life saved. Two alternatives exist to circumvent the impossibility to elicit a willingness to pay in such cases that concern human life.

The first alternative method, the *cost effectiveness analysis*, avoids estimating the benefits of lives saved. Instead it compares alternatives on the basis of their costs and a single quantified, but not monetized, effectiveness measure. The classical example is the cost of different measures per statistical life saved (see for instance Morall, 2003). This approach puts more emphasis on the assessment of costs. If it is based only on the assessment of budgetary costs it may underestimate the full economic costs of a policy move.

The second alternative method is the QALYs (Quality Adjusted Life Years) approach, which is generally used in the medical and public-health field. The costs of alternative policies are compared to the health changes, measured over two dimensions: the quality of life (morbidity) and the length of life (mortality). Several alternative methods exist for estimating the costs of mortality and morbidity and evaluating in money terms the benefits of government action resulting in a reduction of sanitary risk. Statistical dose-effect methods are used to estimate the risk reduction. With the human capital method, a value is placed on the reduced risk of premature death based on an evaluation of discounted labour income flows. For an individual of a given age, the value of the statistical life prolonged by a regulation corresponds to the discounted sum of the mathematical expectation of the person's revenues (Freeman, 1993). With the cost of illness method, a value is placed on the reduced morbidity resulting from a regulation, based on an estimate of medical costs and productivity losses due to illness (Buzby *et al*., 1996). Opportunity costs from investing in activities that reduce the risk are included in the value of reduced illness (Landelfeld and Seskin, 1982). The main drawback of these approaches is their inability to reflect consumers' responses in demand and their indirect impact on producers. The costs estimated through QALYs methods are not mapped into demand adjustments linked to reactions of consumers. Consequently, they cannot take into account market price reactions and their concomitant impact on producers and consumers.

QALYs are generally used in the medical and public-health field, while WTP methodologies are the main instruments in transportation and environmental economics. See Hammitt (2002) for discussion and comparison of underlying key advantages and drawbacks of these two alternative approaches. For the analysis of NTMs both methods could in principle be used, depending on the specific case at hand. WTP measures can most efficiently be used if the market failure issues linked to NTMs relate to quality aspects that cannot be translated into clearly

identifiable short-term illness (such as the preferences for animal welfare, the origin of products, the protection of endangered species, negative preferences for GMOs).

Whatever method is used, there will always be limits to the precision and the scope of the measurement of costs and benefits. The use of different models that explain the same phenomenon may lead to different results. One way of dealing with that problem is to evaluate each model separately and then compare their results, perhaps by taking into account probabilities with which each model predicts its outcome (see for example Treasury Board of Canada, 2007).

5.2 The valuation of producer-based externalities

There is a large scientific literature estimating the impact of various pests and pathogens on agriculture (CABI Compendium, numerous articles in *Weed Science*, *The Agronomy Journal*, *Weed Technology*, among many other journals). The *CABI Compendium* series draws on available scientific information worldwide and includes a wealth of information on yield loss for a multitude of pathogens and pests on various crops, forest, livestock, and aquaculture. The Compendium series scan the last 40 years of scientific literature.

The most recent reviews of the costs associated with invasive species are Pimentel *et al*. (2000) and Pimentel *et al*. (2005). Using a large survey of the ecological and agronomic literature, these two articles provide agricultural and environmental costs for an extensive list of invasive species. The uncertainty surrounding the latter estimates is huge but they nevertheless provide point estimates for yield losses or other shifts in the production function or in cost induced by these invasive species. The work by Pimentel *et al*. is a useful source to parameterize both losses in production and those associated with global common issues, such as loss of biodiversity, extension of endangered species and others.

Progress has been considerable recently in integrating epidemiological models into economic analysis. Pendell *et al*. (2007) provide such an analysis for the US Midwest to analyze a hypothetical outbreak and spread of Foot and Mouth Disease. Several papers look at optimum quarantine policies (surveillance, tests, monitoring) in open or regional economies integrating sophisticated and realistic modelling of infestation dynamics and their spatial dimension (Adamson and Cook, 2007; Bicknell *et al*., 1999; Cook, 2007; Kompas and Che, 2003 and Kompas *et al*., 2004). These analyses rely on stochastic dynamic control, numerical methods, and sometimes spatial models, to quantify the diffusion and establishment of invasions and compute optimum quarantine intervention levels based on cost/benefit criteria. Results from these analyses can provide some range of values for simpler models integrating externalities as simpler supply shifts.

A large economic literature exists on weed infestation and the cost of managing them (*e.g.*, Eisworth and van Kooten, 2002; Taylor and Burt, 1984; Jones and Medd, 2000; see also references in Pimentel *et al*., 2005). For example, Eiswerth and van Kooten (2002) analyze the supply impact of weed infestation on yield loss and cost of production on hay pastures for a non-indigenous weed, the yellow starthistle, and considering five management alternatives. This type of analysis provides sufficient information to assess yield loss if nothing is done and the cost of mitigating the invasion. These are the shifters needed to operationalize the cost-benefit framework. There is also an extensive interdisciplinary literature on yield losses

induced by multiple invasive weeds and other pests, see for example Swinton *et al*. (1994) among many others.

Trade as a vector for entry of invasive species has been also studied. Costello *et al*. (2007), and others look at the introduction of various invasive species in US harbours over time and the associated welfare cost. Levine and d'Antonio (2003) analyze the statistical relationship between trade and invasive species for a large set of pests.

In regard to genetically modified products, Wolfenbarger and Phifer (2000), and Qaim and Matuschke (2005) review the available scientific evidence on the cost and benefits of growing GMO crops instead of conventional ones, including yield effects, savings on pesticides, and larger ecological costs having to do with non depletable externalities similar to global commons valued by consumers. Piggott and Marra (2007) analyze the farm level costs and benefits associated with two types of refuge policy and spraying alternatives at the farm-level and for a large seed company, of policy for GMO cotton. Marra and Piggott (2006) analyze the non pecuniary benefits associated with various GMO crops relative to conventional ones.

5.3 The valuation of global commons

Trying to put a value on avoiding mismanagement of resources that are seen to belong to the global community is perhaps the most controversial of the cases discussed in this paper. While countries agree in principle on issues such as the importance of remedial action to avoid climate change or to prevent loss of biodiversity, they disagree in practice when it comes to developing mechanisms that enforce more ecologically sustainable behaviour. Differences in valuation of the global commons and unequal distribution of costs of remedial action are at the root of difficult multilateral negotiations on these topics.

In the context of global commons, economists typically divide the total economic value into 'use values' (value derived from using a resource) and 'non-use values'. The latter can be distinguished into 'existence values' (the sheer presence of a certain eco-system is valued positively) and 'option values' (although the resource is not used now, there is value to having the option to use it later).

Numerous studies exist today that provide some estimates on each of those components, see the references in the digital library of the commons maintained by Indiana University (http://dlc.dlib.indiana.edu/). The most far-reaching, but not uncontroversial, attempt to value global ecosystems services is documented in Costanza *et al* (1997). This study estimates direct and indirect use values of 17 ecosystem services, such as gas regulation, water supply and nutrient cycling. The study is based on previously published data, supplemented with some additional calculations.

If a certain "commodisation" of the global commons externality can be arranged by creating a real market, consumer valuation can be directly observed, and it is not necessary to resort to the non-market valuation methods discussed previously. The price premium that consumers in importing countries are willing to pay for sustainably produced products over non-sustainable ones directly reveals information about their valuation of the global commons in question.

A valuation study addressing global commons issues that is conceptually very close to the framework proposed in this report is provided by Larson (2003). He shows how labelling of shade-grown coffee could contribute to internalizing positive environmental externalities into

consumer demand. Positive effects on tree flora and bird fauna are attributed to coffee grown under shaded, small scale and lower yield conditions.

Large scale and government-backed attempts exist in sustainability labelling schemes for tropical timbers and in marine fisheries. The International Tropical Timber Organisation finds in a recent study (ITTO, 2008) that buyers in importing countries have generally not been willing to pay a large premium for certified products. Observed price premiums can be as low as 2% for UK imports of MTCC-certified meranti sawnwood from Asia, to reach 10-30% for certified tropical timber used in marine construction in Denmark. However, no price premiums have been reported in the Japanese market. Such variation in price premiums can partly be explained by differences across importing countries in consumer valuation of tropical forest. Price premiums differences across exporting countries can partly be explained by uncertainty about the truthfulness of the label which leads to varying price premiums, especially for imports from Africa.

If a price premium is possible, the risk of free-riding also emerges. Producers have an incentive to save on the additional cost of more sustainable resource use, including the cost of certification and identity preservation, while still labelling their product as being of the sustainable variety. If the monitoring of the labelling is imperfect, and consumers learn about this loophole, the value of information carried by the label and the certification scheme will be undermined. This can prompt importing countries to resort to alternative NTMs. Norway, for example, has decided in 2007 to ban all tropical timber from publicly procured construction, regardless of the label.

5.4 Parameterization

Even if a product with a specific characteristic is not available on the domestic market, and hence demand cannot be observed, supply and demand functions can be calibrated. The WTP for the specific characteristic can be obtained from contingent valuation studies or experimental results, as discussed above. Under autarky or under a prohibitive policy precluding imports of foreign products, parameters of the linear demand and supply functions can be calibrated to domestic market prices and quantities.

WTP estimates coming from experiments or contingent valuation have to be integrated in the calibrated demand. A pre-condition is of course that the sample used in the experiments is representative of the general population analyzed in the investigation.[14] From experimental results, the proportions of indifferent and concerned participants can be identified. Results from choice experiments can subsequently be integrated into the calibrated demand function for the proportion of consumers interested in or reluctant to consume a specific characteristic.[15] The revelation of information in the lab allows participants to know the characteristic provided by the foreign product introduced under free trade (with or without a mandatory label). This procedure allows the WTP for the specific characteristic to be isolated econometrically. Of course, the changes in WTP from the experiment can only be used reliably in the calibrated model if the impact of information is statistically significant.

14. This eliminates experimental studies made with students on campus.

15. Note that this group could also be divided into several subgroups according to the importance of the WTP shifts.

Under free trade, the undesirable characteristic of the foreign good is unpalatable for concerned consumers. It causes a parallel inward shift of the demand curve at the initial equilibrium price which is in keeping with the model of Polinsky and Rogerson (1983) and Lichtenberg *et al*. (1998). The relative variations of WTP observed in the experiment focusing on the additional characteristic serve to determine the demand shift (see Marette *et al*., 2008a for details).

The demand variation based on the lab experiment is measured in a vertical demand "decreasing" shift and leads to $\widetilde{D}_2$ in figure 2 with $\delta = [E(WTP^{hh}) - E(WTP^{h})] / E(WTP^{h})$, where *E(.)* denotes the expected value of the WTP for subjects of the experiment who significantly change their WTP after the revelation of the information about the characteristic of the imported product (namely $WTP^{hh} \neq WTP^{h}$), and where *h* denotes the situation before the information was revealed and *hh* denotes the situation after. The relative change δ isolates the relative WTP for the additional characteristic independently from the initial endowment or the initial value of the product offered during the experiment. Note that the welfare computed with unaware consumers can also be estimated with this measure (see Marette *et al*. (2008b) for details).

5.5 Data sources

5.5.1 WTP measures

WTP measures linked to contingent valuation or lab experiments can be directly estimated or alternatively they can be found via meta-analysis of published results. Remaining parameters can often be obtained from outside sources. When using secondary data, it is important to make allowance for the specific situational context and country context in which these estimates are made. WTP estimates obtained in one specific country and in one specific context may not be directly transferable to other situations, and adjustments may be necessary to take such differences into account.

Experimental methods have been widely used recently in many areas linked to food safety or food preferences for some characteristics such as GMOs, organic products, hormone treated beef, the value of biodiversity etc. (See Table 1.1 in Lusk and Shogren (2007b) with its 113 recent references). For issues like food safety, experiments reveal preferences for food safety (Hayes *et al.,* 1995 for the US; and Rozan *et al.*, 2004 for France).

The experiments about controversial goods, such as irradiated food or growth hormones such as rBST, are particularly tailored to analyze trade bans (as presented in Figure 1). They can capture heterogeneous preferences across countries and they provide experimental data when a foreign product is not available on the domestic market. Among the recent proliferation of studies or experiments on GMOs (see Costa-Font *et al*. (2008) for a complete survey), several relate to the different regulatory environments in Europe and the US regarding GMOs. Noussair *et al*. (2002) show that a majority of French consumers is indifferent to GMOs, in comparison with non-GMOs, a view that contradicts the current regulatory practice. Lusk *et al*. (2003) and Lusk *et al*. (2006b) directly compared WTP between the US and some European countries and show a larger level of reluctance to accept GMOs among European consumers compared to the US consumers. These results have been used to assess welfare effects of identity preservation between GMOs and non-GMOs (as for instance A. Sobolevsky, G. Moschini and H. Lapan, 2005).

The ban on hormone-treated beef in Europe inspired a specific experiment. Alfnes and Rickertsen (2003) show that most of the participants in Norway preferred domestic to imported beef. Hormone-treated beef received the lowest mean bid, but 28% of the participants were indifferent or preferred U.S. hormone-treated to U.S. hormone-free beef. Note that this type of experimental result justifies the simplifying partitioning of consumers into only two groups: concerned ones and indifferent ones.

Lagerkvist, Carlsson and Viske (2006), via a choice experiment, and Napolitano *et al*. (2008), via a lab experiment, measure WTP for animal welfare (including the use of hormones). Some experiments study the effect of the COOL (the country-of-origin-labels mentioning the geographic origin of products) program in the US (see Lusk *et al*. (2006a)). Some studies elicit the WTP for biodiversity (Stoneham *et al*. 2003), even if the main technique used for this topic is contingent valuation.

5.5.2 Elasticities

Demand and supply price and income elasticities are available from two databases extensively used for partial equilibrium modelling:

FAPRI (http://www.fapri.iastate.edu/tools/elasticity.aspx) and

USDA-ERS (http://www.ers.usda.gov/Data/InternationalFoodDemand/.

The database underlying the OECD/FAO Agkink-Cosimo model also provides a multitude of elasticity estimates OECD (2007b) and

http://www.agri-outlook.org/pages/0,2987,en_36774715_36775671_1_1_1_1_1,00.html.

Recent estimates of import demand elasticities are provided by Kee *et al*. (2008) who estimate such elasticities for goods disaggregated at the HS-6-digit level for a large set of countries.

5.5.3 Data on policies and trade frictions

Two databases have hitherto been central to the analysis of TBTs and SPS regulations. First, WTO notifications of some NTM measures are collected and processed by the United Nations Conference on Trade and Development (UNCTAD) in the TRAINS database. UNCTAD complements the notifications using national sources and categorizes the various measures into a policy classification of its own as follows: para-tariff measures, price control measures, finance measures, automatic licensing measures, quantity control measures, monopolistic measures, and technical measures. These categories are further disaggregated into finer policy types (see http://r0.unctad.org/trains_new/tcm_link.shtm). TRAINS is available at a cost through the WITS system maintained by the World Bank (http://wits.worldbank.org/witsweb/). WITS makes these data available at the HS-6 commodity level and allows several official motives of the policies (health protection, environmental protection, etc) to be identified. This database was recently used by Disdier *et al*. (2008); Fontagné *et al*. (2005); and Henry de Frahan and Vancauteren (2006), among others.[16]

[16] TRAINS data used for constructing Table 1 of this paper have been obtained directly from UNCTAD and contain the most recent notifications for Mexico, the European Union and Japan that were not available before in the TRAINS database and therefore not used in previous empirical works on NTMs.

TRAINS is largely based on notifications of measures to the WTO (SPS and TBT committees), and this has some important implication for the scope and coverage of the data. WTO members are required to notify only new (or changed) SPS measures since 1995. The notification requirement covers only measures which differ from international standards, guidelines or recommendations, or situations where no standards exist, and, in addition, may have a significant impact on trade. These limited notification requirements are also reflected in the information contained in TRAINS. UNCTAD complements the notifications using national sources. In spite of this effort, TRAINS does not provide a complete coverage of NTMs, and furthermore the country coverage is typically biased towards those countries that diligently notify their measures to the WTO, or those where UNCTAD happens to do complementary data collection efforts. For a discussion of this database see OECD (2008c).

The second important database recently used is Perinorm (www.perinorm.com), a bibliographic database sponsored by the British, German, and French industrial norm agencies (BSI, DIN and AFNOR). It provides information on public standards, which are voluntary, and technical regulations, which are mandatory. Hence, both mandatory and voluntary standards are covered. The database includes national, European and international standards from 23 countries, and provides a total of more than 1,100,000 records on standards from Australia, EU countries, Japan, and the USA. This database was used by Moenius (1999) and (2006) and by Czubala, *et al*. (2007). These authors ingeniously use the data to identify bilaterally shared standards from non-shared ones (Moenius) and international standards from non-harmonized ones (Czubala *et al*., 2007). Czubala *et al*. rely on Perinorm in combination with the online catalogue of the European Committee for Standardization to create an original database of EU product standards applied to textiles and clothing. These data distinguish between "harmonized" standards that are equivalent to ISO standards and those that are not. The inclusion of voluntary standards in Perinorm is an advantage compared to the notifications data developed by UNCTAD representing mandatory TBTs, but the country coverage is much more limited.

The newly created WTO SPS Information Management System (SPSIMS) (http://spsims.wto.org/) provides new and easier access to SPS notifications to the WTO as well as to official trade concerns communicated by Members to the SPS Committee of the WTO. SPSIMS essentially provides online access to textual information. The public version of the system provides SPS information, concerns, and notifications according to their specific needs using searches based on various criteria (geographic groupings, product codes, comment periods, and keywords). The SPS section of the WTO website is a major source of information on mandatory standards and disputes. These SPS notification data are also available through the Inquit database (www.inquit.com). It offers convenient access to SPS measures from September 1999 to May 2007. WTO dispute data has been compiled and analyzed by and are available from Horn and Mavroidis (2006).

WTO members can raise specific trade concerns (STCs) in the SPS and TBT Committees. These concerns pertain to issues raised by one (or more) WTO member concerning measures put in place by other members and deemed to restrict trade. However, not all concerns raised relate to perceived trade restrictions, as countries sometimes only seek clarification on a measure put in place by a trading partner, or remind a trading partner of lacking notifications to the SPS or TBT Committee. Raising an issue as a specific trade concern is an important way to start information exchange and bilateral consultations. Although the WTO secretariat keeps a record of concerns

raised in both Committees since 1995, only the SPS concerns are accessible in a database format through a web-based portal (http://spsims.wto.org/web/pages/search/stc/Search.aspx)[17] The SPS-STC database provides a summary description of cases, as well as pointers to relevant documents. The data on STC cases include a record of which member(s) raised a concern and when, which country(ies), if any, supported the concern, which country(ies) maintained a measure deemed to restrict exports of the country(ies) raising the concern. The data also give an indication of the products involved using the HS coding system. For example, Ecuador and Israel, supported by Kenya expressed concern at the SPS Committee in 2001 over changes in the European inspection procedures on cut flowers. For the European Union, the new procedures aimed at controlling for the presence of harmful non-European organisms regularly intercepted on cut flowers. Following the discussions at the SPS Committee, bilateral consultations between the EU and complainant countries took place and the EU agreed to postpone entry into force of these new procedures after consideration of the potential difficulties faced by certain exporting countries. For this specific trade concern, the SPS-STC database provides the list of countries involved (Ecuador, Israel, Kenya, and the EU), the official documents related to the concern, the affected product (HS06), two subject keywords (plant health, risk assessment) and a description of the concern and its development over time. One potential caveat of this approach based on available data is that it will not capture cases where trade tensions on NTMs are settled bilaterally without raising the issue at the WTO.

Information on international legal instruments relating to food safety is made publicly available through the International Portal on food safety, animal and plant health (IPFSAPH) http://www.ipfsaph.org/). IPFSAPH is a joint undertaking between a number of SPS-recognized standard-setting organizations and international agencies. It was developed by FAO in association with Codex Alimentarius, the IPPC Secretariat and OIE. The database contains binding international legal instruments relating to food safety: international instruments (those developed by standard setting bodies, such as OIE, Codex Alimentarius), regional instruments (mainly European Union regulations), soft law instruments (such as OECD safety considerations for biotechnology 1992, and the FAO Code of conduct for responsible fisheries). The portal provides search facilities by commodity, by country and by cross-sectoral issues (such as human health impact).

The World Bank has also a database developed by Wilson and associates on trade facilitation using survey information from the World Economic Forum. In addition, the World Bank Technical Barriers to Trade Survey (Wilson and Otsuki, 2004b) (http://www1.worldbank.org/wbiep/st-db/) is the first attempt to globally investigate the impacts of technical requirements with surveys. They collect information from agricultural, manufacturing, and trade firms in various emerging market countries regarding technical barriers encountered in export markets, which impact their ability to successfully export. The data collected cover 689 firms in over 20 industries in 17 developing countries.

[17] This is the data used to construct table 1 in this paper. Some work is needed to make this text-based information usable for statistical purposes. A web-based database of specific trade concerns raised at the WTO TBT committee measures was under construction as of end 2009.

6 Concluding remarks

Efficiency costs of NTMs are much less evident than the welfare losses associated with tariffs and quota. NTMs do not necessarily embody the economic inefficiencies that are associated with classical trade barriers, unless they discriminate between sources of supply, and they may be the least trade-restricting policies available in the face of market imperfections. It is therefore not clear a priori that the trade impacts of regulations are inefficient, or that removal of associated non-tariff measures that affect trade would achieve efficiency gains that would exceed the losses from weaker regulation.

The increasing prevalence of NTMs is a reality of trade in agri-food. A systematic assessment, across countries and across products, is much warranted, in particular view of the rising occurrence of trade frictions about food safety and food quality (Josling *et al*. 2004).

This paper contributes to a systematic analysis of economic costs and benefits of NTMs. The proposed methodology is operational for comparing alternative policy choices like standards, border inspections policy and labelling in an international context. The methodology contributes to a more comprehensive welfare analysis of NTMs than that offered by looking at trade affects alone.

A series of case studies is currently underway to explore the applicability of the framework. From the preliminary results, is has become evident that data availability can be a constraining factor, in particular if the NTMs in question concern very specific products, for which statistical agencies usually do not collect detailed data.

The proposed comparative approach to NTMs allows for the identification of alternative ways to address a given regulatory problem. By systematically enumerating costs and benefits for all the different economic actors involved, an evidence-based approach can be followed that yields a solid basis for mutual exchange and identification of least-cost solutions.

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