Framework for analyzing regulations and standards in the NTM-Impact project

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Abstract

This paper outlines issues and challenges in analyzing the impact of regulations/standards on agri-food trade. The discussion will elaborate on two aspects of the program of research on NTMs: (a) linking economic analysis of agri-food trade impacts to specific research questions – impact of public regulations versus private standards, costs and benefits of regulatory measures, and how to integrate risk assessment in the analysis; (b) an introduction to discussion of data selection and methods to analyze the impact of NTMs such as regulations and standards in particular. This overview will set the stage for the ensuing three presentations.

The analytical framework is developed within the EU NTM-Impact project (FP7 KBBE.2008.1.4.05) which foresees data selection and preparation for case studies and a comparative aggregate analysis, focusing on EU agri-food trade.

Summary

1 Introduction

This paper presents a framework for analyzing the impact of regulations and standards on EU agri-food trade. It is based on the EU NTM-Impact project (FP7 KBBE.2008.1.4.05) whose overall objective is to collect and analyze new data on non-tariff measures (NTMs), particularly on governmental regulations and private standards that prescribe the conditions for importing agri-food products into the market of the European Union (EU) and into the markets of the main competing players. The overall aim of the framework that constitutes the first step towards the analyses planned in the NTM-Impact project is to provide guidelines on country and product choice and the selection of specific regulatory measures, as well as to bring together state-of-the-art methodologies and the specific research questions targeted in a systematic way. The analytical framework elaborates on two important aspects: First, sound economic analysis of the impact of regulations and standards on agri-food trade is linked to the specific research questions of the different analyses within the NTM-Impact project, considering specifically public regulations versus private standards, costs and benefits of regulatory measures as well as risk assessment. Second, issues of data selection and methods to analyze the impact of NTMs in general and regulations and standards in particular are discussed.

NTMs are usefully defined as policy measures other than customs tariffs that can potentially have an economic effect on international trade in goods, changing quantities traded, prices, or both (MAST 2008). The project's focus is on an important subset of NTMs which are governmental regulations and private standards. Understanding regulations and standards as instruments correcting for market imperfections and inefficiencies which are associated with production, distribution, and consumption of agri-food products, the project will adapt the MAST (2008) classification system of regulations and standards, including the following categories of measures: Sanitary and phytosanitary measures and their conformity assessment (A200, A300), technical barriers to trade and their conformity assessment (B200, B300), and pre-shipment inspection and other formalities (C000). Furthermore, private standards on sanitary and phytosanitary (A100) and on technical barriers to trade (B100) issues are in the focus of interest when considering the impacts from EU and trade partner NTMs on least developed country (LDC) exports.

The paper is structured as follows. Section 2 discusses the main issues of NTMs with regard to agri-food trade. The third section addresses different methods of measuring the size of NTMs and presents different indicators, differentiating between count measures and stringency measures. Section 4 discusses options for the collection of data on NTMs for the central database which will be developed within the project. The fifth section summarizes the essence of scientific knowledge regarding impact assessment of regulatory measures on agri-food trade and covers measurement challenges for analyzing their impacts in case studies on different product-trade clusters. Section 6 concludes by bringing together the analytical focus and quantification techniques of NTM measurement.

2 Issues of regulations and standards

NTMs such as regulations and standards have been used to address information problems and externalities that are related to societal concerns and cause market failure. Public regulations define minimum food safety and quality requirements, leaving market actors to define private standards that go beyond this minimum. The

increased power of consumers and their awareness of differing production and distribution systems induce food safety and quality demands which go beyond public regulations. Private standards may satisfy the extended demand for food safety and quality. While having a long tradition in regulating domestic agri-food production, regulations and standards also prescribe import conditions and have become increasingly important in international agri-food trade. In the trade context, public regulations that impose import requirements on foreign producers or rather exporters fall under the multilateral trade rules of the World Trade Organization (WTO), more specifically the technical barriers to trade (TBT) and the sanitary and phytosanitary (SPS) agreement. Private standards in agri-food trade are not subject to the WTO rules. While encouraging governments to orientate their import requirements for foreign products towards internationally agreed regulations, the WTO rules maintain the right and obligation of countries to impose their own regulations as long as they are non-arbitrary, nondiscriminatory and least trade-restricting. Providing public goods and facilitating exchange through various means of lowering transaction costs are the important justifications for public agri-food trade regulations (Josling et al. 2004). Minimizing trade related risks, product and product-related process requirements ensure public goods such as food safety, animal, plant, and human life and health but also extend to other quality and technical aspects. With regulations and standards in place, information problems due to product attributes that cannot be directly identified by consumers can be overcome, solving asymmetric information issues between producers and consumers as well as improving the functioning of the market.

With regard to NTMs, market access and competitiveness is the major issue from the perspective of exporters. Despite international coordination and the development of global regulations and standards and common conformity assessment under the institutions like the Codex Alimentarius, the World Organization for Animal Health (OIE), and the International Plant Protection Convention (IPPC) which all are recognized in the WTO trade rules, import regulations continue to differ from country to country, and governments demand that foreign products comply with their requirements. Exporters have to comply with requirements demanded by importing countries and those supplying multiple markets are usually confronted with a patchwork of regulations and standards. The capacity to comply with internationally differing requirements is a crucial issue in assessing the impact of regulatory measures on the exporting countries' competitiveness.

Regulations and standards impose compliance costs on producers that wish to supply foreign markets and can undermine exporters' comparative advantages in trade. In addition to the relative stringency of regulatory measures that importing countries impose on foreign products, country-specific and sector-specific factors, such as infrastructure, administrative services and market structure for example, influence compliance costs and thus the magnitude of the impact regulatory measures may have. While causing costs, import requirements may also bring about benefits for both consumers and producers, and they should be considered in a balanced analysis. Information on the benefits of regulatory measures such as productivity and efficiency gains, better co-ordination and compatibility between links in the supply chain, as well as increased consumer demand is by large missing. Consumers' benefit from regulatory measures is usually measured in terms of their willingness to pay for rules compliant products. If export products are produced according to certain regulations and standards their demand may increase, and buyers may be willing to pay a higher

price for those products. In this case, exporters would find it profitable to comply with even relatively strict import requirements in order to gain access to high-value markets. That is, the profits that exporters can make on the market of the importing country may compensate for their costs of meeting the potentially strict import requirements. As such, regulations and standards do not necessarily restrict trade, and in their presence trade flows may even increase.

Looking at the impact of regulatory issues on the cost structure of producers, a differentiation between fixed (through investment) and variable (through additional activities and process requirements) compliance costs matters. The distinction between fixed and variable costs raises the issue of decomposing the impact of regulatory measures on trade into an intensive and extensive margin. Variable compliance costs on the one hand determine the firms' volume of exports (intensive margin), and on the other hand fixed compliance costs determine whether firms export to a given market (extensive margin). Variable and fixed compliance costs weigh differently for different types of producers. The relation between variable and fixed trade costs in general and firms' productivity characteristics have been established in recent advance of international trade theory, leading to heterogeneous firm models (Helpman et al. 2008).

A further issue that is discussed in the literature is how tight import requirements of developed countries affect particularly agri-food exports from developing and least developed countries (LDCs). Meeting and confirming compliance with them can pose difficulties and in many cases insurmountable challenges for agri-food producers and exporters in developing countries, typically characterized by small and medium enterprises. With their possibly substantial restriction of export opportunities, import requirements demanded by developed countries may have extensive economic implications. However, suppliers of developing countries fulfilling the requirements can benefit from supplying markets of developed countries with tight regulations and standards as potentially substantial gains can be had. Particularly for development purposes, a better understanding of the role of import conditions on exports from developing countries is necessary to better target technical assistance efforts in these countries and to consider potential policy changes so as to further facilitate their trade activities.

3 Identification and measurement of regulatory measures

A number of methods related to the measurement of regulations and standards exist which can be used for quantitative analysis. First, regulations and standards are measured using various count measures. Usually, a binary choice variable is used that is assigned the value of one if a country-pair, product, and year specific trade flow is subject to a regulatory measure and zero otherwise. This binary choice variable presents the base for preparing frequency and coverage type measures. Alternatively, the number of documents or pages describing regulatory measures is counted. Second, regulations and standards are measured through the stringency of their requirements. In several contributions stringency has been derived directly from the requirement, in particular for measures that contain ordinal or cardinal elements such that they can be ranked on an objective scale, e.g. tolerance limits for residues and contaminants. One possible method for measuring the stringency of import requirements going beyond this direct approach is to derive tariff equivalents which determine the equivalent tariff rate that reproduces the changed import level and the altered domestic prices induced by the respective measures. Another method is to make tools operational

which compare regulations and standards across countries on an identical scale and thus provide information on regulations' and standards' stringency in terms of policy heterogeneity.

3.1 Count measures

Frequency measures count the number of regulatory measures or the proportion of products or tariff lines that are subject to regulations and standards within a given product classification. Coverage measures calculate the volume or value of imported goods subject to standards and regulations and are usually expressed as a percentage of the total imports in that product category or tariff line.[1] Few studies systematically apply frequency and import coverage measures to identify the size of regulatory measures. Fontagné, von Kirchbach, and Mimouni (2005) use NTM notification data from the United Nations Conference on Trade and Development (UNCTAD) Trade Analysis and Information System (TRAINS) to calculate the import coverage index which is the ratio of notifying country imports to total world imports for groups of NTMs applied for different risk-reducing regulatory goals. Most studies estimating the trade impact of multiple regulatory measures in econometric models rely on frequency and coverage ratios. Examples are Disdier, Fontagné, and Mimouni (2008), de Frahan and Vancauteren (2006), Fontagné, Mimouni, and Pasteels (2005), and Moenius (2004).

The main advantage of frequency and coverage measures is their calculative simplicity. The only information being necessary is the product (tariff line) and country specific knowledge on the existence of regulatory measures. The content of the specific requirements is not considered. The calculative simplicity attracts a number of criticisms. Regulatory measures are complex and impact different product groups and different countries in different ways. There is little agreement on how to weight the importance of different standards in calculating an aggregate measure of their stringency, indicating their possible impact on trade. It is questionable whether it makes sense at all to calculate the trade impact over an aggregate of all measures. Regulatory measures have an ambiguous impact on trade: regulations may be trade restricting, trade promoting or may have no trade impact at all – a strong tendency cannot be made out from results of an aggregate level (Schlueter et al. 2009). A simple aggregation is not able to identify the potential benefits and downsides of regulations simultaneously. Another drawback of count measures is that the mere existence of regulatory measures does not imply their appropriate implementation and enforcement. Without proper enforcement, regulations and standards may not be effective and the trade impact is not measureable meaningfully. A third problem stems from the fact that the import coverage ratios should be calculated by using the total trade value or volume once standards and regulations are totally removed (Deardorff and Stern 1997). As in practice this information cannot be provided the observed and therefore NTM-biased value or volume of imports is typically used. Despite the above mentioned problems, count measures are often used in the applied literature.

3.2 Stringency measures

The stringency of regulations and standards can be measured directly if cardinal or ordinal elements are part of the measures defining the degree of the NTM. This

[1] Korinek et al. (2008) provide a detailed discussion on advantages and disadvantages of frequency and coverage measures as well as give an overview on existing databases. A review of the current literature is also provided.

includes for instance regulations and standards defining tolerance limits for residues and contaminants, or the duration of a quarantine measure. For example Wilson and Otsuki (2001) and Otsuki et al. (2001) estimate the impact of a maximum residue level for aflatoxin on trade in different products like cereals, nuts, dried fruits, and vegetables which are mostly exported from African countries into the EU. Due to difficulties in assessing directly the stringency of measures regulating or controlling production processes or conformity assessment, the use of the direct approach is however limited.

A measure which allocates a numerical element to an aggregate of regulations and standards is the tariff equivalent.[2] It is based on the idea that regulatory measures impact trade indirectly by changing the transaction costs of trade. As regulatory measures can increase and decrease transaction costs, tariff equivalents can be positive as well as negative accounting for the costs as well as for the benefits of regulations and standards (Marette and Beghin forthcoming). This, ceteris paribus, changes domestic prices in the importing country relative to world market prices without regulatory measures, creating a price effect similar to that which arises when an import tariff is imposed. One way to obtain tariff equivalents is to estimate the quantity impact of regulations and standards on trade and then transform the quantity effect via elasticities into a price effect what is referred as an ad-valorem equivalent of NTMs (Kee et al. 2006). However, tariff equivalents of prohibitive regulatory measures cannot be measured by this approach. Looking at trade and welfare effects of systematically prohibitive policies, Yue and Beghin (2009) propose a method overcoming the lack of observed data on bilateral trade flows which is based on a Kuhn-Tucker approach to corner solutions in consumer choice. Other methods directly concentrate on the price effect and in this case tariff equivalents are, for example, derived by careful price comparison (handy-craft price gap method). In order to obtain appropriate estimates of the price effect, influences on the domestic price unrelated to NTMs such as tariffs, taxes, transportation costs or multilateral resistance need to be corrected for. Although tariff equivalents intuitively illustrate the size of NTMs by allocating prices, there are a number of difficulties associated with implementing them for measuring the impact of regulatory measures on trade. Tariff equivalents are calculated for an aggregate of standards and regulations subject to a product or a product group. This makes it impossible to identify and separate the impact of different regulatory measures which may simultaneously influence trade. Another drawback relates to the amount of necessary information which is not readily available and usually difficult to obtain. As already mentioned above, the price effect induced by regulatory measures has to be separated from other impacts of potential determinants affecting trade flows, and in order to make the necessary corrections additional information is needed. Furthermore, when determining tariff equivalents for NTMs the assumption of perfect competition is most often used (Bhagwati 1965). While perfect competition may approximate the market structure of some agri-food industries, the existence of regulations and standards which provide differentiation in products and may result in imperfect markets renders calculating tariff equivalents for regulations and standards difficult.

Another method takes advantage of differences in regulatory measures between countries, assessing the stringency of regulatory measures in relative terms. The idea

[2] Korinek et al. (2008) provide a detailed discussion on standards and regulations as tariff equivalents and give an overview on literature.

of policy heterogeneity is underlain by the theory that an NTM constitutes a barrier to entry if the measure requires exporting firms to incur additional market entry cost. From this perspective, the differences between the home regulation and the import requirement matter more than the absolute degree of regulation. Nardo et al. (2005) and Kox and Lejour (2005) have prepared a methodology to develop an indicator of policy heterogeneity. It is based on a detailed comparison of import requirements for specific characteristics of products and production processes for individual country pairs. If a country pair has a different policy in place the assigned dissimilarity value is one, and zero otherwise, yielding in binary information per policy item. This is repeated for each policy item and product, before averaging the values and yielding a policy heterogeneity indicator for each country pair for example, or a country deviancy indicator showing the dissimilarity in regulations of one country in comparison to all other countries. Kox and Nordås (2007) find that regulatory heterogeneity has a negative impact on market entry and subsequent trade flows. Furthermore they argue that the impact of regulations in services trade differs from manufactures trade because the delivery of services in a foreign market requires the presence of firms with staff and capital in the foreign country. Hence, firms entering the foreign market must comply with multiple full sets of regulations regarding entrepreneurial activity, human and capital resources – at home and abroad.

4 Options for the collection of data on regulatory measures

The objective of the central database of NTM-Impact is to collect, store and make accessible a set of data on pre-selected governmental regulations for a selected set of agri-food products. In defining what criteria support the decision on what NTMs to include into the central database, two possible leads for criterion development are pursued. First, the products and sectors of key interest to EU export performance; and second, material on concerns and issues from the Market Access Database (MADB).

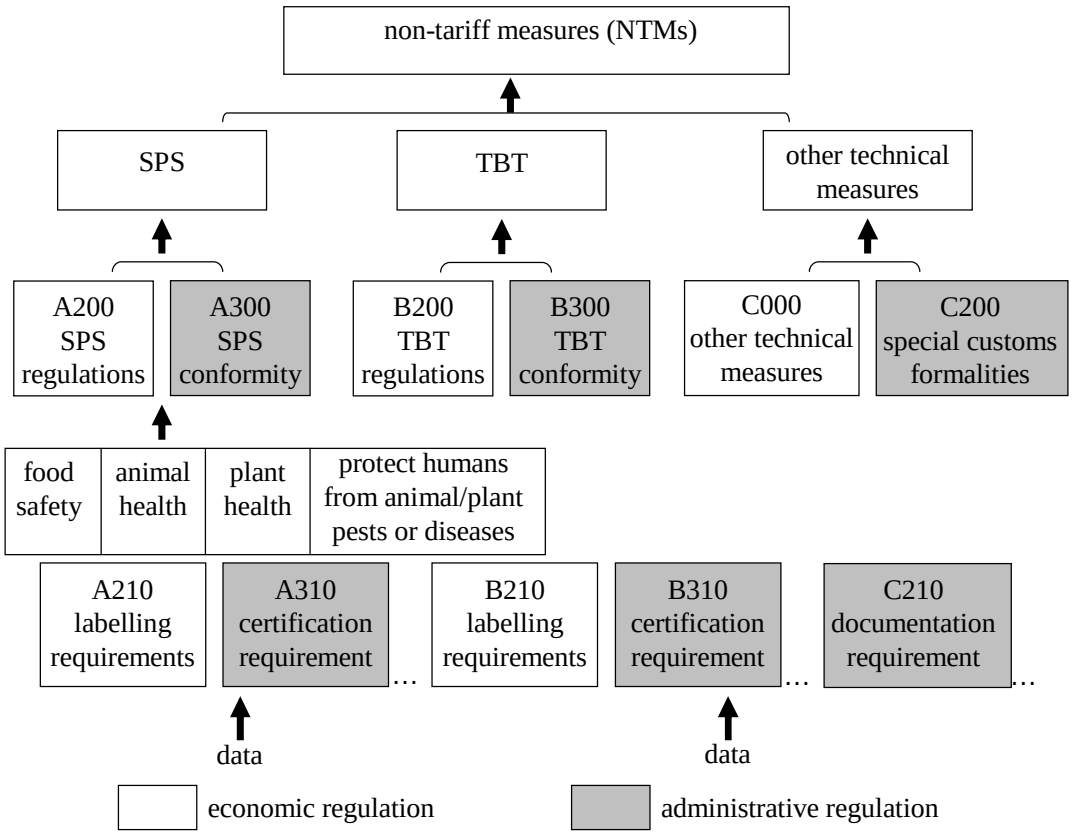
Product selection is a major element in the definition of the scope of the NTM-Impact database as regulations in agri-food trade differ in their coverage across products. The discussion below provides preliminary suggestions for the development of criteria for product selection. A distinction is made between plant and animal products, as there are extensive differences in regulation between plant and animal products. Product selection must follow the interest of analyzing the impact of regulatory differences on agri-food trade between the EU and its ten main export competitors. It is suggested to define two sets of products. Set 1 comprises the main EU export products with high trade volumes. The following options are identified: (1) Incumbents: Top major EU export products 1998-2007 to 10 exports markets; (2) Rising stars: Top fastest growing export products; (3) Potentials: Top major export products to alternative export destinations. Set 2 comprises products for which regulatory differences are perceived as obstacles where the key concerns are the following: (1) Food safety; (2) Animal health; (3) Plant health; (4) Protect humans from animal/plant pests or diseases.

The other main element in defining the scope of the NTM database is material on concerns and issues from the EU Market Access Database (MADB). It is immediately clear from the Trade Barriers section of MADB that technical measures are the main barriers recorded in the database. Over 75 percent of barriers listed are technical measures; almost 60 percent are SPS measures (NTM code A000), 10 percent are technical barriers to trade (NTM code B000) and 8 percent are other technical measures (NTM code C000). For more details on SPS measures, the MADB has a

specific section on SPS measures that supposedly provides input into the central database. The same records that appear in the Trade Barriers section appear yet with additional classifications and search facilities regarding measures, products and countries. There is no one-to-one match however, as the Trade Barriers section lists 12 more SPS-related barriers than the SPS database. Over 60 percent of all entries in the SPS database are on animal health related issues, about 15 percent are on food safety issues and 25 percent are on miscellaneous issues. This distribution of problems does not appear proportional to the amount of problems encountered nor of the volumes of trade; rather is it likely that the dataset contains biases towards types of sectors or issues.

In constructing the central database, the NTM-Impact project takes the idea of policy heterogeneity, and develops it further for the purpose of analyzing the impact of regulations and standards as nontariff measures in agri-food exports of the EU. The database will contain count measures as well as stringency measures concentrating on governmental regulations. If feasible, cardinal or ordinal numbers are included into the database following the direct approach. Based on the idea of the policy heterogeneity approach, methods to compare import requirements measure-by-measure across products and countries will be conceptually and mathematically developed within NTM-Impact. The database will serve two purposes. First, it will be instrumental in providing an overview of NTMs in EU agri-food exports. The perspective is that agricultural products are generally exported after successfully completing an approval process by the importing country. The database will indicate that the likelihood of getting approval differs across countries and products. Despite the presence of the Market Access Database and other relevant sets of data, the European Commission currently lacks such an overview. Second, it facilitates a comparison of import requirements imposed on EU exports to the recommended international standards (Codex, OIE, IPPC), against a benchmark of import requirements for products imported into the EU market. To start with, a template will be developed that lists all relevant EU requirements and the recommended international regulations, if available, and provides a coding system for products, regulatory measures, and time. On the basis of the template, data sampling teams will collect raw data (pdf or text files of legislation, import manuals) on the most recent import requirements for the ten most important EU export competitors, which are Argentina, Australia, Brazil, Canada, China, India, Japan, New Zealand, Russia, and the USA. Regulatory measures at the most specific level are extracted out of these documents, including ordinal and cardinal data. The classification of regulations follows the MAST (2008) classification of NTMs, including the following categories of measures: Sanitary and phytosanitary measures and their conformity assessment (A200, A300), technical barriers to trade and their conformity assessment (B200, B300), and pre-shipment inspection and other formalities (C000). Figure 1 shows how the raw data on regulations is inserted into the classification system, where economic regulation means a measure implemented directly for risk reduction and safety assurance purposes, while administrative regulation means the associated tests to be done that prove that the requirement is met such as conformity assessment measures.

Figure 1: Classification system of regulations



Source: Own compilation

5 Determining the impact of regulatory measures in case studies

It can be thought of many possible situations where import requirements can increase trade and welfare, decrease it or leave it unaltered. The trade and welfare effect of regulations and standards is therefore a priory unclear. This makes the question about how regulatory measures affect trade flows and countries' welfare first and foremost an empirical one. Therefore the following section concentrates on methods measuring the impacts of regulatory measures on countries' trade flows and on their welfare. These methods can be applied in different case studies within the NTM-Impact project which are formulated for different product-trade clusters. Two sets of case studies can be differentiated: First, product-trade clusters which are designed to analyze relative non-tariff measures on imports from the EU compared to other major players exporting the same product; these case studies address the relative competitiveness of EU exporters compared to its main competitors. Second, product-trade clusters which analyze the implications of NTMs in the EU and other high income countries for developing countries; one case study deals here with private standards versus public regulations, and four case studies concentrate on the development impact of NTMs.

5.1 Econometric models

Econometric studies analyzing the impact of NTMs are based on the gravity model which describes bilateral trade flows by a function of exporter and importer gross domestic product (GDP) and world GDP (Deardorff 1998). Under the assumption of trade frictions the assessment of impacts of any form of tariff or non-tariff barriers is allowed, including regulatory measures, by integrating different relevant variables

potentially leading to "distance" between countries. Generally gravity models ask for the impact of NTMs on (bilateral) trade flows. They consider the foregone trade that cannot be explained by tariffs and other potential explanatory variables. As such they do not only consider the trade volume per exporter, but also take into account the number of trade relationships. This is of major importance as on a product-specific level many potential trade relationships do not come about, thus trade flows are zero.

The application of gravity models goes back to Tinbergen (1962) who did the first econometric studies by testing the hypothesis whether economies' sizes and the distance between trading partners are the most relevant explanatory variables for determining the normal pattern of international trade which would prevail when discriminatory trade burdens were absent. The essential assumption of product differentiation for deriving a theory-consistent gravity equation can either be obtained by Heckscher-Ohlin trade theory where trade is impeded and factor prices are not equalized as in Deardorff (1998), by Armington-like specifications assuming differentiation by country of origin as in Anderson (1979) and Anderson and van Wincoop (2003), by Ricardian elements as in Eaton and Kortum (2002), or by monopolistic competition and increasing returns as in Redding and Venables (2004).

Gravity models are quantity-based econometric models. Contrary to simulation models which utilize price terms directly, gravity models include price-terms only implicitly which present a function of observable and unobservable variables. As such gravity models do not provide welfare economics, but the estimated trade flow impact can be transformed into price effects via elasticities to obtain tariff equivalents.

Even though the literature of applied economics discusses several methods of quantifying trade barriers,[3] gravity models seem to be one of the most appropriate methods to measure effects of specific technical regulations while using the cross-sectional richness of trade data. Gravity models of various levels of detail have been used to provide evidence on the trade impact of regulatory measures, whereby some studies take the estimates to derive price effects in terms of tariff equivalents and welfare effects. Gravity studies analyzing the aggregate impact of regulatory measures by using frequency and coverage ratios are for example Disdier, Fontagné and Mimouni (2008), de Frahan and Vancauteren (2006), Fontagné, Mimouni and Pasteels (2005), and Moenius (2004). In contrast, Wilson and Otsuki (2001) and Otsuki, Wilson and Sewadeh (2001) analyze single standards or sector- or product-specific regulations whose stringency is measured on an absolute maximum residual level following the direct approach. Kox and Nordås (2007) follow the policy heterogeneity approach for explaining service trade among EU countries. Moenius (2004) and Fontagné, Mimouni and Pasteels (2005) find out that a positive trade effect prevails in the manufacturing sector and for processed agricultural products, while the trade effect is negative for other products. Exports from developing and least developed countries are negatively affected (Disdier, Fontagné and Mimouni 2008, Wilson and Otsuki 2001, Otsuki, Wilson and Sewadeh 2001) whereas trade between OECD countries is not significantly influenced by regulatory measures (Disdier, Fontagné and Mimouni 2008). The impact of regulations in services trade differs from manufactures trade because the delivery of services in a foreign market requires the presence of firms with staff and capital in the foreign country, forcing firms entering

[3] See Cipollina and Salvatici (2008), Ferrantino (2006), Bora et al. (2002), Beghin and Bureau (2001), and Deardorff and Stern (1997).

the foreign market to comply with multiple sets of regulations and standards (Kox and Nordås 2007).

Several estimation techniques have been applied in the literature. Estimators differ in their consistency and efficiency, whereby the following challenges in estimation have been identified: (1) Many potential trade relationships on a product-specific level are not existent. Standard sample selection bias may result from the need to drop the observations with zero trade flows when log-linearizing the gravity equation (Helpman et al. 2008, Silva and Tenreyro 2006). (2) Potential unobserved firm level heterogeneity caused by an omitted variable which measures the impact of the number of exporting firms may produce biased estimates, i.e. the intensive and extensive margin of the trade impact of trade frictions has to be taken into account (Silva and Tenreyro 2008[4], Helpman et al. 2008). (3) Trade is determined by relative trade barriers. Omitting unobserved country-pair heterogeneity such as multilateral resistance may cause biased estimates (Baldwin and Taglioni 2006, Anderson and van Wincoop 2003). (4) Heteroscedasticity may be present in trade data (Martin and Pham 2008, Silva and Tenreyro 2006).[5] A choice of estimators and models used in gravity literature is: least squares, non-linear least squares, fixed effects and random effects estimation, binary choice estimation, Hausman-Taylor estimation, two-stage estimation procedures, and pseudo maximum likelihood estimation.

5.2 Simulation models

Simulation models have been used in the applied trade analysis of NTMs in general and regulations and standards in particular. Since simulation models are firmly rooted in microeconomic theory they are useful tools for a systematic and economically sound analysis. More specifically, the trade impact and possibly further reaching economic effects are derived accordingly. In two-country simulation models, the trade restricting and facilitating impact of regulatory measures between respective trading countries can be analyzed. When including at least three countries (multi-country models), the analysis can capture possible trade diversion effects due to regulations and standards that on the one hand differ across countries and on the other hand affect trading partners differently. Simulation analysis in particular shows the trade-off between negative and positive effects of regulatory measures, and employing common welfare indicators, simulation analysis sheds light on their welfare (distributional) implications.

In the applied trade analysis changes of regulatory measures are simulated, whereby scenarios often refer to the removal of possible trade barriers. The costs and benefits for producers and/or consumers are introduced in the model equations, and the simulation exercises subsequently models the producer and/or consumer behaviour in response to changing requirements. As many different factors may have counter-balancing effects, the empirical underpinning of reflecting regulations and standards in simulation models seems to be particular important, and sensitivity analysis should generally be used to look into the robustness of results. Next to model parameters and assumptions, how regulations and standards are depicted crucially determines the simulation results. At the demand side, regulations and standards are reflected by consumers' willingness to pay for certain product characteristics which are provided

[4] Silva and Tenreyro (2008) discuss the implementation of the Helpman et al. (2008) trade model and identify its dependence on the homoskedasticity assumption of all random variables as the most important drawback to make it practical.

[5] Baldwin and Taglioni (2006) summarize various canonical mistakes in the gravity literature.

by regulatory measures. At the supply side, simulation models usually depict regulations and standards as additional costs that producers incur when complying, but producers' benefits should also be captured (Marette and Beghin, forthcoming). Like most studies applying simulation models to analyze NTMs, the following paragraphs take the producers' or rather exporters' perspective, thereby concentrating on regulations and standards on the supply side.

Regulatory measures usually describe requirements for specific sectors and/or products in detail. In this regard, partial equilibrium (PE) models have the obvious advantage of capturing sectors (and policy measures) at a more disaggregated level than general equilibrium (GE) models. In the literature, case studies using PE models with a focus on the sector or even only the product affected are found, and they pertain to prominent cases where regulations and standards have either been changed or led to concerns and/or disputes between trading partner countries. The PE models developed in case study work may include distinct characteristics of the measures under review and may also present a detailed representation of the supply chain to provide insight on the impact of regulatory measures at different levels. Another strand of the literature applies GE models in a broad analysis of NTMs across products and countries. As Maskus et al. (2001) state, GE models can provide useful insights about the impact of NTMs due to their consistent representation of the entire economy that allows for analyzing the impact in all sectors, including the possible spill-over effect on those sectors that the measures under review do not directly target.

In simulation models, tariff equivalents are commonly used to model the costs of compliance with regulations and standards. They are obtained by various methods ranging from careful price comparisons to econometric estimation (see section 5.1). The tariff equivalents derived are introduced as wedges between the price for the domestic and foreign product such that this approach to depict standards and regulations essentially yields results similar to those of the usual analysis of tariffs, which are also modeled as price gaps. Unlike tariffs, regulations and standards however do not generate tariff revenues for the importing country, and their trade and welfare effects have to be calculated accordingly. Being modeled as price wedges, regulations and standards are presented as mere border measures that cause costs when the respective products cross the border. From the point of view of firms that wish to export to foreign markets, requirements demanded by importing countries however lead to real trade costs that use up resources and thus affect the firms' export supply function. This is captured by supply shifts using so-called iceberg tariffs that melt away a fixed fraction of the export value on the way from the exporting to the importing country, leading to reduced trade and efficiency losses for exporters. In comparison to price wedges, modeling iceberg tariffs result in a more pronounced trade effect, and the efficiency loss for exporters adds to the usual welfare loss due to restricted trade. For a detailed comparison of the two approaches in the GE modeling framework see Fugazza and Maur (2008).

The size of the supply shift in the iceberg tariff approach is usually approximated by estimates of tariff equivalents for regulatory measures and thus only variable compliance costs are captured. In order to account for the fixed compliance costs, a modeling framework reflecting imperfect competition is necessary and this poses challenges in GE models as a routinely applicable and robust approach is missing. Imperfect competition can be rather easily introduced in PE models. The explicit differentiation between variable and fixed compliance costs allows for determining the economic impact of regulatory measures, in particular the effect of market

structure. In the literature on the applied simulation analysis of regulations and standards, Rau and van Tongeren (2007) specifically model the variable and fixed compliance costs of standards in an oligopolistic PE model, and apply it to EU food safety standards for Polish meat firms. Fixed and variable compliance costs weigh differently across firms, and in another contribution the authors thus employ the concept of heterogeneous firms; for details see Rau and van Tongeren (forthcoming).

Next to reflecting the variable and fixed costs, shifting supply functions allows for including features of the supply chain and the consequent analysis can be used to reveal winners and losers at different levels of the production and supply chain. For example, Lusk and Anderson (2004) use a PE simulation model to analyze how the domestic requirement of country-of-origin labeling affects US meat producers and wholesale and retail meat markets. Furthermore, the benefits of regulatory measures can be accounted for. The benefits relating to productivity gains, reduced transaction and information costs, amongst others, are ideally considered in the approximation of the compliance costs such that the net cost increase for producers and/or exporters is used in the simulation models.

Producers (and consumers) in the importing country clearly benefit from import regulations and standards that reduce food safety risks and/or prevent disease outbreaks and the importation of invasive species. With regard to SPS measures, these benefits in the importing country are taken into account in a risk-based approach. When modeling domestic producer benefits from import requirements on the one hand and the costs that the respective measure causes for exporters on the other hand, the resulting trade-offs can be determined in simulation analyses. For example, in the case of a removal or less stringent SPS import requirements, the welfare gains from increased trade can be offset by the possible production losses following the importation of invasive species or disease outbreaks in the importing country. Taking into account the costs and benefits of import standards and regulation in a more comprehensive way, such risk-based analyses can also be used to investigate the optimal policy response that maximizes welfare. Peterson and Orden (2008), for example, calculate the optimal level of food safety regulation for US imports of Mexican avocados accounting for the probabilities of pest infestation (fruit fly) and the costs for US producers (costs to prevent production losses) as well as for Mexican exporters (compliance costs).

The risk-based analysis of regulations and standards crucially relies on scientific information about the probability of an outbreak and the spread of diseases or pests. This combination of natural sciences/epidemiology and economics in a risk-based analysis is promising, but also poses major challenges given the considerable uncertainty about the risks and their economic consequences. In the literature, several case studies applying PE models conduct a risk-based analysis of import standards and regulations. Beghin and Bureau (2001) provide an excellent overview of existing studies, and important recent contributions can be added, for example Peterson and Orden (2008), Wilson and Antón (2006), Yue et al. (2006) and Gray et al. (2005).[6]

[6] Note that Gray et al. (2005) apply a dynamic PE model in order to evaluate the costs and benefits of aflatoxin standards for US supply and demand of pistachios over a period of 50 years. Dynamic models allow for analyzing how the effects of regulations and standards change over time and the long-term impact can be determined.

6 Linking the analytical focus to quantification techniques

Several approaches to analyze the size and the impact of NTMs in general and regulations and standards in particular exist in the literature. Overall, there is no unifying method and the different approaches applied all have their advantages and disadvantages in terms of practicability, coverage and ability to capture certain features of regulatory measures. All regulations and standards have an impact on bilateral trade flows and on the welfare of concerned countries. The choice of the appropriate quantification technique decisively depends on the analytical focus, i.e. on the concrete research question of impact assessment. Table 1 gives an overview of quantification techniques in different NTM modeling approaches, bringing together quantification methods and the analytical focus/research question of the analysis. The quantification techniques which are stated in the first two columns from the left can be divided into measures of size (see section 3) and impact (see section 5) of regulations and standards. The table gives examples of literature, and indicates whether the measurement method quantifies the trade impact or the price and welfare impact. The concrete focus of measurement or the research question of interest is depicted in the right column of table 1.

All gravity models aim at quantifying the trade impact of regulatory measures. Gravity models utilizing count measures or stringency measures (direct approach) focus foremost on market access and competitiveness; some studies explicitly determine the issues of developing countries. Employing the policy heterogeneity approach measuring the stringency of regulations and standards, the focus of measurement is on market access and competitiveness, additionally on the differentiation between variable and fixed compliance costs. All so far mentioned models use log-linear least squares estimation incorporating fixed or random effects as the case may be. The following gravity models do not explicitly include NTMs as explanatory variables, but imply a general border barrier which implicitly comprises regulations and standards. The focus of measurement is here on methodological issues. When quantifying the trade impact of trade frictions using two-stage estimation based on Heckman (1979), the specific focus of measurement is on the appearance of zero trade flows or on potential unobserved firm level heterogeneity, taking into account the intensive and extensive margin of the trade impact of trade frictions, and aiming at overcoming sample selection bias. If the focus of measurement is on unobserved country-pair heterogeneity, multilateral resistance variables or fixed and random effects models are applied. Overcoming the problem of heteroscedasticity which may be present in trade data, appropriate quantification techniques are pseudo-maximum likelihood, standard Tobit, or Heckman maximum likelihood.

Simulation models focus on the analysis of welfare effects of regulatory measures, directly modeling producer and consumer choices. Market and trade effects of regulations and standards are usually analyzed by including estimates of their tariff equivalents, which can be considered as stringency measures of NTMs as they allocate a numerical element to an aggregate of regulatory measures. When focusing on the appearance of zero trade flows caused by prohibitive regulatory measures, a Kuhn-Tucker approach to corner solutions is a suitable quantification technique. If firm heterogeneity and market structures are in the focus of measurement, tariff equivalents including costs of mitigation strategies against externalities can be used in simulation models. Simulation models can also include an additional cost term modeling the stringency of regulatory measures instead of tariff equivalents. This cost

term indicates the impact on prices. Costs and risk of a pest outbreak are included when focusing on a risk-based analysis for example, or compliance costs are directly contained, potentially differentiating between variable and fixed compliance costs, when focusing on market access and heterogeneous firms.

There is further room for improving the impact analysis of regulations and standards. As said before, the comparison of regulations and standards remains most difficult for regulatory measures having no cardinal or ordinal element. The quality and safety implication of those measures could be translated into cost structures for defining their stringency. Furthermore, the health and safety induction of regulatory measures is essential for deriving a ranking of least-trade distorting regulatory measures in the sense of the SPS agreement.[7] Bringing the trade impact and the health and safety implication of regulatory measures into a relation would offer guidelines to policy makers on how to make use of least-trade distorting but still effective regulatory measures governing agri-food trade.

[7] The provisions of the SPS agreement require that regulations targeting specific national agri-food safety objectives are minimal with respect to their trade effects (Art. 5.4) and not more trade-restrictive than required (Art. 5.6).

Table 1: Overview on measurement issues in different NTM modeling approaches

Quantification technique		Author	Quan-tity effect	Price/ welfare effect	Focus of measurement
NTM size	NTM impact				
Gravity models					
Count measure: frequency and coverage ratios	Log-linear least squares with fixed or random effects	Disdier et al. 2008; de Frahan and Vancauteren 2006; Fontagné et al. 2005; Moenius 2004	x		Market access and competitiveness; developing countries' issues
Stringency measure: direct approach	Log-linear least squares with fixed or random effects	Wilson and Otsuki 2001; Otsuki et al. 2001	x		Market access and competitiveness; developing countries' issues
Stringency measure: policy heterogeneity approach	Log-linear least squares with fixed or random effects	Nardo et al. 2005; Kox and Lejour 2005; Kox and Nordås 2007	x		Market access and competitiveness; differentiation between variable and fixed compliance costs
-	Two-stage estimation based on Heckman (1979)	Helpman et al. 2008; Silva and Tenreyro 2006	x		Zero trade flows; sample selection bias
-	Two-stage estimation based on Heckman (1979)	Helpman et al. 2008; Silva and Tenreyro 2008	x		Unobserved firm level heterogeneity - extensive and intensive margin; sample selection bias
-	Multilateral resistance variables; fixed effects and random effects models	Anderson and van Wincoop 2003; Egger 2005	x		Unobserved country-pair heterogeneity - relative trade barriers (multilateral resistance)
-	Pseudo-maximum likelihood; standard Tobit; Heckman maximum likelihood	Silva and Tenreyro 2006; Martin and Pham 2008	x		Heteroscedasticity in trade data

Simulation models					
Tariff equivalents: price effect via quantity effect	Partial equilibrium model	Kee et al. 2006	x	x	Market access and competitiveness; domestic welfare
Tariff equivalents: Kuhn-Tucker approach to corner solutions	Partial equilibrium model	Yue and Beghin 2009	x	x	Zero trade flows caused by prohibitive regulations
Tariff equivalents: costs of mitigation against externality	Partial equilibrium model	Marette and Beghin forthcoming		x	Market and competitive structure - firm heterogeneity; costs and benefits of regulatory measures
Costs and risk of pest outbreak	Partial equilibrium model	Peterson and Orden 2008; Wilson and Antón 2006; Yue, Beghin, Jenson 2006		x	Risk-based analysis
Compliance costs	Partial equilibrium model	Rau and van Tongeren 2007, forthcoming		x	Market access and competitiveness; firm heterogeneity; differentiation between variable and fixed compliance costs

Source: Own compilation

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