

A REVIEW OF THEORETICAL APPROACHES AND MATHEMATICAL MODELS FOR NON-TARIFF BARRIERS TO TRADE: SANITARY AND TECHNICAL BARRIERS FOR AGRICULTURAL PRODUCTS¹

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1. Introduction

Sanitary and technical barriers to commerce are becoming an increasingly important research area in international economics, not only because they impose barriers to trade, but also because consumers are more increasingly sensitive to them. Individual companies are taking advantage of this situation by offering differentiated products and gaining the confidence of their clients. Many developing countries in particular are putting more efforts on this research area, while at the same time taking part in the fora of the World Trade Organization (WTO) where these issues are discussed.

A number of these barriers raise costs and cause losses in competitiveness. Others, however, may actually exclude goods and suppliers from the market. Surveys held in several countries show that a significant share of these requirements is no longer under the scope of government regulations. Instead, they consist more and more of voluntary standards, developed by different elements of the private sector.

The communication and transportation technologies that have driven the spread of global economic integration have also helped spread the concerns and requirements about food safety, consumer and territory security, environmental protection, and animal welfare, especially among the population of higher income groups, even in developing countries. Thus, under the assumption that consumers will always prefer more than less of quality and security, we will tend in the future to have stricter requirements on trade, both for production and marketing.

Even if we assume that this change in perspective will benefit consumers in all countries, the developing nations face difficulties in complying with the new requirements. Finance limitations, technology and labor restrictions, and cultural and religious factors cause delays in adopting the higher standards. Certainly, compliance within the developing countries augments the quality and technological lags between the modern and traditional sectors within some developing countries. In Brazil, for instance, the producers of fruit who export are rapidly adopting quality certification labels. However, this is not the case for all farmers and regions in the country.

On the other side, developed countries implement changes faster and obtain faster results in terms of trade performance. Moreover, they usually count on more government support and private organization to update and keep pace with innovations and higher consumption patterns. Thus, lags between the richer countries and the poorer ones are also tending to increase.

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Roberts and Unnevehr (2005) state that the additional costs of reduced trade caused by sanitary and technical requirements must be balanced against the public health benefits of safer food. The need for balance between costs and benefits among countries is what makes these measures so controversial in international trade.

Sanitary or technical requirements (barriers) may be socially desirable. Calvin and Krissoff (1998) support this idea by affirming that unlike a tariff, this kind of requirement may increase national social welfare if it corrects a market failure by incorporating important product externalities in the product price.

Maskus and Wilson (2001) relate the need to address such market failures with the presence of asymmetric information on product quality, inadequate provisions to safeguard public health, and the risk of network incoherence. They note that standards have impacts on both static and dynamic market failures, suggesting there are subtle efficiency and welfare tradeoffs.

In this sense, it is understandable why those authors argue that the WTO's developing-country members should consider standards and technical barriers to be priorities on the post-Seattle trade agenda. This view was expressed by large developing countries, such as India, high-income countries, such as Korea, and least-developed countries in Sub-Saharan Africa and Central America. They raised two critical questions: a) the necessary technical assistance for implementing WTO obligations on standards and conformity assessment; b) concerns about the environmental regulations used to restrict imports by developed countries.

A number of examples will illustrate the importance of trade disputes on sanitary and technical measures. Maximum residue limits (MRL), quarantine requirements, pest and disease controls, and pest-risk analysis are some of the most frequent issues. Considering effective disputes in the international market, there is the beef case between the US and the European Union; the mad-cow disease dispute between the US and Japan; the Mediterranean fly in mangos between Brazil and Japan, and the papaya case involving Brazil and the US.

The World Trade Organization forum to deal with those situations is the technical Committee of the Sanitary and Phytosanitary Agreement (SPS), although some problems are also submitted to the Technical Barriers to Trade Agreement (TBT) Committee. Little by little, these themes are being included in the regional agendas discussed through the regional integration processes, but what seems really to be working is to deal with them through bilateral agreements on specific issues. This is so because harmonization on sanitary and technical requirements is very difficult to achieve among countries at highly divergent development levels.

Technical requirements are discussed under the scope of TBT, but survey evidence from current commerce shows that the challenges are increasingly toward voluntary technical standards rather than compulsory ones. Burnquist et al. (2006) asked many companies about their complaints on technical regulations as barriers to trade. Many of them could remember only the voluntary standards they had to comply with to export. Thus, the focus of the discussion shifts from the government policies to the private-sector strategies. This latter is off the negotiation agenda, however, even though it is still in the range of domestic government actions.

An additional issue is related to the difficulty in disentangling the legitimate requirements from those with a protectionist motivation. This caveat justifies the

focus of this paper on discussion of tools to obtain a better comprehension of the legitimacy of specific trade barriers.

Finally, we note that disputes about sanitary and technical barriers, in commerce as well as in the negotiations, are generated and sustained because a scarcity of knowledge and methods to properly address them still prevails.

2. Objectives and Organization of the Paper

This paper aims to present an updated review of literature on the conceptual background for sanitary and technical barriers to trade. A second goal is to review the methodologies available to quantify the effects of such barriers. For years, identifying, classifying and quantifying the effects of such barriers have been an awkward challenge for researchers.

The literature review encompassed by this paper is divided into four basic sections. The first one, section 3, presents the concepts and definitions on Non-Tariff Barriers to trade, particularly focused on sanitary and technical barriers. Additionally, this section will emphasize the evolution of issues as the requirements of firms and governments have changed over time. Their legitimacy and classification will also be components of this section (3.2).

Following the identification and classification of the barriers, researchers need to cope with the challenge of collecting data and organizing them in a way to facilitate modeling and the analysis of policies. That is the focus of the third part (3.3) of this section.

Section 4 examines the methodological approaches previously utilized by other authors to evaluate the effects of sanitary and technical barriers to trade. This section does not pretend to enter into great detail. Instead, it proposes to highlight trends and specific features that contribute to choosing methods for future studies. Researchers have been committed to this economic frontier in trade policy, searching for more robust and parsimonious models.

Finally, section 5 attempts to provide a very brief review of the approaches that can provide direct inputs for public policies. Many authors have included these methodologies in the studies reviewed in the previous section. Separating the topic helps to emphasize the need for developing tools well suited to help governments to take decisions on the topic.

Clearly, information generated by other methodologies discussed in section 4, as well as the information implied throughout section 3, will be essential for the public and private sectors to deal with sanitary and technical barriers to trade. However, section 5 delves into the determinants of methods for public policies and decisions. The social costs and benefits, plus the political difficulties regarding sanitary and technical disputes, are addressed in this section.

That discussion has special implications for developing countries. Such countries face serious budget restrictions and have been very demanding of tools to facilitate public choices.

3. Identifying Sanitary and Technical Barriers to Trade

3.1. Divergences and Convergences of Concepts and Definitions

There is a consensus in the literature that sanitary and technical barriers be included in the wide range of Non-Tariff Barriers to Trade (NTBs). Nonetheless, the first and perhaps the major issue concerning the NTB is its own definition. What is a non-tariff barrier? How can we differentiate a legitimate requirement from a NTB that affects welfare and trade? What kind of NTB should be the priority for a public policy in developing countries? What should be the full understanding of legitimacy? These are not simple questions, nor do they have simple answers, in particular in regard to sanitary and technical barriers.

Hillman (1996) defines NTBs to be all restrictions, other than traditional customs duties, that distort trade. Precisely, “as a generic shorthand to describe a world of government measures, other than tariffs and customs taxes, which restrict or distort international commerce between domestic and imported goods and services”.

There are other definitions that allow including standards of identity, measure, and quality, SPS, and packaging measures. Many authors consider that the NTBs comprehend a set of regulations including many policy instruments (Roberts, 1998; Thornsbury, 1998; Miranda, 2001; and Thornsbury et al., 1999²).

The first divergence in concepts arises from the several ideas mentioned above. As far as the economic agents involved in trade are concerned, all restrictions that distort trade might be considered non-tariff barriers, except those by custom duties. But the set of NTBs will be shorter if someone adds to that statement the conditional of “any governmental restriction” (as public policy). So, even if voluntary (private) standards are affecting trade flows, for the governments they are not considered barriers, in the sense of being subjected to public policy intervention.

Even though recent developments attempt to aggregate the voluntary standards to the set of NTBs, under the scope of government agencies there is little room for negotiation. However, the government is expected to provide infrastructure to support the compliance of countries to standards. Before going into this matter, it is convenient to deal with the differences between regulation and standard.

So far, regulation and standards were mentioned with no regards to their definitions. Nevertheless, it is worth distinguishing them formally: regulation is often defined as a mandatory requirement imposed by public authorities, whereas a standard is defined as a voluntary specification emanating from market forces (Sykes, 1995, apud Maskus and Wilson, 2001).

The WTO defines a standard as follows: “ (...) standards set out specific characteristics of a product — such as its size, shape, design, functions and performance, or the way it is labeled or packaged before it is put on sale. In certain cases, the way a product is produced can affect these characteristics, and it may then prove more appropriate to draft (...) standards in terms of a product's process and production methods rather than its characteristics per se. (...)” (Baller, 2007).

² Thornsbury, S., Roberts, D., De Remer, K., and Orden, D., 1999. A First Step in Understanding Technical Barriers to Agricultural Trade. In: Peters, G.H., and von Braun, J. (Eds.), Food Security, Diversification and Resource Management: Refocusing the Role of Agriculture?, 453-463. Brookfield Vermont: Ashgate.

Despite the importance of standards for achieving efficiency, they can damage trade. Baller (2007) states “while integrating the markets of those who participate, standards can act as a barrier to those who are excluded”.

An important point to make in developing a better understanding of NTBs is that definitions based on economic theory often emphasize that the term “barrier” to trade should not be used for interferences that may incidentally restrict trade but whose principal objective is to correct market inefficiencies. This perspective implies that measures that restrict trade by chance while correcting market inefficiencies and addressing legitimate concerns should not be qualified as an NTB (Beghin and Bureau, 2001). Hence, a broader definition for an NTB is related to the legitimacy question.

This is a second important point because in today’s world it is becoming increasingly complex to judge if a sanitary and technical requirement is a barrier or not. Hence, if a measure could be considered to be legitimate, instead of in a narrower and stricter classification as a barrier, results for public policies and private interests would be easier and more workable. Later, we will look into this comparison, supported by Miranda and Barros’ (2005) study. However, there is no doubt that identifying the supportive arguments for raising a standard (compulsory or voluntary) is a first step to deal with the legitimacy issue.

For Roberts and De Remer (1997) technical barriers can be defined as: “Standards governing the sale of products in national markets which have as their *prima facie* objective the correction of market inefficiencies stemming from externalities associated with the production, distribution and consumption of these products”. Baldwin (1970), on the other hand, restricted the concept to those measures that decrease world global revenue and Mahé (1997) to those that lead to a decrease in world welfare (apud Beghin and Bureau, 2001). These are similar to the idea enunciated by Beghin and Bureau (2001) in qualifying a standard as protectionist if it differs from one that would be chosen by a world welfare-maximizing social planner.

An additional perspective is to compare the regulation focused on international trade with the one that would prevail if designed only for domestic purposes. For Fisher and Serra (2000) the definition for NTBs relies on this rationale. These authors characterize a minimum standard as protectionist when it exceeds what a social planner would adopt if all producers were domestic. This makes it possible to account for the welfare enhancing effect of a standard in the presence of negative externalities.

In addition to the topics discussed above there is a very important distinction to be made between a trade-oriented concept and a welfare-oriented concept. According to Beghin and Bureau (2001), the two conceptions will lead to different approaches for empirical studies.

A comprehensive analysis should thus first clarify the reasons for establishing standards/regulations. That will facilitate the choice of the analytical tool to assess their effects, examine their legitimacy and relevance, and help identify other goals to be achieved. In this context, the economic literature has built a list of reasons to raise standards. For instance, Maskus and Wilson (2001) suggest that such arguments are related to facilitating production and exchange, reducing transaction costs, guaranteeing quality, and achieving the provision of public goods.

Baller (2007) proposes three situations in which standards are needed. The first is a situation in which compatibility of inputs or among final products needs to be assured.

The second is a situation in which there is asymmetric information between producers and consumers about product quality (two cases: experience and credence goods). Finally, there are situations in which goods are produced or consumed under negative externalities. According to Baller (2007), market actions will usually take care of the cases in which compatibilities are required because they are related to efficiency reasons. Baldwin (2000) refers to these kinds of standards as horizontal.

For dealing with the two other cases described by Baller (2007), which characterize market failures, government will have to interfere. Generally, measures in these cases consist of minimum quality standards to guarantee the health and safety of the consumer or provide for the protection of the environment. These are known as vertical standards (Baldwin, 2000).

To conclude, more than ever it is important to make efforts to internalize the discussions on certification and other voluntary standards and to bring them to the perspective of public policy. This is because even private companies will always have freedom to choose their quality requirements. The ability to provide them will depend on the supply of public goods, and this is particularly true for developing countries.

The legal framework for analyzing sanitary and technical barriers to trade include the Sanitary and Phytosanitary (SPS) and the Technical Barriers to Trade (TBT) Agreements under the WTO. Provisions to guide the regulation and negotiation about the two sets of issues are given by these Agreements. Roberts et al. (1999) and Burnquist et al. (2005) provide a review of these provisions.

Finally, it is worth noting why it is important to undertake a study of both sanitary and technical barriers, despite the differences between them. Their nature and goals are generally different, and the first has a scientific basis, which is not necessarily the case for the second. Despite these differences, there are common relevant features in dealing with them. For example, at the margin they are both always related to human security, food safety, territory protection, animal, plant and human health, and environmental protection. On the other hand, the SPS and TBT committees and their performances are very distinct. This provides significant differences in the speed at which these agreements are evolving among countries.

Another argument favoring this joint approach relates to the potential positive balances in welfare analysis, even though the requirements demanded can generate losses for world trade. Hence, most of the challenges concerning concepts, negotiations, methods and public decisions are the same for both types of obstacles.

3.2. The Classification of NTBs and the Legitimacy Issue

Even though international agreements try to prevent countries of using technical and sanitary regulations to restrict trade, sometimes a requisite could be established to protect domestic suppliers from foreign competition. This perspective explains the efforts of several authors to find a classification system that throws more light on the sanitary and technical regulations adopted by individual countries.

In 1998, the Trade Policy Staff Committee (TPSC) published a set of questions to evaluate the consistency of foreign trade requirements with the provisions of the SPS Agreement. A subcommittee of the TPSC had developed this set of questions - Information for Evaluation of the Consistency of Foreign Trade Measures with the provisions of the WTO Agreement on the Application of Sanitary and Phytosanitary

Measures to be used as a tool to systematically collect and organize information on these issues (USDA, 1998). This list of questions included the following: a) description of the SPS barrier; b) market impact; c) health objective of the measure; d) scientific basis for the measure; e) consistency of the measure; f) transparency and other procedural issues; g) previous or ongoing consultations; h) comparable measures; and i) other information.

Roberts et al. (1999) also proposed a classification scheme – one with multiple objectives: (1) to provide a conceptual foundation for evaluating technical barriers to trade, (2) to guide the specification of economic models, and (3) to provide policymakers and analysts with a framework to help in discussions and negotiation processes. Technical barriers are first classified by policy instrument (total or partial bans, mandatory specifications, or information requirements) and scope (domestic or universal). Hence, they could be evaluated as if they were standard trade barriers.

As a second step, Roberts et al. (1999) established a classification by regulatory goal, which indicated how and why domestic demand and supply schedules could change as a result of the success or failure of a technical measure in correcting the market inefficiency. This analysis makes it possible to verify whether a measure is welfare-reducing or welfare-enhancing. This classification emerges from recognizing three broad goals for technical measures that restrict trade: protecting the economic interests of producers, protecting the health and economic interests of consumers, and protecting the environment. From this perspective, requirements might also be divided into risk-reducing or non-risk reducing.

Josling et al. (2004) updated Roberts et al. (1999), suggesting some changes in the analysis – still with the goal of identifying and classifying the regulatory measures. Their goal was to provide legislators and analysts with a framework for discussing trade disputes and negotiating international regulations. They adopted three criteria: first, identify the regulatory agents; second, verify the dimensions of the measure; and third, determine the tools employed by the regulatory measures. According to the authors, the regulatory process tends to raise more controversy since it can be used to differentiate products, adding value to them, and at the same time effectively creating barriers to imports.

Additionally Popper et al (2004) prepared a report for the US National Institute of Standards & Technology (NIST), which provides a definitional context and proposes criteria for identifying specifically TBT-like practices. They consider a technical barrier to be a measure that is, or becomes, inconsistent in relation to the TBT Agreement. They realized that in practice it is often difficult to discern WTO-inconsistency in relation to the TBT measures - considering all those factors analyzed to distinguish a true barrier from a legitimate (nondiscriminatory, minimally trade-restricting and transparent) technical measure. They conclude that the determination of legitimacy is only possible on a case-by-case basis.

Popper et al. (2004), however, recommend the development of a “checklist” to aid in the identification of TBTs containing the following questions based on the TBT literature: a) Is the measure or its enforcement purely cost increasing? b) Is the measure set at a level that is stronger than required to achieve a policy objective? c) Does the measure increase the profitability of domestic producers at the expense of foreign producers? d) Is there a legitimate and defensible rationale for preparing, adopting and applying standards, conformity-assessment procedures, or technical regulations that are not based on international standards, recommendations and

guides? e) Was the measure introduced after imports began to take an appreciable share of the local market? f) Is the net effect of the technical regulation, conformity-assessment procedure, or standard to prevent foreign entrants into a national market?

Popper et al (2004) assert that if several answers to these questions are affirmative, there is evidence to propose a more detailed investigation into the trade effects of those measures. Although the objective of the technical measures may seem to be solely to restrict trade, the authors emphasized that the regulation may in fact increase trade flows because it promotes a standardization of the foreign products, making them competitive with the domestic products.

According to Popper et al. (2004), the TBT Agreement does not define a “TBT” per se. Rather, it defines acceptable behavior and specifies that technical measures must be applied in a non-discriminatory way. It recognizes the legitimacy of trade-affecting technical measures in some instances and sets ground rules for establishing and maintaining them. Unlike the SPS, the TBT Agreement treats the so-called “sound science” as an element for consideration, but not a fundamental basis for establishing policy. “The absence of more rigorous requirements for risk assessment under the TBT Agreement leaves considerable room for maneuver in determining the acceptability of regulations, standards, and conformity-assessment procedures, including necessity” (Popper et al, 2004).

Miranda and Barros (2005) also suggest a systematic procedure to evaluate qualitative and quantitative data to obtain a better understanding of the level of legitimacy of a specific sanitary or technical requirement. Their main goal was to generate a background for establishing a ranking of relevance for the barriers, thus providing a tool for the optimization of public policy in addressing NTBs in developing countries.

Miranda and Barros (2005) developed a larger three-part checklist to analyze the legitimacy of technical and sanitary measures being faced by agribusiness commerce. This method can be applied to study requirements raised by the private sector or by the government as well. The checklist could also be applied to regulations notified by WTO members to the SPS and TBT Committees as the basis for anticipating a diagnosis for future possible barriers.

The method consists of applying a checklist that encompasses three parts that are expected to support government and the private sector towards definitions and actions to be taken to prevent sanitary or technical requirements from becoming protectionist trade instruments. The relevance analysis built up from the three diagnoses will be composed of two main components: the economic impact analysis and the identification of the legitimacy level (Miranda and Barros, 2005).

The first diagnosis evaluates whether a measure is worth questioning from the economic point of view. The sanitary or technical regulation with null or insignificant impacts on trade and on production in the exporting countries could be immediately included in a minor priority category, even though it lacks a scientific basis or lies outside of SPS and TBT principles. That diagnosis shall be carried out through a list of questions that comprise the first part of the checklist and the answers shall produce a result that would comprise the Index of Economic Relevance.

Some of the relevant questions from this perspective are: What is the relevance of the goods affected by the new regulation or by the procedures of conformity assessment? What are the direct and indirect costs that the new measure might bring? How does

the regulation affect the country's competitiveness compared to other suppliers in the international market? What about regional effects?

The second part of the checklist is related to the legal and juridical aspects that consider the basic principles and provisions established by the WTO, and specifically by the TBT and SPS Agreements. The goal is to verify if the requirements evaluated are close to or far from following the provisions proposed by these institutions. Therefore, it allows one to verify if the regulations have support under the scope of their provisions. As the legality of the measure is increasingly contestable, the higher will be its grades by means of the answers. Thus, the more indefensible it is considered to be in terms of the scope of the legality.

This part of the checklist highlights criteria such as transparency, non-discrimination, national treatment, and availability of a scientific basis - all necessary to comply with the principles of the SPS and TBT Agreements (Miranda and Barros, 2005).

It is worth citing Maskus and Wilson (2001): basing trade-policy dialogue and decisions largely on administrative interpretations of trade law alone is increasingly problematic in areas of highly charged health, safety and environmental laws. The WTO agreements require that regulations reference, where available, international norms and, in the case of the SPS Agreement, in areas of risk to health and safety, be assessed on available scientific evidence.

So, the third part of the analytical framework proposed looks into the technical and scientific aspects supporting the sanitary or technical measure being evaluated. Furthermore, it examines the level of their essentiality in terms of reducing the risk level for human, animal and plant health, and for the environment. The importance of international institutions of reference like the IPPC, the OIE and the Codex Alimentarius is evident. In the case of TBT, the lack of official indications for scientific and technical organizations of reference is a severe limitation. This lack is not prevented by the TBT agreement.

Hence, this part of the analysis establishes some criteria for the assessment of technical and scientific consistency. This approach, plus the previous criteria discussed (legality), leads to an evaluation of the measure's legitimacy level. The more the requirement is based on scientific international references, the lower its grades will be. It aims to identify the consistency level of the measures, considering even the credibility level of the scientific and technical aspects that support these measures. Another interesting point to consider in this diagnosis is the availability of lower cost alternative measures, basically related to technological and financial aspects.

Although this analysis is very subjective in relation to quantitative evaluation, it provides a first attempt to start ranking the sanitary or technical requirements on their legitimacy and economic importance, comparatively, to support government decisions. In despite of this caveat (that is being improved by the authors) the qualitative study provides a new approach to assessing the relevance of a sanitary or technical measure.

A concluding remark for this section is that further developments regarding technical and sanitary barriers will still have to face the difficulties involving the harmonization of these requirements. Moreover, most of the time, the disputes will deal with questions related to legitimacy, and certainly the economic aspects have to be considered for political decisions.

3.3 Collecting Data for Sanitary and Technical Barriers to Trade: Some Research Experiences

3.3.1. Notification, Specific Trade Concerns, and the Inventory Approach

One of the greatest challenges to research on sanitary and technical barriers to trade is to identify them, evaluate their legitimacy, and keep track of them. As a result it is also difficult to build a database on them that provides systematic information to conduct studies, to provide input for negotiations, and for public policies. The scarcity of databases on this topic is also one of the caveats for choosing the methods to apply to their evaluation.

Even though notifications to the SPS and TBT Agreements are not necessarily barriers to trade, they can provide a rich source of information for modeling. This is so because many regulations reported can become obstacles to future commerce. A further point of view is that notifications can highlight trends in terms of sanitary and technical barriers in the future.

This source has limitations because several countries do not provide information on all their sanitary and technical regulations. Thus, a commercial dispute may arise from a requirement imposed by a country that did not previously notify its partners through the WTO. However, keeping track of the notifications and of the agendas of committee meetings provide a great opportunity to anticipate or identify trade problems.

Another approach to collecting useful data for the analysis of the sanitary and technical barriers to trade are the Specific Trade Concerns (STC) reports, released by the SPS and the TBT technical committees. The STCs contain the register of trade disputes between countries and that were taken to discussion before those committees during regular meetings. They are probably the closest proxy for these kinds of barriers in the international market because, indeed, they were born from effective trade problems.

Other types of data can be useful, although many of them do not generate good results when subjected to econometric analysis. For example, counting the number or the level of regulations on a specific topic, such as the Maximum Residues Limit (MRL), does not provide even modest results in modeling. So, even if they provide a good overview about disputes, technology differences, and compliance costs they present limitations as a source of data for quantitative modeling.

An additional source of information is data about the prohibition of imported products entering a country through customs. However, only the United States has a systematic process to collect and store such information, together with a database called Operational and Administrative System for Import Support (OASIS). This database has been useful for several studies related to trade barriers involving this country.

The data collection and organizations discussed above are usually reviewed under the scope of inventory methods in the evaluation of the effects of non-tariff barriers. Although the inventory methods have been considered a quantitative approach by most authors, in this paper they are understood as a tool to supply information useful to describe the barriers and their trends, but mainly for modeling.

The inventory approaches can be used both in quantitative or qualitative assessments about the role of domestic regulations as trade barriers. Beghin and Bureau (2001) suggest three sources of information that can be used:

- a) Data on regulations, such as the number of regulations, which can be used to build various statistical indicators;
- b) Data on frequency of detentions; and
- c) Data on complaints from industries reported to international bodies, against discriminatory regulatory practices.

According to Ndayisenga and Kinsey (1994), apud Beghin and Bureau (2001), the quantitative estimates can rely on the catalogue of technical and sanitary barriers (identification and description) organized through lists. The use of sanitary and technical barriers can be analyzed using simple statistics. These measures may include: (1) number of restrictions, (2) frequency ratios (number of product categories subject to an NTB as a percentage of the total number of product categories in the classification); and (3) the import coverage ratio (calculated as the value of imports of each commodity subject to an NTB as a percentage of imports in the corresponding product category).

According to Beghin and Bureau (2001), there are other measures that are more refined, albeit under tenuous assumptions, which could also be adopted. An example would be the percentage of standards based on international references, which would indicate the overall compliance of national standards with widely used international standards.

The complaints against discriminatory regulatory practices are often used to support claims about the existence of an NTB, sanitary or technical. According to Beghin and Bureau (2001), there are large differences among countries in their ability, and perhaps in their administrative procedures, to file complaints against third parties within, as well as outside, the notification procedure of the WTO. They consist of the above-mentioned Specific Trade Concerns (STC). “Because of the intrinsic bias in the sample of complaints, the information is perhaps best used in a qualitative way” (Beghin and Bureau, 2001).

Some studies using this approach are: Henson et al. (2000), Fontagné et al. (2001), Barros et al. (2002), Moenius (2004), Machado and Miranda (2007); and also Swann et al. (1996); Moenius (1999); Lux and Henson (2000); Otsuki et al (2001); Henson et al. (1999) and (2001), apud Beghin and Bureau (2001). Table 1 presents a summary of the papers found in the literature review on this specific topic.

The number of countries adopting a certain barrier could be another indicator to include in the models. That is the interesting idea proposed by Fontagné et al. (2001), who note that when a barrier is set by only a limited number of countries, it is more likely to be used for protectionism goals.

Beghin and Bureau (2001) note some limitations of the inventory approach applied for technical and sanitary regulations. For example, different standards would not be expected to have similar effects. Besides that, they consider the number of standards, or the number of pages of domestic regulations, to be a poor proxy for the trade restrictiveness of the whole regulatory set. In fact, it is not clear if there is any correlation between the number of measures and their effect on trade. Barros et al.

(2002) notes that the reporting by countries is probably uneven, and thus the basis on which the discussion is conducted is biased.

Table 1 – Data used for inventory approaches regarding SPS and TBT issues

Reference	Data used for inventory approaches
Ndayisenga and Kinsey (1994)*	- The percentage of standards based on international references; - Data on detentions at the border; and - Complaints against discriminatory regulatory practices.
Swann et al. (1996)*	Counts of voluntary national and international standards recognized by the UK and Germany
Moenius (1999)*	Counts of binding standards in a given industry as a measure of stringency of standards
Lux and Henson (2000)*	Border detentions in the US
Otsuki et al (2001)	Maximum allowable contamination, adopted as a direct measure of the severity of food safety standards
Fontagné et al. (2001)	Frequency statistics: different thresholds on the number of countries implementing restrictive regulation for a given tradable good (environmental trade barriers)
Barros et al. (2002)	Notifications to SPS/WTO for Western Hemisphere countries as a proxy of sanitary barriers and trends for international regulation
Moenius (2004)	Number of country-specific and shared standards (and gravity model)
Silva and Miranda (2007)	Notifications to SPS/WTO on residues
Longhi Jr. and Miranda (2007)	Data of refusals registered by the OASIS for fruits imports
Sbarai and Miranda (2007)	Notifications to TBT related to environmental legitimate objectives
Machado and Miranda (2007)	Notifications to SPS and TBT on beef sanitary issues, and also the Specific Trade Concerns related to the SPS Agreement

Source: elaborated by the authors. * Apud Beghin and Bureau (2001).

Baller (2007) also reports some criticisms about a quantitative analysis that derives the trade effect of diverging standards directly from the number or costs of standards. The author explains that there are a large number of available standards. Additionally, it is very difficult to match standards across countries, given the wealth and idiosyncrasy of legal documents that are available and relevant.

Further comments from Baller (2007) stress that a general weakness of these attempts to estimate the effects of standards on commerce is that they are not based on a sound theoretical framework. In fact, the author adds that the attempts to model standards barriers and their remedies theoretically are also very limited in number and have been undertaken only very recently. All of them use Krugman's (1980) framework as the basis to model trade between countries, but are very different in the way they are being implemented.

Despite these limitations, inventory-based methods can be useful for directing attention to the frequency of occurrence of various types of NTBs and to the trade or production coverage of NTBs. They can also provide indications about the importance of the problem and not the quantification of the effect of regulations on trade per se.

In Brazil, CEPEA's³ team on international economics is developing studies that use the notifications and STC data to describe sanitary and technical problems in commerce. The first study, by Barros et al. (2002), analyzed the adoption of SPS in Western Hemisphere countries. The participation of countries in the SPS regulation was evaluated with a profile of their notification issues over time.

Later, Machado and Miranda (2007) studied how Brazilian beef trade was being submitted to notifications on SPS and TBT, as well as the STCs. The analysis considered the requirements from a selected set of countries, particularly related to FMD and mad-cow disease. The authors analyzed the notifications selected through the tool proposed by Josling et al. (2004) and Roberts et al. (1999). They identified some trends in the regulation process. Most notifications focused on sanitary customs controls. The mad-cow and foot-and-mouth diseases accounted for the most frequently applied regulations by countries on the beef market. Concerning the beef sector, it was demonstrated that both importer and exporter countries, small or large, notify the SPS and TBT Committees. So, it seems that in the SPS technical Committee, there is a more balanced participation for all countries.

Still considering the notifications and the information they contain to have a better understanding and prevision of future challenges, Silva and Miranda (2007) and Sbarai and Miranda (2007), respectively, evaluate the regulations on residues, notified to the SPS agreement, and the environmental requirements, reported to the TBT Agreement.

Silva and Miranda (2007) study the way countries are addressing the residue issue under the provisions of the SPS Agreement. They list the SPS notifications related to the chemicals and additive residues, categorizing them in order to facilitate analysis. They discovered that developed countries, namely the United States, the European Union, and Canada account for the higher participation in the SPS/WTO notification system regarding regulations on residues. There was a particular concern about non-compliance with the maximum residue limits (MRL) required.

About 15 per cent of the total set of SPS notifications from January 1995 to June 2006 were related to residues. There was an increasing trend over this period. Comparatively, Burnquist et al. (2004), considering only the notifications of the Western Hemisphere countries notifications to SPS/WTO, found a larger share for residues. Even these last results involve chemicals instead of only residues (as a key-

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word for the search). The analysis showed an outstanding share of 26 per cent of the whole set of SPS notifications in the area of the North-American Free Trade Agreement. Moreover, almost 90% of these 26% were released by the United States and Canada. Burnquist et al. (2004) conclude that this result identifies what challenges will prevail in the future international market.

Regarding fruits and vegetables products, a previous study by Telteboim et al. (2007) analyzed the MRLs required by importers for commercializing important fruits for Brazil. These authors compared the MRL referendee by the Codex Alimentarius with the limits adopted by ANVISA (Brazil) and by other countries (the US, Canada and the EU). They notice that despite the efforts made by the WTO to harmonize the technical and sanitary standards, countries set different limits, which generates difficulties and additional costs in international trade.

The work developed by Sbarai and Miranda (2007) has a different focus as it concerns the environmental requirements, under the TBT Agreement, that are being imposed on countries through regulation. Their results show that most notifications apply to processed goods, not agriculture and livestock. However, those imposed on these products mostly emphasize the genetically modified organisms, energy and air pollution.

Other examples of inventory approaches conducted by CEPEA's staff is Longhi Jr. and Miranda (2006), which analyze the cases of fruit import refusals into the US market, registered by the OASIS because of sanitary and technical non-compliances. Athukorala and Jayasuriya (2003) and Gebrehiwet et al. (2007) also used this information to evaluate sanitary restrictions for international markets and the problems about compliance with requirements.

The main idea supported by keeping track of the TBT and SPS notifications in Silva and Miranda (2007), Machado and Miranda (2007) and Sbarai and Miranda (2007) is related to the relevance of keeping them for public policies decisions. Since budgets for the developing countries do not allow their governments to have experts for all the technical areas and subjects, it would be useful to have a surveillance system to identify new regulations or standards proposed by countries and their relevance. Such a system could prevent future disputes, considering that regulations with a potentially impact would be identified before they come into force in their countries of origin. Moreover, following and realizing trends in the regulation processes may orient officials about how to allocate human and financial resources.

3.3.2. Surveys

Most of the specialized literature on NTBs includes the surveys in the list of quantitative methods to evaluate their impacts. In the same way this study addressed the inventory method as a tool for collecting data and qualitative information instead of a quantitative approach, this survey is addressed in the same way. Thus surveys are more properly included as a systematic way to collect data, quantitative or qualitative, which can be used for more refined measures of NTBs.

In fact, according to Laird (1996), the survey makes it possible to narrow the scope of analysis to be focused on the really relevant issues on technical requirements, especially if they were previously identified by an inventory method. In the surveys, researchers consult directly with the trading agents to identify their understanding of

the barriers. Surveys can also be designed to provide information such as ranking the importance of the measures on a scale, which can be used in econometric studies.

Referring to Baller (2007), firm-level surveys conducted in both industrial and developing countries consistently identify technical regulations as the main non-tariff barrier (World Bank TBT Survey, 2004; OECD metasurvey 2003, apud Baller, 2007). Also in a firm level analysis Chen, Wilson and Otsuki (2004) show that testing procedures and lengthy inspection reduce exports of developing countries by 9% and 3%, respectively, and that standards reduce the likelihood of exporting to more than three markets by 7%.

Other surveys can be mentioned. The OECD (1999) analyzed 55 firms in three sectors in the US, Japan, the UK and Germany on export impediments. The USDA (1996) developed a survey that provided cross-section data to characterize the extent to which economic-based protection exists. Several studies derived from this survey quantified the trade impact of questionable technical barriers on US agricultural exports (Roberts and De Remer, 1997; Thornsbury et al., 1999; and Thornsbury, 1998).

Henson et al. (2000) developed a survey to study the problems that developing countries face to meet the SPS Agreement and the difference of this approach is that instead of contacting companies, the questionnaires were sent to the enquiry points.

The World Bank TBT survey included 689 firms in over 20 industries in 17 developing countries (Wilson and Otsuki, 2004). The goal was an attempt to gauge the direct impact of standards and technical regulations on firms' production costs and export performance. About 70 per cent of these firms reported that they faced technical regulations in their export markets. EU and US regulations were generally considered to be the most important by the firms surveyed. The study shows that to meet standards, firms invest in additional plant or equipment, one-time product redesign, product redesign for each export market, additional labor for production, additional labor for testing and certification. Alternatively, they lay off workers instead of making these types of investment to keep the costs from increasing.

Faria and Burnquist (2006) evaluated the degree in what technical requirements restrict Brazilian exports, based on a survey applied to 77 firms. The variables represented six types of technical measures that are usually imposed upon exported products. The questionnaire was based upon the model proposed by Wilson e Otsuki (2004) and OCDE (2000). The six types of technical requirements faced by firms were: requirements on the production process, package, labeling, tests for conformity assessment, quality specifications, and environment requirements. Exporting companies from all the countries and associated with the Industry National Confederation (Confederação Nacional das Indústrias – CNI) were selected (Faria and Burnquist, 2006).

To facilitate the interpretation of the results, Faria and Burnquist (2006) used a factorial analysis to reduce the number of variables involved. This allowed the construction of two indicators of the degree of restrictiveness of the technical barriers focused by the study. These were an indicator of requirements of technical specification (ITS) and an indicator for information and label requirements (IIL). Descriptive statistics and paired "t" tests showed that the firms surveyed considered the ITS more restrictive to their exports. That is, they have been subject to greater

restrictions affecting the production process, including quality, the production process pattern and conformity assessment.

About 55 per cent of the total companies sampled were domestic, and most of them exported to both developing and developed countries (40.4%). It is notable that the quality requirements showed the highest average of interference on Brazilian exports. Following them in importance, we had conformity tests and process requirements. Labeling showed the lower importance (Faria and Burnquist, 2007).

According to Wilson e Otsuki (2004), similar results were verified in a World Bank study of the effects of technical barriers on the exports of developing countries. It seems that the same requirements that restricted exports from Argentina, Nigeria and India, among other countries, affected Brazilian exports as well.

However, Weyerbroeck and Xia (1998) and USGAO (1997) expressed reservations about surveys such as that of the USDA in 1996 when used for quantification purposes. Even so, the quantification approach is appropriate if it deals with measuring the compliance costs faced by firms and industries.

Finally, the general understanding is that using surveys to evaluate the impacts of barriers to trade on sectors is useful if other sources of information are not available. This approach allows one to uncover evidence about existing barriers, which was not clearly perceived by researchers or government agents, or even by the private sector. Usually these hidden barriers are difficult to measure. Like administrative ones (Beghin and Bureau, 2001), they increase transaction costs and are not raised by the respective firms until a survey is conducted and clarifies its effects.

4. Mathematical Approaches to Measure Effects of Sanitary and Technical Barriers to Trade

Some authors have previously reviewed the available and usual methods to quantify the impacts of non-tariff barriers, not only on trade, but also on welfare. These include Deardorff and Stern (1998), Laird (1996), Maskus and Wilson (2001) and Beghin and Bureau (2001).

The SPS impacts on trade and welfare are largely unknown, primarily because we lack regular information on the incidence of these measures, and also because of underdeveloped methods of economic assessment (Beghin and Bureau, 2001; Maskus and Wilson, 2001; Roberts et al., 2004, Roberts and Unnevehr, 2005). Beghin & Bureau (2001) are particularly focused on methods aimed at estimating the effects of sanitary, phytosanitary and technical barriers, not only on the market equilibrium and trade flows, but also on economic efficiency and welfare. They point out that attempts to quantify the effects of such measures have often centered on a particular product and have relied on methods from other economic fields.

Maskus and Wilson (2001) also review this topic, exploring the reasons for measuring the effects of standards and regulations. They note that there is a significant interest of policy agents in having solid empirical work on the level at which such regulations affect trade. According to the referred to paper, evidence on questions related to those regulations and their shocks on the economic variables, gathered from detailed firm-level surveys, would be of great interest to firm managers, researchers and policymakers.

The mathematical approaches should be based upon the evidence of how these requirements act on economics and social variables. In this sense, it is interesting to quote Maskus and Wilson (2001) when they assert “regulatory barriers exist in principle to achieve important objectives that would go under-served in the private market, such as public-health maintenance or environmental protection”. So, they conclude that the social losses of eliminating these regulations could overcome the economic efficiency gains. Moreover, sometimes standards could even expand trade. As a result, Maskus and Wilson conclude that one cannot assure that trade impacts of technical barriers are inefficient and should be negotiated multilaterally.

Thus, approaches that use more general models may improve understandings about those questions. Hence, considering the analytical frameworks for the measurement of NTBs, Beghin and Bureau (2001) list some papers.

Roberts et al. (1999) distinguish three economic effects for the regulation. This is a very convenient place to start this review because it deals with the theoretical framework that leads to the different possible effects of the barriers on economies:

- a) the regulatory protection effect, i.e., the rents to the domestic sector;
- b) the supply shift effect on the domestic supply induced by compliance cost; and
- c) the demand-shift effect arising from new information that increases consumer demand for the product.

The aforementioned authors used comparative-statics analysis, in a partial equilibrium model, to show the differences in welfare effects of these three components of NTBs. In their approach they prove that all the methods that rely on a tariff equivalent (price wedge method) are only appropriate for measuring trade volume effects, but do not give a tariff equivalent that provides welfare interpretations.

The supply-shift component captures both the effect of imports on the domestic supply (in the absence of regulation) and the potentially beneficial impact of the regulation, should it limit the cost of pathogens, for example (even if it involves some additional costs of testing and detection). A measure of NTB based on aggregate welfare should consider both effects (Roberts et al, 1999).

An important point to stress is that the cost of regulation affects differently the small and large firms. Moreover, regulations modify the structure of competition and affect mark-ups and rents, according to the literature review made by Beghin and Bureau (2001). Ganslandt and Markusen (2000) also account for the fact that standards can impose a fixed cost of entry that affects competition, and may also lead to multiple equilibria, an effect well known in the literature of industrial organization.

Finally, the demand side of this subject is addressed. The regulation affects domestic demand, which may cause shifts in supply, providing opportunity for generating welfare gains by the imposed regulation. This could eventually offset, at least partially, the losses involved by the protection effect of the regulation. Maskus and Wilson (2001) point out that this is possible for a welfare-based measure of NTB as well as for a trade-based measure. The demand side effect may increase access to a market that would, otherwise have been limited to an exporter of sub-standard protection. They recommend a literature on industrial organization:

- a) Bureau et al. (1998) and Bureau and Marette (2001): the regulation brings information and therefore avoids or reduces costs of assessing product quality, so it causes a demand shift;

b) Casella (1996) and Fisher and Serra (2000) account explicitly for the public good effect of regulations and to the reduction of transaction costs induced by them and standards as well;

c) Harrison et al. (1996); Maskus et al. (2000): regulation can increase the demand elasticity of substitution and bring economies of scale by permitting producers to settle on a limited range of product features/processes.

A more didactic classification of the methods used for addressing the evaluation of sanitary and technical barriers is proposed by Laird (1996) and Beghin and Bureau (2001): the price wedge method; inventory-based approaches; survey-based approaches; gravity based approaches; risk-assessment-based cost-benefit measures; stylized microeconomic approaches; and sectoral or multi-market models. Some of these will be briefly presented below, together with some new approaches. It is important to remember, however, that the inventory-based approaches and the surveys were discussed above. They were considered to be inputs for the other models mentioned more than properly methods of quantification.

This paper will present updates of quantification developments. However, it is still in an incomplete and draft version, particularly pointing out the research conducted in developing countries. It will also consider the advantages and disadvantages of adopting the several approaches indicated above.

4.1. The Price Wedge Method

The price wedge method relies on the idea that NTBs can be gauged in terms of the impact on the domestic price in comparison to a reference price, and that this will provide a tariff equivalent. Although this method is conceptually oriented toward measuring the impact of a NTB, the estimate of the price wedge can be used as an input in a partial or even general equilibrium model that would allow one to evaluate the welfare effect of that NTB (Beghin and Bureau, 2001).

The tariff equivalent is estimated by calculating the price wedge between the imported good and the domestic substitute. The correct measure would be to compare the price that would prevail without the NTB to the price that would prevail domestically in the presence of the NTB. The assumption is that the price paid to suppliers would remain unchanged (Deardorff and Stern, 1998). As these prices are usually not known, the tariff equivalent has to be based upon the comparison between the domestic and the foreign price in the presence of the NTB. Adjustments can be made for retrieving the price situation in the absence of the NTB, using trading quantities and supply and demand elasticities of domestic and imported goods (Laird and Yeats, 1990, apud. Beghin and Bureau, 2001). The best option is to use the CIF price of the imported good as paid by the domestic importer to the exporter, including the transport costs but excluding tariffs.

In the case of a regulation, including sanitary and technical measure, the tariff equivalent can be measured as a residual when the price difference is corrected for tariff, handling and transportation costs. It is also necessary to correct for differences in product quality, which is clearly a limitation of this approach (Beghin and Bureau, 2001).

An illustrative example is the estimation of the tariff rate equivalents for technical regulations on the apple sector, undertaken by Calvin and Krissoff (1998). They

assume that the price gap consists of the tariff and technical barrier tariff-rate-equivalent for similar apples (i.e., same variety, grade, size) and also accounting for transport costs. They divide the monthly price wedge into the known tariff rate and the technical barrier tariff-rate-equivalent (residual). In a next step, this information becomes an input for a cost-benefit analysis.

One of the criticisms of this method is that even if it allows the measurement of the effect of a set of NTBs, it does not make it possible to recognize precisely what those NTBs are. This method is valid only under the assumption that imported goods are perfect substitutes to domestic goods. This consists of the second criticism of its use. It is difficult to reflect quality differences of imported goods, and that is one of the reasons it was recognized to be difficult to apply for large-scale studies. Additionally, another caveat is that if exporting firms are able to price discriminate, the price wedge method will also reflect rents rather than NTBs.

4.2. Approaches Based on Gravity Models

Gravity models are one of the most successful and widely used models for the analysis of trade issues. They have been extensively used to study trade patterns among countries. They are supported by some advantages: they require a relatively limited amount of data; a theoretical background has been elaborated to give support to the models -- after many years of criticisms; and finally, they are able to evaluate the trade-enhancing effect of different NTB regulations in the estimation of trade flows (Gebrehiwet et al., 2007).

In most of the empirical research, gravity models assume perfect substitution among goods from different countries. However, if goods are differentiated by origin, the typical gravity equation becomes misspecified and the estimation biased (Bergstrand, 1985).

Feenstra (2004) presents a simple version of the gravity equation, under the assumption of free trade, in which all countries have identical prices. This assumption is omitted by allowing different prices to reflect the existence of trade barriers among countries.

Regarding the existence of barriers to trade, one noted approach to quantify NTBs is to consider the foregone trade that cannot be explained by tariffs. Thus, a typical way is to look at the residuals from the economic regressions of trade flows on the various other relevant factors. In this sense, the gravity model is a remarkable option, considering they have been used for a long time to estimate the “home bias” or the “border effect” in trade. The bias stems partly from national regulations that hamper trade (Beghin and Bureau, 2001).

An interesting application of the method estimates how much trade is foregone only because of the “border effect” (Mc Callum, 1995, apud Feenstra, 2004). Since this controversial study, numerous attempts were made to include some explanatory variables in the analysis, including language, indicators of “remoteness”, cultural differences, etc.

It is possible to introduce information on regulations as explanatory variables, estimates using the methods described above (number, frequency of regulations, survey based impacts), or in certain cases the level of standards themselves, provided that there is some variability across countries or over time (e.g. the level of chemical

residues). Beghin and Bureau (2001) point out that robust methods such as variance analysis or principal component analysis applied to the border effect term could help quantify the impact of NTBs on trade.

A very interesting feature is that gravity-based models attempt to measure the trade impact of NTBs rather than their welfare impact. Therefore, they may ignore some of the effects that the regulations have to correct market failures, but still restrict trade. However, the sign of the variables that capture the NTB effect in the regression is not constrained, and it is possible to capture the trade enhancing effect of regulations when they act as standards that facilitate trade.

Moenius (1999), apud Beghin and Bureau (2001), measures the trade impact of TBT, using a gravity model for bilateral trade volumes. He focuses on the trade impact of standards (voluntary norms) rather than on regulations due to data limitations. The results show that a shared standard has a large trade promoting effect between the nations sharing the standard. He incorporates econometric refinements (correction for autocorrelation, causality testing etc). It was possible to estimate the impact of a one-per cent increase in the number of bilaterally shared standards on bilateral trade volume.

Otsuki et al. (2001) used the method to explain trade patterns among countries and to determine the effect of European aflatoxin standards on African exports. They verified that the new (and more stringent) EU standards were likely to be a major barrier to African exports of dried fruits and nuts. Although their econometric approach remains very simple, because the aflatoxin maximum residue shows statistical variation in their panel they exploit the possibility of using the level of standard itself as an explanatory variable.

Gebrehiwet et al. (2007) also applied a gravity model to estimate the trade effect of phytosanitary measures. In this case, the authors attempt to estimate the trade foregone due to the aflatoxin level set by five OECD countries on South African food exports. Significant trade elasticity for the aflatoxin regulation was obtained. This phytosanitary variable was included directly in the gravity model as the total aflatoxin standard of the importing country. The study simulated the trade flow that would have occurred if those selected countries had adopted the CODEX standard recommended for the total aflatoxin level. This procedure made it possible to assess the difference between this situation and the real world.

Baller (2007) estimated a two-stage gravity model while investigating the trade effects of the regional liberalization of technical barriers that occurred through harmonization and the mutual recognition agreements (MRAs) for testing procedures. This paper adds to the existing literature by formalizing the effects of MRAs and harmonization initiatives on bilateral trade flows and by applying this new theoretical framework empirically. The theoretical part of the paper is framed in terms of Melitz's (2003) heterogeneous firms approach.

Quoting Baller (2007), Melitz (2003) notes "the decision of a firm to enter into an export market hinges crucially on the level of fixed cost in a given market". It is in that way that technical barriers to trade are introduced – as an important kind of fixed export cost. Hence, the TBT liberalization can then take the form of MRAs and be modeled as a reduction in fixed export cost – or complete harmonization – modeled just like an elimination of fixed costs for all but the home market. In this way a firm makes a joint entry decision for all markets in the harmonizing region.

One of the caveats for the gravity model is to attribute departures of trade from what the model can explain to a mix of national effects, including NTBs. The model is unlikely to be able to explain all trade flows in detail, even in the absence of domestic regulations and other factors entering in the “border effect”. Moreover, when focusing on detailed products and spatial trade flows between given countries, the prediction is likely to be sensitive to the assumptions of the models.

However, the use of multivariate analysis could help in sorting out the share of the regulations in the “border effect”. Furthermore, when standards do not show enough statistical variability to be used as regressors, econometric refinements could also make it possible to deal with binary variables (allowed or banned), or with discrete variables, that are often the only characterization of NTBs. Overall these approaches, coupled with proxy variables from survey or inventory-based methods, are a promising area of research (Beghin and Bureau, 2001).

4.3. Stylized Microeconomic Approaches and Sectoral Models

For Beghin and Bureau (2001) the effect of an NTB can be assessed by looking at the displacement of the market equilibrium induced by a regulation. Provided that microeconomic data, even cross-section or panel, are available, the effect of regulations on supply and demand can be measured by standard estimates of cost or profit functions, as well as utility or demand functions estimated econometrically. The authors assert also that the duality theorems can be used to estimate a shadow price associated with the variable representing a standard (or a binding regulation).

Fischer and Serra (2000) examine a situation for a country imposing a minimum standard on a good produced by a domestic and a foreign supplier. They show that depending on the size of the foreign market and the fixed setup cost of producing at two standard levels, the domestic firm will press for the stricter standard, which will exclude the foreign industry. These authors applied a microeconomic approach.

A large body of literature, derived from research on industrial economies, has focused on the complex effects of regulations and standards (OECD, 1999). However, Beghin and Bureau (2001) emphasize that the associated literature has remained largely theoretical. Consequently, quantitative results for evaluating the impacts of the barriers have not been searched.

According to the abovementioned authors, different ways were tried to include the effect of standards on the structure of competition among firms in stylized partial equilibrium models; or to discuss the strategic interactions among firms reacting to new regulations. The way regulations modify the information available for consumers was also considered. Beghin and Bureau reviewed this topic and summarized the related literature. They assume that the welfare effects of a regulation are different if consumers can assess or not the quality of the products, before or after consumption. They also assume that regulations can modify the costs of signaling quality and that possibly result in network externalities and economies of scale. They note that more sophisticated supply and demand equations, with parameters estimated econometrically, should be the following steps from this perspective in to widen the range of questions to be evaluated on this topic.

Another interesting approach was proposed by Baller (2007), in which the influence of Mutual Recognition Agreements (MRAs) was examined on both export probabilities and trade volumes for partner countries. Regarding harmonization, his

results suggest that the agreement's impact on parties is negligible. Third party developing countries do not seem to benefit from the market integration effect brought about by harmonization in other regions. Overall, effects on the probability that a new firm will export are much more pronounced than the effects on the trade volumes of incumbent exporters. This is important indeed, once governments frequently try to increase the number of exporting companies.

Some limitations of this approach are related to its robustness, to the simplifying assumptions, and to the difficulty in providing estimates of the various effects in empirical implementations. Another issue involves the difficulty in quantifying the consumer responses and market displacements induced by a new sanitary or technical barrier. As a result, the industrial organization approach can almost be considered the same category as the inventory approach and the surveys because its focus is on the qualitative effects more than the quantitative. However, according to Beghin and Bureau, it provides a framework to integrate the competition aspects and the informational effects into an econometric approach in partial equilibrium modeling.

More specifically about the partial equilibrium models, they provide a framework for analyzing tariff-rate equivalents of sanitary or technical regulations and standards. One advantage of them, compared to the gravity models, is that it allows an assessment of both impacts of a regulation - on trade flows and on welfare (Beghin and Bureau, 2001).

However, for illustrating the use of the sectoral or multi-market models for dealing with NTBs, there are some papers worth mentioning, like Calvin and Krissoff (1998), Paarlberg and Lee (1998), Kume and Piani (1999), Peterson and Orden (2006), and Miranda and Barros (2006) and others mentioned by Beghin and Bureau: Thilmany and Barrett (1997), Sumner and Lee (1997) and James and Anderson (1998).

Calvin and Krissoff (1998) quantified the phytosanitary barriers to US apple exports to Japan by calculating tariff-rate equivalents through a partial equilibrium model approach. The authors examine the trade and welfare impacts of removing phytosanitary barriers and tariffs under two assumptions regarding transmission of the bacterial disease fire blight: i.) first, that transmission via commercial fruit is not possible, and ii.) second, that it can occur. They explained that another alternative for estimating the impact of TBs is measuring actual costs involved in preparing a product to comply with phytosanitary requirements in other countries. But this is very complicated because even if the phytosanitary standards for a type of apples (Fuji) were made equivalent to those for others (Red and Golden Delicious) apples, the regulatory cost for exports still would be difficult to estimate, since the protocol targets specific inspection practices in a particular growing area, as well as quarantine treatments for the final product to be shipped.

In order to measure the trade and welfare impacts of reducing trade barriers, Calvin and Krissoff (1998) developed a simple partial-equilibrium, two-equation modeling system that endogenously determines the sanitary barrier tariff-rate equivalent and the level of trade. It should be emphasized that other studies and information are necessary with this methodology requirement. For instance, a likelihood model estimating the probability of disease transmission, an epidemiological study on the physical consequences of disease/pest entrance in the importing countries in the case it was transmitted, and in addition, the investigation on the impacts of the disease/pest on other hosts beyond the one in study.

Instead of measuring the expected loss due to a possible disease infestation and the supply shift it would result, Calvin and Krissoff estimate the threshold where the loss associated with the supply curve shift precisely overcomes the gains from trade. In the end, the authors conclude that even if there were a legitimate scientific justification for a TB, there seems to be no economic justification for the restrictive technical barrier.

Kume & Piani (1999) propose to measure the addition to Brazilian exports if the US, Japan and the European Union abolished all their tariff and non-tariff barriers on a selected set of exportable goods. The model assumes that the tariff reduction or the tariff equivalent (for the NTB) is completely included in the imported product price.

Consequently, there would happen to be an increase of imports in these countries. Because of the lack of data, particularly to identify the non-tariff barriers, Kume and Piani adopted some strategies for the estimation. A particularly interesting one was to replace data from Brazil by data for Mexico, when the case analyzed was the exports to the US. In this case the authors simulate the advantages of having the same treatment a free trade area would provide to Brazil in dealing with NTBs. They estimated that Brazilian-US bilateral trade would increase at least three times in relation to the 1995 reference year.

Miranda and Barros (2006) present another illustration of a sectoral study. The authors measure the impacts of sanitary and other relevant events on Brazilian beef exports. The econometric model was applied to Brazilian beef export sales for the period of 1992 through 2000. The residuals were analyzed using a time series intervention model.

Similar to the idea of including dummy variables for sanitary rules in an econometric model, it is also possible to assess the impact of shocks applying a time series method, through intervention models and using intervention variables to explain specific occurrences identified in a time series of behavior.

The first step was to adopt an export sales model built for the Brazilian beef sector, reported by Miranda (2001). A basic structural model representing the domestic supply and demand for Brazilian beef generates the estimated forms, testing two different assumptions: the imported good is not a perfect substitute for the domestic market, and there is no perfect substitution in the international market between beef from other countries and Brazilian beef. As a result, the authors had a final equation that represented the equilibrium price for Brazilian beef foreign sales quantity, and another one for export volume, considered to be a surplus from the domestic market. This procedure made it possible to take into account the effects of domestic variables on export performance. The residuals were examined to identify the effects of interventions previously selected through the literature review and interviews (looking for events that could be associated with non-tariff barriers).

Applying transfer functions and intervention models to the residuals generated from the econometric model on trade assumes that a detailed knowledge about the issue and the determinants of trade, protectionism, sanitary, and other relevant events to the studied sector are available (Miranda and Barros, 2006). Alternatively, the authors also tried a time series approach, seeking to verify the intervention effects directly by their own data generating process. Hence the basic variables affecting Brazilian exports were included as transfer functions, explaining the time series of exports. The sanitary and other relevant events were considered by using the intervention variable

(Jenkins, 1979; Vandaele, 1983)⁴. Transfer functions also comprise a moving average operator, an autoregressive operator, and a lag parameter just like the time series definition of exports. To evaluate the impact of an intervention variable, a term is added to the transfer function, which also includes a lag, a moving average operator and an autoregressive operator.

This application of the model requires a piece of information about the market and about the relevant events (sanitary and technical – outliers) affecting trade flows. In addition, some expectation is required of the outliers' behavior after the shock occurred (event).

5. Public Policy Choices – Models to Support Government Decisions on Sanitary and Technical Issues

It is important to recognize all the efforts to have a better understanding about sanitary and technical requirements and their effects on economics and social aspects. Their ultimate goal is to provide inputs to public policies, or even to private agents. These policies are not only related to trade, but also to industrial policies (infrastructure, exports promotion and others) and capacity building (education, technical assistance, opportunities to face international knowledge and technologies and others factors). It comprehends the provision of laboratorial infrastructure, technology investments, improvement or the regulation and government support to guarantee food safety, environmental protection, animal and plant health and so on. The education policies to provide a general enhancement of a country's ability to deal with these subjects are particularly important.

Thus, even though the knowledge provided by identification of sanitary and technical obstacles, data collection and legitimacy studies, tools in advanced methodologies to address quantitative data consists of information to give support for government decisions. They lack a more applied public policy view. Besides, for the private sector, as well, this knowledge is also essential because most of the impacts of new requirements will be posed directly on companies, which will certainly need to make adjustments to comply with them and still keep competitive in the international market.

Regarding that context, this section aims to present some additions to the methodologies discussed above. They consist of a review of approaches directly related to simulations that provide evidences and inputs to make choices clearer to government agents. That is the case of the cost-benefit analysis, integrated with risk assessment (Calvin and Krissoff, 1998; Orden and Romano, 1996), and currently being adopted by WTO members to reach the requirements of the Regulatory Impact Assessment — RIA (Randaelli, 2003; OECD, 2004). In this sense, another approach could be the comparative Relevance Index, proposed by Miranda and Barros (2006), to rank the sanitary or technical obstacles according to their legitimacy level and to their economic impacts.

⁴JENKINS, G.M. Practical experiences with modelling and forecasting time series. Prentice Hall: Channel Island, 1979. 146p.

VANDAELE, W. Applied time series and Box-Jenkins models. New York: Academic Press, 1983. 417p.

Another important framework to address the public policies needs is the general equilibrium model. They are becoming an important tool to simulate different policies in several levels and intensities, and that allow evaluating not only the domestic and regional impacts on trade and welfare, but also to consider effects joint with other countries, such as the GTAP applications.

Finally, this introduction leads us to conclude that this section is focused on an *ex-ante* approach to deal with sanitary and technical barriers to trade, more than on an *ex-post* approach, which would imply having a better understanding and perception about historical information on those barriers. In turn, this section intends to support the idea of addressing the sanitary and technical barriers increasingly in an *ex-ante* approach, because of their nature and the risks involved. Such an effort would provide conditions to anticipate disputes in international trade and to be more pro-active and less reactive regarding sanitary and technical problems.

5.1. Risk Assessment-Based Cost-Benefit Analysis (CBA)

Risk assessment approaches have been integrated into cost-benefit calculations and indirectly contribute to the measurement of the effect of regulations. Rather than quantifying the actual impact of this measure on trade, they provide some indication of what should be included as trade barriers on the basis of the effect of regulations on welfare. In fact, citing Calvin and Krissoff (1998), economists consider welfare analysis, which evaluates the costs and benefits of a technical barrier on producers, consumers, and net social welfare to be a critical first step of any policy assessment.

Beghin and Bureau (2001) affirm that the combined use of scientific and cost-benefit assessment is one of the most promising areas of research in the identification and assessment of the effects of NTBs. They comment that traditionally, sanitary questions have been addressed with little economic concerns, and illustrate with the case that the scientific evidence of contamination or spread of a disease through trade is the relevant criteria (cited OECD, 1999).

The frequent use of cost-benefit analysis (CBA) for policy decisions on sanitary issues suggest that it could be used more widely to distinguish those measures that restrict trade but address a market failure, from those that have negative welfare impacts. Still citing Beghin and Bureau (2001), if this concept could translate into more weight being given to economics in international agreements in the future, the scope of this method would be even greater.

As stated by the aforementioned authors, when SPS regulations aim to correct market failures one difficulty that arises is often the identification of the protectionist component of the regulation. In other cases, comparing the costs of compliance to the gains associated with the reduction of an externality (such as the prevention of contamination or pest infestation) can help unravel the efficiency and the protectionist effect of a regulation. Decomposing the welfare effects, it is possible to assess the welfare loss associated with a measure whose costs exceed benefits. When the benefits are found negligible, this approach provides a sufficient test to classify an NTB as a trade distortion.

Some applications that could be cited are Bigsby and Whyte (2000), who proposed to measure both economic effects and probability aspects of risk, focusing on the case of pest infestation; and James and Anderson (1998), providing an economic assessment of quarantine regulation. Arrow et al. (1996), also apud Beghin and Bureau (2001),

argued for a more systematic use of cost-benefit analysis in the environment and health sectors so as to evaluate the legitimacy of the regulations that can be excessively costly for taxpayers and consumers.

Calvin and Krissoff (1998) noted that if the sole intent of a phytosanitary barrier were to protect domestic producers from import competition, relaxing this barrier would improve consumer welfare, reduce producer welfare, and yield a net gain in social welfare. Conceptually, both consumers and producers potentially could gain if consumers compensate producers for the removal of an artificial obstacle. On the other hand, if this barrier protects an industry from the costs associated with the introduction of a foreign plant disease or pest, its relaxation would further reduce producer welfare. If the disease or pest has a serious impact on yield or production costs in the new environment, the additional reduction in producer welfare could be so significant as to eliminate any consumer welfare gains and justify the barrier on both economic and scientific grounds. “Alternatively, if producer losses are relatively small, removing the phytosanitary measure could still increase net welfare, and that would not be justified on an economic basis”(Calvin and Krissoff, 1998).

In the SPS perspective, one important case is the analysis carried out by the USDA about avocado trade policy with Mexico. It is a compelling illustration that the mix of science-based evaluation and cost-benefit analysis can be useful in the identification of NTBs (defined as measures which have a negative impact on welfare) as well as the settlement of SPS trade dispute (Orden and Romano, 1996). The analysis proved to be useful in identifying the protection motive based on the legitimacy of pest avoidance. Moreover, the cost-benefit analysis elaborated for the avocado case resulted in evidence very useful to government in adopting policies welfare-enhancing.

However, according to Bigsby (apud Calvin and Krissoff, 1998), there is often uncertainty regarding the level of disease and pest risk associated with trade. This can provide either the basis for a legitimate concern or a convenient excuse to justify a trade barrier. This scientific uncertainty, particularly in cases of low probability but high-consequence events, can lead to an extremely conservative approach to setting phytosanitary barriers. As a result, potential welfare gains to trade may be lost.

It is worth mentioning some limitations related to this method. For instance, besides the large levels of uncertainty which surround the size of risks and their economic consequences; the necessity of assessing the probability of a disease or pest spread and the associated costs in the case of SPS measures. Even other regulatory barriers could be addressed with cost-benefit analysis. The effect of standards on consumers' willingness to pay for goods is perhaps even more difficult to quantify, especially in the case of subjective risks, or in the case of the ethical characteristics of the goods (Beghin and Bureau, 2001).

Recently, several countries are increasingly adopting a new application for the CBA. These countries were compelled to define methodologies to systematize the assessment and monitoring of regulatory public policies – the so-called Regulatory Impact Assessment (RIA). The RIA is under the preview of the TBT Agreement. In general, these impacts have been evaluated through a cost-benefits analysis. However, case-by-case studies carried out by some countries made it possible to conclude for mixing several techniques, aiming at the improvement of the impact assessment in a qualitative and quantitatively way.

The 2003 report from the European Commission (Randaelli, 2003) indicates that handling the regulation process became a priority for European institutions, searching for a better regulation that includes not only a structure to deal with regulation but also impact evaluation procedures that are well established. The regulatory management presents the following components as key-features: formulation, design, and assessment of a proposed legislation. This is justified by the understanding that a regulation poorly defined may generate more damage than benefits to the society. The tool to be applied during the policy formulation phases is known as Regulatory Impact Analysis (RIA).

The main idea is to evaluate the regulation before it is established, instead of adopting *ex-post* methodologies to assess its effects. The new European system to address this impact analysis, since 2002, involves three dimensions: economic, social and environmental assessment (Randaelli, 2003).

The OECD (2004) explains that several nations have impact analysis systems similar in terms of scope, quality control, cost-benefit analysis and evaluation on the effects related to competition and market opening, even though their names vary: RIA (Regulatory Impact Analysis of Regulatory Impact Assessment), RIS (Regulatory Impact Statement), RIAS (Regulatory Impact Analysis Statement). Variations among the RIAs are related to their focus, some more area specific, others for partial analysis or even very simple checklists. Regarding the methods to quantify and qualify costs and benefits, countries concentrate on quantitative analysis, although there is a trend to use them combined with descriptive studies, of a qualitative nature (European Union, 2003).

According to Radaelli (2003), the specialized literature provides general criteria to choose the methodologies to evaluate the effects of regulations. Even though many countries adopt the CBA, they have not been going further than to evaluate the cost of compliance with the regulations. Thus advances have been very modest in developing a wider cost-benefit analysis. There is also the possibility of adopting the cost-effectiveness analysis, the multi-criteria analysis and even the simpler checklists.

The CBA is a recommended technique to evaluate projects when the real components of costs or benefits can not be properly represented through market prices. Hence, the market is not able to evaluate correctly the relevant conditions.

Cost-effectiveness analysis (CEA) is a kind of economic analysis that compares the costs and results related to two or more actions. In the case of conformity assessment impacts, costs refer to the necessary resources as companies adjust to the regulation.

The Multicriterion Analysis (AMC) is a quantitative technique applied to decision analysis when a monocriterial approach (like ABC) does not provide inputs sufficient to evaluate a problem. This can be applied to decision processes where several agents interact and a decision is based upon many criteria (economic, social, environmental, sanitary, religious and so on). The objective of this kind of technique is to identify and select the best alternative facing a complex problem of decision-making. Criteria consist of attributes or indicators that allow the comparison of alternatives according to a certain point of view. They can be measurable, like the monetary values (tariffs, prices and capital costs) or not easily measurable (comfort, security, safety). In the latter case the quantification of indicators is made through methods of punctuation, weights and ranking.

To conclude, agencies from a number of countries from around the world are engaged in regulations to improve food safety and in turn public health. In each case there is renewed interest in risk assessment and benefit-cost analysis.

5.2. The Relevance Index

Regarding limitations of the developing countries, particularly as related to their budget constraints, it is important to develop tools to rationalize the allocation of resources concerning trade policies. To this end, Miranda and Barros (2005) started to develop a method of analysis and organization of data on sanitary and technical requirements imposed by countries. The goal was to have a mechanism to help government agents to identify and rank priorities for public policies and international negotiations.

Their proposal consists of building a comparative Relevance Index (RI) that results from collecting data using the checklists approach (explained in section 3.2). These data encompass three parts: (1) an analysis of the economic impacts; and (2) the legitimacy analysis, which has two components: the legality analysis and the technical-scientific one. The first step of the analysis is to calculate the Economic Relevance Index (ERI) by summing points obtained in each question through the first diagnostic about the economic impact. The same procedure is then used to determine the number of points in diagnoses 2 and 3, which refer to legality and consistency, respectively. The sum of these two will result in the Illegitimate Index (ILEG) for each of the technical or sanitary measures analyzed.

A high number of points in Checklist – Part 1 is taken as an indication that such measure presents an expressive impact upon economic variables related to firms, to the industry or even to the country subject to the technical/sanitary requirement. The sum of points of Checklist - Part 2 leads to indexes that represent a greater degree of illegality, the higher its magnitude, indicating that the measure is not according to international legal references. Using the same rationale, the higher the number of points obtained in Checklist – Part 3, the greater its scientific inconsistency, indicating a low technical and scientific basis supporting the technical requirement. The sum of these two indexes corresponds to the ILEG.

The Index of Relevance (IR), which is calculated as a weighted sum of squares of the ERI and ILEG, where λ and $(1-\lambda)$ represent the weights and λ stands for the level of importance attributed by decision makers to the economic importance of the restrictive technical measure. Since λ is a value between 0 and 1, the $(1-\lambda)$ stands for the importance attributed to the illegitimate status of the measure. These parameters must express distinct interests that may exist in various countries, or to different decision makers, governments or any other relevant agent involved in the process⁵.

The most significant advantage in building a rank for sanitary or technical barriers according to their legitimacy and economic grades is the opportunity to establish priorities. Different categories of barriers could be determined instead of trying to affirm if the requirements are obstacles or not. The categories could range from a low importance barrier, in all senses (economic, legally or scientifically aspects), to the

⁵This method was first explained in Barros and Miranda (2005) and is still being developed at the Center for Advanced Studies in Applied Economics – ESALQ/University of Sao Paulo, Brazil, currently in the empirical application step.

highest priority for the country interests. In the first case, the government could simply ignore the obstacle and if any action is to be adopted, the private sector will be leading it.

But, on the other hand, the extreme case of the highest priority would require efforts from both government and the private sector, taking the issue to disputes settlement at the WTO. However, nobody would deny the relevance of taking care of it.

Between the two cases, a large variety of measures shall appear, some more demanding of public policy support, others more feasible to become a negotiated trade dispute. However the matter is that this systematic could prevail government to allocate too much time and resources in cases that not worth it.

5.3. Computable General Equilibrium Models⁶

Complementary analyses of the social impacts of regulations may be obtained by the use of computable general equilibrium (CGE) models. Such models make it possible to simulate the effects of shocks on variables that affect the system. For instance, conformity assessment may positively impact the exports of a sector. The use of a CGE model may make it possible to measure at least some of the economic and social effects of the procedure. These include the impacts on production, employment, real wage, prices, variations in costs, and even the impacts on other sectors.

Deardorff & Stern (1985)⁷, cited by Miranda (2001), asserted that the best way to evaluate the general and restrictive effect of a non-tariff barrier would be a general equilibrium model for world trade. In such a model, product flows could be disaggregated and trade could be analyzed under the free trade hypothesis. Leamer (1989) also suggested this framework to estimate the effects of trade barriers and emphasized the theoretical foundation demanded for using this kind of modeling.

As an advantage, Beghin and Bureau (2001) mention that CGE models can allow for the analysis of cross-sectoral effects while explicitly taking into account the impact on factor markets. The caveat about the CGE approach relates to the level of aggregation and the quality of data typically used.

Further applications of this approach are necessary for an evaluation of the potential of such models to deal with sanitary and technical barriers to trade. Some attempts were undertaken at CEPEA to use a CGE model of the general economy to evaluate the effects of sanitary barriers on Brazil's meat exports. However, the results were not significant and, indeed, very small. Hence, even though the Brazilian meat industry frequently faces serious restrictions on its export performance, we have a lot to do to insert an analysis of sanitary measures into CGE models.

6. Final Comments: Challenges for the Developing Countries

The original goal of this paper was to update the literature on the conceptual and methodological approaches available to address the issues of sanitary and technical

⁶ This approach was not a main focus at this paper. However, it deserves further comments and a specific review.

⁷ DEARDOFF, A.; STERN, R. Methods of measurement of non-tariff barriers to trade. Geneva: UNCTAD IST/MD/28,. 1985.

barriers to trade. There is not a single nor simple conclusion to the paper. Instead, many questions have been raised for further and more detailed discussion.

There is no doubt that the sanitary and technical requirements imposed by governments, or even companies, are increasing and becoming more restrictive. This is a serious challenge for developing countries, which experience sizeable losses in export revenues or incur higher production and marketing costs to comply with the requirements.

A first conclusion we draw is the need to enlarge the conceptual framework for analyzing non-tariff barriers so as to cover the trends being faced by companies in the day-to-day experience of international trade. This is particularly the case with technical standards in which case companies are more affected by voluntary standards than by compulsory regulations. This should be a major issue in multilateral negotiations as well as in regional integration processes, and should involve not only TBT issues, but also probably the SPS.

The traditional literature on international economics does not consider voluntary standards (private strategies) to be a policy under government control. However, increasingly this kind of requirement puts pressure on companies to comply so they can be competitive and obtain access to richer consumers. In this sense, the developing countries will probably start to increase their demand on public agents to provide conditions to help achieve those requirements. The need for infrastructure to meet the demands will probably be important.

Beghin and Bureau (2001) recommend a research program that will help address the difficult ambiguities where the protectionist component is unclear but where the regulations have a genuine concern about consumer protection. This focuses on the conceptual studies regarding the legitimacy issue, but certainly it is not a topic to be addressed only by the economists. The negotiations under the WTO and other organizations will have to consider the broader perspective to be relevant in dealing with trade disputes.

Reflections on the negotiations can already be noticed. One of the recent proposals of issues to be addressed by the TBT Technical Committee involves strengthening the participation of some important organizations that deal with normalization, such as the International Organization for Standardization (ISO). This is a consequence of the relevance these voluntary standards are assuming in the international market place.

Hence, economists and policy agents will increasingly have to deal with the definitions, the tools to collect data, and the methods to quantify impacts on trade or on welfare as a whole if they are to address the issues of voluntary standards.

Another suggestion is that improvements in empirical approaches will likely need to require a higher degree of specification in the methods, whatever they happen to be. This includes: surveys for collecting quantitative data, econometric models for a sector or industry, or cost-benefit analysis. This increased specificity is required because of the complexity of sanitary and technical barriers to trade and the ambiguity that occurs when they are introduced into more general and large-scale models.

Some experiences using CGE models for evaluating the effects of sanitary and technical measures on economies have been tried. Usually, however, the results have not been very rewarding. Most of the results show very small effects and provide little contribution to the discussions. Even though the specific measures considered are well known to have significant effects on sectoral or regional variables, the models so far

are unable to capture these effects. It is interesting that research continues to improve other mathematical approaches so as to have better inputs to be inserted in the CGE models. In the future, these models may thus provide improved insights for public policies choices.

We suggest that more analysis of the incidence of non-tariff barriers to trade may be helpful in specifying the general equilibrium models. The discussion above about the legitimacy issue suggests some ambiguity about where the benefits accrue and the costs reside. Clarification of these issues may produce more accurate models.

Whatever models researchers may adopt to consider public policy issues, advances in categorizing different types of measures, evaluating their legitimacy and their restrictiveness are really demanded to provide proper tools for public agents. This is indeed very important for developing countries, which face serious budgets limitations in attending to all trade disputes.

More research on the social costs of labor in the developing countries may help improve the accuracy of cost-benefit analyses. Labor markets in these countries are incomplete and discontinuous. Thus the evaluation of the social costs of labor for purposes of further analyses can be helpful in improving the accuracy of such analyses.

It is essential to count on an active participation of developing countries in relevant international fora to discuss sanitary and technical regulation and normalization. These countries need to represent and defend their interests, and in a scientifically and technically correct way. The current low participation of developing countries in international organizations and fora implies that interests of the developed countries largely drive the sanitary, technical, quality, environmental, legal and scientific guidelines.

A technical barrier to trade that may become increasingly important in the future involves measures that may be out in play to attenuate global warming. Recent suggestions have implied that barriers to be trade be imposed if countries are not following the agreed-upon rules to mitigate global warming. These may proliferate in the future, and in principle may take on a variety of forms.

Food safety, environmental protection, human, animal and plant health questions are all worldwide concerns. Furthermore, developing countries face severe restrictions in financing research and providing infrastructure, as well as skilled professionals to work with sanitary and technical economic issues. It is necessary to insist on the importance of providing technical assistance for the developing and less developed countries. This would be very productive in the sense that more sophisticated methods and knowledge could become easier to access for policy makers in the developing countries.

For instance, the use of cost-benefit analysis is critical for understanding the social welfare effects of regulatory policies, but it requires a great deal of information. Additional studies from a multidisciplinary perspective (phytopathology, entomology, statistics, and so on), and access to data are usually available only for government proposals. This method could become very useful for public decisions, resource allocation and adoption of measures to comply with requirements.

This is in accordance with the point of view presented earlier – *ex-ante* approaches to deal with sanitary and technical barriers may be very useful to avoid future problems in international trade, particularly for developing countries.

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