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A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade

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Foreword

This report develops a conceptual framework for the assessment of costs and benefits associated with non-tariff measures that allows an evidence-based comparative assessment of alternative regulatory approaches. It was prepared by Frank van Tongeren (OECD Secretariat), John Beghin (Iowa State University), and Stéphan Marette (INRA), and benefited from contributions by Joanna Komorowska (OECD Secretariat).

Keywords

Information and product quality; standardization and compatibility, economics of regulation, agriculture in international trade, trade policy; international trade organisations.

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Executive Summary

Governments are increasingly called upon to respond to a variety of concerns raised by society in many areas such as the environment, animal welfare and food safety. Corrective actions are expected when markets either do not exist or fail and hence result in inefficient outcomes. If market solution is not satisfactory, governments have a number of options available to intervene, including regulatory, subsidy or tax based measures. Responding to some of those concerns is a purely local or national matter with little or no incidence on trade or trade policy. But in the case of traded goods, non-tariff measures (NTMs) are becoming an increasingly important policy tool particularly against a background of continued trade integration and lowering classical barriers to trade, such as tariffs and quotas.

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.

Assessing the economic effects of NTMs poses significant challenges. Many technical measures may restrict trade but improve welfare through reduction in negative externalities (*e.g.* through reduced risk of importing pests or diseases) or informational asymmetries (*e.g.* through a label providing to the consumers details on the product). 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.

Efficiency costs of NTMs are hence much less evident than the welfare losses associated with tariffs and quantity measures. They 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 report develops a unified analytical framework to assess the costs and benefits of measures for stakeholders along the supply chain: domestic consumers, producers and governments, as well as foreign suppliers, and where relevant it can even include foreign consumers and governments. Trade effects are part of the assessment, as measures impact on trade as conduit of the externality, but trade effects are not the sole focus. The analytical framework allows comparison of alternative ways to design measures and discerns their trade and welfare effects. For example, an import ban (or prohibitive

standard) to keep the domestic market free of some undesired product characteristic can be compared to allowing trade under the condition that the foreign product be clearly identifiable (*e.g.* through labelling).

The central notion of the framework is to distinguish those consumers (or producers) that are concerned by the negative or positive externality and product attributes, from those that are not concerned. The value that concerned consumers attach to avoiding the undesired product characteristic is a key variable in the cost-benefit assessment of measures that address failures affecting consumers. Estimating empirically this value is a challenge, but recent advances in consumer economics are promising. On the production side, the value of avoiding a failure is directly related to the value of the production loss that can occur if the failure remains unabated.

The cost-benefit framework is essentially a modular partial equilibrium model, with demand and supply relationships, that can be calibrated to empirical data and allowing the calculation of economic welfare effects. The modular set-up renders the approach flexible enough to expand it with side calculations. For example, detailed estimates of costs associated with monitoring and enforcement of measures could easily be added, but are not currently elaborated. The report also mentions several extensions that can be incorporated but are not fully discussed, such as non-prohibitive standards where both domestic and foreign firms make costly efforts to comply and consumers are to some extent able to identify the degree of compliance. Other extensions include entry and exit of firms in the face of fixed and variable compliance cost.

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.

Application of the framework to specific issues will need to address limitations of the method developed here, especially when human health issues are concerned. For such cases, alternative methods have been briefly reviewed in this report and those could be applied. The empirical results will depend on the configuration of parameters and on the quality of data used. To determine the robustness of the results and to underline the limits a thorough sensitivity analysis with alternative assumptions, ranges of parameter values and different scenarios can be employed. Showing whether a conclusion is robust under a range of plausible parameters can be more valuable than one single positive welfare estimate.

The 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.

A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade

1. Introduction

The German Reinheitsgebot ("purity law") for beer dating back to a Bavarian law of 1516 is a well known example of a set of rules that describe how a product meant for human consumption had to be produced in order for it to enter the market. The Reinheitsgebot was partly motivated by concerns about food safety, assuring that the right ingredients were used.[1] Four and a half centuries later, the German insistence that beer had to be brewed according to this standard had to give way in the interest of freer trade on the internal market of the EU. Since the unilateral German standard has been abolished consumers can now enjoy beers from other European and non-European suppliers next to beer that is still produced under the old Reinheitsgebot.

This historical anecdote nicely illustrates the issues treated in this report. 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. Such was largely the case in the 16th century beer market in Bavaria, which was very localized with very little cross-border trade. 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. Banning all non-compliant products from the domestic markets, as was the case in the German beer market before the European Court of Justice ruling in 1987, is one very drastic instance of such a non-tariff measure (NTM).

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 (Levine and d'Antonio, 2003). Imports can carry invasive species such as pathogens, pests, or weeds, foreign to an economy's ecology (CABI, various). Different trade partners may have different food safety standards and

1. Another motivation was to restrict the use of wheat in beer brewing so as to divert wheat into bread production. Next to the brewing ingredients (barley, hop and water) the law also regulated the sales of beer in terms of packaging requirements and pricing. Bavaria insisted on national acceptance of the Reinheitsgebot as a precondition for German unification under Otto von Bismarck in 1871. It became a Germany-wide law only in1907. The controversy over what may be called a proper "beer" in Germany continues to the present time. Another motivation was to restrict the use of wheat in beer brewing so as to divert wheat into bread production.

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.

The different forms of NTMs carry different costs and benefits for different parts of society. For example, banning non-compliant beers from the German market has benefited some domestic beer producers by excluding foreign competition, it may also have protected consumers from consuming unsafe ingredients, but it also deprived some consumers of access to foreign varieties of beer, once the technology was in place to make beer tradeable over longer distances.

This report develops a framework for a systematic accounting of economic costs and benefits of NTMs. By looking explicitly into potential benefits that NTMs may generate through addressing various types of market failures, this approach differs substantially from the recent literature on non-tariff barriers[2], which tends to have a narrow mercantilist focus on foregone trade (*e.g.* Otsuki *et al*., 2001). The cost-benefit framework developed here allows for an economic assessment of different alternative ways to address the same market failures. Three broad classes of market failures are considered: 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. Finally, we also touch upon the problem of limited monitoring of compliance with food standards.

A unified framework is developed that allows the assessment of economic effects of NTMs designed to address these different types of market failures. 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. In practice the distinction between the two groups may be hard to make. 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 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

2. Note that non-tariff barriers are a subset of the broader concept of non-tariff measures as used in this report, since it is not clear a priori whether a given measure in fact constitute a barrier to trade.

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 framework is modular, in the sense that 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 overall objective of the work as defined in the scoping paper OECD (2007a) is to investigate the significance of NTMs covering agricultural and food trade and to quantify their economic impact. By aiming to develop a framework for economic assessment of selected non-tariff measures initiated by governments in the agri-food sector in OECD countries, the current report presents a first step towards an evidence-based approach that will yield a solid basis for mutual exchange and identification of least-cost solutions. The present report discusses a conceptual framework to facilitate a comparative assessment of different approaches to address a given market failure or imperfection through regulatory measures that have a bearing on international trade. The conceptual work is complemented by a number of empirical case studies that are identified using a data-driven selection procedure and that highlight strengths and weaknesses of the conceptual framework.

The report is structured as follows. We first review the major forms of market failures and imperfections in section 2. Section 3 describes policy instruments associated with the failures identified in section 2; section 4 describes their trade effects. Section 5 discusses potential changes in market structure induced by NTMs and associated costs of compliance. Section 6 discusses the use of cost-benefit methods compared to alternative methods. A proposed modelling approach is presented in section 6. The remaining sections provide guidance on how to empirically implement the proposed framework. Section 7 reviews recent developments in valuation of external effects. Section 8 explains how to implement the framework, which is illustrated in Section 9. The last section provides a potential roadmap for further development. Several Appendices provide supplementary information on NTMs (Appendix 1), and the modelling approach (Appendix 2).

2. A taxonomy of market failures and imperfections

This section discusses the major forms of market imperfections and market failures which are relevant for 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.

2.1 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.3 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

2.2 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

3. 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.

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).

2.3 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 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.

2.4 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. 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)[4] 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 (OECD, 2007a) 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.

4. 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 first report in July 2008.

3.1 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 (See section 8 on TRAINS-WITS). 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 is currently being 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[5]. 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 following (the full list with additional sub-categories is provided in Appendix 1):

A. Sanitary and phytosanitary measures
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)

5. The case study countries are Brazil, Chile, India, Philippines, Thailand, Tunisia and Uganda.

The subset of measures under categories (A) through(C) is most relevant for the current report. 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 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. Category A280, 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 (A 310) 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 recognized (see subcategories covered in A320, Lack of Recognition).

3.3 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 (B100 and subcategories). 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 (B200 and subcategories) 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 (B230 subcategory). GMO regulations are another subcategory of B200, and so are identity preservation and environment-specific requirements, addressing either production-based externality and/or commons issues.

Subcategory B300 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.

3.4 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. Sub-category C100 covers pre-shipment inspections to check conformity of the products, potentially addressing the above mentioned failure of omission; C200 covers custom formalities not included in (A) and (B). Finally C900 is the residual of last resort (technical measures n.e.s.). These are not obviously motivated by market imperfections.

4. Trade effects of NTMs

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. From the outset, this project is designed to go beyond this type of approach and to comprehensively account for welfare implications of policies addressing externalities and market imperfections. Many NTMs may restrict trade but improve welfare in the presence of the negative externalities or informational asymmetries discussed above. 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.

There is also 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.

As trade can be a vector for transmission of an externality, some NTMs directly address trade as the source of the externality, such as through a restriction or prohibition in the case of an outbreak of infection. Several papers have looked at these restrictions with animal disease outbreaks (Wilson and Anton, 2006; Lee and Paarlbergh, 1998; Pendell *et al*., 2007 among others).

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.

5. Industry structure and NTMs

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).

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.

6. The use of cost-benefit analysis and alternative methods

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. There are several reasons why cost-benefit analysis is widely considered (OECD, 2006c). First of all, it provides a rational basis for decision making by forcing the decision maker to consider the beneficiaries and losers of a policy change. Secondly, cost-benefit analysis requires any policy to be considered as one of a series of options. Thirdly, cost-benefit analysis helps to determine the optimal scale of the policy, in the sense of choosing the option that maximises net benefits. Moreover, when enumerating investment decisions a cost-benefit analysis explicitly accounts for time through a process of discounting.

Being deeply rooted in the theory of welfare economics the cost-benefit analysis takes individual preferences into account.[6] It translates the theoretical notion of preferences into an applied measurement of consumer choices through the willingness-to-pay (or willingness to accept) concept. Section8 below discusses recent advances in measurement of willingness to pay (WTP), and alternative applied methods.

Despite its appeal, various constraints may impede the realization of exhaustive cost-benefit analysis. 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. The CBA framework

6. 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.

with 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).

7. Cost-benefit framework: a modular approach

This section introduces a framework to systematically assess costs and benefits of NTMs addressing the external effects and market imperfections discussed previously. 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 Appendix 2.

Table 1.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).

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.

7.1 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 $i=\{1,\ldots,N\}$ 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:

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

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 $\beta=0$. [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:

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

7. The case where consumers attach a positive value to the characteristic is completely symmetric. It is captured by taking a negative value for $r2$.

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.

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]:

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

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

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

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 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.

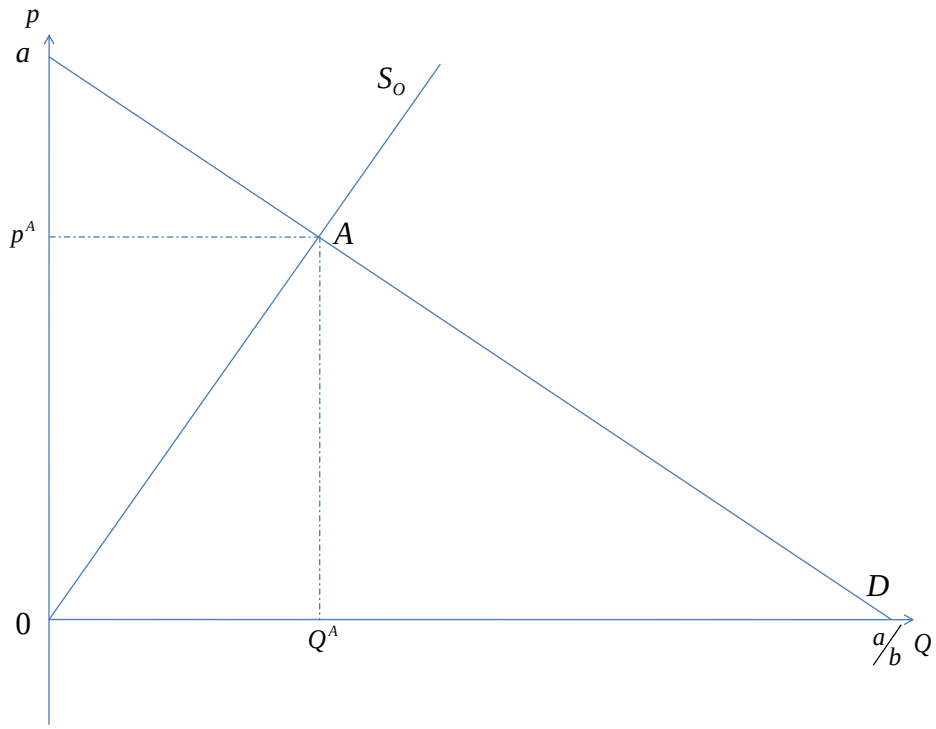
Prohibitive standard

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.

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

Figure 1. Consumption externality, prohibitive standard



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.

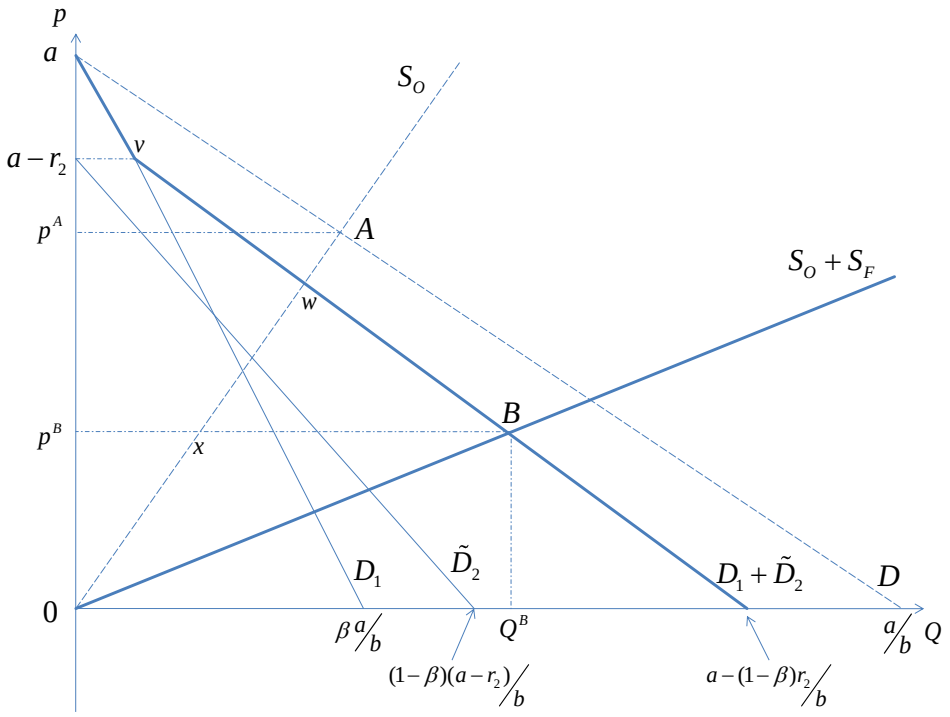
On the demand side, recall that a proportion β of consumers is completely indifferent between domestic and foreign products, since these consumers are not concerned by the additional characteristic brought by the foreign producer. This subgroup has an overall demand D_1. A proportion (1-β) of consumers 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 $p_2^D(Q,1)$).

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

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.

the absence of information about the product characteristic makes it impossible to distinguish the two 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.

Figure 2. Consumption externality, free trade



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-β) 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.

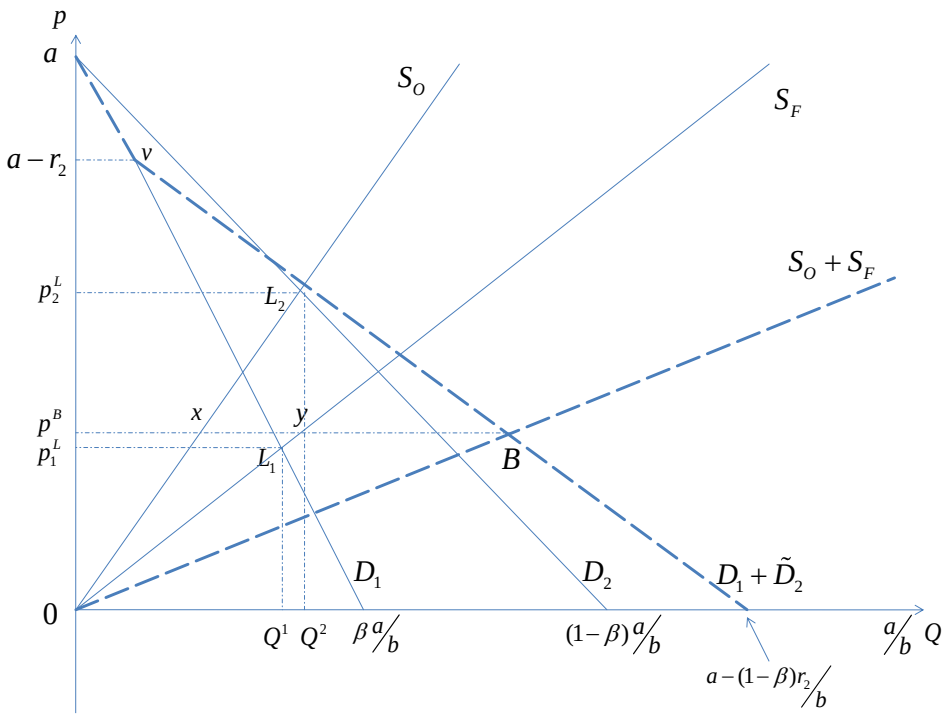
The effect of trade liberalization on the domestic country, *i.e.* the comparison between the welfare OAa under autarky and the welfare $OxBva$ under free trade is ambiguous. If area xBw is larger than area $vaAw$, the decrease in price is large enough for trade liberalization to be beneficial to the 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-β) 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*.

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).

Figure 3. Consumption externality, mandatory label



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.

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 $0\,p_1^L L_1$, which is clearly lower than the welfare $0\,p^B y$ 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_O 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_O 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.

7.2 Market failures affecting producers

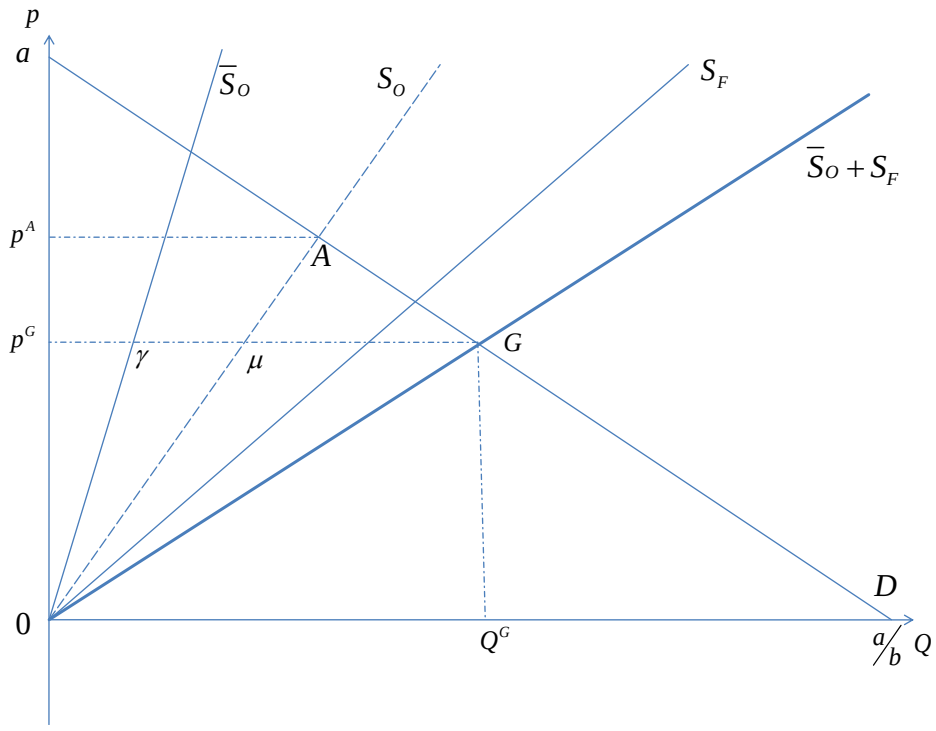
Production-based failures, such as animal or plant disease outbreaks, can be conceptualized as a negative shock on supply as shown in Figure 4, inducing a shift or a pivot of the marginal cost curve. This follows Orden and Romano (1996), Wilson and Anton (2006), and Peterson and Orden (2008). The initial 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.

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.

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

7.3 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.

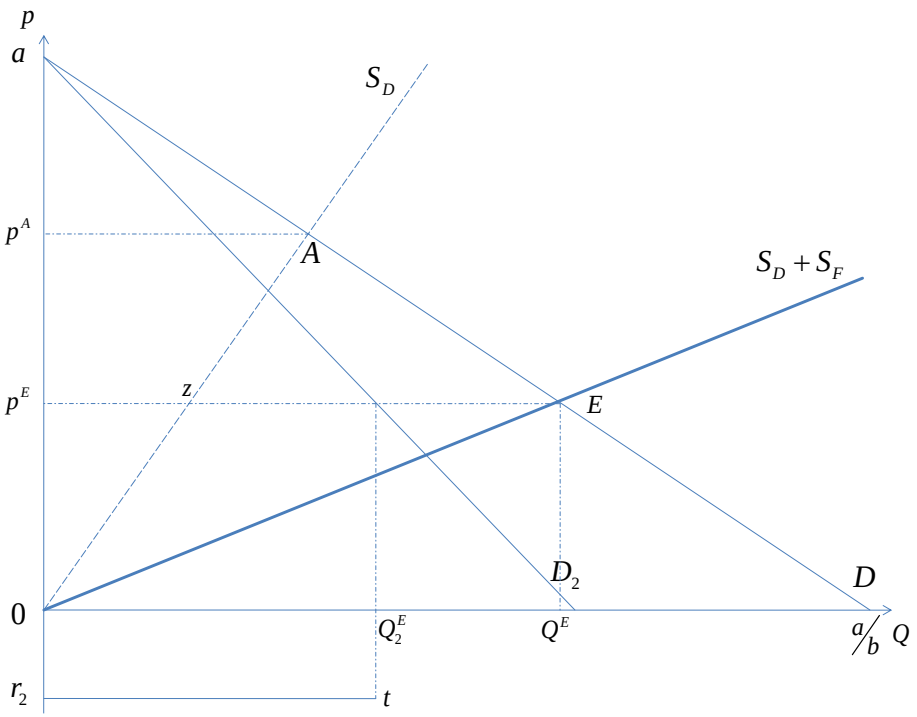
In Figure 5 free trade leads to an equilibrium price p^E that equalizes demand and total (domestic plus foreign) supply. Because their atomistic consumption decision does nothing to abate the global externality, it does not impact the demand of concerned consumers when the market opens to foreign producers (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 Ozp^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.

7.4. Extensions

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).

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 (2008) 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).

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,b) and OECD (2008 a,b), 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.

Foreign consumers and foreign governments

A comprehensive analysis should take foreign consumers and foreign governments into account, perhaps imposing their own policies. Since regulations tend to differ between countries, especially if they are at different levels of development, this raises the issue of mutual recognition or harmonization.

Border inspections and other non-tariff border measures

Inspections at the border or other non-tariff border measures such as single port of entry lead to increased variable trade costs. Conceptually these can easily be incorporated by introducing a tariff-equivalent of such measures that increases the foreign supply price paid by domestic consumers. Hummels (2001) develops a method to empirically estimate the tariff equivalent of time delays at the border.

Pre-shipment inspection

Instead of inspecting goods once they arrive in the port of destination, compliance may be checked at the point of departure (perhaps even at the production facilities). For the assessment of the effects of those measures, it should be taken into account who bears the pre-shipment inspection costs. If it is the country of destination, it should be accounted as a cost in the importing country. However, if costs have to be borne by the exporter, it obviously increases the cost of exporting. Inspection costs might also be split between the two countries. Regardless of the question who pays the inspections costs, their incidence operates like a tax on imports.

8. Recent advances in measuring valuation of market failures and global commons

This section discusses recent advances in empirically measuring the valuation that consumers attach to product characteristics. Arguably, this is the most critical part of the analysis, as consumer's willingness to pay for (or avoid) certain product characteristics largely determines the welfare assessment. 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 information asymmetries, but also when current trade policies exclude imports. It is beyond the scope of this report 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). As this publication does not discuss experimental methods, this report elaborates somewhat on this approach which is increasingly being used and is of particular relevance to issues treated in this report.

8.1 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. Two types of non-market valuation methods can be used, namely the QALYs approach, discussed in Section 6 above, and the WTP approach.

QALYs methodologies may be incorporated into the cost-benefit framework proposed here, in particular for damage for which consumers are not aware (Figure 3). As discussed in Section 6, a drawback of this approach is its inability to reflect responses of consumers in demand. In other words, the costs estimated through QALYs methods have no equivalent in terms of demand adjustments linked to reactions of consumers, as the adjustments presented in the figures above.

In contrast, methods based on estimates of WTP allow economists to assess consumers' reaction. These methods make it possible to include quality-related aspects that cannot be translated into identifiable short-term illness.

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 economics* (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. The numerical example presented below uses WTP measures derived from laboratory choice experiments. 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).

Before briefly detailing some of these WTP methods, it is particularly important to reflect on the robustness of these methods, in particular respondents' incentives 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. 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.

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. Huffman *et al*. (2003, 2007) show the sensitivity of WTP to the source of information (NGOs, Multinationals or public health authorities). 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.

By directly revealing willingness to pay, the experimental method makes it possible to obtain a monetary estimate of all the benefits arising from a given policy measure impacting trade. Note that almost all papers in lab experiments elicit WTP but do not integrate them into welfare analysis. By estimating the value of information, Rousu *et al*. (2004, 2007) come close to welfare measurement but without any link to a calibrated model.

8.2 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 and visible 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.

8.3 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 report. 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 this 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.

9. Towards implementation of the framework

This section explains how the framework proposed in section 6 can be made operational for actual policy analysis. The section goes through the usual steps involved in implementation of a model, from specifying functional forms to finding estimates of important parameters of the specified model, and various data types required to calibrate the model and their sources.

9.1 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.

Without the introduction of the foreign product, the demand and supply equations on the domestic market are represented by linear approximations with the corresponding elasticity at the point of approximation. From equation (2), the overall demand without information (with $I = 0$) is defined by $Q(p) = (a - p)/b$. With the observed quantity $\hat{Q}$ sold over a period, the average price $\hat{p}$ observed over the period, and the direct price elasticity ε $(= (dQ/dP)(P/Q))$ obtained from econometric estimates, the calibration leads to estimated values for the demand equal to $1/\tilde{b} = -\varepsilon\hat{Q}/\hat{p}$, $a = \tilde{b}\hat{Q} + \hat{p}$. Section 8.2 below mentions several elasticity databases that are publicly available to draw from.

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.[13] 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 in a way consistent with the framework defined by equation (1) and (2) in subsection 6.1.[14] 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.

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 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

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

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

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. With the model calibrated for an initial price p^A and integrated in the cost benefit analysis the value of the shift is $r_2 = -\delta p^A$. This is to be incorporated into equation (2), with a decreasing demand shift for $\delta < 0$ and positive demand shift for $\delta > 0$. This value measures the shift of the demand calibrated at a price p^A. Note that the welfare computed with unaware consumers can also be estimated with this measure (see Marette *et al*. (2008b) for details).

9.2. Data sources

WTP measures

As explained in section 7, 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.

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.

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. A drawback of these datasets arises from uneven reporting by countries and heterogeneous coverage of measures across countries and commodities. It may say more about reporting behaviour than regulations. 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).

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.

10. An illustration: labelling of fish

The following example illustrates the application of the cost-benefit framework for NTMs. It assesses the impact of mandatory labelling in the case of fish consumption in France and is based on Marette *et al*. (2008a). The illustration evaluates the impact of a label providing health information affecting consumer choice between a relatively "risky" type of fish (*i.e.* tuna) and a type of fish that is not only "less risky" but in addition offers health benefits (*i.e.* sardine). From a health policy perspective, a shift of consumption towards sardines is desirable because the latter contains more of the healthy omega-3 fatty acids and less of the unhealthy methylmercury than tuna does. However, policies that induce substitution away from tuna have international trade implications, as most canned tuna (95%) and canned sardines (99%) consumed in France is imported. In particular, foreign producers of tuna would face a declining demand after the revelation of information about risk (as in Figure 3). This could have significant impact on tuna-exporting countries in the developing world, such as Ivory Coast, and the Seychelles (Ofimer, 2007). This example corresponds to a welfare evaluation that is very close to the case comparing Figure 2 and Figure 3 above. The possibility of a prohibitive standard, amounting to a ban on tuna imports, is not considered here, but would be conceptually close to the comparison of Figure 1 and Figure 2 above. The price impact of a prohibitive ban would likely be substantial.

To obtain consumer's valuation of the health attributes and to obtain an assessment of the value of product information linked to a mandatory label, a laboratory choice experiment was conducted. Subjects invited to participate were French women of childbearing age, since fish is particularly important during pregnancy. Following the methodology described in subsection 9.1, the results of the experiment are calibrated with market data and elasticity estimates to determine the value of the information. Compared to the framework outlined in this report, an additional factor is the presence of two goods (tuna and sardines) that are substitutes in consumption.

Parameters of the model are initially calibrated such as to replicate prices and quantities in France for the year 2002 (Table 2), the most recent complete year when the analysis was undertaken. For the supply side, a linear supply function is calibrated to elasticity estimates that are found in the literature. The calibration of linear demand function parameters uses own-price and cross-price elasticity estimates for both tuna and sardines. Three different demands are calibrated for the initial situation without information on product attributes: 1) A group of consumers who purchase both tuna and sardines; 2) a group of consumers who only purchase tuna; and 3) consumers only purchasing sardines. The aggregation of demands of different subgroups leads to the overall demand.

The initial demand allows welfare to be computed in the absence of health information. The welfare impact of information is obtained using the results from the lab experiment to update demand after the health information has been revealed.

It is assumed that only the demands of consumers consuming both types of fish are modified by health information provided to them.[15] From the choice behaviours in the experimental setting the response to product information can be observed. From the experiment and from the definition of δ in subsection 9.1, the average increase in the relative sardine WTP is $\overline{\delta}_{sardine} = 0.79$ after the revelation of information, which leads to an increasing demand shift (see Marette *et al*., 2008a). The average change in the relative tuna WTP is $\overline{\delta}_{tuna} = -0.21$ after the revelation of information, which leads to a decreasing demand shift. These values from the experiment sample are extrapolated to the corresponding French population to calibrate the shifts in demands for tuna and sardines. In order to single out the subgroup of the consumers being "at risk", or "concerned", from those that are "indifferent" (not concerned by the health message of this experiment), the analysis assumes that only households with women of childbearing age and/or with young children under age 14 are relevant (recall that only women of childbearing age participated in the experiment since this group is targeted by food safety authorities). This distinction is made on the basis of medical evidence that clearly identifies this group as being at greater risk. The group of households "at risk" represents 50.5% of French consumers. The rest of the population is considered as completely indifferent with $\delta_{sardine} = 0$ and $\delta_{tuna} = 0$, which is a restrictive assumption.

Table 2. Demand Specification for canned tuna and canned sardines in France

Variable	Description	Values	
Canned Tuna	Overall consumption in France in 2002 (in tons)	63 845	
	Average price in 2002 (in euros)	6.1	
	Supply elasticity	0.2	
Canned Sardines	Overall consumption in France in 2002 (in tons)	11 484	
	Average price in 2002 (in euros)	8.2	
	Supply elasticity	0.2	
Consumers	1) purchasing both sardines and tuna		
% of households consuming sardines and tuna[3]		65%	
	Demand elasticities	Tuna	Sardines
	Own-price	–0.58*	–0.476*
	Cross-price	–0.059*	0.144*
Consumers	2) only purchasing tuna		
% of households consuming only tuna		32.5%	
	Own-price elasticity of demand	–0.534*	
Consumers	3) only purchasing sardines		
% of households consuming only sardines		2.5%	
	Own-price elasticity of demand	–0.451*	

Source: Marette *et al*. (2008a). For the estimation for the elasticity, * indicates significance at the 5% level in the regression between the log of quantities and the log of prices.

15. An extension could allow for the additional possibility that consumers who only purchase tuna and consumers who only purchase sardines change their consumption but the experimental procedure based on the substitution between these products was not designed for this case.

To measure different forms of information diffusion, a case where all the 50.5% of concerned households receive health information is distinguished from a case where only half of these concerned consumers are reached by this information. The change in profits for foreign producers of canned tuna and canned sardines can be singled out from the supply chain profits (canning industry and domestic retailers). The estimation of foreign producers' profits takes into account the share of imports relative to domestic consumption of canned fish (95% for canned tuna and 99% for canned sardines) and it takes into account the share of the canning industry in the total value added of the supply chain. Based on import prices and retail prices, the estimated share of the consumer price received by the tuna canning industry is 48% and the share of the consumer price received by the sardines canning industry is 37%. The rest of the total value added goes to the French retailers. We now turn to the results.

Table 3. Economic effects of labels (information) to prices and different groups (in euros)

		Unit	All concerned consumers receive information (50.5% of population)	Half of the concerned consumers receive information (25.25% of population)
Price variations				
Δp_T	Tuna absolute	Euros	–0.28	–0.14
$\Delta p_T / \hat{p}_t$	Tuna relative	%	–4.6%	–2.3%
Δp_s	Sardine absolute	Euros	3.70	1.85
$\Delta p_s / \hat{p}_s$	Sardine relative	%	45.2%	22.6%
Surplus variation when prices vary				
$\Delta\Pi_T$	Change of profits for the total canned tuna supply chain	Euros	–21 579 855	–10 832 098
$\Delta\Pi_T^F$	Change of profits of foreign producers	Euros	–9 977 086	–5 008 039
$\Delta\Pi_S$	Change of profits for the total canned sardine-supply chain	Euros	54 931 214	26 503 449
$\Delta\Pi_S^F$	Change of profits for foreign producers	Euros	20 444 841	9 864 315
$\Delta\Pi_S^F + \Delta\Pi_T^F$	Change of total foreign producers profits		10 467 755	4 856 276
ΔCS_1	Change of surplus non-concerned consumers	Euros	–13 830 515	–12 576 828
ΔCS_2	Change of surplus concerned consumers	Euros	7 609 339	8 403 685
ΔW^O	Domestic welfare		16 662 428	6 641 931
ΔW	Total welfare (domestic welfare+ foreign profits)	Euros	27 130 183	11 498 207
$\Delta W / W$ (%)	Relative total welfare change	%	2.8%	1.2%

Source: Marette *et al*. (2008a) and authors' estimation for profits of foreign suppliers.

Table 3 provides the economic impact of information on prices and surpluses of agents for the year 2002. The demand shifts imply a fall in the equilibrium price for tuna ($\Delta p_T < 0$) and an increase in the equilibrium price for sardine ($\Delta p_S > 0$).The price change for sardines is larger than the absolute value of the price change for tuna, because the demand-increasing shift for sardines is larger than the demand decreasing shift for tuna. Consequently, profits for tuna producers fall, while profits for sardine producers surge. Foreign tuna producers suffer from the revelation of information, but this loss is outweighed by the benefit to foreign sardine producers, since the change in total foreign profits is positive. Retailers who capture more than half of the value added in the supply chain (52% of the consumer price for tuna and 63% of the consumer price for sardines) benefit from the revelation of information. Consumers in households at risk benefit from the information, as shown by the positive change of their consumer surplus. This group benefits from having the possibility to make better informed consumption decisions. The change in surplus of these concerned consumers is a little higher when half of the concerned consumers receive information compared to the full revelation to all concerned consumers (EUR 8.4 million compared to EUR 7.6 million). Indeed, the benefit linked to additional information mainly comes from information about the omega 3 content of sardines. However, the large upward price effect for sardines partially cancels out these benefits linked to the revelation of information. Consumers not concerned by the information suffer from the subsequent change in market prices with a negative change in their consumer surplus. This loss comes from the large price increase for sardines that outweighs the positive impact of the small price decrease for tuna. As non-concerned consumers mainly consume tuna, the change in surplus of these non concerned consumers is of similar magnitude under both scenarios since the price variation of tuna is relatively low with a relatively inelastic demand. Table 3 shows a positive net welfare gain from informing households at risk despite some losses for tuna producers and for consumers not concerned by the revealed information.

Note that this analysis could be extended by considering other NTM instruments, such as a mercury standard imposed on tuna, and tax and subsidy instruments (Marette *et al*., 2008b). As underlined above, the results of this type of analysis depend on the configuration of parameters and on the quality of data used. To determine the robustness of the results and to underline its limits a thorough sensitivity analysis with alternative assumptions, ranges of parameter values and different scenarios can be employed. Showing whether a conclusion is robust under a range of plausible parameters can be more valuable than one single positive welfare estimate. This simple example illustrates the applicability, feasibility, and flexibility of the proposed framework.

11. Concluding remarks

This report opens the way toward 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.

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 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. This approach gains particular importance in view of the rising occurrence of trade frictions about food safety and food quality (Josling *et al*. 2004).

The proposed methodology also opens possibilities for analytical work based on the newly proposed NTM classification by the MAST group.

By applying the proposed framework to several cases with different policy settings and in different markets will gain insights into its applicability and limitations under a variety of circumstances, and whether the model is able to provide reliable estimates of all benefits and costs. Two papers (TAD/TC/CA/WP(2008)4) and TAD/TC/CA/WP/RD(2008)1 prepared for the Joint Working Party on Agriculture and Trade discuss the data availability and selection of possible cases for further analysis.

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Appendix 1:

The MAST Classification of NTMs

Classification of Non-Tariff Measures (version June 2008)

A000 SANITARY AND PHYTOSANITARY MEASURES	*Sanitary and phytosanitary measures include laws, decrees, regulations, requirement, standards and procedures to protect human, animal or plant life or health.*
A100 *Voluntary standards*	*Rules, guidelines or characteristics for products or processes and production methods, which are designed to protect human, animal and plant health and life.(e.g. composition, quality and hygiene), approved by recognized bodies at international, national or sub-national levels, or those set established by private companies. Voluntary standards do not have the authority of law.*
A110 International Standards	*Standards developed by international standards organisations. By definition, international standards are suitable for universal, worldwide use.*
A111 Production Process standards	*Standards defining processes for the production chain that will contribute to the safety and suitability of products.*
A112 Product characteristics standards	*Standards defining the characteristics requested for products (e.g. size, colour, composition and quality) and contribute to the safety and suitability of products.*
A119 International Standards, n.e.s.	
A120 National Standards	*In general, each country or economy has a single recognized Standards Body (NSB). SPS allows countries to set their own standards which must be based on science. Applications of these rules must be limited to the extent necessary to protect human, animal or plant life or health. These rules should not be used arbitrarily or unjustifiably to discriminate between countries where identical or similar conditions prevail.*
A121 Production process standards	*Standards defining processes for the production chain that will contribute to the safety and suitability of products*
A122 Product characteristics standards	*These will rule the characteristics requested for products (e.g. size, colour, composition and quality) and will contribute to the safety and suitability of products.*
A129 National Standards, n.e.s.	
A130 Subnational Standards	*Standards that may be imposed by a state or region within a country imposing extra requirements beyond national standards.*
A131 Production process standards	*Standards defining processes for the production chain that will contribute to the safety and suitability of products.*
A132 Product characteristics standards	*Standards defining the characteristics requested for products (e.g. size, colour, composition and quality) and contribute to the safety and suitability of products.*

A139 Subnational Standards, n.e.s.	
A140 Private Standards*	*Standards demanded by private entities, such as organizations representing supermarket chains and other bodies. (e.g. pesticide regulations, traceability and general hygiene of foodstuffs).*
A200 *Sanitary and phytosanitary regulations*	*Sanitary and phytosanitary regulations include laws, decrees, requirements and procedures to protect human, animal or plant life or health. Compliance is mandatory.*
A210 Labelling, Marking and Packaging requirements	*Measures regulating the kind, colour and size of printing on consumer packages and labels and defining the information that may or should be provided to the consumer which is directly related to food safety.*
A211 Labelling requirements	*Labelling is any written, electronic, or graphic communication on the consumer packaging or on a separate but associated label.*
A212 Marking requirements	*Measures defining the information for transport and customs, that the transport/distribution packaging of goods should carry, which are directly related to food safety.*
A213 Packaging requirements	*Measures regulating the mode in which goods must be or cannot be packed, in conformity with the importing country handling equipment or for other reasons, and defining the packaging materials to be used, which is directly related to food safety.*
A220 Traceability requirements	*Traceability is the disclosure of information regarding the origin of live animals and animal products as well as for agricultural products, including product processing history, and the distribution and location of the product after delivery. It aims to track through all phases of production and distribution.*
A221 Origin of materials and parts	*Description of geographical origin of animals, plants and their derivative products.*
A222 Processing history	*Description of all stages of production*
A223 Distribution and location of products after delivery	*Description of transport, handling and storage of products after the production is finished*
A229 Traceability requirements, n.e.s.	
A230 Tolerance limits for residues and contaminants, or restricted use of certain substances	*Maximum concentration of residue levels permitted (MRLs) on food, feed, wood, plants etc., or restriction on the use of certain substances as ingredients*
A231 Tolerance limits for residues of or contamination by certain substances in foods and feeds	*Maximum Residue Limits (MRL) for toxic and other harmful substances and contaminants that enter the product during the production and/or distribution processes (e.g. insecticides, heavy metals, POPs and chemicals generated during processing such asacryl amide).*
A232 Restricted use of certain substances in foods and feeds	*Restriction on the use of certain substances as ingredients, which are therefore reasonably expected to exist in the final product. As a result, their specification is also important to prevent the risks arising from their use*

A240 Regulation of foods or feeds derived from, or produced using genetically modified organisms (GMO)	*These regulations may include labelling and authorization requirement or outright prohibition.*
A250 Hygienic requirement	*Restrictions to avoid contamination by microorganisms and parasites in foods and feeds that cover production, manufacturing, transport and storage conditions. Includes post-harvest treatment and pathogen controls*
A260 Disease prevention measuresA261 Restriction/prohibition in case of outbreak of infectious diseases	*Measures to protect animals, humans and plants from any infectious/contagious diseases. Covers restrictions other than quarantine requirements. Measures included in this category are typically more of an ad-hoc and time-bound nature*
A262 Quarantine requirement	*Requirement to quarantine imports for a certain period. It is not a prohibitive measure. Quarantine supposes also quarantine fees, inspection fees, veterinary fees, boarding, fumigation etc.*
A270 Regulations on productions processes:	*This group of entries registers safety regulations relating to the production process (such as for example HACCP). It covers primary production (plant & animals) and processing. National regulations that provide that only foods produced under certain code of practices can be accepted for sale are also included.*
A271 Plant growth processes **A272 Animal raising or catching processes** **A273 Food and feed processing, including storage and transport** **A279 Regulations on productions processes, n.e.s.**	
A280 Geographical restrictions	*Prohibition on imports of specified products from countries or regions due to presence of phytosanitary hazards (e.g. insects, mites, plant pathogens)*
A290 Sanitary and Phytosanitary regulations n.e.s.	
A300 Conformity assessment related to SPS	*Control, inspection and approval procedure, including procedures for sampling, testing and inspection, evaluation, verification and assurance of conformity; and accreditation and approval*
A310 Certification requirement	*Certification requirements either in the exporting or importing country*
A311 Certification by government agencies of the countries of origin	*Requirement to obtain certifications from the exporting country.*
A312 Certification by local agencies in the destination market	*Requirement to obtain certifications from the importing country.*
A320 Lack of recognition	*Certifications issued by a country or authority are not recognized by the importing country.*
A321 Lack of acceptance of internationally recognized accredited conformity assessment bodies	*International certifications are not recognized by the importing country.*

A322 Lack of acceptance of certificates of conformity assessment bodies issued in the country of origin	*Certifications from exporters are not recognized by the importing country.*
A323 Lack of acceptance of Self Declaration of Conformity (SDoC)	*SDoC: procedure by which a supplier provides a written assurance that a product conforms to specified requirements*
A329 Lack of recognition, n.e.s.	
A330 Testing requirement	*Includes sampling requirement and are usually associated to testing or laboratory fees*
A340 Inspection and clearance requirement	*Imports require inspection and/or clearance to be accepted. Inspection can be done by public or private entities.*
A350 Registration requirement	*Importers may need to be registered in the importing country. It is often the case for sensitive products such as medicines and/drugs. Exporters need to contact a registered importer.*
A360 Repetition in destination market of identical tests for same or equivalent regulations	*For a given regulation, a same test must be performed within a destination country at national, regional and/or local entry points*
A370 Translation requirement for reports or certificates	*Documents must be translated to the language of the destination countries*
A380 Requirement to pass through specified entry point or customs	*Certain goods must be cleared at a specific entry point within a destination country for availability of testing or inspection facility*
A390 Conformity assessment related to SPS n.e.s.	
A900 Sanitary and phytosanitary measures, n.e.s	
B000 TECHNICAL BARRIERS TO TRADE	*Technical barriers to trade (TBT) are regulations/standards referring to technical specification of products and conformity assessment systems thereof*
B100 *Voluntary standards*	*Rules, guidelines or characteristics for products or processes and production methods (e.g. size, colour, composition, quality, security and safety), approved by a recognized bodies at international, national or sub-national levels, or those established by private companies. Compliance is not mandatory as voluntary standards do not have the authority of law.*
B110 International Standards	*Are standards developed by international standards organisations? By definition, international standards are suitable for universal, worldwide use.*
B111 Production Process standards	*Standards defining processes for the production chain that will contribute to the security, safety and suitability of products.*
B112 Product characteristics standards	*Standards defining the characteristics requested for products (e.g. size, colour, components and quality) and contribute to the security, safety and suitability of products. Also includes those related to product performance.*
B113 Management system standards	*Standards that provide requirements or give guidance on good management practice, establishing a framework on production (e.g. the quality system of a manufacturing business might include looking at more efficient manufacturing processes or speeding up distribution).*
B119 International Standards, n.e.s.	

B120 National Standards	*Technical standards to be applied at National Level regulating product technical characteristics and production processes*
B121 Production process standards	*Standards defining processes for the production chain that will contribute to the security, safety and suitability of products.*
B122 Product characteristics standards	*Standards defining the characteristics requested for products (e.g. size, colour, components and quality) and contribute to the security, safety and suitability of products. Also includes those related to product performance.*
B129 National Standards, n.e.s.	
B130 Subnational Standards	*Standards that may be imposed by a state or region within a country imposing extra requirements beyond national standards.*
B131 Production process standards	*Standards defining processes for the production chain that will contribute to the security, safety and suitability of products.*
B132 Product characteristics standards	*Standards defining the characteristics requested for products (e.g. size, colour, components and quality) and contribute to the security, safety and suitability of products. Also includes those related to product performance.*
B139 Subnational Standards, n.e.s.	*Standards demanded by non-governmental bodies, such as private companies. (e.g. computer software standards or electric appliances).*
B140 Private Standards*	
B200 ***Technical regulations***	
B210 Labelling, Marking and Packaging requirements	*Measures regulating the kind, colour and size of printing on packages and labels and defining the information that may or should be provided to the consumer. Labelling is any written, electronic, or graphic communication on the packaging or on a separate but associated label, or on the product itself.*
B211 Labelling requirements	
B212 Marking requirements	*Measures defining the information for transport and customs, that the transport/distribution packaging of goods should carry.*
B213 Packaging requirements	*Measures regulating the mode in which goods must be or cannot be packed, in conformity with the importing country handling equipment or for other reasons, and defining the packaging materials to be used.*
B220 Traceability requirements	*Traceability is the disclosure of information regarding the origin of materials and parts, including product processing history, and the distribution and location of the product after delivery. It aims to track through all phases of production and distribution.*
B221 Origin of materials and parts	*Description of geographical origin of materials and parts.*
B222 Processing history	*Description of all stages of production*
B223 Distribution and location of products after delivery	*Description of transport, handling and storage of products after the production is finished*
B229 Traceability requirements, n.e.s.B230 Tolerance limits for residues or restricted use of certain substances	*Maximum concentration or restrictions to use certain substances*

B231 Tolerance limits for residues or contamination by certain substances	*Maximum limits for toxic and other harmful substances and contaminants that enter the product during the production process.*
B232 Restricted use of certain substances	*Restriction on the use of certain substances as components or additives, which are therefore reasonably expected to exist in the final product. As a result, their specification is also important to prevent the risks arising from their use*
B240 Regulation on genetically modified organisms (for reasons other than food safety)	*Restriction on imports if genetically modified organisms are used in the production.*
B250 Identity requirement	*Conditions to be satisfied in order to identify a product with a certain denomination (e.g. minimum, percentage content of an ingredient that gives the name to the final product such as cocoa content in "chocolate")cocoa)*
B260 Environment-specific requirement	*Conditions or requirements that aim to prevent environmental damage or ensure protection of the environment.*
B270 Other product characteristics requirements	
B280 Other production process requirements	
B290 Technical regulations n.e.s.	
B300 *Conformity assessment related to TBT*	*Control, inspection and approval procedure, including procedures for sampling, testing and inspection, evaluation, verification and assurance of conformity, and accreditation and approval*
B310 Certification requirement	*Certification requirements either in the exporting or importing country*
B311 Certification by government agencies of the countries of origin	*Requirement to obtain certifications from the exporting country*
B312 Certification by local agencies in the destination market	*Requirement to obtain certifications from the importing country*
B320 Lack of recognition	*Certifications issued by a country or authority are not recognized by the importing country.*
B321 Lack of acceptance of internationally recognized accredited conformity assessment bodies	*International certifications are not recognized by the importing country.*
B322 Lack of acceptance of certificates of conformity assessment bodies issued in the country of origin	*Certifications from exporters are not recognized by the importing country.*
B323 Lack of acceptance of Self Declaration of Conformity (SDoC)	*SDoC: procedure by which a supplier provides a written assurance that a product conforms to specified requirements*
B329 Lack of recognition, n.e.s.B330 Testing requirement	*Includes sampling requirement and are usually associated to testing or laboratory fees*
B340 Inspection and clearance requirement	*Imports require inspection and/or clearance to be accepted. Inspection can be done by public or private entities.*
B350 Registration requirement	*Importers may need to be registered in the importing country. It is often the case for sensitive products that may be related to security issues. Exporters need to contact a registered importer.*
B360 Repetition in destination market of identical tests for same or equivalent regulations	*For a given regulation, a same test must be performed within a destination country at national, regional and/or local entry points*
B370 Translation requirement for reports or certificates	*Documents must be translated to the language of the destination countries*

B380 Requirement to pass through specified entry point or customs	*Certain goods must be cleared at a specific entry point within a destination country for availability of testing or inspection facility*
B390 Conformity assessment related to TBT n.e.s.	
B900 ***Technical barriers to trade, n.e.s.***	
C000 OTHER TECHNICAL MEASURES	
C100 ***Pre-shipment inspection***	*A physical inspection of goods before they are shipped in the country of export, which establishes the exact nature of the goods. The inspection assures that the goods are in accordance with the accompanying documents that specify their customs tariff code, quality, quantity and price.*
C200 ***Special custom formalities not related to SPS/TBT***	*Formalities to be fulfilled at the customs, which are not related to the administration of SPS/TBT measures*
C210 Documentation requirement	*Requirement to produce any document used to declare shipments to Customs in the country of import*
C220 Direct consignment requirement	*Goods must be shipped directly from the country of origin, without stopping at a third country*
C230 Requirement to pass through specified port of customs	*Goods must pass through a designated entry point and/ or customs office, which might slow down the import clearance process.*
C240 Transportation restrictions	*Particular transportations conditions, norms or laws stipulated by National Authorities of each country that may be considered as restrictive*
C241 Restrictive Air transportations regulations	
C242 Restrictive Sea transportations regulations	
C243 Restrictive land transportations regulations	
C290 Special custom formalities not related to SPS/TBT, n.e.s.	
C900 ***Technical Measures n.e.s.***	
D000 PRICE CONTROL MEASURES	*Price control measures are implemented to control the prices of imported articles in order to: support the domestic price of certain products when the import price of these goods are lower; establish the domestic price of certain products because of price fluctuation in domestic markets, or price instability in a foreign market; and counteract the damage resulting from the occurrence of "unfair" foreign trade practices.*
D100 ***Administrative pricing***	*By administrative price fixing, the authorities of the importing country take into account the domestic prices of the producer or consumer; establish floor and ceiling price limits; or revert to determined international market values. There may be different price fixing methods, such as minimum import prices or prices set according to a reference*
D110 Minimum import prices	*Pre-established import price below which imports cannot take place*

D120 Reference prices and other price controls	*Pre-established import price which authorities of the importing country use as reference to set a floor or ceiling price*
D190 Administrative pricing n.e.s.	
D200 *Voluntary export price restraint*	*A Voluntary export price restraint is an arrangement in which the exporter agrees to keep the price of his goods above a certain level.*
D300 *Variable charges*	*Variable charges are taxes or levies aimed at bringing the market prices of imported agricultural and food products in line with the prices of corresponding domestic products 2. Primary commodities may be charged per total weight, while charges on processed foodstuffs can be levied in proportion to the primary product contents in the final product. These charges include:*
D310 Variable levies	*The rate of tax varies inversely with the price of imports. These charges are applied mainly to primary products. It may be called flexible import fee.*
D320 Variable components	*The tax includes a fixed component and a variable component. These charges are applied mainly to processed products where the variable part is applied on the primary products or ingredients included the final product. It may be called compensatory element.*
D390 Variable charges n.e.s	
D400 *Antidumping measures*	*Antidumping measures are taken against a dumping action of an exporter. It is considered that dumping takes place when a product is introduced into the commerce of an importing country at less than its normal value, i.e. if the export price of the product exported is less than the comparable price, in the ordinary course of trade, for the like product when destined for consumption in the exporting country.*
D410 Antidumping investigations	*Antidumping investigations are initiated either following a complaint by local producers of similar goods or self-initiated by importing country authorities when they have cause to believe that dumping may be materially injurious to national competing producers or third parties' exporters. Provisional duties may be applied during the investigation.*
D420 Antidumping duties	*Antidumping duties are levied on certain goods originating from specific trading partner(s) to offset the dumping margin. Duty rates are generally enterprise-specific.*

D430 Price undertakings	*Undertakings to increase the export price may be offered by exporters to avoid the imposition of antidumping duties. Under WTO rules, prices can be negotiated for this purpose, but only after the dumping has been proved.*
D500 Countervailing measures	*Countervailing measures are intended to offset any direct or indirect subsidy granted by authorities in the exporting country. These may take the form of countervailing duties or undertakings by the exporting firms or by authorities of the subsidizing country.*
D510 Countervailing investigations	*Countervailing investigations are initiated either following a complaint by local producers of similar goods or self-initiated by the importing country authority to determine whether the imported goods are subsidized and cause material injury.*
D520 Countervailing duties	*Duties levied on certain goods to offset the amount of subsidization granted by the exporter on the production or trade of these goods, when the subsidy is assumed to hurt domestic industry.*
D530 Price undertakings	*Undertakings to increase the export price may be offered by exporters to avoid the imposition of countervailing duties. Under WTO rules, prices can be negotiated for this purpose, but only after the injurious effect of the subsidy has been proved.*
D600 *Safeguard duties*	*Emergency and/or temporary duties imposed as a safeguard action. A country may take a "safeguard" action (i.e., restrict imports of a product temporarily) to protect a specific domestic industry from an increase in imports of any product which is causing, or which is threatening to cause, serious injury to the domestic industry that produces like or directly competitive products.*
D700 *Seasonal duties*	*Seasonal duties are applicable at certain times of the year, usually in connection with agricultural products.*
D900 *Price control measures n.e.s.*	
E000 QUANTITY CONTROL MEASURES	*Quantity control measures are aimed at restraining the quantity of goods that can be imported, regardless of whether they come from different sources or one specific supplier. These measures can take the form of restrictive licensing, fixing of a predetermined quota, or through prohibitions.* (Most quantity control measures are formally prohibited by the GATT 1994, but can be applied under specifically determined circumstances (Article XI))
E100 *Non-automatic licence*	*This licence is and import licence, which is not granted automatically. The licence may either be issued on a discretionary basis or may require specific criteria to be met before it is granted.*

E110 Licence with no specific ex-ante criteria	*This licence, which is sometimes also referred to as a discretionary licence, is issued at the discretion of the issuing authority.*
E120 Licence for specified use	*This licence is limited to operations generating anticipated benefit in important domains of the economy, such as export production, investment projects, etc.*
E130 Licence linked with local production	*This licence requires the compulsory linkage of imports with local market outputs.*
E140 Licence combined with or replaced by special import authorization	*In addition to or instead of a licence issued by the main licensing body (usually the ministry of trade), a special import authorization or an inscription in a register is required by a specialized authority which is coordinating a sector of the domestic economy (ministry of industry, ministry of agriculture, etc).*
E150 Licence for non-economic reasons	*This licence is granted for political, religious reasons, or others, which hare not economic.*
E151 Licence for political reasons	*This licence is issued for political reasons rather than economic.*
E159 Licence for non-economic reasons, n.e.s.	
E190 Non-automatic licensing n.e.s.	
E200 *Quotas*	*Quotas involve restricting the importation of specified products through the setting of a maximum quantity or value of goods authorized for import. The different forms of quotas are:*
E210 Global quotas	*Global quotas are quotas established on the basis of the total quantity or value of imports of specific products, which can be filled on a first-come, first-served basis, or pre-allocated to different suppliers*
E211 Unallocated quotas	*Quotas that are filled on a first-come, first-served basis without allocating among exporters*
E212 Allocated to exporting countries	*Quotas which are pre-allocated among potential exporters*
E220 Bilateral quotas	*Quotas of imports reserved for a specific country*
E230 Seasonal quotas	*Quotas of imports for a given period of the year, usually set for certain agricultural goods.*
E240 Quotas linked with purchase of local goods	*Quotas defined as a percentage of the value of similar locally purchased goods.*
E250 Quotas for non-economic reasons	*Quotas for other reasons, rather than economic.*
E251 Quota for political reasons	*Quotas that are granted on the basis of political rather than economic reasons.*
E259 Quotas for non-economic reasons, n.e.s.	
E260 Tariff Rate Quotas	*A system of multiple tariff rates applicable to a same product. The lower tariff rates apply up to a quota of imports, and the higher rates are charged on imports which exceed the quota amount. Quota may be defined in terms of quantity or value.*
E270 Quotas linked with domestic production	*Compulsory linkage of imports (of materials or parts) with localproduction*15
E290 Quotas n.e.s.	
E300 *Prohibitions*	

E310 Total prohibition (not for SPS reasons)	*Prohibition without any additional conditions or qualifications*
E320 Suspension of issuance of licences	*The suspension of issuance of licences is a form of de facto prohibition. This situation may arise in cases related to short-term balance-of payments difficulties, or for other reasons.*
E330 Seasonal prohibition	*Seasonal prohibition involves the prohibition of imports during a given period of the year. This is usually applied to certain agricultural products.*
E340 Temporary prohibition	*This prohibition is set only for a limited period of time, though it may not refer to a fixed ending date. It is usually for urgent matters.*
E350 Prohibition of importation in bulk	*Requirement that products must be imported in small packages or containers*
E360 Prohibition of products infringing patents or intellectual property rights	*Prohibition of copies, counterfeits or imitations of patented or trademarked products*
E370 Prohibition for non-economic reasons	*Prohibitions for political, religious reasons, or others, which are not economic.*
E371 Prohibition for religious, moral or cultural reasons	*Some countries will prohibit the import, use, or possession of any item that is held to be contrary to the tenets of their Faith. This could include non religious materials, pork, alcohol products and illicit drugs or any other item that could be contrary to religion precepts. Any product that is related to pork even if it's not used as food like pig skin is still prohibited in some countries.*
E372 Prohibition for political reasons (Embargo)	*Prohibition of imports from a country or group of countries, applied for political reasons.*
E379 Prohibition for non-economic reasons, n.e.s.	
E390 Prohibitions n.e.s.	
E400 *Quantitative safeguard measures*	*Measures having effect on quantitative restrictions. Quantitative safeguard measures are adopted when the government of the importing country wishes to prevent or remedy serious injuries resulting from a sudden increase of imports, or to facilitate adjustment.*
E500 *Export restraint arrangement*	*An arrangement by which an exporter agrees to limit exports in order to avoid imposition of restrictions by the importing country, such as quotas, raised tariffs or any other import controls5. The arrangement may be concluded at either government or industry level.*
E510 Voluntary export restraint arrangements (VERs)	*Voluntary export restraints are arrangements made by government or industry of an exporting country to voluntarily limit exports in order to avoid imposition of mandatory restrictions by the importing country.*
E511 Quota agreement	*Export quotas, which a given exporting country would accept from an importing country to avoid imposition of mandatory restrictions*
E512 Consultation agreement	*Agreement that includes provisions for consultation with a view to introducing restrictions under certain circumstances*
E513 Administrative co-operation agreement	*Agreement that includes provisions for administrative cooperation with a view to avoiding disruptions in bilateral trade.*
E590 Export restraint arrangements n.e.s.	
E900 *Quantity control measures n.e.s.*	

F000 PARA-TARIFF MEASURES	*Other measures that increase the cost of imports in a manner similar to tariff measures, i.e. by fixed percentage or by a fixed amount, calculated respectively on the basis of the value and the quantity, are known as para-tariff measures. Four groups are distinguished: customs surcharges; additional taxes and charges; internal taxes and charges levied on imports; and decreed custom valuation.*
F100 ***Customs Surcharges***	*Customs surcharges, which are also called surtax or additional duty, is an ad hoc trade policy instrument to raise fiscal revenues or to protect domestic industries.*
F200 ***Additional taxes and charges***	*Additional charges, which are levied on imported goods in addition to customs duties and surcharges and which have no internal equivalent, and which comprise various taxes and fees. The category of additional charges includes the tax on foreign exchange transactions, stamp tax, import licence fee, consular invoice fee, statistical tax, tax on transport facilities and charges for sensitive product categories. Various other taxes, such as the export promotion fund tax, taxes for the special funds, the municipal tax, registration fee on imported motor vehicles, customs formality tax, etc., are classified as additional charges, n.e.s.*
F210 Tax on foreign exchange transactions **F220 Stamp tax** **F230 Import licence fee** **F240 Consular invoice fee** **F250 Statistical tax** **F260 Merchandise handling or storing fees** **F270 Tax on transport facilities** **F280 Taxes and charges for sensitive product categories** **F290 Additional charges n.e.s.**	*Article III of the GATT Agreement allows internal taxes to be applied to imports; however, these taxes should not be higher than those applied to similar domestic products.*
F300 ***Internal taxes and charges levied on imports***	
F310 General sales taxes	*The general sales tax levied on imports is the equivalent of those internal taxes that are applied to all or most products. Three types of internal axes can be distinguished: first, the one commonly known as sales tax, which is an ad valorem tax based on the gross receipts of sales of goods, collected at regular intervals from traders; secondly, the turnover tax or multiple sales tax, which is a tax imposed at more than one level of production and distribution and is based on gross receipts, resulting in a accumulation of taxes; thirdly, the value-added tax which is a modified turnover tax based on the net value added instead of on the gross receipts, avoiding accumulation of taxes and not affecting the price structure and the allocation of resources.*
F330 Taxes and charges for sensitive product categories **F390 Internal taxes and charges levied on imports n.e.s.**	

F400 ***Decreed Customs Valuations***	*Customs duties and other charges on selected imports can be levied on the basis of a decreed value of goods (the so-called "valeur mercuriale" in French). This practice is presented as a means to avoid fraud or to protect domestic industry. The decreed value de facto transforms an ad-valorem duty into a specific duty*.
F900 ***Para-tariff measures n.e.s***	
G000 FINANCE MEASURES	*Financial measures are intended to regulate the access to and cost of foreign exchange for imports and define the terms of payment. They may increase import costs in the same manner as tariff measures.*
G100 ***Advance payment requirement***	*Advance payment requirements related to the value of the import transaction and/or related import taxes, are made at the time an application is lodged, or when an import licence is issued. These payment requirements can consist of:*
G110 Advance import deposit	*Advance import deposits require the importer to deposit a percentage of the value of the import transaction before receiving the goods. No interest is paid on these deposits.*
G120 Cash margin requirement	*Cash margin requirements entail depositing the total amount of the transaction value in a foreign currency, or a specified part of it, in a commercial bank, before the opening of a letter of credit.*
G130 Advance payment of customs duties	*Advance payment of custom duties entails paying all or part of the customs duties in advance; no interest in paid on these advance payments.*
G140 Refundable deposits for sensitive product categories	*Refundable deposits are charges which are refunded when the used products or the containers they came in are returned to a collection system.*
G190 Advance payment requirements n.e.s.	
G200 ***Multiple exchange rates***	*Varying exchange rates for imports, depending on the product category. Usually, the official rate is reserved for essential commodities while the other goods must be paid at commercial rates or occasionally by buying foreign exchange through auctions*.
G300 ***Restrictive official foreign exchange allocation***	*These restrictions are usually executed by the central bank in the form of permits, visas, authorizations, etc, and are intended to control import flows. Foreign exchange allocation is sometimes prohibited under this measure.*
G310 Prohibition of foreign exchange allocation	*No official foreign exchange allocations available to pay for imports.*
G320 Bank authorization	*A special authorization needs to be obtained from the central bank.*
G330 Licence linked with non-official foreign exchange	*A licence is granted if official foreign exchange is not required*.
G331 External foreign exchange	*A licence is granted only for imports required for technical assistance projects and other sources of external foreign exchange.*
G332 Importers' own foreign exchange	*A licence is granted if importers have foreign exchange held in an overseas bank.*
G339 Licence linked with non-official foreign exchange, n.e.s.	
G390 Restrictive official foreign exchange allocation, n.e.s.	

G400 ***Regulations concerning terms of payment for imports***	*These regulations cover the terms of payment of imports and the obtaining and use of credit (foreign or domestic) to finance imports.*
G500 ***Transfer delays, queuing***	*Transfer delays and queuing relate to the maximum permitted delays between the date that goods have been delivered and the date of the final settlement of the imported goods (usually 90, 180 or 360 days for consumer goods and industrial inputs and two to five years for capital goods). Queuing takes place when the prescribed delays cannot be observed because of foreign exchange shortages, and when transactions are settled after a longer delay.*
G600 ***Surrender requirement***	*This requirement relates to the surrender of foreign exchange earnings to the central bank.*
G900 ***Finance measures n.e.s.***	
H000 ANTI-COMPETITIVE MEASURES	*Measures to grant exclusive or special preferences or privileges to one or more limited group of economic operators, for social, fiscal, economic or political reasons.*
H100 ***Single channel for imports***	*The requirement that all imports, or imports of selected commodities, have to be channelled through state-owned agencies or state-controlled enterprises. The private sector is sometimes also granted exclusive import rights.*
H110 State trading administration, for importing	
H120 Sole importing agency	
H190 Single channel for imports, n.e.s.	
H200 ***Compulsory national service***	*Compulsory national service consists of government-backed exclusive rights of national insurance and shipping companies on all or a specified share of imports.*
H210 Compulsory national insurance	
H220 Compulsory national transport	
H290 Compulsory national service, n.e.s.	
H900 ***Anti-competitive measures, n.e.s.***	
I000 EXPORT RELATED MEASURES	*Export-related measures are measures applied by the government of the exporting country on exported goods.*
I100 ***Export taxes***	*Export taxes/duties are taxes collected on goods or commodities by the government of the exporting country. Export taxes can be set either on a specific or an ad valorem basis*
I200 ***Export quantitative restriction***	*Restrictions to the quantity of goods exported to a specific country or countries by the government of the exporting country for reasons such as: shortage of goods in the domestic market; avoiding antidumping measures; or for political reasons.*
I210 Export Prohibition	*Prohibition of exports of certain products*
I220 Export quotas	*Quotas that limit value or volume of exports.*
I230 Licensing or permit requirements to export	*Exporters are required to obtain licensing or permit by the government of the exporting country to export products.*
I240 Registration, tight regulation or restriction to export	*Requirement to register products before being exported (for monitoring purposes)*
I290 Export quantitative restrictions, n.e.s.	

I300 ***Certification***	*Requirement by the exporting country to obtain sanitary, phytosanitary or other certification before the goods are exported*
I400 ***Inspection fee***	*A fee levied by the government authority of exporting country to cover the cost of inspection for exporting products*
I500 ***State trading administration***	*All or parts of exports of selected commodities have to be channelled through specific enterprises identified by governments.*
I600 ***Dual pricing schemes***	*Different prices for products are applied depending on whether they are sold on domestic market or export markets.*
I900 ***Export measures n.e.s.***	
J000 TRADE-RELATED INVESTMENT MEASURES	
J100 ***Local content measures***	*Requirement to use certain minimum levels of locally made component, which restrict the level of imported components.*
J200 ***Trade balancing measures***	*Measures limiting the purchase or use of imported products by an enterprise to an amount related to the volume or value of local products that it exports*
J900 ***Trade-related investment measures, n.e.s***	
K000 DISTRIBUTION RESTRICTIONS*	*Restriction to limit and rule the way the products are distributed. It may be controlled through additional license or certification requirement.*
L000 RESTRICTION ON POST-SALES SERVICES*	*Measures restricting producers of exported goods in exporting countries to provide post sales service in the importing country*
M000 SUBSIDIES*	*Financial contribution by a government or government body to a production structure, being a particular industry or company, such as direct transfer of funds or potential transfer of funds (e.g. grants, loans, equity infusions), payments to a funding mechanism and income or price support.*
N000 GOVERNMENT PROCUREMENT RESTRICTIONS*	*Measures controlling the purchase of goods by government agencies, generally by preferring national providers*
O000 INTELLECTUAL PROPERTY*	*Intellectual property legislation covers patents, trademarks, industrial designs, lay-out designs of integrated circuits, copyright, geographical indications and trade secrets.*
P000 RULES OF ORIGIN*	*Rules of origin cover laws, regulations and administrative determinations of general application applied by government of importing countries to determine the country of origin of goods. Rules of origin can restrict trade when it is difficult to determine the origin of the final product if raw materials and parts come from different countries. Rules of origin are important in implementing such trade policy instruments as antidumping and countervailing duties, origin marking, and safeguard measures.*

* Until further decision by MAST members, no efforts will be made to collect measures under these categories from official sources. These categories have been created in order to reflect potential concerns by traders through surveys and questionnaires.

Classification of procedural obstacles

A:ARBITRARINESS OR INCONSISTENCY

1. Behaviour of public officials
2. Product classification and/or valuation
3. Application of procedure, regulation, or requirement (including inconsistencies between local and national procedure or regulation)

B: DISCRIMINATORY BEHAVIOUR FAVOURING SPECIFIC PRODUCERS OR SUPPLIERS

1. Local suppliers or producers in destination market
2. Suppliers from other countries
3. Large (or small) companies

C: INEFFICIENCY OR OBSTRUCTION

1. Excessive documentation requirement
2. Strict/detailed/redundant testing, certification or labelling
3. Administrative delay (*e.g.* in authorisation, approval)
4. Complex clearances mechanism (*e.g.* several entities have to approve)
5. Short submission deadlines for required information or forms
6. Outdated procedures, (*e.g.* lack of automation)

Lack of resources, (*e.g.* understaffing, scarce equipment in destination market)

D: NON-TRANSPARENCY

1. Inadequate information on laws/ regulations/registration
2. Unannounced change of procedure, regulation or requirement
3. Lack of inquiry point
4. Non-transparent government bid or reimbursement process
5. Non-transparent dispute resolution
6. Informal payment expected or required

E: LEGAL ISSUES

1. Lack of enforcement, *e.g.* patents, copyrights, trademarks, confidentiality
2. Inadequate due process/appeals process/dispute resolution
3. Inadequate legal infrastructure

F: UNUSUALLY HIGH FEES OR CHARGES (*e.g.* for stamp, testing or other services rendered)

Appendix 2.

Derivation of Market Equilibria and Welfare Measures

This appendix provides details on the derivation of the consumer demand functions and gives the analytical expressions for the calculation of welfare effects for the different cases discussed in the main text.

The inverse demand for indifferent and concerned consumers

Recall the utility function (1):

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

Maximization of (1) under the budget constraint $pq_i + w_i = y_i$, where y_i denotes the income of person *i*, leads to the following inverse demand function $p = a - \bar{b}q_i - I \times r_i$. The corresponding demand for the consumer *i* is $q_i(p) = (a - p - I \times r_i)/\bar{b}$. Aggregate demand over all consumers is then $Q = \sum_{i=1}^{N} q_i(p)$ leading to $Q = N(a-p)/\bar{b} - I \times \sum_{i=1}^{N} r_i / \bar{b}$. By assuming $b = \bar{b}/N$, inverting aggregate demand leads to the inverse demand function

$$p^D(Q, I) = a - bQ - (I \times \sum_{i=1}^{N} r_i)/N. \qquad (1')$$

We assume that a proportion $\beta = N_1/N$ of consumers are completely indifferent to the specific characteristic, with $r_i = 0$ for every i=1,.., N_1. The proportion $(1-\beta) = 1 - N_1/N$ of consumers is reluctant to consume the specific characteristic and associate a damage per unit consumed equal to r_2 across all this subgroup. In this case, it is possible to divide the previous aggregate demand in two subgroup demands, with $Q_1^D(p) = \sum_{i=1}^{N_1} q_i(p) = N_1(a-p)/\bar{b}$ for the consumers indifferent to the negative characteristic, and $Q_2^D(p, I) = \sum_{i=1}^{(N-N_1)} q_i(p) = (N - N_1)\left[a - p - I \times r_2\right]/\bar{b}$ for the concerned consumers. With $b = \bar{b}/N$, $N_1 = \beta N$ and $(N - N_1) = (1-\beta)N$, the respective inverse demands are given by (2) in the main text.

Welfare

For each configuration, domestic welfare is derived by considering surplus areas associated with supply and demand and externalities when they arise.

Consumption-based externalities directly linked to consumption

Prohibitive standard (import ban)

Analytical expressions at the equilibrium under autarky (with a trade ban) are

$p^A = \frac{a\,c_O}{c_O + b\,M_O}$ for the price,

$Q^A = \frac{a\,M_O}{c_O + b\,M}$ for the quantity,

$PS^A = \int_0^{Q^A} [p^A - p_O^S(Q)]dQ = \frac{a^2\,c_O M_O}{2\left(c_O + b\,M_O\right)^2}$ for the overall profits of domestic producers,

$CS^A = \int_0^{Q^A} [p^D(Q) - p^A]dQ = \frac{a^2\,b{M_O}^2}{2\left(c_O + b\,M_O\right)^2}$ for the consumer's surplus,

$W^A = PS^A + CS^A = \frac{a^2\,M_O}{2c_O + 2b\,M_O}$ for the welfare.

Free Trade

Analytical expressions at the equilibrium under free trade are

$p^B = \frac{c_O c_F\left(a - (1-\beta)r_2\right)}{c_O(c_F + b\,M_F) + bM_O c_F}$ for the price,

$Q^B = \frac{(c_O M_F + c_F M_O)\left(a - (1-\beta)r_2\right)}{c_O(c_F + b\,M_F) + bM_O c_F}$ for the quantity,

$PS_O^B = \int_0^{q_O^B} [p^B - p_O^S(Q)]dQ = \frac{c_O(c_F)^2 M_O\left(a - (1-\beta)r_2\right)^2}{2\left[c_O(c_F + b\,M_F) + bM_O c_F\right]^2}$ for the overall profits of domestic producers,

$CS_1^B = \int_0^{q_1^B} [p_1^D(Q) - p^B]dQ = \frac{\beta\left(ab(c_O M_F + c_F M_O) + c_O c_F(1-\beta)r_2\right)^2}{2b\left[c_O(c_F + b\,M_F) + bM_O c_F\right]^2}$, for the indifferent consumer's surplus,

$CS_2^B = \int_0^{q_2^B} [p_2^D(Q,1) - p^B]dQ = \frac{(1-\beta)\left(ab(c_O M_F + c_F M_O) - r_2\left(b(c_O M_F + c_F M_O) + \beta c_O c_F\right)\right)^2}{2b\left[c_O(c_F + b\,M_F) + bM_O c_F\right]^2}$, for the reluctant consumers' surplus,

$W^B = PS_O^B + CS_1^B + CS_2^B$ for the domestic welfare,

$PS_F^B = \int_0^{q_F^B} [p^B - p_F^S(Q)]dQ = \frac{c_F(c_O)^2 M_F\left(a - (1-\beta)r_2\right)^2}{2\left[c_O(c_F + b\,M_F) + bM_O c_F\right]^2}$ for the overall profits of foreign producers.

Free trade with a mandatory label

Analytical expressions at the equilibrium under free trade with a label are

$p_1^L = \frac{a\,c_F\beta}{c_F\beta + b\,M_F}$ for the first price,

$Q^1 = \frac{a\,M_F\beta}{c_F\beta + b\,M_F}$ for the first quantity,

$CS_1^L = \int_0^{Q^1}[p_1^D(Q) - p_1^L]dQ = \frac{a^2 b\,{M_F}^2\beta}{2\left(c_F\beta + b\,M_F\right)^2}$, for the indifferent consumer's surplus,

$PS_F^L = \int_0^{Q^1}[p_1^L - p_F^S(Q)]dQ = \frac{a^2 c_F\,M_F\beta^2}{2\left(c_F\beta + b\,M_F\right)^2}$ for the overall profits of foreign producers.

$p_2^L = \frac{a\,c_O(1-\beta)}{c_O(1-\beta) + b\,M_O}$ for the second price,

$Q^2 = \frac{a\,M_O(1-\beta)}{c_O(1-\beta) + b\,M_O}$ for the second quantity,

$CS_2^L = \int_0^{Q^2}[p_2^D(Q,0) - p_2^L]dQ = \frac{a^2 b\,{M_O}^2(1-\beta)}{2\left(c_O(1-\beta) + b\,M_O\right)^2}$, for the reluctant consumer's surplus,

$PS_O^L = \int_0^{Q^2}[p_2^L - p_O^S(Q)]dQ = \frac{a^2 c_O\,M_O(1-\beta)^2}{2\left(c_O(1-\beta) + b\,M_O\right)^2}$ for the overall profits of domestic producers.

$W^L = PS_O^L + CS_1^L + CS_2^L$ for the domestic welfare,

Production-based externality.

Analytical expressions at the equilibrium under free trade are

$p^G = \frac{ac_Oc_F}{c_O(c_F + b\,M_F) + bM_Oc_F(1-\lambda)}$ for the expected price,

$Q^G = \frac{a(c_OM_F + c_F(1-\lambda)M_O)}{c_O(c_F + b\,M_F) + bM_Oc_F(1-\lambda)}$ for the quantity,

$PS_O^G = \int_0^{q_O^G}[p^G - p_O^S(Q)]dQ = \frac{a^2c_O(c_F)^2(1-\lambda)^2M_O}{2\left[c_O(c_F + b\,M_F) + bM_Oc_F(1-\lambda)\right]^2}$ for the overall expected profits of domestic producers,

$CS^G = \int_0^{Q^G}[p^D(Q) - p^B]dQ = \frac{b\left(a[c_OM_F + c_F(1-\lambda)M_O]\right)^2}{2\left[c_O(c_F + b\,M_F) + bM_Oc_F(1-\lambda)\right]^2}$, for the consumer's surplus,

$W^G = PS_O^G + CS^G$ for the domestic expected welfare,

$PS_F^G = \int_0^{q_F^G}[p^G - p_F^S(Q)]dQ = \frac{a^2c_F(c_O)^2M_F}{2\left[c_O(c_F + b\,M_F) + bM_Oc_F(1-\lambda)\right]^2}$ for the overall expected profits of foreign producers.

Global commons externality

Analytical expressions at the equilibrium under free trade are

$p^E = \frac{ac_O c_F}{c_O(c_F + b\,M_F) + bM_O c_F}$ for the price,

$Q^E = \frac{a(c_O M_F + c_F M_O)}{c_O(c_F + b\,M_F) + bM_O c_F}$ for the quantity,

$PS_O^E = \int_0^{q_O^E} [p^E - p_O^S(Q)]dQ = \frac{a^2 c_O (c_F)^2 M_O}{2\left[c_O(c_F + b\,M_F) + bM_O c_F\right]^2}$ for the overall profits of domestic producers,

$CS^E = \int_0^{Q^E} [p^D(Q) - p^B]dQ = \frac{b\left(a(c_O M_F + c_F M_O)\right)^2}{2\left[c_O(c_F + b\,M_F) + bM_O c_F\right]^2}$, for the consumer's surplus,

$EX = r_2(1-\beta)Q^E = r_2 Q_2^E = \frac{r_2(1-\beta)a(c_O M_F + c_F M_O)}{c_O(c_F + b\,M_F) + bM_O c_F}$, for the externality

$W^E = PS_O^E + CS^E - EX$ for the domestic welfare,

$PS_F^E = \int_0^{q_F^E} [p^E - p_F^S(Q)]dQ = \frac{a^2 c_F (c_O)^2 M_F}{2\left[c_O(c_F + b\,M_F) + bM_O c_F\right]^2}$ for the overall profits of foreign producers.