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THE ECONOMICS BEHIND NON-TARIFF MEASURES: THEORETICAL INSIGHTS AND EMPIRICAL EVIDENCE

by

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Abstract

The paper presents a review of recent work both theoretical and empirical related to the impact of non-tariff measures with a focus on technical regulations. A minimalist theoretical set-up to analyse non-tariff measures is first presented. Various empirical approaches and techniques used to assess the impact of technical regulations are discussed. Empirical results obtained across strategies are then surveyed.

Keywords: Non-tariff measures, trade barriers, welfare

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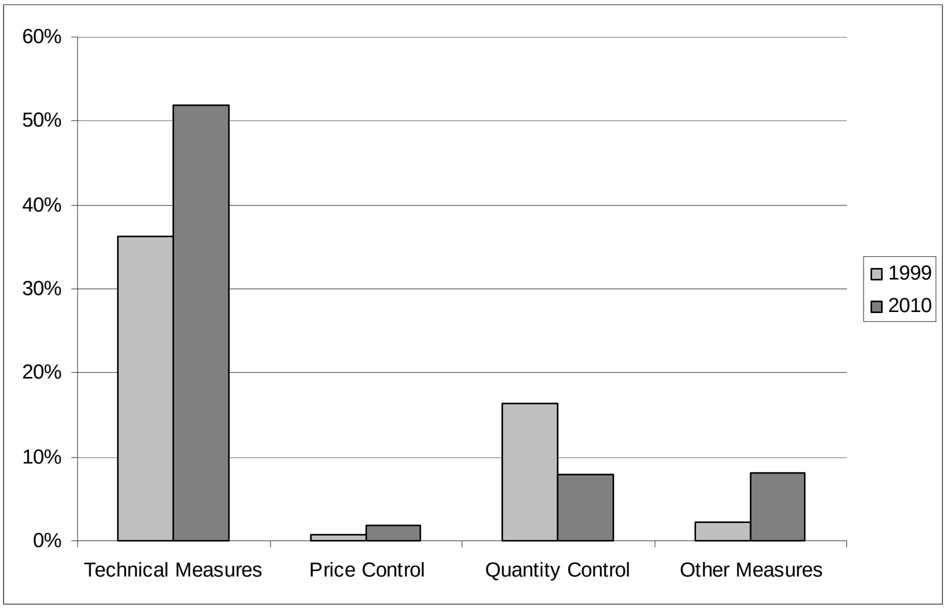
1. INTRODUCTION

Non-tariff measures (NTMs) and in particular technical measures have become a prominent feature in the regulation of international trade in goods. This pattern is illustrated by figure 1. While technical regulations were imposed on almost 37 per cent of tariff lines in 1999, the equivalent figure for 2010 is more than 50 per cent. The bulk of technical regulations are grouped in two major categories, namely sanitary or phytosanitary (SPS) measures and technical barriers to trade (TBTs). The former includes regulations and restrictions to protect human, animal or plant life or health, while the latter addresses all other technical regulations, standards and procedures. SPS measures and TBTs are the objects of two World Trade Organization (WTO) agreements that impose disciplines to trade that go beyond the usual non-discrimination. Independently from their objective and legal framework, SPS measures and TBTs can have important effects on international trade. In terms of incidence, TBTs are by far the most used regulatory measures, with the average country imposing them on about 30 per cent of products and trade. Countries also impose SPS measures on an average of approximately 15 per cent of trade. The large incidence of TBTs and SPS measures raises concerns for developing countries' exports. These measures impose quality and safety standards which often exceed multilaterally accepted norms. However, policy is proceeding with little economic analysis. There is substantial literature on individual types of NTMs, and in some instances sophisticated empirical analysis of their effect (such as for antidumping). However, this information is likely to be instrument, industry or country specific. There are good reasons why this is the case and these reasons are likely to stay. Under a common denomination NTMs regroup a vast array of trade (and in some instances non-trade) policy instruments. Unlike tariffs, NTMs are not straightforwardly quantifiable, not necessarily easy to model, and information about them is hard to collect (figure 1).

Figure 1.
Frequency index by broad type of non-tariff measures (1999 and 2010)



Source: Gourdon and Nicita (2013).

This paper offers a review of some recent work both theoretical and empirical related to the impact of NTMs with a focus on technical regulations. The objective is not to review an exhaustive list of relevant papers but rather to take the reader as close as possible to the frontier of current research within a comprehensible analytical framework. The issue of legitimacy of a measure is only briefly discussed as a proper treatment is beyond the scope of the paper.

The difficulty in analysing technical regulations essentially originates in the fact that such measures could have contrasting effects on exports and consumption, and eventually on welfare. From the producer point of view, a major difference between measures falling into the technical regulations type, and other more standard NTMs is the existence of compliance costs that do not translate straightforwardly into an ad valorem change in production costs and eventually prices. Those compliance costs may include the fixed costs of upgrading the equipment and/or practice codes, obtaining certificates, altering marketing strategies, and the like. Such compliance costs echo the conventional "standards as barriers" argument in the international development literature on market access (Otsuki et al., 2001). From the consumer point of view, however, a technical measure may increase the demand for imports if the measure is informative (Thilmany and Barrett, 1997). For instance, the measure can signal a higher quality of imports via information disclosure such as trademarks, labelling requirements, detailed description of certain attributes or restricted toxic residues. The quality improvement effect corresponds to the "demand enhancing effect" or "standards as catalyst" argument.

The present paper is organized as follows. Section 2 presents and discusses a minimalist theoretical set-up to analyse NTMs. Section 3 is dedicated to the empirical approaches and techniques used to assess the impact of technical regulations. Section 4 is a survey of empirical results obtained in a selection of papers. Section 5 concludes the paper.

2. MAIN ISSUES FOR THE THEORETICAL CHARACTERIZATION OF NON-TARIFF MEASURES

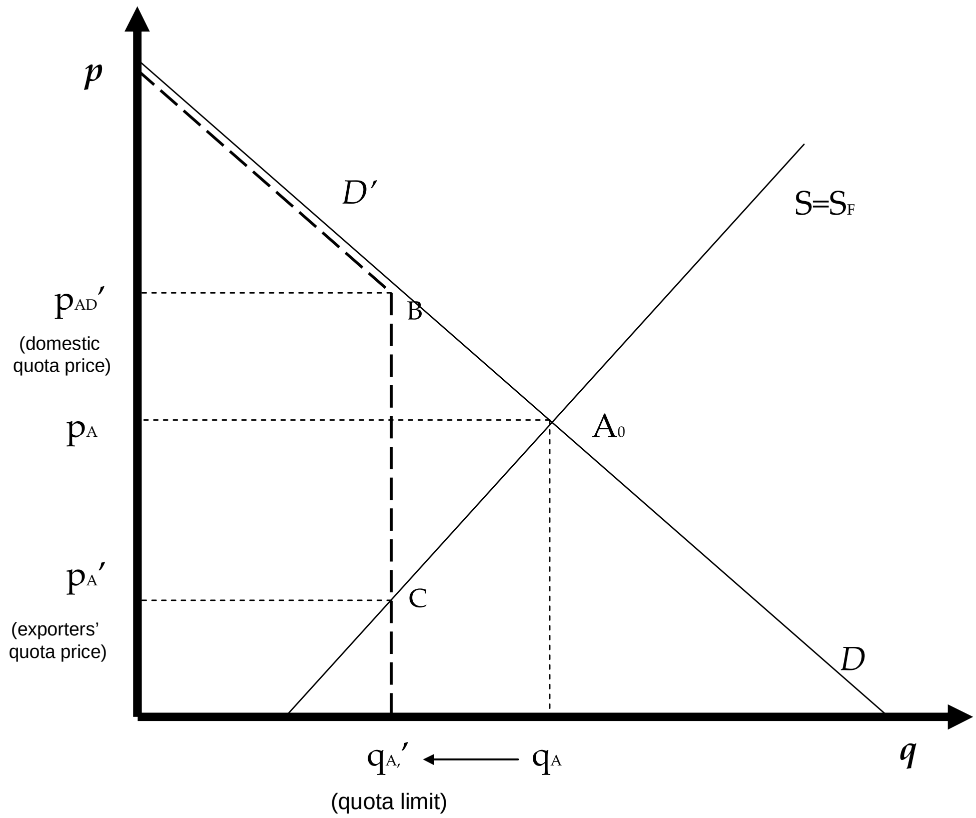
The standard approach to appreciate price and quantity effects of NTMs is based on the canonical supply–demand diagram for imports. Independently of the nature of the NTM this approach allows qualification of the cost/price-raising, trade-restricting effect at the border, which can be termed the protection effect or more generally the trade-cost effect. The term protection effect has an explicit negative connotation. This would not be justified if the NTM responsible for the effect had no protectionist objective. Hence, we will opt thereafter for the term of trade-cost effect.

2.1 A MINIMALIST APPROACH: THE SINGLE MARKET APPROACH

In this basic theoretical framework it is relatively easy to illustrate how any measure could be made equivalent to an ad valorem tariff. The most discussed equivalence is that between a quota and a tariff. Intuitively, a quota, similarly to a tariff, introduces a wedge between the price received by foreign producers facing the quota and the price paid by domestic consumers for these imports. This is illustrated in figure 2, which focuses on the import market.

Typically, the analysis of a quota gives similar results to that of a tariff. The quota limits the level of imports to q_A'. As a consequence the domestic price of imports rises to p_{AD}' which is above the world price p_A. In the classical case of the large country, the world price of the imported good falls to p_A'. This is as if the demand curve becomes the dashed line labelled D' with a kink at q_A'. It might be the case that the quota is set above the level of free trade imports implying that it is not binding. In that case the quota has no effect. Otherwise, the quota gives rise to "rents" because of the price wedge it creates. These rents may be captured either by the government of the importing country if import licences/rights are auctioned, the domestic residents if they are given import licences/rights with no financial counterpart, or foreigners if they have the import licences/rights with no financial counterpart. The way the quota is administrated will eventually affect welfare analysis but not new equilibrium properties.

Figure 2.
Application of a quota on imports



A similar analysis applies to NTMs such as voluntary export restraint, variable levy on imports, government procurement regulation or any other measure whose main objective is to limit deliberately imports of a specific good through the imposition of a wedge between the world price and the price charged to domestic consumers (see, for example, Baldwin (1991) and Deardorff and Stern (1997) for a detailed analysis).

However, NTMs could generate categories of economic effects which are not prima facie a trade-cost effect (Beghin, 2008) even though they translate into a similar impact on traded prices and quantities. This is essentially true for measures such as TBTs and SPS measures or any with a technical regulatory content. The rationale or political intent for this kind of measures is not necessarily the protection of local/domestic industries. These categories of NTMs often have other stated social or administrative objectives designed to regulate the domestic market. Meeting these objectives also leads to a shift in the supply curve and/or to a shift in the demand curve (Roberts et al., 1999) as in the case of classical NTMs such as quotas. The difference is found in the fact that the change in prices due to the measure does not generate any private or public rent.

Typically prices vary as a consequence of variations in the cost of production and or changes in consumption behaviour. More precisely, supply-shifting effects occur when regulations are used to tackle externalities affecting international trade of goods, such as preventing the sale of products hazardous for health or creating standards to increase compatibility and interoperability. Such regulations can specify the production process (for example, the use of a certain technology), or product attributes (for example, a maximum content of given components) required for conformity.

Demand-shifting effects are required for certain types of market failures, for instance by making it compulsory to provide certain information to consumers, thus affecting their behaviour.

Supply-shift effects are of particular relevance to TBTs and SPS measures. Demand-shift effects can be identified for any sort of technical regulation.

Ganslandt and Markusen (2001) explain how standards and technical regulations have both trade-impeding and demand-enhancing effects, the former by raising the costs of exporters and the latter by certifying quality and safety to consumers. However, in order to illustrate the impact of NTMs such as TBTs and SPS measures on prices and quantity traded, we adopt the theoretical framework used by Disdier and Marette (2010). The framework is based on a set of simplifying assumptions but without loss of generality in its main analytical features. The analysis focuses on a specific good market and excludes any general equilibrium mechanisms. The market good is assumed to be homogeneous (or quasi homogeneous) except for a characteristic potentially dangerous to consumers. Foreign and domestic goods can carry this characteristic. Domestic consumers may or may not be aware of the latter. If they are aware they internalize the damage in consuming that good. Demand is derived from quadratic preferences and supplies are derived from a quadratic cost function. Assuming that foreign and domestic products are perfectly homogeneous and thus perfectly substitutable, the result is a standard linear demand and supply diagram. The most interesting refinements are the dissociation between foreign and domestic supply and the possibility to undertake welfare graphical analysis.

In figure 3, consumers internalize the possible damage related to the dangerous characteristic of the product under consideration. As a consequence and assuming that the demand curve is linear in the cost related to the possible damage, the demand curve shifts to the left. The size of the shift depends on whether the dangerous feature is in both the domestic and foreign good or not. The demand curve moves independently of the implementation or not of a standard. The implementation of a standard exclusively affects supply curves as its impact is on the production process and thus on production costs. With internalization the new market equilibrium occurring in A' is characterized by lower consumption (*from* q_A *to* q_A') and lower price (*from* p_A *to* p_A'). The fall in consumption is reflected in lower levels of both domestic production and imports. Figure 4 represents the case where the dangerous characteristic is possibly carried by foreign goods only. In that context, the implementation/reinforcement of a standard by domestic regulators affects imports exclusively, that is foreign producers. This implies that only the foreign supply curve is affected directly. We further assume that consumers have internalized the damage before the action of the regulator. The starting equilibrium is made to coincide with the post-internalization equilibrium illustrated in figure 2. The consequence of the domestic standard is an increase in the equilibrium price (*from* p_A' *to* p_A'') and a fall in imports and thus domestic consumption (*from* q_A' *to* q_A''). The overall impact (that is, with respect to the initial equilibrium in figure 3 characterized by the coordinates of point A) with internalization by consumers of the damage cost is clearly a fall in the quantity consumed but an indefinite impact on the equilibrium price (p_A stands above p_A'). The sign of the change in the equilibrium price will depend on the probability of contagion, the associated cost form the consumer point of view and the stringency of the standard. Standard stringency could be modelled essentially in two ways. The most straightforward one is by the inclusion of a parameter indicating the proportion of output exported that eventually enters the destination market after inspection. With a more stringent standard this proportion is reduced. The proportion parameter behaves as a standard supply-shift parameter. This approach has been applied to figures 3 and 4 with the additional assumption that no fixed/sunk costs exist. The second approach consists of having a sunk (or fixed) cost parameter that varies with the application and stringency of a standard. Sunk costs are linked amongst other elements to the firm's costs of market entry and of compliance with regulations. These two approaches are not exclusive and if taken separately they both generate comparable results from at least a qualitative point of view. In the case of the presence of sunk/fixed costs, the supply curve is no longer linear.

Figure 3
Internalization of damage costs

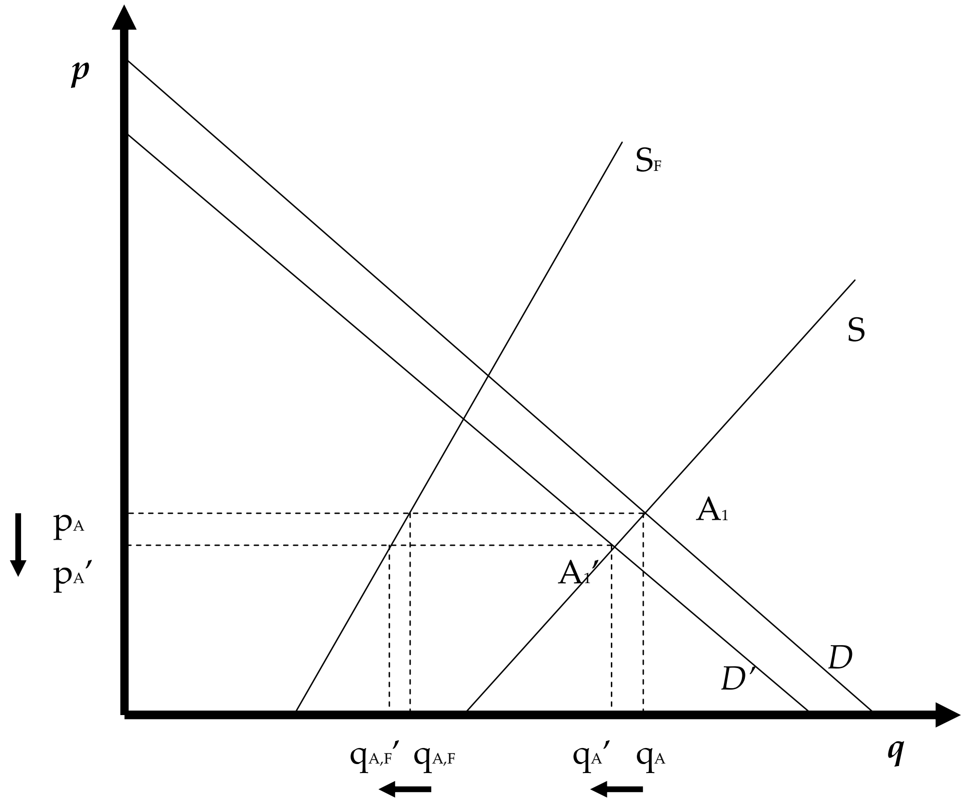
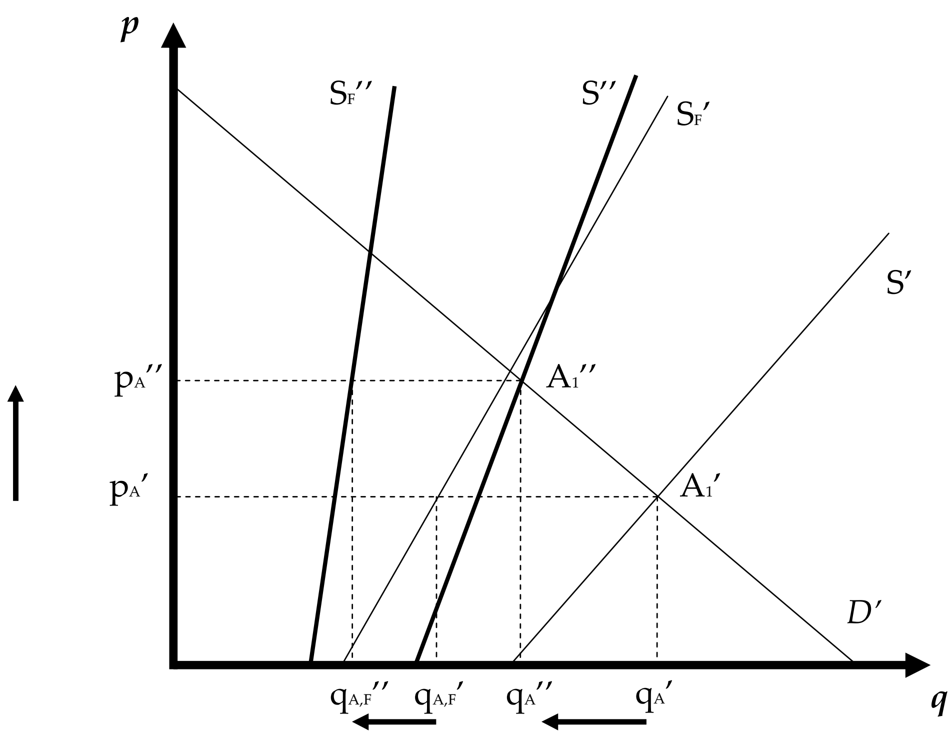


Figure 4
Application of a public standard

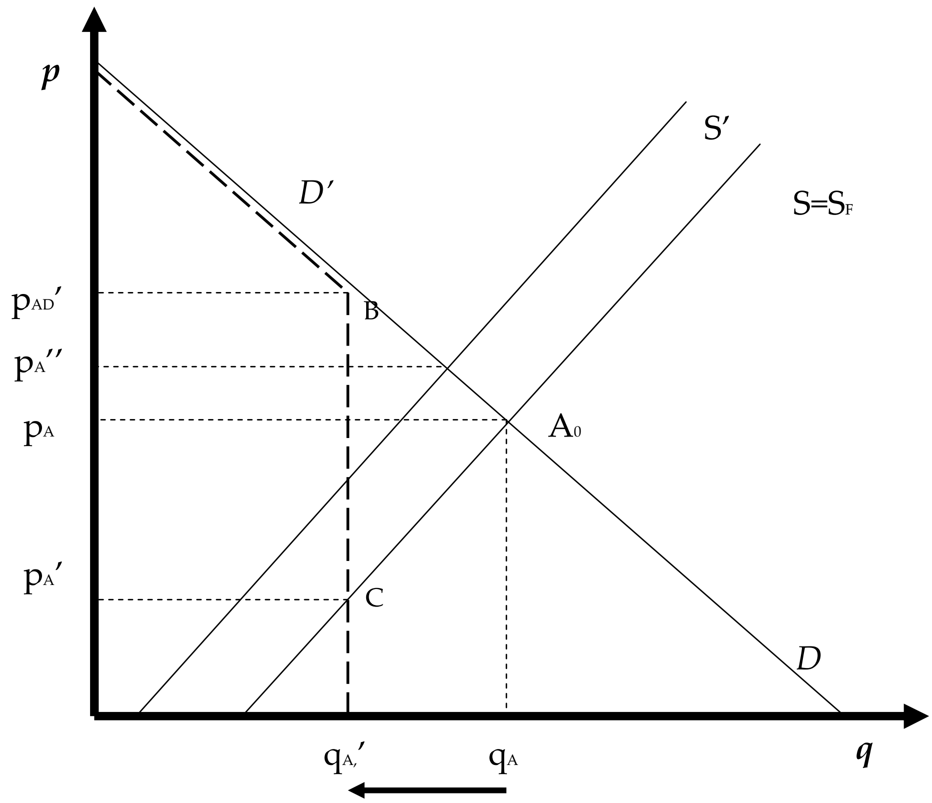


Besides internalization of the damage, the so-called demand-enhancing effect could also lead to a shift in the demand curve. A public standard possibly affects consumer's information set and behaviour. If the measure appears to be informative and signals a higher quality of the permitted imports it may enhance the demand for imports. As a response to the measure the demand curve would shift to the right, counteracting the demand shift coming from the internalization of damage by consumers. The demand-enhancing effect should be considered separately from the internalization of possible damage although the two could be related. Their correlation may not be of the most intuitive. Indeed, if we allow internalization to be imperfect, then the implementation of the standard could raise the awareness of consumers and as a consequence it would increase the incidence of internalization.

2.2 MULTIPLE OVERLAPPING NON-TARIFF MEASURES

The effect of a specific NTM on price and quantity may be difficult to identify in a situation where several NTMs are implemented for the same product. Whether from a theoretical or an empirical point of view, the simplest approach is to consider that the overall impact is related to the relative strength in trade restrictiveness of each NTM in place. That is, there is a dominant NTM in terms of impact which encompasses the impact of all other NTMs. This configuration is illustrated in figure 5 which represents the combination of a quota and some technical regulation. The quota is assumed to be binding and its restrictiveness on imports is such that the cost effect of the technical regulation is absorbed by the quota price effect. In other words, the equilibrium price increase gives no indication of the technical regulation price effect.

Figure 5
Multiple overlapping non-tariff measures



However, there are also cases where the impacts of NTMs do not overlap but add to each other. For instance, if we consider the case of a combination of any ad valorem para-tariff measure and some technical regulation, the aggregate price effect would be the resultant of the price effect of both NTMs. Theoretically, both measures affect the cost of exporting to the implementing country and thus shift the supply curve to the left.

Generally speaking, when one of the NTM implemented has a quantity restriction dimension, it is likely that multiple NTMs have a cumulative but not additive effect.[1] If multiple NTMs all affect production costs their respective effects cumulate and most probably add to each other.

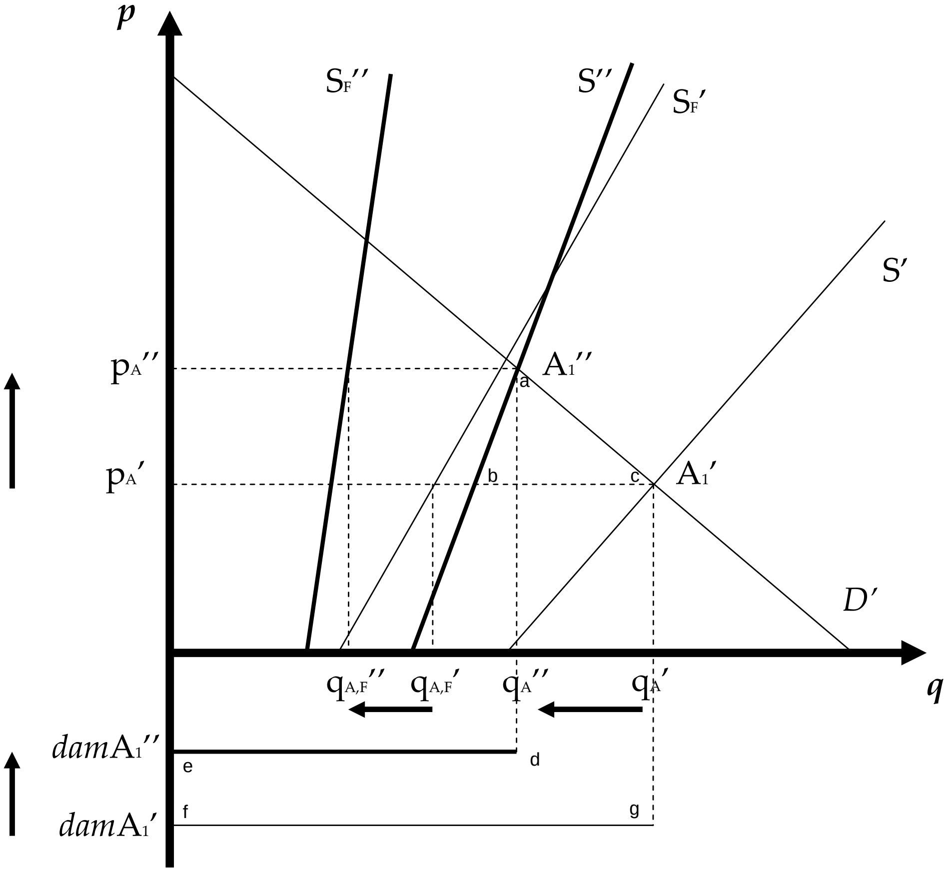
2.3 WELFARE ANALYSIS

Welfare analysis in a basic single-market linear demand–supply framework such as the one adopted in previous sections is straightforward. Consumer and producer surpluses are directly reflected by areas under and above the demand and supply curves, respectively. Deadweight losses are triangular areas whose size depends on the relative elasticity of demand and supply curves. In figure 2 for instance, welfare is given by the sum of domestic consumers' surplus and domestic and foreign producers' profits, the overall deadweight loss generated by the introduction of a quota corresponds to the triangle ABC.

When considering measures such as SPS measures and TBTs welfare must also account for the damage linked to the dangerous characteristic of the product whether the latter is internalized or not by domestic consumers. The internalization leads to a change in demand which de facto affects equilibrium and thus welfare. However, welfare is usually seen from the point of view of a social planner implying that the cost of damage should be included in the set of welfare components. The overall damage cost can be estimated by the probability of having contaminated products times the per unit damage costs expressed in units of the reference good. The implementation of an SPS measure or a TBT will reduce the probability of contamination. This is shown in figure 6, which is a reproduction of Figure 3 with a graphical representation of the damage cost of the dangerous characteristic. We further assume that there is no internalization of the damage possibly caused by the dangerous characteristic and that the latter pertains to foreign goods only. The move from $damA_1'$ to $damA_1''$ reflects the fall in the probability of contamination due to the implementation of the measure. The welfare net impact is a priori unclear, despite the existence of the standard deadweight triangle, as the damage cost related to the dangerous product characteristic has been reduced by the public standard. As long as the "savings" in damage cost are larger than the deadweight loss, the net welfare impact remains positive; that is, as long as in figure 6 the area defined by $q_A'q_A''defg$ (the reduction in damage cost) remains larger than the area abc (deadweight loss).

[1] See Tilton (1998) for an illustration based on Korean exports of cement to Japan.

Figure 6
Application of a public standard and welfare



2.4 BEYOND THE MINIMALIST APPROACH

There are two major shortcomings in the preceding approach. First, it is a partial–partial equilibrium analysis and, second, it remains essentially static. A partial equilibrium model, as the one underlying the graphical analysis used here, focuses only on one part or sector of the economy, assuming that the impact of that sector on the rest of the economy and vice versa are either non-existent or small. A general equilibrium analysis on the contrary explicitly accounts for all the links between sectors of an economy – households, firms, governments and countries. It imposes a set of constraints on these sectors so that expenditures do not exceed income and income, in turn, is determined by what factors of production earn. These constraints establish a direct link between what factors of production earn and what households can spend. A general equilibrium approach is not necessarily easy to put into practice as it would require more elaborated modelling especially if the unit of analysis had to be the product. In addition, before turning to general equilibrium considerations it is important to make sure that those considerations would generate important additional information. As to the second shortcoming mentioned previously, it can be illustrated qualitatively in our minimalist set-up. Generally speaking, a dynamic set-up would allow to qualifying the adjustment process going from the original equilibrium to the post policy reform one. The best that can be achieved in the situation described is comparative statics but with the application of a multidimensional adjustment process. A good illustration is given by the demand-enhancing effect of the implementation of a standard. Such an effect comes simultaneously or with some lags after the public standard has been implemented. As mentioned previously, the economic effect is a demand shift effect moving the demand curve to the right. For the sake of simplicity we assume that the two behavioural features are orthogonal to each other. A demand-enhancing effect can in theory be stronger in impact than the rise in production cost due to the fulfilment of the standard requirements. If this is verified then the implementation of the standard could lead to an increase in both price and quantity at equilibrium. It would also lead to an improvement in overall welfare always assuming that the implementation of the standard has reduced the probability of damage by raising the quality of products consumed.[2] This result would hold whether the dangerous characteristic is specific to the foreign product or its domestic equivalent, or both.

3. MAIN METHODOLOGICAL ISSUES IN QUANTIFYING NON-TARIFF MEASURES[3]

Among the methodologies expected to be the more reliable in quantifying NTMs, inventory, price comparison and quantity impact are the most often used. However, even in the simplest theoretical framework, the economic and welfare effects of NTMs cannot be unequivocally determined. This feature is not exclusively inherent to multiple NTMs but also to NTMs such as SPS measures and TBTs. The main objective in the quantification of NTMs has been to produce price effects estimates and translate them into ad valorem equivalent measures (AVEs) (also called, although misleadingly, implicit tariffs or implicit rates of protection). This approach is particularly attractive as it would synthesize in one single metric the impact of an instrument with multiple dimensions often interrelated with each other. However, the analysis undertaken in the previous section has pointed to the fact that this ad valorem equivalent does not necessarily have to be positive, and even if it is positive it does not necessarily reflect a restrictive quantity effect. Hence, the ideal empirical strategy should provide estimates of both quantity and price effects in order to allow for a proper qualification and identification the NTM impact. Recently, advances in gravity-based analysis have set the basis to disentangle the various effects of the implementation of technical measures for a specific good market. Accounting for the possible existence of contrasting effects due to the implementation of an NTM also drives the recently revived cost–benefit analysis.

3.1. INVENTORY MEASURES

The simplest aggregate indicators of the use and incidence of NTMs are the frequency index and the coverage ratio. A frequency index is the share in total tariff lines containing one or more NTMs. The share can be expressed in weighted terms based on either imports or production. The coverage ratio is the percentage of imports affected by one or more NTMs to total imports. These inventory measures allow the summarization of information on NTMs collected at a disaggregated level in one indicator. Detailed information collected for a country at a disaggregated level is necessary for the computation of these measures.

The frequency index accounts only for the presence or absence of an NTM, and summarizes the percentage of products to which one or more NTMs are applied. In more formal terms, the frequency index of NTMs imposed by country *j* is computed as:

$$F_j = \left[\frac{\sum D_i M_i}{\sum M_i} \right] \cdot 100$$

[2] See Carrère and De Melo (2011) for discussion and further illustrations.

[3] Refer to Deardoff and Stern (1997) and Ferrantino (2006) for a comprehensive review and discussion of the issue. Useful discussions are also found in Maskus et al. (2001) on quantification of technical barriers to trade. Beghin and Bureau (2001) discuss sanitary and phytosanitary standards.

where D is a dummy variable reflecting the presence of one or more NTMs and M indicates whether there are imports of product i (also a dummy variable). Note that frequency indices do not reflect the relative value of the affected products and thus cannot give any indication of the importance of the NTMs on overall imports.

A measure of the importance of NTMs on overall imports is given by the coverage ratio which measures the percentage of trade subject to NTMs for the importing country j. In formal terms the coverage ratio is given by:

$$C_j = \left[\frac{\sum D_i V_i}{\sum V_i} \right] \cdot 100$$

where D is defined as for the previous equation, and V is the value of imports in product i. One drawback of the coverage ratio, or any other weighted average, arises from the likely endogeneity of the weights (the fact that imports are dependent on NTMs). This problem is best corrected by using weights fixed at trade levels that would arise in an NTM- (and tariff-) free world, otherwise, the coverage ratio would be systematically underestimated. While that benchmark cannot be reached, it is possible to soften the endogeneity problem (and test for the robustness of the results) by using trade values of past periods.

The immediate advantage of such instruments is the relative ease with which they can be collected, in essence not much more difficult than compiling tariff schedules. Inventories of NTMs do represent valuable information that could, if updated on a regular basis, help keep track of the evolution of the relative incidence of different types of NTMs on trade flows of goods, and of the evolution of their incidence relative to tariffs. Another obvious advantage is that information can be very NTM type-specific and highly disaggregated at the product level. On the other hand, these indicators have limitations in that they do not give any direct information about possible impact on price and quantities produced, consumed or traded. They are normally used to construct indicators of trade restrictiveness that in turn can be used to estimate quantity and/or price effects.

3.2 PRICE COMPARISON

A more direct measurement of the price impact of NTMs is price comparison (also called price wedge). This enables the easy computation of so-called ad valorem equivalents. Yet serious conceptual and data problems are likely to arise in the estimation and interpretation of tariffs equivalents. First, it is necessary to identify the appropriate prices to use and this is likely to be problematic. While it is fairly easy to obtain information on the price paid by the importers of a good, it might become difficult to obtain the corresponding price prevailing in the domestic market especially at a fairly disaggregated level. This becomes even more difficult if data collection has to be done for a large set of countries. Other drawbacks are: the price comparison implicitly assumes perfect substitution between imported and domestic goods and the price differential does not convey information about how the NTM operates in practice (Beghin and Bureau, 2001). Another factor is that the comparison is made in the presence of the NTM distortion (and not by comparison to a benchmark case without distortion; see Deardoff and Stern, 1997).

3.3 BUSINESS SURVEYS

Business surveys or structured interviews have also been used to obtain information on the prevalence of NTMs. Survey investigations could be used to collect data for a specific analytical purpose such as information about the frequency of NTMs, or the relative importance of different measures, such as their trade restrictiveness or trade impact. One problem is that surveys tend to be very resource intensive. This feature is likely to constrain the scale and scope of the investigation and the extent to which the collected information can be seen as representative of the sector or industry. Surveys also tend to rely on perception information rather than on statistical data, and differences in methodology make comparisons between different survey sources difficult.

3.4 QUANTITY IMPACT

Quantity-impact calculations should also provide precise information about the effect of NTMs on trade, but similarly to price comparison it may be challenging to obtain appropriate data to compute the exact impact. An advantage of quantity-based indicators is that a general approach to the measurement of the quantity effects of NTMs can be undertaken, leading to the possibility of systematic and repeated estimation. Such an approach could ideally (with a sufficiently large dataset) include all categories of NTMs and thus isolate the individual impact of each. Quantity estimates associated with information about import demand elasticities that can be used to derive price effect estimates, and thus the computation of AVEs. This is the methodology followed in Kee et al. (2009). The theoretical foundation for this kind of study is the n-good n-factor general equilibrium model with log-linear utilities and log-linear constant returns to scale technologies (see for instance Leamer, 1988). This model allows for both tariffs and NTMs to deter trade with effects that vary by importing country and good. The empirically tested, reduced form of the model is given by:

$$\ln m_{n,c} = \alpha_n + \sum_k \alpha_{n,k} C_c^k + \gamma_{n,c}^{core} Core_{n,c} + \alpha_{n,c}^{DS} \ln DS_{n,c} + \phi_{n,c} \ln(1 + tar_{n,c}) + u_{n,c} \quad (1)$$

Once ad valorem equivalents of each NTM are computed then it is also possible to obtain an overall level of protection at both the good and country level. There are drawbacks to this methodology, the most important being certainly that it cannot fully account for the endogeneity of imports to the presence of NTMs, and this is likely to bias the elasticities estimates.

3.5 GRAVITY MODELS

The gravity model of trade has also been used to estimate the value impact of NTMs. In a cross section, a value impact is comparable to a quantity impact after some price normalization. However, in terms of identification of the effect of the implementation of an NTM measure, a panel structure is preferable even if it may complicate the empirical decomposition of variations in value into price and quantity variations.

The standard gravity estimation is implemented at the product level or at the industry level. In the former, estimation is in most cases product specific and often limited to a restricted sample of countries (see, for example, Disdier and Marette (2010)). In the case of implementation at the industry level, although the analysis could be exhaustive in terms of industry coverage it is usually restricted to a limited number of countries (see, for example, Xiong and Beghin (2011)). Besides data availability, empirical strategies must also account for computational constraints. A full fledge gravity model run at the product level (for example, HS-6 digit) for a multiple-country sample (more than 20 countries) for a period of 3 years or more may not be easily estimated, especially when controlling for possible selection bias.

The general specification of the gravity model is as follows:

$$\ln x_{sij,t} = \phi_{sij,t} \ln\left(1 + tar_{sij,t}\right) + \gamma' NTM_{sj,t} + \beta' z_{ij} + fe_{si} + fe_j + fe_t + \varepsilon_{sij,t} \quad (2)$$

where *tar* is the tariff applied by country *j* on imports of good *s* from country *i*, *NTM* is a set of NTM-implementation-related indicators, *z* is the typical set of bilateral gravity variables and the *fe* variables refer to fixed effects sector exporting country specific, importer specific and time specific. The *NTM* set could reduce to the standard dichotomic indicator of the existence of an NTM, possibly capturing its trade cost effect. However, it could also include variables allowing for the identification and estimation of the demand-enhancing impact discussed above. In Xiong and Beghin (2011) a variable measuring the difference in stringency between the SPS measure applied domestically and that applied in the destination country is expected to capture the demand-enhancing effect. Another variable taking the most stringent SPS measure as reference is expected to capture the trade cost effect.

In the "new" new trade theory, the existence of sunk costs to export affects the probability of firms' capability to export. This translates into a selection bias *à la* Heckman when dealing with empirical analysis. Hence, the use of the Heckman sample selection model seems appropriate when observing a high incidence of zeros in the bilateral trade relationships matrix. The Heckman selection model applied to the gravity model writes:

$$\ln\left(x_{sij,t} \mid x_{sij,t} > 0\right) = \phi_{sij,t} \ln\left(1 + tar_{sij,t}\right) + \gamma' NTM_{sj,t} + \beta' z_{ij} + \eta IMR_i + fe_{si} + fe_j + fe_t + \varepsilon_{sij,t}$$

$$x^*_{sij,t} = \phi^*_{sij,t} \ln\left(1 + tar_{sij,t}\right) + \gamma'^*_{sij,t}\ NTM_{sj,t} + \beta'^* z_{ij} + fe^*_j + fe^*_{si} + fe^*_t + \mu_{sij,t} \qquad (2')$$

where $x_{sij,t} > 0$ if and only if $x^*_{sij,t} > 0$. *IMR* is the standard inverse Mill's ratio obtained from the selection equation. The error term in the exports value equation and the error term in the selection equation are assumed to have a bivariate normal distribution with zero means, standard deviation σ_ε and σ_μ and correlation $\rho_{\varepsilon\mu}$. With selection, NTMs' marginal effect in the outcome equation does not correspond to the coefficient any more.[4] Assuming that the *NTM* set of variables reduces to a single continuous indicator its unconditional marginal effect is given by:

$$\frac{\partial \ln E\left(x_{sij,t}\right)}{\partial NTM_{sj,t}} = \frac{\partial \ln\left(x_{sij,t} \mid x_{sij,t} > 0\right)}{\partial NTM_{sj,t}} + \frac{\partial \ln \Phi\left(\frac{\theta' k_{selection}}{\sigma_\mu}\right)}{\partial NTM_{sj,t}}$$

$$\frac{\partial \ln E\left(x_{sij,t}\right)}{\partial NTM_{sj,t}} = \gamma_{sij,t} + \frac{\gamma^*_{sij,t}}{\sigma_z}\gamma_{sij,t}\delta_i + IMR\frac{\gamma^*_{sij,t}}{\sigma_\mu}$$

where $IMR = \frac{\phi\left(\frac{\theta' k_{selection}}{\sigma_\mu}\right)}{\Phi\left(\frac{\theta' k_{selection}}{\sigma_\mu}\right)}$ is the inverse Mill's ratio. *Φ* and *φ* are the cumulative standard normal function and standard normal density function respectively. δ_i is a function of the *IMR* and of $\theta' k_{selection}$, which corresponds to a set of regressors appearing in the selection equation of (2').

Assuming that the *NTM* set of variables reduces to a single binary indicator its unconditional marginal effect when going from 0 to1 is given by:

[4] See, for example, Greene (2011) or Hoffmann and Kassouf (2005) for a complete derivation.

$$\Delta \ln E(x_{sij,t}) = \gamma_{sij,t} + \gamma^{*}_{sij,t}\Delta IMR + \Delta \ln \Phi\left(\frac{\theta' k_{selection}}{\sigma_{\mu}}\right)$$

where

$$\Delta \ln \Phi\left(\frac{\theta' k_{selection}}{\sigma_{\mu}}\right) = \ln \Phi\left(\frac{\theta' \bar{k}_{selection}(1)}{\sigma_{\mu}} - \frac{\theta' \bar{k}_{selection}(0)}{\sigma_{\mu}}\right)$$

when the marginal effect is computed at the mean values.

In both expressions the unconditional marginal effect is a combination of the effect associated to a change in the value of exports for exporting firms, and the effect associated to a change in the probability of observing positive exports.

Sufficient variation is needed to identify parameters in the selection and outcome equations. In theory this implies that variables explaining selection should differ from variables explaining outcome. In practice enough variability would be obtained by identifying at least one variable that affects the IMR but not the exports value equation. This is referred to as the exclusion restriction. In the gravity context the identification of such a variable remains problematic and often identification is made to rely exclusively on the normality of the residuals that is on the condition that $Cov(\varepsilon_{sij,t}, \mu_{sij,t}) = 0$. The variable repeatedly used in the restricted model is common language. Helpman et al. (2008) used common religion and proxy variables for fixed costs of exporting taken from the Doing Business World Bank database. These authors further argue in the light of their theoretical insights that the empirical model should also correct for the fact that the shape of the distribution of firms' productivity determines the share of exporting firms. Correction terms for both the export selection bias and the intensive margin bias should be included. Correction for the intensive margin bias is usually omitted although its influence may dominate the export selection bias, especially in North–North trade relationships (Belenkiy (2009)).

A proper disentangling strategy should permit the determination of how a change in technical regulations policies affects different agents in international trade. Identifying the two separate effects could also lead to better policy, especially in presence of externalities associated with trade. The information retrieved from such investigation could be used to assess the legitimate nature of the measure. For instance, in the case that consumers are not found to respond to the quality improvement induced by a tighter measure, the latter should be subject to further scrutiny for possible protectionism. However, qualitative features may also have to be taken into consideration. It may be the case, for example, that the absence of direct demand-enhancing effect could also be consistent with policies addressing long-term deleterious health or environmental effects valued by society but neglected by consumers (see Peterson and Orden (2008) for a detailed discussion).

3.6 APPLIED GENERAL EQUILIBRIUM MODELS

Thanks to advances in computer and simulation technology, such as the Global Trade Analysis Project (GTAP) (Hertel, 1997) and efforts to improve data collection and availability (trade analysis and information system (TRAINS) being a leading example). Applied general equilibrium (AGE) simulations of tariff reductions can now be carried out almost routinely. General equilibrium modelling has played an important role in the WTO multilateral negotiations, helping assess complex negotiation modalities and global interdependencies but also fuelling a public debate on the direction and magnitude of estimates. The same cannot be said of NTMs. The Fugazza and Maur (2008) paper offers a truly global and detailed assessment of NTMs in an AGE model (the standard GTAP model) using recent econometric estimates of NTM AVEs computed by Kee et al. (2009). The authors follow the path opened by the work of Andriamananjara et al. (2004), which was limited to a subset of sectors.

Of the three effects mentioned above, the protection effect of NTMs is the most immediate candidate for assessment in a AGE model, provided that the correct impact estimates are available. Protection effects are usually assessed at the border. These border effects generate a wedge either between the world price and the domestic price in the importing country or between the world price and the domestic price in the exporting country. As discussed previously, protection effects also arise beyond (within) the border because NTMs do not necessarily discriminate between domestic and imported goods. Tackling these beyond-the-border effects would require a model including increasing returns to scale and export specific costs. Moreover, the assessment of the other economic effects in an AGE context is much more complex. Although it would be desirable to investigate how one can identify and separate the cost and the welfare-enhancing dimension of NTMs, it is difficult to think of a methodology that would allow this to be carried out in a systematic way. Detailed information is needed; it would have to be provided by technical experts (Deardoff and Stern, 1997) and probably only for specific products or a limited range of countries.

All in all, standard AGE models do not offer many ways to include demand-shift and supply-shift effects and none of them are fully satisfactory.

3.7 COST–BENEFIT ANALYSIS

Since NTMs do not necessarily embody the economic inefficiencies that are associated with classical trade barriers, it is not always the case that the trade impacts of regulations are inefficient, or that removal of associated non-tariff measures that affect trade would achieve efficiency gains that would exceed the losses from weaker regulation. For this reason, specific NTMs are often analysed in a cost–benefit framework. An example of a cost–benefit framework applied to NTMs is given by Van Tongeren et al. (2009). The main advantage of such an approach is that the quantification of costs and benefits for all the different economic actors (domestic consumers, domestic and foreign producers, domestic government, and the like) involved allows for a more tailored evidence-based treatment of specific NTMs. This comparative approach to NTMs allows for the identification of alternative ways to address specific regulatory problems. Cost benefit analysis is generally used only in specific case studies of NTMs of particular importance where detailed information can be obtained. In practice, the traditional cost–benefit framework expands the analysis to cover not only one cost or benefit associated to the presence of the NTMs, but also those associated with not having the measure in place. Ultimately, this methodology contributes to a more comprehensive welfare analysis of NTMs than that offered by looking at trade affects alone. In the cost–benefit framework the costs of the measures are generally imputed on the bases of the “willingness to pay” methods. That is the value (or costs) that consumers and producers impute to removing (or implementing) the measure. For example, the value that consumers give to avoid an undesired product characteristic is a key variable in the cost–benefit assessment. Clearly, the validity of the cost–benefit analysis depends on the accuracy to which the willingness to pay is computed. This can be quite challenging to compute. There are various methods used to measure willingness to pay (reviewed by Lusk and Shogren, 2007). Contingent valuation methods involve directly asking individuals about their willingness to pay to obtain an otherwise unavailable good. Choice experiments indirectly determine the willingness to pay by econometric estimation based on choices models. Experimental economics uses simulations and control groups to reveal the willingness to pay of agents.

4. EVIDENCE

The following review of the empirical evidence of the impact of NTMs on trade is not exhaustive and includes essentially trade and welfare impacts obtained in gravity or gravity-related estimations and AGE models simulations.

Gravity estimations

Empirical work on the trade impact of technical measures has proliferated rapidly over the last twenty years, especially with investigations based on gravity equations. The literature shows a wide range of estimated effects from significantly impeding trade to significantly stimulating trade.

Several indicators have been used to proxy the strength of technical measures. For instance Otsuki et al. (2001), Wilson and Otsuki (2004) and Wilson et al. (2003) use maximum residue levels (MRLs). MRLs enter the regression as numerical values, a straightforward and accurate measure of the technical measures of interest. However, in most cases, technical measures do not have any direct numerical measurement and their identification remains purely qualitative. In that context, proxies have to be constructed. The most commonly used proxies of technical measures are dummy variables, AVEs of the policies, frequency ratios and count variables. Choices among these different proxies could lead to different estimates of trade effects of technical measures. Few researchers have tried and compared different proxies within their investigations (see Disdier et al. (2008), discussed below) and most researchers focus on one of them only.

One of the early and more discussed studies on the impact of SPS standards on trade is Otsuki et al. (2001). These authors provide one of the first empirical analyses on the large impact of SPS measures on developing countries exports. Using a gravity model framework, their analysis investigates the impact of European Union regulations on aflatoxin (a naturally occurring mycotoxin that frequently contaminates fruits and grains) on a few selected African export products. Their findings indicate a quite important effect of the European Union regulation on African exports of cereals, dried fruits and nuts. They quantify it as accounting for about 65 per cent export loss. Since this paper, a number of other studies have investigated similar issues in different countries and sectors using quantitative methods.

Wilson and Otsuki (2004) find that a 10 per cent increase in stringency of the MRL on chlorpyrifos (an organophosphate insecticide) on bananas could lead to a 14 per cent decrease in international trade of this good. Wilson et al. (2003) find that if MRLs of antibiotics on beef were harmonized to the Codex Alimentarius standard, the rise in beef world exports would exceed 3 billion tons. More than twenty per cent of that rise would originate from South Africa, Brazil and Argentina. Again using data for the European Union, Chevassus-Lozza et al. (2008) find positive trade effects of sanitary measures, and negative or insignificant impacts of phytosanitary and quality measures. More specifically, their results suggest that for new member States (Bulgaria and Romania excepted) sanitary measures do not act as a barrier to trade at entry to the European Union market and even significantly stimulate traded volume for firms in those States fulfilling sanitary requirements. As far as Bulgaria and Romania are concerned these measures still act as barriers to trade. However, once the barrier has been overcome, the impact on traded volume is slightly positive.

For third countries, applying the quality measures reduces both the decision to export and the volume traded. In addition, the authors can infer from their results that the impact of NTMs on the degree of European market access is less a matter of the specific nature of the NTM than of the degree of harmonization of the various measures amongst European Union countries.

Anders and Caswell (2009) find that implementation of hazard analysis critical control points (HACCP) reduces United States' seafood imports from large exporting countries.

Disdier et al. (2008) find, in their preferred specification with the AVE of NTMs, negative or insignificant impacts of TBTs and SPS measures on agricultural and food aggregate trade amongst the Organization for Economic Cooperation and Development (OECD) countries. However, they also find that trade from developing countries towards OECD countries does see a significant reduction because of NTMs. The originality of their approach lies in the fact that they investigate the impact of NTMs using different proxies for the incidence of the latter. In a standard gravity model the authors regress, along with the usual gravity explanatory variables, the bilateral tariff rate and three different variables for SPS measures and TBTs: the tariff AVE of NTMs as computed in Kee et al. (2009), a dummy equal to unity when the HS-6 level line has a notified SPS measure and a frequency index of NTMs. They also investigate the impact of 30 disaggregated technical measures amongst industries defined at the HS-2 aggregation level. Effects are estimated to be positive for 8 industries, insignificant for 12 industries, and negative for 10. The disaggregated findings of Nardella and Boccaletti (2004), Fontagné et al. (2005) and others further underline that the direction and the significance of trade effects of technical measures appears to vary considerably across product groups and trading partners.

These papers constitute a rich, although not exhaustive, set of illustrations of both trade-impeding and trade-enhancing effects of technical measures. However, coherence in results may be difficult to appreciate without further formal investigation. In this regard, Li and Beghin (2010) conduct a meta-analysis to identify the sources of systematic variations found in estimated trade effects of technical measures. In that regard, they investigate both data sampling and methodology differences. They find that analyses of agriculture and food industries lead to estimates of trade effects of technical measures, which are less likely to be positive. They also find systematic impeding effects of SPS regulations on agricultural exports sourced from developing countries and going to developed countries. This finding is robust and emerges in different estimation strategies (robust regression and multinomial logit), suggesting that SPS regulations appear to be trade barriers rather than catalysts. These authors also find that econometric models that control for unobservable country–pair heterogeneity are more likely to produce positive (and less likely to produce negative) and significant estimates of trade effects of technical measures than those models that do not control for it. The aggregation level of the trade data is also expected to affect the estimated trade effects. The authors find, although not unequivocally, that the more disaggregated data tend to provide relatively more positive significant estimated trade effects of technical measures.

Xiong and Beghin (2011), as previously referred to in section 3.5, establish an econometric approach to disentangle the demand-enhancing effect and the trade-cost effect of any standard/technical regulation. Their econometric model is used to examine the impact of technical measures on agricultural trade among OECD countries in 2004 and as such significantly refines the findings of Disdier and al. (2008). Technical measures facilitate intra-OECD agricultural trade, as these measures enhance consumers' demand for imports more than they impede exports. In a further disaggregated analysis of technical measures imposed on vegetable preparations primarily targeting mycotoxins, they find that these measures tend to lead to additional intra-OECD trade in vegetable products. However, they also find that technical measures affecting dairy products tend to decrease trade in those products among OECD countries in their net effect. In both sectors demand-enhancing effects are estimated to be significant. In a comparable disaggregated analysis focusing on Japanese cut flowers, Lan and Yue (2009) show that estimates of the trade effects of SPS measures are biased when the induced quality changes are not considered.

Hence, the separate identification of supply and demand effects is expected to help to determine if a standard/technical regulation is driven by public awareness or potential protectionism. The disentanglement of the effects of SPS measures on consumers and producers makes also possible the welfare evaluation of a policy change, as pursued in Disdier and Marette (2010). These authors use an analytical framework, applied to crustacean imports in several countries, to link the mercantilist and welfare aspects of NTMs. Their estimates suggest that although antibiotic residue limits reduce crustacean imports into the United States, the European Union, Canada, and Japan, they improve both domestic and international welfare.

Applied general equilibrium exercises

Andriamanajara et al. (2004) offer a large-scale study of impact of NTMs in an AGE model. They include 14 product groups and 18 regions. This work first estimates global AVEs for NTMs, using price data from Euromonitor and non-tariff barrier (NTB) coverage information from UNCTAD. The price effects obtained are generally very large: up to 190 per cent in the wearing apparel sector in Japan and the bovine meat sector in China. The estimate of the price incidence in wearing apparel in the European Union is 60 per cent. The authors then use their AVEs to simulate in GTAP the welfare effects of a removal of the selected NTMs. Global gains are important (US$90 billion) arising mostly from liberalization in Japan and Europe and in the textile and machinery sectors.

Other important works such as Gasiorek et al. (1992) and Harrison et al. (1994) simulate the effects of regulations harmonization in the European Union in the post Maastricht era. The former adopt the sand in the wheel approach and assume that trade costs are reduced uniformly by 2.5 per cent, allowing for the characterization of short run and long run equilibrium. The latter use a similar framework, extended to endogenize the elasticity of substitution between domestic and European Union goods to account to some extent for the demand-shift effect mentioned previously. Results in these two studies suggest that the impact of harmonization could reach 2.4 per cent of gross domestic product (GDP). In a country-focused but otherwise similar computational set-up, Chemingui and Dessus (2008) assess the impact of NTBs in Syria. They introduce estimates of price effects of NTBs as regular tariffs. AVEs of NTBs are obtained in their study using the price comparison approach. Welfare gains could range between 0.4 and 4.8 per cent of GDP depending on whether or not dynamic effects (associated with a technological catch-up with the rest of the world) are taken into consideration.

With the surging political interest in trade facilitation, several recent studies have attempted to capture its potential benefits, using the sand in the wheels approach. Hertel et al. (2001) are the first to introduce an efficiency-shock variable in GTAP to simulate the impact of lower non-tariff trade costs such as customs clearance costs in the free trade agreement between Japan and Singapore. Total expected welfare gains for the agreement are worth $US 9 billion annually, with most of these accruing from the trade facilitation component. Fox et al. (2003) account for the different nature of costs created by NTMs by modelling both the direct costs and the indirect transaction costs of lack of trade facilitation at the United States–Mexico border. Direct transaction costs are modelled as a usual import tax, reflecting a transfer of rent between importers and domestic agents, while indirect transaction costs are modelled as pure efficiency losses. They find indirect costs to be the major source of welfare gains. Walkenhorst and Yasui (2005) follow the same approach to estimate the gains to be expected from trade facilitation liberalization, additionally splitting the taxes between those borne by importers and those borne by exporters. They find important welfare gains, around US$40 billion (arising for nearly 80 per cent from efficiency gain effects). Francois et al. (2005) assess the impact of trade facilitation reform related to the WTO Doha round of negotiations. They adopt the trade efficiency cost approach to simulate the impact of improvements in trade logistics. In their baseline simulation scenario, trade logistics impediments represent 1.5 per cent of the value of trade. Results suggest that income effects related to trade facilitation reform could represent 0.2 per cent of GDP and two fifths of overall reform impact.

Fugazza and Maur (2008) demonstrate the importance of modelling both the demand and supply-shift effects of technical measures in policy analysis using AGE models. Most importantly their simulation results underline substantial differences in effects, depending on whether AVEs are introduced using shocks on import tariffs or on technological change. The sign of the welfare impact can be reverted in more than 50 per cent of the cases.

5. CONCLUDING REMARKS

The incidence of technical regulations in the world of NTMs has increased substantially over the last two decades and the trend is not expected to revert. Technical regulations can impact directly both exporters' and importing consumers' behaviour with ambiguous net effects in contrast to more standard NTMs such as quotas. Theoretical analysis, even in a partial–partial equilibrium context (one good one market) reveals that technical measures can affect trade volumes and/or the propensity to trade in either direction. Indeed, a tighter public regulation/standard promotes trade if its demand-enhancing effect dominates its trade-cost effect; it impedes trade if its demand-enhancing effect falls short of the trade-cost effect. The analytical ambiguity of the impact of technical measures on international trade calls for a more careful empirical quantification and identification of the trade effects of these measures, a task we pursue in this investigation.

The present review, although not exhaustive of existing empirical works, has revealed a mixed picture of estimated impacts. Different TBTs and SPS measures are found to generate different trade effects for different exporters and different industries. The variations in findings can be explained by variations in data samples, mostly variations in industry, country, and aggregation level. Variations in estimated trade effects may also be caused by different forms of technical measures proxies, model specifications, and other methodology variations.

The most recent empirical works based on a refined theory underlying gravity equations and econometric estimation techniques have addressed new issues, such as the treatment of zero trade flows. These advances in empirical approaches represent a clear improvement although they are limited to country- sector- or measure-specific analysis. This is not only due to the very nature of technical regulations but also to binding constraints in econometric estimation.

Nevertheless, these recent contributions represent an important step towards a systematic qualification of the nature of a technical regulation. Indeed, the empirical estimates obtained can help identify whether a measure is legitimate or has been implemented essentially for protectionist purposes.

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