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Measuring protection: mission impossible?

Maria Cipollina (University of Molise, Italy) and *Luca Salvatici* (University of Molise, Italy)

Working Paper 06/07

TRADEAG is a Specific Targeted Research Project financed by the European Commission within its VI Research Framework. Information about the Project, the partners involved and its outputs can be found at http://tradeag.vitamib.com

Measuring protection: mission impossible?*

Maria Pina Cipollina and Luca Salvatici

(University of Molise)

Abstract

In the international trade literature there seems to be some confusion between "openness" and "protection" measures. The aim of this paper is to bring together the "state of the art" in quantifying trade policy measures, so we focus on the extent of the protection granted by policies rather than on the degree of openness of the economy.

Given the huge size of literature dealing with these issues, we limit our review as follows. On the one hand, we focus on trade policies implemented at the border: accordingly, we do not consider all the other possible public interventions influencing trade flows. On the other hand, we take into account only indexes explicitly adopting a metric expressed in a "scalar aggregate" (tariff- and quota-equivalent measures, or an index in a closed interval).

We distinguish between indexes that aggregate across products (same barrier for more products) and indexes that aggregate across instruments (more barriers for the same product). Finally, in order to classify the large number of indexes covered in our review, we propose a typology based on three categories: incidence, outcome and equivalence.

Keywords: Protection, Tariff and Non-Tariff barriers, Tariff and Non-Tariff measures.

JEL classification: F13, F19

* The authors are solely responsible for the contents of this paper. This work was in part financially supported by the "Agricultural Trade Agreements (TRADEAG)" project, funded by the European Commission (Specific Targeted Research Project, Contract no. 513666); and in part supported by the Italian Ministry of University and Technological Research ("The new multilateral trade negotiations within the World Trade Organisation (Doha Round): liberalisation prospects and the impact on the Italian economy").

1. Introduction

This paper provides a survey of attempts to capture empirically the seemingly intuitive notion of trade restriction. Protectionism is simultaneously one of the most used and vaguely defined terms in contemporary policy discussion. Our point of departure relative to the literature is the measurement of trade restriction, assessing how protected are particular economies and how rapidly (or slowly) is liberalization occurring.

We focus on empirical studies that sought to quantify the overall impact of a set of policies. Protection indicators would need to fulfill certain requirements and constraints: ideally, they should be comprehensible, transparent, and capable of straightforward interpretation. Operationally, any measures of protection should meet the following requirements:

i) they should be able to indicate if a protectionist policy does exist;

ii) they should be able to rank different policies according to their degree of restrictiveness;

iii) they should guarantee a consistent scaling of all degrees of restrictiveness.

In any case, they should at least be able to tell whether trade policies are being liberalized, but they should also be useful in the context of quantitative models of policy impacts and market projections.Measures of protection have long been of interest to international economists, and this interest has been renewed with the introduction of a new approach to gauging trade restrictiveness, which draws on the theory of index numbers (Anderson, 1995). As it is revealed by the long bibliography attached to this paper, a huge amount of research has been undertaken on this subject. Within this there are numerous excellent literature surveys, such as Baldwin (1989), Laird and Yeats (1990), Pritchett (1996), Deardorff and Stern (1998), Anderson (2002) and Ferrantino (2006). We make no attempt to be comprehensive, since our aim is of offering a “road map” through this large body of literature: those seeking a detailed discussion of specific issues should refer to the papers themselves. In organizing the survey, we had two contrasting objectives. On the one hand, we wanted the studies to be consistent with one another in order to ensure comparability across studies. On the other hand, we wanted to encompass a variety of methodological approaches, such as general or partial equilibrium models, or econometric estimates. The common feature of the papers considered is the attempt to construct some measures summarizing the levels of trade restrictions implied by different policy instruments on different traded commodities.

The next section sorts out some common misunderstandings existing in the literature, defines the boundaries of our review and provides a typology to classify existing indexes. In order to keep the paper within reasonable bounds, we focus on import related policy instruments implemented at the border, such as measures to control the volume (e.g., quota restrictions and licenses) or the price of imports (e.g., tariffs), and we limit our analysis to the literature that summarizes these trade policy instruments into a common metric. Accordingly: (1) we do not consider other public policies, such as monetary or domestic policies, though they may have a very significant protectionist impact; (2) we do not consider the growing branch of the literature based on the intensity of trade flows, as in the case of the gravity models.

There are two fundamental obstacles to constructing summary statistics of the overall level of trade restrictions in an economy. On the one hand, in order to sum over different policy instruments it is necessary to express them in a common metrics. This is the *conversion* problem, and the solutions proposed in the literature are reviewed in section 3. On the other hand, the level of trade restriction in each industry must be weighted appropriately. This is the *index number* problem: section 4 reviews the weights used in the literature. Finally, theoretical and practical virtues and failings of the different methods of measurement are discussed in section 5, while section 6 concludes.

2. *Methodology*

Information on the papers included in our survey is summarized in Table 1. The grid is composed by eleven columns. The first two columns report the *authors* ad the *year* of the papers. Then we describe the *trade policy index* and the metrics on which it is expressed. The following five columns provide more information about the empirical application: *country coverage* (with special emphasis on the *EU*), *product coverage* (with special emphasis on *agriculture*), the *time frame*, and the *source* of policy data. The latter is crucial in order to compare the results of different studies, since existing databases differ under two main respects. On the one hand, the policy coverage varies a lot, especially in terms of the number of non-tariff barriers considered. On the other hand, databases provide information at different level of aggregation. In both cases, the data used as input for the analysis already face the two basic problems of aggregation dealt with in the literature: across policy instruments and across products. The last two columns report the *methodology* followed and classify the indexes according to the *typology* presented below (section 2.2).

2.1 Openness vs. Protection

As it is well-known, empirical research to date has used a lot of (perhaps even too many) protection indexes. In part this is because it is hard to obtain detailed and accurate information on trade policy: even for OECD countries internationally comparable data – especially on non-tariff barriers (NTBs) – are difficult to obtain. However, it is striking the persistence of a lot of confusion between "openness" and "protection" measures. This is especially true for the literature focusing on the linkage between trade policy and growth (Dollar, 1992; Sachs and Warner, 1995; Harrison 1996; Edwards, 1998; Frankel and Romer, 1999; Rodriguez and Rodrik, 1999; Baldwin, 2003; Yanikkaya, 2003).

The common measure of openness is the ratio of actual exports plus imports to GDP. The problem is that openness depends not only on the level of trade restrictions, but also on a set of nonpolicy variables such as endowments, economic size, tastes and technology. Since the concept of openness is linked to trade intensity, one may think that a low degree of openness implies a high degree of protection. However, this would be quite a wrong inference: the lack of openness is neither a necessary nor a sufficient condition for protection. Relatively modest trade flows may be due to several factors that are not related to trade policy and two different countries may register the same level of openness notwithstanding the implementation of different trade policies, or different level of openness even if they share the same trade barriers. Apparently, even if there are obvious links, openness and protection are two different concepts.

We define *trade protection* as a set of government policies imposed in order to protect domestic producers against foreign competition from cheaper imported goods and services. The paper focus on the measurement of the protection granted by policies rather than on the assessment of the (structural) degree of openness of the economy.

The consequences of a given policy may provide the weights for the aggregation scheme, but they are not of interest *per se*. This allows us to exclude from the review the literature, starting with Balassa (1985) and Leamer (1988), which focuses on the deviations of the actual volume of exports from the volume predicted by a simple structural model of trade. More recently, a vast (and growing) literature based on gravity models assess the difference between potential and actual trade flows: these papers are not considered here, since they do not use trade policy variables as explanators of trade patterns or deviations from the predicted pattern. In conclusion, we focus on policy indexes rather than on the evaluation of the policy impact. This implies that we only consider scalar indexes based on metrics expressed in terms of prices (e.g., tariff-equivalent measures) or in terms of quantities (e.g., quota-equivalent measures), or using an *ad hoc* scalar included in a closed interval.

Here a "policy" is considered as a conscious act of legislation as opposed to a circumstance or economic condition. Even limiting ourselves to the measures concerning the flow of international goods, not services, there are a wide array of policy instruments that affect trade. If we adopt a policy coverage based on the economic effects, the list of measures that have price-raising, trade-reducing, welfare-reducing, or other economic effects is likely to be endless. As a consequence, we do not consider indexes concerning policies which may have an indirect effect on imports but which are not directly applied at the border.

More specifically, we do not consider indicators based on monetary policies. For instance, Krueger (1978) and Bhagwati (1978) define the "anti-export bias" as the ratio between the exchange rate effectively paid by importers and the exchange rate effectively faced by exporters: if this ratio is greater than 1, the trade regime is biased against exports. Some authors used measures of price distortion based on the idea that a deviation from the purchasing power parity indicates a distortion in trade flows. Examples are provided by the works of Aiken (1992) that presents a measure of trade policy intervention based on a country's relative price structure and the structure of relative world prices, and Dollar (1992) aiming to capture the degree to which the real exchange rate is distorted from its free-trade level by national trade regimes. In the same vein, the black market premium on foreign exchange is frequently used to show the severity of trade restrictions and serves as a proxy for price distortions present in both current and capital account transactions (Chen, 1999), as well as a proxy for overall price distortions (Barro, 1991).

Moreover, we do not consider indexes based on domestic policies, such as social and industrial policies. Many economists focus on economic and social aspects to construct subjective indexes of openness and classify trade regimes. Some examples are the Sachs-Warner index, the World Bank classification of trade policies, and the Heritage Foundation index. The Sachs-Warner index is a zero-one dummy, which takes the value zero (one) if the economy is closed (open) according to any one of a set of criteria related to tariff barriers to trade, non-tariff barriers, the treatment of exports, the type of economy and the size of the black market premium (Sachs and Warner, 1995). Another index of this type is the World Bank index which is a subjective measure of trade liberalization based on the effective rate of protection, the use of direct controls and export incentives, and the degree of exchange rate overvaluation (World Bank, 1987). It takes values from 1 to 4, ranging from a "strongly inward-oriented" to a "strongly outward-oriented" economy. Finally, the Heritage Foundation index measures trade openness by classifying countries into five categories according to ten factors including tariff rates, NTBs coverage and corruption (see Edwards, 1998). Other indexes widely used in order to assess support granted to the agricultural sector, as in the case of the producer or consumer subsidy estimates computed by the OECD (1994), are not considered here as well.

The focus of this review is on trade policies implemented at the border, which includes the following categories of trade barriers (see Table 2):

- *Tariff and Para-Tariff measures.* Tariff measures include all duties applied on imports in order to protect domestic producers against foreign competition, and can be expressed in monetary terms (*specific*) or percentage values (*ad valorem*). Para-tariff measures include customs surcharges such as import license fees, foreign exchange taxes, stamps, etc..

- *Measures to control the volume of imports*. A wide range of measures are used to control the volume of imports. These include prohibitions, quantitative restrictions (QRs) on imports, non-automatic licensing, import authorizations, as well as export restraint agreements (ERAs). Quotas are restrictions on the quantity or value of imports of specific products and are determined for a specific period of time, and modified periodically. They may be applied globally (to all countries), plurilaterally (to a group of countries) or bilaterally (to a single trading partner), and also at certain times of the year (seasonal quotas), usually during the growing season for protected agricultural products. Voluntary export restraints (VERs) are usually informal export restraint arrangements between exporting and importing countries in which the exporting country agrees to limit, for a certain period of time, the quantity of specific exports below a certain level in order to avoid imposition of mandatory restrictions by the importing country.

- *Measures to control the price of imported goods*. These include, in addition to specific or *ad valorem* tariffs, the use of reference or trigger price mechanisms, variable levies, antidumping duties and countervailing measures. Other examples are tariff quotas, seasonal tariffs, voluntary export price restraints. Variable levies are special charges imposed on imports of certain goods in order to raise their price to a domestic target price. Anti-dumping duties are levied on certain goods originating in a specific trading partner or specific trading partners to offset the effect of dumping.[1] Countervailing measures are special charges on certain goods to offset the effect of any bounty or subsidy granted directly or indirectly on the manufacture, production or export of these goods. Other price measures include minimum prices, voluntary export price restraints, government procurement procedures, and certain other procedures which increase the costs of imports.

- *Technical barriers.* They are imposed at the frontier to apply various standards for health, sanitary, and safety reasons, as well as marking and packaging requirements, to imported products to ensure that imported products conform to the same standards as those required by law for domestically produced goods. These barriers are particularly difficult to quantify, since they have multiple economic effects.

2.2 Types of indexes

The answer to the seemingly simple question "how should we measure the protection of a country's trade policy?" requires overcoming two main hurdles: conversion and aggregation problems (Figure 1).

On the one hand, protection can take many different forms– tariffs, quotas, antidumping duties, technical regulations – so, we need to convert the different instruments into a common metric. Since any trade policy has impacts in different areas (producer or consumer welfare, volume of trade, efficiency loss, etc.), there is no perfect solution for converting them into an *ad valorem* equivalent. For example, the equivalence between tariffs and import quotas has attracted a large body of research which shows that "full equivalence" (in terms of all relevant economic effects) is almost never valid, because it requires very stringent assumptions (Bhagwati, 1965).

A typical way for overcoming this problem is to transform trade policies into *ad valorem equivalents* (AVEs). In principle, this solves the first aggregation problem, since we summarize the

[1] Article VI of the General Agreement on Tariffs and Trade (GATT) permits special anti-dumping duties that are equal to the difference between the import price and the normal value of the product in the exporting country (the "dumping margin").

trade restrictiveness of different trade policy instruments applied on imports of a particular good. If we focused only on this good, the assessment of protection would be done: unfortunately, trade policy is set at the tariff line level and there are (literally) thousands of tariff lines in a typical tariff schedule. Then one needs to summarize all this information in one aggregate and economically meaningful measure. At minimum for economic modelling, the aggregation must convert individual tariff lines into aggregates that conform to higher-level aggregation for production/consumption data.

We classify the indexes proposed in the literature in three categories: incidence, outcome and equivalence. As it is showed in Table 3, these categories differ under two main aspects: existence of an equivalence criterion, use of a counterfactual approach. The definition of an equivalence criterion implies that the construction of an index will depend upon the purpose of the index itself. The use of a counterfactual approach implies that the calculation of the index does not only rely on observed data, but it requires the use of statistical or equilibrium models in order to assess what would have happened after a policy change.

Incidence measures are based on the intensities of the policies themselves, so that they are easily derived from direct observation of the policy instruments. They measure the level of protection without considering the rate at which it is translated into market (economy) specific trade *distortions*. They provide a sort of "self-contained" assessment of the policies under consideration, since they ignore any effects of these policies on specific markets (economies). The level or dispersion of tariffs (see section 4.1) and the frequency of the various types of NTBs (see section 3.1) are typical examples of incidence measures. Apparently, these indexes are far from satisfactory, but it should be recalled that aggregate policy commitments are usually expressed as incidence measures. More sophisticated indexes, as a matter of fact, introduce "variables" (typically the weights to be used in the aggregation) different from the policies under consideration, and policy-makers do not want that compliance may be influenced by events out of their control.

Outcome measures[2] are based both on policy variables and "weights" – such as trade, production or consumption shares, GDPs, etc. – to be used in the aggregation process. This means that some economic effects of existing policies are taken into account, though these indexes remain "a-theoretic" since they are not computed according to some "equivalence criteria" (e.g., welfare, volume of imports). However, there are outcome measures, for example the trade-weighted average tariff (see section 4.2), that do have an interpretation as first-order approximations to some "true" (equivalence) indexes. Moreover, it is worth noting that there are cases of outcome measures using

[2] Pritchett (1996) provides a different definition of "outcome-based measures" as those assessing what the outcome would have been without the trade barriers. In our terminology, this definition would include all the measures using a counterfactual approach, thus encompassing both outcome and equivalence measures.

counterfactual weights, that is based on estimated rather than observed data. Examples of this latter typology are the so-called “generalized moments” (see section 4.2).

Equivalence measures provide results that are equivalent to the original data in terms of the information we are interested in. The greatest advantage of this class of measures is that they are unequivocal, because their definition is predetermined. These indexes provide an assessment of how far actual observations are from other hypothetical equilibria. As a consequence, explicit model structures and/or estimated parameters are needed for their computation. Since they are not only based on observed data (as in the case of the outcome measures), they require some maintained assumptions in terms of model/methodology.

Models allow the counterfactual computation of an index of restrictiveness which is “equivalent” to the actual policies in terms of the chosen impact. Econometric approaches are used for *ex post* analysis, while partial or general equilibrium models allow for the creation of counterfactual scenarios (Piermartin and The, 2005). As a consequence, equivalence measures are not only dependent on the structural features of the economy, but they are “model dependent” in that the value of the index will vary as the underlying modelling choices and parameters change. On the other hand, theoretically sound indexes provide benchmarks which are useful for the interpretation of the most widely used outcome measures. Equivalence measures have been mostly developed by Anderson and Neary through several indexes (e.g., TRI, MTRI, DERP: see section 4.3). The large number of applications carried out in recent years could be classified according to several dimensions: type of equivalence (e.g., welfare, profits, etc.); type of model (econometric, partial or general equilibrium); type of metrics (price or quantity); and type of assessment (absolute or relative measures).

Table 4 provides a comprehensive tabulation of the measures of trade policy, sorted into the different categories.

3. *Aggregation across policy instruments.*

Non-tariff barriers (NTBs) are well-known to be pervasive, difficult to quantify and politically sensitive (Dee and Ferrantino, 2005). They are pervasive because regulations designed to address legitimate market failures may have incidental but unwarranted effects on trade. They are difficult to quantify since they are not published in tariff schedules and they are not expressed in simple “metrics”, such as percentage or monetary values. Finally, they are politically sensitive because measures that are difficult to quantify may also be less transparent, which helps to avoid public discussion. When such measures do receive public attention, their direct impact on trade may be less clear to the public than for easily quantified measures such as tariffs.

Quantitative measures of NTBs have long been of interest to international trade. Laird and Yeats (1990), Deardorff and Stern (1998), and more recently Ferrantino (2006) offer an accurate description of various NTBs and discuss the progress made in the quantification of their effects.

3.1 Incidence measures

Data on restrictions, such as the number of restrictions, can be used to construct various statistical indicators. The most common incidence measures are frequency-type measures based upon inventory listings of observed NTBs that apply to particular countries, sectors, or categories of trade.

Measures used to evaluate the level of non-tariff restrictions are the average coverage of quantitative restrictions, given by the percentage of goods affected by quotas or voluntary export restraints (Edwards, 1998). More generally, the frequency-type measures record the number, form, and trade coverage of non-tariff policies as determined from special surveys, frequency of complaints by trading partners, and government reports (Baldwin, 1989). They are simple statistics used to provide an indication of the frequency of occurrence of NTBs.

The most widely available source of information on NTBs is the TRAINS database. It is widely used in research to generate frequency counts of the share of tariff lines:

(1) $$F_j = \frac{\sum_k D_{kt}}{N} \cdot 100$$

where D_k is a dummy variable that takes the value of one if NTBs are applied to the tariff line item k, and zero otherwise; and N is the total number of tariff lines.

Dollar and Kraay (2004) argue that NTBs coverage ratios do not effectively capture how severe non-tariff barriers are. Apparently, the main shortcoming of these measures is that they do not take account of the different importance of the barrier across sectors and products, since they do not assess how restrictive each barrier is. One sector can have many products that are subject to low NTBs, while other sectors can have very restrictive NTBs for few products. However, the first sector will have a much higher NTBs coverage ratio than the second sector. For this reason, any interpretation of data using these measures should be made with extreme caution. Nevertheless, these indexes are useful for providing an indication of existing barriers, especially when reliable and detailed information necessary for construction of tariff-equivalent are not available.

Recognizing that detailed tariff equivalents of NTBs are not readily available at the tariff line level, Cline (2005) recommends that NTBs coverage ratios (the share of production or trade affected by NTBs) be converted to *ad valorem* equivalents through the use of benchmark NTBs weights. The benchmark NTBs weights are subjective assessments of the distortionary effects of NTBs relative to an equivalent average tariff rate.[3]

The last example of incidence measure is the R-index of restrictiveness of product specific Rules of Origin (PSRO) constructed by Estevadeordal (2000) and Cabot et al. (2005). It is an ordinal index computed at the tariff line level, ranging from one (least restrictive) to seven (most restrictive), i.e. $1< Ri <7$. In addition to the inevitable arbitrariness, the R-index has other shortcomings. It does not control for the degree of preferences and for the characteristics of the different activities: satisfying a change of tariff classification involving a change at the heading level for intermediate activities is likely to be easier than if it is to be satisfied for a final good activity.

3.2 Outcome measures

Outcome measures are based both on policy and observed data to be used as "weights" in the aggregation process. Frequency of occurrence of NTBs (represented by the share of total tariff lines containing NTBs) can also be expressed in weighted terms based on either imports or production. Usually, the weights used are percentage of imports covered by NTBs or by certain types of NTBs (Ando and Fujii, 2001).

The NTB frequency (*F*) expresses the fraction of imports subject to NTBs, considering each category of world trade in that category (Nogues et al., 1986; OECD, 1994; Bacchetta and Bora, 2001). For example, import coverage ratios of NTBs can be weighted by the value of imports of each commodity subject to NTBs as a percentage of imports in the corresponding product category. The percentage of trade subject to NTBs for an exporting country *j* at a determined level of product aggregation can be expressed by the trade coverage ratio (*C*):

$$(2) \quad C_j = \frac{\sum_k D_k M_k}{\sum_k M_k} \cdot 100$$

where D_k is a dummy variable that takes the value of one if NTBs are applied to the tariff line item *k*, and zero otherwise; M_k is the value of imports in item *k*.

Some authors calculate different NTBs coverage ratios (as the fraction of affected imports on world imports) using different threshold in terms of potentially affected world imports (Fontagné et al., 2001[4]).

A problem for the interpretation of these weighted measures is due to the endogeneity of the import value weights. The restrictiveness of NTBs could preclude all imports of item *k* from country *j* so

[3] Cline (2005) goes on computing a "total tariff equivalent" as the average of the tariffs and the tariff equivalents of NTBs.

[4] They analyse the impact of environment-related trade barriers (ETBs) drawing a distinction between risk and environment management on the one hand, and protectionist policies on the other: they find that half of world trade is potentially affected by environmental protectionism.

that the weight M will be zero and, in consequence, the trade coverage ratio will be downward biased.

In order to lessen this problem, the weights could be provided by the shares in domestic production. Anyway these production-weighted indexes may not be consistent, since the actual effect of the NTBs varies across products and across countries and this kind of index cannot show which are binding (and how much these affect the economy) and which are not (Adriamananjara and Nash, 1997).

The IMF elaborates a Non-tariff Restrictiveness Rating (NRR) that consists of a three-point scale evaluating a country's use of non-tariff trade restrictions (such as quotas, restrictive licensing requirements, bans, state trading, or exchange restrictions) based on the aggregate amount of trade or production affected: the value 1 means that NTBs are absent or minor (less than one percent of production or trade are subject to NTBs); the value 2 means that NTBs are significant, applied to at least one important sector (between one and 25 percent of production or trade are affected by NTBs); and finally, the value 3 means that many sectors, or entire stages of production are covered by NTBs (more than 25 percent of production or trade is affected).

The most obvious limitation of the IMF-NRR is the insufficient differentiation of intensity between the ratings. The use of only three broad categories allows for a "lumping effect" due to the fact that countries with significantly different non-tariff policies are grouped together. For example, both a country with only minor barriers, covering 5 percent of trade and a country with up to 25 percent of trade affected, will have the same rating.

Ad valorem equivalents

In order to put together various policy instruments, so that they can be compared, summed or used in large-scale modelling exercises, the natural solution is to compute AVEs of each instrument. The overall level of protection imposed by country i on imports of good k can be written as:

(3) $$pr_{i,k} = ave_{i,k} + \tau_{i,k}$$

where $pr_{i,k}$ is the overall level of protection that country i imposes on imports of good k; $ave_{i,k}$ is the AVE of NTBs that country i imposes on imports of good k, and $\tau_{i,k}$ is the *ad valorem* tariff applied by country i on imports of good k.[5] However, the wide multiplicity of trade barriers (non-tariff barriers, such as quotas, import license requirements, domestic content requirement, tariff and para-tariff charges and so forth) makes difficult to construct an *ad valorem* index of trade restrictiveness that is comparable across countries and over time.

[5] Adding AVEs of NTBs and tariffs to obtain an overall level of protection in principle assumes that none of the protection instruments is binding. Alternatively, if there is any reason to believe that one of the policy instruments is binding, then one can define (Kee, Nicita, Olarreaga, 2005):
$pr_{i,k} = \max\left(ave_{i,k} + t_{i,k}\right)$.

There is no perfect solution for converting a specific tariff into an *ad valorem* equivalent, since we know that a specific tariff has nothing like the effect on trade of an *ad valorem* tariff: a specific tariff provides higher protection to low unit value goods, that is to unprocessed or low quality goods (Feenstra and Boorstein, 1991). The approximation will always be local, for a given value of a world price.

Different works in the literature provide examples of the use of price comparison techniques for quantifying the effects of non-tariff measures. NTBs tend to limit trade so that they create scarcity and high price. Then, the degree of NTBs restrictiveness can be measured by the price differential that it drives between the price of imported goods and the producer price of the domestic substitutes, or alternatively, between the domestic and the world price. The wedge between the distorted and the non-distorted prices is the key input used in studying the potential economic effects of the removal of existing NTBs.

The price wedge is equal to the difference between the domestic price of a good which is protected by NTBs and the reference price of a comparable good.[6] Usually the price effect or price wedge is associated with each NTB in order to provide an AVE (Beghin and Bureau, 2001). Price comparison techniques provide direct measures of price impacts of NTBs, the so-called implicit tariffs or implicit rates of protection. Ideally, they require to know the prices that would prevail both with and without the NTB. However, most of the literature relies on price-gap approaches expressing the degree to which NTBs raise domestic prices above international prices.

The tariff equivalent (*TE*) is a type of price impact measures and represents the rate, t, by which the domestic border price, P_k, of the imported good exceeds the price, P_i, paid by domestic importers to foreign exporters, inclusive of transport costs to the importing country and any tariffs levied by this country. It is:

$$(4) \quad TE = \frac{P_k - P_i}{P_i}$$

These measures have the advantage of capturing the effects of non-tariff barriers, as well as tariffs. Nevertheless they require data that are not readily available in many countries. Many attempts to assess the effects of NTBs use retail price data, since they are easier to observe than prices at other stages of the supply chain. The most widespread critique on the use of retail price is that many primary and intermediate traded goods do not have retail prices, and presence or absence of NTBs may differently affect them. Furthermore, they contain wholesale and retail margins which complicate the identification of the NTB mark-up (Ferrantino, 2006).

More generally, the main limitation is that formulas measuring NTBs in an implicit way (as a percentage price wedge between imports and domestic prices) are valid only under the assumption

[6] This is what Ferrantino (2006) calls the "handicraft" method.

that imported goods are perfect substitutes (Baldwin, 2003). Without perfect substitutability price wedges are not due only to NTBs: since available data are often too aggregated to reflect differences in quality of imported goods, the interpretation of the results is questionable.

Price gap measures of final goods trade protection in OECD economies are presented by Bradford (2003). He focuses on non-tariff barriers to goods trade, uses retail price data, along with direct data on distribution margins, transport costs and indirect taxes from input-output sources, and uses a level of product classification where perfect substitution is more likely to be a reasonable assumption, in order to generate estimates of overall price gaps between goods in different countries. Then, he converts consumer prices to producer prices using data on distributional margins (wholesale trade, retail trade and transportation costs). His measure of protection is:

(5) $pr_{ik} = \max(ppr_{ik}, 1 + tar_{ik})$

where tar_{ik} is the tariff rate for good k in country i and ppr_{ik} is given from the ratio of each country's producer price to the world price, P^{p}_{ik}/P^{w}_{i} . The producer price is the ratio $P^{c}_{ik}/(1+m_{ik})$, where P^{c}_{ik} is the consumer price of good k in country i, as taken from the OECD data, and m_{ik} is the margin for good k in country i, as taken from the national input-output table. The common world price is found by adding the international transport cost to the lowest export price in the sample. Finally, he uses a computable general equilibrium (CGE) model to assess the welfare effects of NTBs. Results show that OECD countries impose significant costs on themselves and on less developed countries.

In any case, an import price without the tariff is needed. The price used for the conversion has, in practice, a considerable impact on the value of the *ad valorem* equivalent. In spite of endogeneity problems, a unit value of imports can be used. Experience proves that it is extremely difficult to match the relevant datasets (trade and tariffs) because tariff lines are often set at a very detailed level (8-digit level or more).

Gibson et al. (2001), working on a large sample of countries, converted all the specific tariffs using the unit value of world trade at the 6 digit level, while Bureau et al. 2000, and Jank et al. (2002) used a 3 year average unit value of imports or exports of the particular county at the 8-digit level. The former approach introduces a bias, since it leads to some tariff peaks that are somewhat "artificial", because a specific tariff for a given commodity is converted in an *ad valorem* equivalent using a price that reflects a much broader category.[7] Nevertheless, the latter approach is not necessarily superior, because at the 8 digit level or more, one can only use unit values of the imports of the particular country (because of the lack of consistency of classifications across countries beyond the 6-digit level). For example, the EU trades wheat of very peculiar quality. Using the unit

[7] For example, Gibson et al (2001) find a tariff peak of 540 per cent for sugar beet in the EU. From the same specific tariff, Bureau et al (2000) derive "only" a 69 per cent ad valorem tariff.

value of EU wheat imports to convert the specific tariff into an *ad valorem* equivalent leads to a tariff that is likely to be too low, compared to the protection granted in the EU.

These examples show that both assumptions suffer from drawbacks, but are nevertheless defendable and lead to very different estimates of *ad valorem* equivalents. It is also worth mentioning the approach followed in the MAcMap database (Bouët et al., 2004). Specific tariffs are converted in AVEs using the median UV of world-wide exports originating from a reference group the exporter belongs to.[8]

MAcMap also attempts to solve the problems raised by the treatment of TRQs. The proposed methodology is based on the idea that the calculation should reflect the marginal level of protection. Accordingly, three market regimes are considered, depending on the level of the fill rate:

- if the fill rate is less than 90% (quota not binding), the inside quota tariff rate is chosen as the applied rate;
- in the (90%–99%) range (quota assumed to be binding), a simple arithmetic average is used;
- if it is higher than 99% (quota binding), the applied rate is equal to the outside quota tariff rate.

3.3 Equivalence measures

In principle, the effects of non-tariff import barriers may be quantified by estimating the tariff that would produce the same overall impact. The problem is that the impacts of NTBs are multidimensional and there is not a measure that gives an equivalence in all dimensions. It is necessary to establish an equivalence criterion and to quantify the effects of NTBs with respect to the dimension we are interested in. In this perspective, there is a growing literature using econometric models to estimates changes in prices, trade flows and economic performances due to the introduction of a NTB.

Bora et al. (2002) give guiding principles for measuring NTBs: "first of all, nontariff measures should be constructed to reflect equivalence to tariffs in terms of their effects on the domestic prices of the traded goods. Only direct effects on domestic prices should be used to define tariff equivalence. ….There are many NTBs in practice for which high-quality measures are simply not available. Given the uncertainty that surrounds the measurement of NTBs, it would be best to construct approximate confidence intervals. Estimates of NTBs should be done at the most disaggregated levels possible" (page 14).

There exists several papers in the literature which have estimated the tariff equivalents using different econometric methodologies and data. Recent econometric models to estimate NTBs come in a number of varieties. According to Ferrantino (2006), a broad distinction can be made between price-based and quantity-based models: price-based models look for evidence that NTBs cause the

[8] These groups are defined on the basis of a hierarchical clustering based on GDP per capita.

domestic price of certain goods to be higher than it otherwise would be, while quantity-based models look for evidence that NTBs cause trade in certain goods to be smaller than it otherwise would be.

Price-based methods aim to identify the extent to which higher domestic prices may be attributable to NTBs, correcting for other factors which may influence prices but are not due to NTBs. In order to explain more carefully the systematic reasons for international price differences, many models exploit the so-called Balassa-Samuelson effect, which explains the higher absolute price level in rich countries with the higher levels of productivity in tradables relative to non-tradables.

Andriamananjara et al. (2004), for example, find that much of the international deviation in goods prices can be explained by deviation in the prices of non-tradeable services. Moreover, data on NTBs from both TRAINS and Manifold and Donnelly (2005) databases are used to identify countries and products for which NTBs effects might be expected and estimates are generated for these effects. In the same vein, Dean et al. (2003) use retail prices (that are considered to be composites of the prices of imported and domestically produced goods, including distribution costs and transport costs) and impose some simplifying assumptions to the theoretical model for estimating a tariff equivalent of the NTBs which varies across sectors and regions.

The price-wedge approach is often used to quantify the impact of sanitary and phytosanitary (SPS) regulations and other technical barriers to trade (TBT) on market equilibrium and trade (see, for example, Calvin and Krissoff, 1998, and Yue et al., 2005).

Calvin and Krissoff provide a tariff equivalent of phytosanitary barriers in the Japanese apple market regarding the risk of contamination by fire blight. They use the law of one price under a homogeneous commodity assumption (arbitrage condition) to calculate the tariff equivalent of SPS barriers affecting apple imports in Japan to avoid damages from fire blight. Yue et al. derive a revamped tariff-equivalent estimate of a TBT, by relaxing the homogeneous commodity assumption and accounting explicitly for commodity heterogeneity and perceived quality of substitutes and trade costs.

The tariff equivalent of the TBT, TBT_T, is a function of the relative cost of the two goods (p_{k1} and p_{k2}, their volumes (Q_{k1} and Q_{k2}), the elasticity of substitution (σ), the preference parameter (α), international trade costs (IT_R), internal transaction and transportation cost (T_R), and border tariff (*tariff*):

$$(6)\quad TBT_T = p_{k1}\frac{1-\alpha}{\alpha}\left(\frac{p_{k1}}{p_{k2}}\right)^{\frac{1}{\sigma}} - p - IT_R - tariff - T_R$$

where price p represents the price/cost of imported good. Equation (6) nests the conventional technique that assumes perfect substitutes leading to the TBT in order to explain the differential between the domestic price and international price adjusted for transportation.

Another approach for measuring NTBs is to model the determination of quantity rather than price, and then to include an index of trade restrictiveness in a quantity equation. Quantity-impact measures focus on changes in the volume of imports and domestic production caused by various non-tariff policies. As in the case of price comparison measures, it is hard to obtain appropriate data to compute the exact quantitative impact of an NTB.

In a study of trade liberalization in Africa, Nash (1993) estimates changes in the "tariff-equivalent" of multiple restrictions on imports in a number of developing countries. Nash derives an estimate of changes in the tariff equivalent of all restrictions on imports using the import demand function:

(7) $M = a + bY + c[P_M E(1+t)]$

where M is imports (in quantity, not value, terms), Y is income, P_M is import price in dollars, E is the real exchange rate, and $(1 + t)$ is the "tariff equivalent" of import restrictions, that is, a measure of the increase in domestic prices that would be needed to reduce import demand to the same degree as the import restrictions[9]. If all variables are in natural logarithms, then the above equation can be differentiated and re-arranged to show:

(8) $\%\Delta(1+t) = \{\%\Delta M - b\%\Delta Y - c[\%\Delta P_M + \%\Delta E]\}/c$

where $\%\Delta$ is the percentage change in a variable, and b and c are the import elasticities with respect to income and price. Data are available for imports, income, import prices, and the exchange rate; and the elasticities can be estimated (or assumed on the basis of previous estimates for other developing countries), so the change in $(1 + t)$ can be computed.

The estimate of effects of trade barriers on quantities can in turn be converted into an effect on prices by use of an assumed or an estimated price elasticity of demand. In a recent study, Kee et al. (2004b) derive country-by-country quantity impacts of NTBs by analyzing trade data econometrically. They provide AVEs of NTBs for 104 developing and developed countries, considering core NTBs (price and quantity control measures) and non-core NTBs (according to UNCTAD's classification), namely technical regulations and monopolistic measures, such as single channel for imports, as well as agricultural domestic support. They do not include other NTBs because of the lack of data. Estimates are provided at the tariff line level (HS6-digit), following Leamer's (1990) approach which compares actual imports with trade flows predicted according to

[9] In principle $P_M E(1+t)$ is the full domestic price of the imported good. If it is rationed by a non price mechanism, $(1+t)$ includes the marginal value of waiting time, bribery, or other costs incurred to purchase the good.

country specific factor endowments. Then quantity impacts are converted into price equivalents using import demand elasticities estimated at the tariff line level (Kee et al., 2004a).[10]

In principle, one can detect the effects of NTBs using either price data or quantity data. In practice, the relative abundance and degree of detailed data on trade flows makes them attractive for analytical purposes. On the other hand, trade data are often value rather than pure quantity data and care needs to be exercised in the microeconomic assumptions used to interpret the results. Another argument for using trade flow data can be adduced from the fact that NTBs have a first-order impact on the level of imports but only a second-order effect on domestic prices. The disadvantage of using quantities, though, is that there are two sources of statistical uncertainty: from the analysis of trade flows itself and from the separate analysis in which the elasticities (necessary in order to transform the effects on trade flows into AVEs) were obtained (Ferrantino, 2006).

Knowledge of the types of NTBs that are most likely to produce increases in trade or economic welfare upon their removal would be very useful. Apparently, the single price gap reflects the cumulative effects of all policies. Econometric methods offer some promise in this respect, though it must be recalled that the presence of restrictive or inefficient policies tends to be correlated.

For example, Ando and Fujii (2001) estimate the tariff equivalents of both core NTBs (price and quantity control measures) and non-core NTBs (automatic licensing measures, monopolistic measures and technical measures, based on the UNCTAD classification system) in 13 APEC economies, focusing on price differentials between the c.i.f. price of imported goods and the domestic producer price of the domestic substitutes at the 4 digit level. They econometrically estimate a relationship between overall tariff equivalents and by-type frequency ratios (with other control variables), and use this estimated relationship to decompose the overall tariff-equivalents by five types: price control measures, quantity control measures, auto-licensing measures, monopolistic measures, and technical measures. Their estimates reveal that a certain degree of protection is provided by both core and non-core NTBs . In particular, developed countries with low general tariffs, or with low preferential tariffs under a number of free trade agreements, significantly protect domestic industries by non-core measures, such as technical measures. On the other hand, developing countries do not heavily apply NTBs to their commodities except agriculture and food processing sectors.

Finally, it is worth mentioning a recent paper by Sharma (2006) which uses a standard partial equilibrium method to quantify equivalent quotas for deviations in tariff cuts, or rather for the portion of the tariff that is not reduced as per a general tariff cutting formula. It is equal to:

(9) *Quota-equivalent of tariff deviation* $= \Delta M/M_0 = - \eta_m * [\Delta t/(1+t_0)]$,

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[10] The methodology follows Kohli (1991) and Harrigan (1997) where imports are treated as inputs into domestic production rather than as final consumption goods as in most of the literature.

where $\Delta M/M_0$ is percentage change in import, η_m is import demand elasticity, Δt indicates change in tariff or deviation in tariff cut and t_0 is the tariff rate before tariff cuts. Interestingly, a similar mechanism has been proposed by the EU in the present WTO negotiations in order to compute the commitments that should be undertaken for the so-called "sensitive products".

4. Aggregation across products

With several products, the question arises: what does average quantity restriction (or price increase) represent the restrictiveness of the system? As we will see in the following, the problem of calculating a scalar index that aggregates the levels of protection granted to the producers of all commodities is a particularly difficult index number problem.

4.1 Incidence measures

Tariff moments

Incidence measures are constructed from data on the actual barriers themselves. Typical examples of this typology are measures used to evaluate the level (or dispersion) of tariffs through the direct observation of the policy instruments. The common ways to assess the protective effect of tariffs are the arithmetic mean (or simple average) to capture the overall level of tariffs and the standard deviation to measure the dispersion of tariffs as the spread or distance of most observations from the arithmetic mean (or simple average).

A simple (i.e., unweighted) average tariff has obvious disadvantages. First of all, tariff schedules sometimes have distributions that are highly skewed to the right so that arithmetic mean and standard deviation are not the most appropriate measures. In this case the mean may overestimate the central tendency of the data and the most representative measure should be the tariff median, which measures the midpoint of the tariff schedule's distribution.

When a country's tariff schedule is normally distributed the mean and median tariffs would be very close but, when the tariff schedule is highly skewed, both the mean and median give useful information. High mean and high median denote high levels of protection for a country or commodity sector found across most tariff-lines. The opposite side of the low mean and median indicates low levels of protection for a country or commodity sector found across most tariff-lines. The intermediate case of high mean with low median (or low mean with high median) suggest extremely high (or low) levels of protection for a few specific commodities result in high (or low) mean, although most tariff-lines are low (or high).

The average tariff rate is clearly an imperfect measure of trade restrictiveness, since simple averages of tariff lines ignore the different economic importance of the product lines under consideration and it does not take into account the relative importance of tariffs among sectors and products. More generally, the relationship between tariff rates and trade volumes is not that strong:

trade volumes are determined by many factors other than policy and available data on tariffs are a very imperfect measure of trade policy (Dollar and Kraay, 2004).

Many of the papers reviewed here compute simple tariff averages, though in many cases this is done only to show how misleading the results can be. Among those focusing on the simple average as a tariff aggregator, Gibson et al. (2001) argue that high tariff protection was granted to agricultural commodities during the period 1995-1999. In fact, the global average tariff on agricultural products was 62 percent, much higher than those on manufactured items. Furthermore, the same authors found that the EU's highest tariff rates affected mainly products in the dairy and meat sectors. Looking at tariffs on exports of Least Developed Countries (LDCs), Hoekman et al. (2001) found that, during the period 1996-98, the EU imposed the highest average tariff for agricultural and food products with an average of 40,3 % (compared to an average of 7,4 % for all products).

The dispersion of the tariff structure is at least as important, in terms of impact, as its average level. An uneven tariff structure, as a matter of fact, can result in more severe trade distortions than a slightly higher, but more balanced overall level of protection. This has led many practitioners to supplement averages of tariff rates by incidence measures of tariff dispersion, such as the unweighted standard deviation or coefficient of variation of tariffs (CV), defined as the ratio of the standard deviation to the mean:

$$(10) \quad CV = \frac{\left(\frac{1}{K} \sum_{k=1}^{K} (t_k - \bar{t})^2 \right)^{\frac{1}{2}}}{\bar{t}}$$

where CV is the coefficient of variation, the numerator is the standard deviation of tariffs and $\bar{t}$ is the average tariff.

A subjective measure is the IMF's Overall Trade Restrictiveness Index (IMF, 2005).) that consists of two components: the Tariff Restrictiveness Rating, and the Non-tariff Restrictiveness Rating[11]. The Tariff Restrictiveness Rating consists of a 5-point scale, based on the simple unweighted average of a country's tariff rates. The rating was designed so that broadly equal numbers of countries were represented in each of the 5 categories. By combining the Non-tariff Rating with the Tariff Restrictiveness Rating, the IMF elaborates an overall trade restrictiveness rating that is a ten-point scale.

Tariff escalation

A typical example of incidence measure is the tariff wedge which represents the simplest measure of tariff escalation. It consists in protecting processed products at higher level than primary products

[11] See section 3.2 for a description of the Non-tariff Restrictiveness Rating.

and represents the major consequence of the tariff dispersion. The tariff wedge (τ^w) is given by the difference in nominal tariffs between the output commodity and the input commodity:

(11) $\tau^w{}_{yx} = \tau_y - \tau_x$

where $\tau^w{}_{yx}$ is the tariff wedge between output commodity *y* and input commodity *x*, τ_y is the *ad valorem* equivalent of the tariff on the output commodity *y*, and τ_x is the *ad valorem* equivalent of the tariff on the input commodity *x*. Nominal tariff escalation occurs when $\tau^w{}_{yx} > 0$, nominal tariff de-escalation takes place when $\tau^w{}_{yx} < 0$ and tariff parity is defined as $\tau^w{}_{yx} = 0$.

A FAO study by Lindland (1997) examines the impact of the Uruguay Round on tariff escalation in agricultural products in three major agricultural markets (EU, Japan and USA). It points out that, as a result of the Uruguay Round tariff concessions, more than 80% of nominal tariff wedges between raw materials and their processed products have decreased in nominal terms.

The main limitations of this method are that nominal tariffs wedges do not fully represent the intensity of protection caused by the tariff structure and do not provide information about the impact of tariffs on the value added of processed products. Furthermore, they compare nominal tariffs of final output and only one input, so that they can scarcely be applied to fabrication processes involving multiple inputs and/or multiple outputs. Typically, this occurs with a commodity such as chocolate. The chocolate results more protected than cocoa beans or cocoa paste but it does not mean that there is tariff escalation, since the technological process involves the introduction of sugar, which is often protected by very high tariffs, for example in the EU and the US (Bureau et al., 2004). As a consequence, when there are several different protected agricultural inputs it is difficult to conclude to the existence of tariff escalation. Finally, since tariff wedges do not take into account the value added, they cannot be compared across commodities (Lindland, 1997; Antimiani, 2004; Antimiani and Salvatici, 2005).

4.2 Outcome measures

Observed weights

<u>Weighted moments</u>

The simplest and most commonly-used approach for measuring the degree of protection is the weighted average rate of tariff charges, τ^a, using as weight the respective share in imports valued at border prices.[12] The average tariff can be written as a weighted average of tariff rates:

(12) $\tau^a = \sum \omega^*_k \tau_k$

where τ_k (equal to t_k / P^*_k) is the *ad valorem* tariff rate on good *k* and the weights ω^*_k, based on import volumes M_k valued at world prices P^*_k rather than at domestic prices P_k :

[12] When individual tariff rates are not available, some authors determine the collected tariff ratios. The average rate is determined by calculating the revenue collected from tariffs and duties as a percentage of total imports (Edward,1998).

(13) $\omega_k^* = \frac{M_k P_k^*}{\sum M_k P_k^*}$.

Despite its convenience (it is intuitive and easy to calculate), the trade-weighted average tariff immediately runs into some weaknesses. The most obvious shortcoming is the so-called "endogeneity bias": highly taxed imports tend not to be imported (Anderson and Neary, 2005). Using imports as weights leads to an underestimation of the protection level of a country. The negative correlation between the level of tariffs and the level of imports implies that a high (low) tariff generates limited (large) imports and its contribution to the overall protection is then reduced (increased). Then, import-weighted averages tend to understate the significance of just those tariffs that have been most successful in reducing imports. Furthermore, tariffs have greater effects on trade volume when they apply to imports in relatively elastic demand; but it is precisely these goods whose weights fall fastest. If there is a positive correlation between import demand elasticities and tariff levels, high tariffs receive a low weight whereas low tariffs receive a high weight.

In order to escape these shortcomings, several authors suggested alternative weighting schemes. For example, production shares would assure that highly protected commodities produced in large amounts get appropriately large weights, but this method can result in an upward bias, because many factors other than tariffs affect agricultural production levels(Adriamananjara e Nash, 1997). In addition, production data at the tariff-line level are rarely available.[13]

In bilateral comparisons, a useful technique for assessing the real level of tariff protection is to use averages that take into account the proportional relevance of sensitive products. Gehlhar and Wainio (2002) reconstruct tariffs for the food processing sectors using a weighting scheme that takes into account exporter's trade composition. It represents an effective and practical way to combine large numbers of trade flows and tariffs into a simple average putting the greatest emphasis on those tariffs in the importing country that are of the greatest importance to the exporting partner. More specifically, this is done by weighting each of the importing country's tariffs by the proportion of the exporting country's total exports accounted for by each tariff-line within a given commodity category. For example, Jank et al. (2002) find that while the (non-weighted) average tariff on agricultural and food products in the European Union was less than 20 per cent (*ad valorem* equivalent), an appropriate weighting scheme that accounts for the structure of exports of each developing country lead to an average EU tariff of 84 per cent for Ecuador exports and 75 per cent for Uruguay exports.

Bilateral tariffs faced if all exports went to each destination were firstly introduced by by Sandrey (2000) in order to compute the Relative Tariff Ratio (RTR) index. This approach assumes that only

[13] The share of the domestic value of consumption is another alternative, but also biased to the extent that high tariffs reduce consumption. Similar to production, consumption data are generally not available at the tariff-line level.

the bilateral partners exist in the world and provides a series of bilateral indexes. The RTR is simply the ratio of the two respective bilateral tariffs. For example, for every percentage point which the EU faced into New Zealand, New Zealand faced 15.24 into the EU. Conversely, since one index is the reciprocal of the other, for every percentage point which New Zealand faced, the EU faced 0.07 percentage points.

The previous bilateral indexes clearly show the weighting of a specific country's revealed comparative advantage as measured by its major export basket against each major partner's border protection, and can therefore claim some legitimacy by that linkage to trade theory. Accordingly, using the structure of overall exports of a country to weight the importing countries tariffs is particularly appropriate for bilateral comparisons. However, it does not allow for consistent (i.e. transitive) comparisons of market access.

Global imports (exports) can be used as weights, but they may constitute import structures radically different from those of the region considered. Bouët et al. (2001 and 2004) retained the option of weighing the imports of a country by those of a reference group the country belongs to in the aggregation of tariffs from the MAcMap-HS6 database[14]. The authors find an aggregate level of protection applied by importer and faced by exporter and minimize the endogeneity bias in the aggregation procedure, by making use of a weighting scheme based on groups of countries ("reference groups") the assembly criteria being GDP per capita.

More specifically, the weighting of tariffs across products and across exporters is not based on bilateral exports, but rather based on the exports of the partner toward the reference group the importer belongs to. By substituting the reference group to the importer, the endogeneity bias is decreased. The world is divided into 5 reference groups corresponding to different levels of development and for each product "hs6" imported by country "reporter" from country "partner" the weight used is:

$$(14) \quad Weight_{hs6,partner,reporter} = M_{hs6,partner,RefGrp(reporter)} \frac{M_{.,.,reporter}}{M_{.,.,RefGrp(reporter)}}$$

Where $M_{hs6,\ partner,\ reporter}$ refers to the value of product hs6-partner-reporter triplet, "RefGroup(reporter)" refers to the reference group the country "reporter" belongs to, and "." refers to the total, so that $M_{.,.,reporter}$ refers to the total value of "reporter"'s imports. The last term is a normalization factor and only matters as long as data are aggregated among reporters. When aggregating across reporters/importer for a given partner/exporter and a given product, weights are

[14] MAcMap-HS6 database provides *ad valorem* equivalent measures of tariff duties and tariff rate quotas for 163 countries and 208 partners, at the six-digit level of the Harmonized System (see Bouët et al, 2004).

normalized by the share of total imports from this reporter in total imports of its reference group, in order to account for the fact that reporters and reference groups may differ in sizes.

Results on European protection in agricultural sector are showed in Table 5. Applied protection by importers in agricultural sector is larger in Europe (17,9%), as compared to Canada (14,9%) and USA (5%), but is smaller than in Japan (35,3%). Conversely, faced protection by exporters is larger in Europe (18,6%) than in Canada (16,4%) and Japan (13,9%), but is smaller than USA (19,3%).

Also in the case of outcome measures, as it was the case for incidence measures, practitioners often supplement weighted averages of tariff rates by measures of dispersion incorporating some weighting schemes. But this has little to recommend it. First, qualifications must be made in interpreting changes in tariff dispersion. More generally, there is no satisfactory rule for combining the measures of average and dispersion to yield a measure which might be comparable across countries or across time (Anderson and Neary, 2005).

Effective rate of protection

A well-known measure of trade protection is the effective rate of protection which takes in account the effects of tariffs both on inputs and outputs. There are two ways to measure effective protection, and therefore assess how much the final product is protected relative to the raw material. The concept of the effective rate of protection was developed by Balassa (1965) and Corden (1966) to measure the increase in value added in an industry under protection relative to what value added would be under free trade. In other words, it is the percentage increase in value added per unit in an economic activity which is made possible by the tariff structure relative to the situation in the absence of tariffs:

$$(15) \quad pr_y = \frac{VA_y - VA_y^*}{VA_y^*}$$

where pr_y be the effective protective rate for activity y; VA is value added computed with distorted prices (i.e., including tariffs), while VA^* is value added at world prices. It depends not only on the tariff on the final product but also on the input coefficients and the tariffs on the inputs.

On the other hand, Leith (1968) defines effective protection as the proportional change in the "price" of the value added due to the tariff structure. Bruno (1979) and Woodland (1982) provide microeconomic foundations for Leith's approach. It measures protection on a value-added basis rather than on the basis of the final price of a product and thus takes account of the level of protection on intermediate inputs as well as the final product. Assuming that one unit of output y necessitates the use of a_{xy} quantity of inputs x, we can write the value added per unit of output at free trade prices and in presence of tariffs respectively equal to:

$$(16) \quad VA_y^* = P_y^* - \sum_x a_{xy} P_x^*$$

and

(17) $VA_y = P_y^*(1+\tau_y) - \sum_x a_{xy} P_x^*(1+\tau_x)$

where P_y and P_x are, respectively the nominal price per unit of y at free trade prices and the nominal price per unit of input x at free prices; x_i and τ_y are the nominal tariff in *ad valorem* equivalent of input x and of output y; a_{xy} is the share of input x in cost of y at free trade prices, given by a_{xy} = q_{xy}*P_x/P_y and q_{xy} is the physical input x per unit of output y. Then the effective rate of protection pr_y can be rewritten as:

(18) $pr_y = \dfrac{\tau_y - \sum_x a_{xy}\tau_x}{1 - \sum_x a_{xy}}$ $(0 < a_{xy} < 1)$

If a constant coefficient (i.e. Leontief) technology is assumed, the share of the raw material in a final product is kept constant regardless of relative prices. In this case the Leith and Corden measures are equal.

Equation (18) shows the relationship between nominal tariff wedge and effective rate of protection. When $t_y > t_x$ (then $pr_y > \tau_y > \tau_x$), tariff escalation takes place and pr_y increases with the increase in a_{xy}; when $\tau_y < \tau_x$ (then $pr_y < \tau_y < \tau_x$) and $\tau_y < a_{xy}\tau_x$ (then $pr_y < 0$), tariff de-escalation occurs and pr_y decreases with the increase in a_{xy}; when $\tau_y = \tau_x$ (then $pr_y = \tau_y = \tau_x$), there is a tariff parity and pr_y is not affected by change in a_{xy}.

The effective rate of protection overcomes the limitations of tariff wedges as a way to measure tariff escalation, since it focuses the attention on gross outputs of sectors taking account of the role of intermediate inputs (Lindland, 1997). The major problem in terms of empirical application, compared to the nominal tariff wedge, is that it needs accurate data on prices and technical input-output coefficients, which are not always available.

The effective rate of protection makes a distinction between protection on the primary input and on the final product so as to isolate the protection on the value added component of a processed product. On the one hand, the "endogeneity bias" may lead, among other things, to an underestimation of the effective protection in cases of "escalated" tariff structures (Pritchett and Sethi, 1994). On the other hand, the above definition entails a number of drawbacks and it has been showed that in a general equilibrium framework it does not provide an accurate measure of the attraction of primary resources in one sector (Bhagwati and Srinavasan, 1984). Nonetheless, despite its limitations[15] the effective rate of protection remains one of the most common indicators to evaluate trade policy: "Effective protection concept is the ranch house of trade policy construction – ugly but apparently too useful to disappear" (Anderson, 1998b).

[15] Greenaway and Miller (2003) summarize theoretical shortcomings and criticism of this measure of protection.

In a recent study, Bureau et al. (2004) analyze the protection granted to the processing sector by the existing tariff structure of EU, US, Japan and South Africa, by constructing indicators of effective protection, so as to take into account the tariffs imposed on raw commodities and to measure precisely whether or not the value added is also protected by the tariff structure. In particular, they calculate effective rates of protection based both on MFN and applied rates. As far as the EU is concerned, with the exception of the few countries that benefit from ACP and the EBA agreements, the protection in beef market, processing industry (since processed good faces a higher tariff than fresh one, for examples fish and filets) remains very high. They find evidence of tariff escalation on sugar products. In spite of the high protection on sugar, processed pineapple and pineapple juice face a much higher MFN tariff than fresh pineapple. The calculation of effective protection rates suggests that there is a significant degree of protection on the value added.

Counterfactual weights

Regression analyses

Weighted tariff rates are also constructed from regression. For example, Barro and Lee (1994) developed an own-import weighted tariff rates on intermediate inputs and capital goods (*owti*), constructed from UNCTAD data, and a measure of "Free trade openness" (*freeop*), constructed from a regression based on the physical dimension of each country and the average distance to capitals of world 20 major exporters weighted by the values of bilateral imports. They use these measures to compute a measure of tariff restriction (*freetar*):

(19) $freetar = freeop * \log(1+owti)$

The intuition underlying this index is that distortionary effects of trade restrictions should be larger in economies that, in the absence of trade restrictions, would be more exposed to trade.

As far as the effective protection is concerned, Bureau and Kalaitzandonakes (1995) estimate a flexible functional form allowing for substitution between outputs and between inputs. However, the estimation they propose requires a functional form accounting for input substitutions, and thus raising the problem of data for econometric estimates or of picking appropriate (and constant) substitution elasticities. Practical difficulties might offset some of the theoretical advantages.

Generalized moments

In order to characterize changes in the distribution of tariffs, Anderson and Neary (2006) introduce generalized or substitution-weighted tariff moments. These are equal to weighted moments, where the weights are the elements of the substitution matrix ($E_{\pi\pi}$, i.e. the Hessian of the trade expenditure function that will be introduced in the next section) normalized by the domestic prices.

Define the ad valorem tariff rate on good *k* relative to the domestic price base as:

(20) $T_k \equiv \tau_k / P_k = \left(P_k - P_k^*\right) / P_k \qquad 0 \le T_k < 1$

The T_k are related to tariff rates defined with respect to world prices ($t_k = \tau_k / P_k^*$) by:

(21) $T_k = \tau_k /(1-\tau_k)$

Anderson and Neary (2006) define two generalized moments of the tariff structure. The first is the generalized average tariff ($\overline{T}$):

(22) $\overline{T} = \sum_k \sum_z S_{kz} T_z$

where S_{kz} denote both the individual elements of a matrix of substitution S and (when either good k or good z is zero) the corresponding cross-price effects with the *numeraire* good[16].

The second is the generalized variance of tariffs (V):

(23) $V \equiv \sum_k \sum_z S_{kz} (T_z - M(T))^2$

where:

(24) $M(T) = \sum_k \sum_z S_{kz} (T_z - 1)$.

Generalized moments do not have an interpretation in themselves, but do provide valuable insights if we want to assess the effects of changes in actual tariffs on welfare and import volume. Anderson and Neary (2006), as a matter of fact, show that the effects on welfare and import volume of a change in tariffs are fully described by their effects on the generalized mean and variance of tariffs.

4.3 Equivalence measures

In order to introduce the equivalence measures, we first recall how the effects of trade policy can be expressed using the textbook description firstly provided by Dixit and Norman (1980) and widely used since then (Anderson, 1994; Feenstra, 1995). The focus is on economic efficiency, defined in terms of the welfare of a representative agent. Distributive issues are ignored and protective purposes are set exogenously by the government which returns its net revenues from trade distortion to the agent. It makes no essential difference whether imports are for final consumption or intermediate input use nor does it matter whether export as well as import trade policies are considered.

On the other hand, assuming a small economy with perfect competition and constant returns to scale does not allow for terms of trade gains due to the trade policies. In other terms, we focus on the deadweight loss from distorting production and consumption decisions, ignoring possible gains from improving the terms of trade, or from shifting profits between countries due to changes in the scale of firms (Feenstra, 1995).

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[16] S is a symmetric n-by-n positive definite matrix all of whose elements sum to one, and the normalised own-price effects S_{kz} are positive for all k, while the normalised cross-price effects S_{kz} are negative if and only if goods k and z are general-equilibrium net substitutes

Let the index k denote goods $k = (1,...,K)$ that are sold at the international price vector $P^* = (P_1^*,..., P^*_K)$ and at the domestic price vector $P = (P_1,...,P_K)$. The vector χ includes all the variables assumed exogenous, such as the world prices ("small country assumption") or the fixed endowment of factors of production. The optimal behaviour of the representative agent can be expressed through the trade expenditure function - $E(P, U, \chi)$ - and is obtained as the difference between the consumer's expenditure function - $e(P, U)$ - and the gross domestic product function - $g(P, \chi)$. Making use of the properties of duality, we know that:

i) the derivatives of the expenditure function with respect to prices equal the levels of consumption;

ii) the derivatives of the gross domestic product function with respect to prices are the economy's general equilibrium net supply functions;[17]

iii) the trade expenditure function is homogeneous of degree one in prices and its derivatives with respect to prices are the compensated import demand functions – $m_k (P, U, \chi)$ - which are homogeneous of degree zero in prices.

Given this structure of supply and demand, the other element of the model is provided by the external budget constraint. The constraint is expressed through the balance of trade function - $B(P, U, \chi)$ - that summarizes the three possible sources of funds for procuring imports: earnings from exports, earnings from the distortion of trade - G - and international transfers. Assuming that the latter are equal to zero and that tariffs (vector t) are the only trade policy, we get:

(25) $B(\cdot) = G - E(\cdot) = 0.$

Total differentiating the external budget constraint (25) using the small country assumption ($dP = dt$) implies:

(26) $B_P dU + B_P dP = 0.$

The first term ($B_P dU$) is the change in net trade expenditure at constant prices that could take place, for example, as a consequence of a gift from abroad. The second term ($B_P dP$) is the marginal cost of tariffs, which is positive if tariff increases are inefficient. This is quite an intuitive assumption, but it should not be taken for granted, even if we have ruled out possible gains due to imperfect competition or due to terms of trade. In case of partial liberalization, as a matter of fact, cross price effects can make the marginal cost negative.

According to Anderson and Neary (1996), a general definition of a policy index is as follows: depending on a pre-determined reference concept, any aggregate measure is a function mapping

[17] Accordingly, each derivative can be equal either to the supply function or to minus the input demand function if the good is an intermediate input. Treating imports and domestically produced goods as imperfect substitutes (i.e., the "Armington assumption") and considering only final consumption, the derivatives of the gross product function with respect to prices of tariff-constrained goods would be equal to zero.

from a vector of independent variables - defined according to the policy coverage - into a scalar aggregate. Consequently, the elements that define a theoretically consistent policy index of trade restrictiveness include the following:

- the policy coverage (e.g., tariffs, import quotas, border and domestic policies, etc.);
- the reference point for the "equivalent-impact" we are interested in (e.g., iso-welfare measures, iso-income measures, etc.);
- the scalar aggregate, that is the policy instrument into which are translated the policy measures covered (e.g., tariff-equivalent measures, subsidy-equivalent measures, quota-equivalent measures, etc.).

Price space

<u>Expenditure</u>

Bach and Martin (2001) firstly proposed a tariff aggregator that keep expenditure constant. Anderson and Neary (2005) call it the "true average tariff" (τ^{δ}) and define it as:

(27) $\tau^{\delta} : E\left[\left(1+\tau^{\delta}\right)P^{*}, u^{0}\right] = E^{0}$

where E^0 is trade expenditure in the tariff-distorted equilibrium: $E^{0} = E\left(P^{0}, u^{0}\right)$.

Equation (27) states that τ^{δ} is the uniform tariff that would induce the same level of trade expenditure at the initial level of utility as the actual vector of initial tariffs. Like the trade-weighted average tariff, the true average tariff can be written as a weighted average of individual tariff rates, with the difference that weights allow for substitution in import demand.

Drawing on the literature on the cost-of-living, weighting tariffs by existing import values is analogous to a Laspeyres price index which uses initial period weights, while weighting by hypothetical import values under free trade is analogous to a Paasche price index using terminal period weights. As a consequence, the Fisher ideal index, given by the geometric average between the Laspeyres and Paasche indexes, would represent an exact price index for a linear, Leontief or quadratic function. Cline's "adjusted import weighting" (2002) follows this line of reasoning in order to get an appropriate measure of protection. As a matter of fact, he uses as weights an average between the observed import level and a measure of the import value that would occur if the protection were removed. The free-trade import volume (M_1) equals the original volume (M_0) plus the change implied by the removal of the tariff t according to the price elasticity of the import demand (α):

(28) $M_1 = M_0 + M_0(-\alpha[\frac{-t}{1+t}])$.

In practice, Cline introduces several simplifying assumptions: on the hand, the absolute value elasticity of the import demand functions is assumed to be equal to 1; on the other hand, the weights are averaged according to a simple mean, rather than using the geometric average corresponding to the Fisher "ideal" price index. Accordingly, the adjusted import base M^* is given by:

$$(29)\quad M^* = \frac{M_0 + M_1}{2} = \frac{M_0}{2}(\frac{2+3t}{1+t}) = M_0(\frac{1+1,5t}{1+t}).$$

Then, the Cline's weighted average tariff, t^*, is equal to:

$$(30)\quad t^* = \sum \varphi_k t_k$$

where t_k is the tariff rate in category k, and the weights φ_k are calculated as:

$$(31)\quad \varphi_k = \frac{M_k(\frac{1+1,5t_k}{1+t_k})}{\sum_k M_k(\frac{1+1,5t_k}{1+t_k})}$$

and M_k is the value of imports in category k.

In the same vein, but following a more rigorous approach, Bach and Martin (2001) are able to obtain a closed-form solution for the expenditure tariff aggregator. Assuming a CES functional form for the trade expenditure function, with all domestic prices equal to 1 in the base equilibrium, the uniform tariff equivalent is given by:

$$(32)\quad \tau^\delta = \left(\frac{1-\beta^\delta}{\sum_{k=1}^{K} \beta_k (1+t_k)^{\sigma-1}} \right)^{\frac{1}{1-\sigma}} - 1$$

Finally, Manole and Martin (2005), assuming separability between domestic and imported products, obtain a closed-form solution defined exclusively over a group of imported commodities (no domestic product):

$$(33)\quad \tau^\delta = \left(\sum_{k=1}^{K} \beta_k (1+t_k)^{\sigma-1} \right)^{\frac{1}{\sigma-1}} - 1$$

The "true average tariff" has some potential uses: because of the prevalence of the "Armington assumption" in modern models, it is the appropriate index to use to aggregate tariffs across sub-sectors in partial equilibrium studies and in CGE models. However, the index itself is of relatively limited interest. Because it focuses on private-sector behaviour (defined by the trade expenditure function) only and ignores the government budget constraint: if a uniform tariff equal to τ^δ were imposed, the economy would not be in equilibrium (since the balance of trade would not equal its initial level).

Tariff revenue

Bach and Martin (2001) propose a tariff aggregator that keeps tariff revenue constant. Also in this case, Manole and Martin (2005) obtain, using the assumption of separability between domestic and imported goods, a closed-form solution for a CES tariff aggregator (τ^R):

$$(34)\quad \tau^R = \frac{\sum_{k=1}^{K} t_k \left(1+t_k\right)\beta_k}{\left(\sum_{n=1}^{N} \beta_n \left(1+t_k\right)^{\sigma-1}\right)^{\frac{1}{1-\sigma}}}$$

where the β_n's are value shares of imports at domestic prices and σ is the elasticity of substitution.

Welfare

The Trade Restrictiveness Index (TRI), developed by Anderson and Neary (1994), is a uniform tariff-equivalent, iso-welfare measure. In terms of policy coverage, for the sake of simplicity, the following presentation deals only with tariffs. Although the inclusion of import quotas introduces some analytical complications – for example in terms of how the quota rent is shared between the importing and exporting country (Anderson and Neary, 1992) – both price and quantity import restrictive policies can be included in the TRI, as well as domestic policies (Anderson, Bannister and Neary, 1995).

The TRI (Δ) is defined as the inverse of the uniform tariff factor (one plus the uniform tariff) which would compensate the representative consumer for the actual change in tariffs, holding constant the balance of trade. Formally:

(35) $\Delta(P^1, u^0; \chi^0) = [\Delta: B(P^1/\Delta, u^0; \chi^0) = 0]$.

If new tariffs are equal to zero, $1/\Delta$ - 1 is the uniform tariff which is equivalent in efficiency to the original trade policy. More generally, $1/\Delta$ is the scalar factor of proportionality by which period 1 prices would have to be adjusted to ensure balanced trade when utility is at period 0 level. Notice that this is not the same as introducing a uniform tariff rate (except when we deal with a full liberalization).

The TRI defined in equation (35) is a compensating variation type of measure, since Δ is used to deflate period 1 prices in order to attain period 0 utility. In principle, it is possible to define an "equivalent (variation) TRI" (Δ^{EV}):

(36) $\Delta^{EV}(P^0, u^1; \chi^0) = [\Delta: B\,(P^0\Delta, u^1; \chi^0) = 0]$,

which would operate on period 0 prices in order to attain period 1 utility.

The equivalent TRI is in principle superior because of its transitivity property, but, since actual prices are not necessarily equal to a radial expansion of the free trade prices vector, it will not be generally defined in the move all the way to free trade. However, by the same token, it should be noticed that the "compensating TRI" is not generally defined if we start from a situation of free trade. In this case, as a matter of fact, a radial contraction of the distorted prices is not necessarily equal to the free trade prices.

In order to obtain a better understanding of the definition provided above, let us consider the consequences of trade liberalization of goods subject to a tariff. We define:

P^1 = new (that is, after trade reform) price;

π = counterfactual price that would restore utility to the old level,

τ = uniform (compensating) tariff rate,

Since $P^1(1+\tau) = \pi$, if we assume a tariff decrease ($P^1 < \pi$), the uniform tariff factor $(1+\tau)$ is greater than one. Furthermore, $(1+\tau) = 1/\Delta$ means that the TRI is equal to $1/(1+\tau)$. This implies that a reduction in trade distortions leads to $\Delta<1$.

In case of linear import demand functions:

(37) $m_k = \alpha_k - \beta_k P_k$,

we can derive an explicit formula for the welfare-equivalent uniform tariff (Feenstra, 1995):

(38) $\tau^{\Delta} = \left[\sum_{k}^{K} t_k^2 z_k \right]^{1/2}$, where $z_k = \frac{P_k^{*2}\beta_k}{\sum \left[P_k^{*2}\beta_k \right]}$

Comparing equation (38) with the trade-weighted average tariff τ^a in equation (12), the former is a mean of order 2, while the latter is an arithmetic mean. The TRI weights, then, correctly takes into account the welfare cost of distortions as an increasing function of the mean and the variance of the individual tariff rates ("Harberger Triangle effect").

The small country assumption is a convenient, though admittedly unrealistic feature of the TRI. If tariffs do not influence world prices, they may enhance welfare only improving the allocative efficiency within the country. In a small country setting, then, we are able to gauge protection by the degree of a country's "self-inflicted harm". Since it is well understood that tariffs may impact domestic welfare by altering the world prices, the TRI can be considered a sort of upper bound in terms of the measurement of the overall welfare impact[18]. Salvatici (2001), Lloyd and MacLaren (2002), and Anderson and Neary (2005) relax the small country assumption, defining a welfare-equivalent index with endogenous world prices.

Moreover, it is worth recalling that the TRI uses a Balance of trade function approach to the evaluation of welfare change (that is, a *compensation measure*), while most CGE models evaluate welfare changes using a *money metric of utility measure*. In a distorted economy, the results of these two approaches do not coincide (Anderson and Martin, 1993). As a consequence, in order to

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[18] Anderson and Neary (2003), argue (footnote 8) that , "there is a rationale for a *ceteris paribus* trade restrictiveness index that fixes world prices even when these prices are in fact endogenous". Such a "rationale" may be represented by the fact that, by keeping world price constant, we focus on the component of welfare explained by allocative inefficiency within the country, and not by the degree of market power of the country.

compute the TRI with a standard multiregional general equilibrium model such as the GTAP one, we need to redefine the index along the lines described by Salvatici (2001).

Most of the existing applications of the TRI use a general equilibrium approach (Anderson, 1995; Anderson and Neary, 1994 and 1996; Bach and Martin, 1998; Salvatici, 2001; Lloyd and MacLaren, 2002). The advantages of general equilibrium modelling are mainly greater theoretical consistency, the ability to calculate explicitly the level of the TRI and changes in it, and the possibility to provide a consistent aggregation of a detailed protective structure. On the other hand, in order to use a disaggregated model, which is able to capture the detail of actual protective policies, it is necessary to significantly simplify the structure of commodity and factor substitution.

In a partial equilibrium framework, the TRI may still be calculated provided a number of analytic shortcuts are taken. A partial TRI is defined over the trade policy instruments applicable to the markets of interest only. This implies two major simplifying assumptions. Firstly, it is assumed that changes in trade policy do not affect the prices of other goods (prices of traded goods have already been held constant with the small country assumption). As a matter of fact, if we are concerned with trade restrictions on a single industry, it seems reasonable to ignore changes in the prices of non-traded goods and factors, if that industry accounts for a relatively small share of the GDP. The second simplifying assumptions is that the goods to be considered are separable from others in excess demand.

Bureau and Salvatici (2004a and 2004b) compute the TRI for the agricultural sectors included in the GTAP database of the QUAD countries. They use the index in order to compare the performance of different tariff cutting formulas, introducing into a CES import demand system some elasticity values taken from the literature. On the other hand, Kee et al. (2005) estimate the uniform tariff that could keep welfare constant given the observed tariff structure as well as the estimate of the NTBs AVEs (see section 3.2) for 91 countries assuming linear import demand functions (see equation (37)). The econometric approach adopted allows to work at the tariff line level, and to know the standard errors of the estimates entering into the calculation: consequently, it is possible to associate a standard error to the value of the TRI. The major drawback of this approach is that it ignores the general equilibrium of cross price effects.

The proportional change in the TRI is a weighted average of the proportional changes in domestic prices. Totally differentiating equation (36) we get

$$(39)\quad \frac{B'_P}{\Delta}dP - \frac{B'_P P}{\Delta^2}d\Delta = 0,$$

then

$$(40)\quad \hat{\Delta} = \frac{\sum_k B_{P_k} P_k (dP_k / P_k)}{B_P^{'} P} = \sum_k \left(\frac{B_{P_k} P_k}{B_P^{'} P} \right) \hat{P}_k .$$

The weights in (40) turn out to be the proportions of marginal deadweight loss due to each tariff, and they depend on the partial derivatives of the B(.) function with respect to prices. Ordinarily, the marginal deadweight loss due to each tariff ($B_{Pk}dP_k$) is positive, since tariff increases are inefficient. However, this should not be taken for granted, since cross price effects can make it negative. The theoretical ambiguity about the sign of the weights in (40) means that the TRI is not completely free from counterintuitive, "second-best" results.

Bureau, Fulponi and Salvatici (2000) compute the rate of change of the agricultural TRI implied by the Uruguay Round Agreement on agriculture, and compare it with the changes that would have been implied by different tariff cutting formulas. The major weakness of this approach is that it relies on the knowledge of some "reasonable" elasticity parameters in order to compute the marginal cost of the trade distortion (see equation (40)). That is, we must rely on the computation of an hypothetical change in imports, rather than focus on the observed change due to the actual tariff. Although most of the empirical applications seem to show a low sensitivity of the TRI results to the elasticity values used in the computations, it remains true that the index relies heavily on elasticity parameters arbitrarily assumed or chosen between those available in the literature (O'Rourke, 1997).

Even if all the existing presentations of the TRI focus on import tariffs and quotas, it is important to note that the interpretation of the TRI differs according to the type of trade policy considered (Salvatici, Carter and Sumner, 1997). Table 6 summarizes the impact of changes in the different types of policies in terms of changes in the TRI, the volume of trade and the welfare level.

Each of the rows in Table 6 represents a reduction in a trade distortive policy, with different intensities across markets that are summarized through the TRI. Assuming that all goods are substitutes, welfare impacts are always positive. Import taxes and export subsidies fit our previous description: Δ<1 and a reduction in a trade distortion is signaled by an increase in the TRI.

However, in terms of import subsidies and export taxes the results are reversed. In these cases world prices are higher than domestic prices and a reduction of the distortions leads to an increase of the latter: Δ>1 and trade liberalization leads to an increase of the TRI. The bottom line is that great care should be used in interpreting the TRI results, especially if different types of border policies are taken into account.

In Table 6 the impact on trade flows is obviously the opposite if we consider the reduction of taxes versus the reduction of subsidies. Even if in each case the resulting volume of trade is closer to the one prevailing under free trade, it is important to realize that the concept of "trade restrictiveness" assumed in the definition of the TRI is a very precise (and limited) one. It is related, but nonetheless very different from the one that could be considered, for example, in the context of trade negotiations. In that case, the trade volume displacement due to a certain set of policies may very well be more relevant to cross-country comparisons than the effects on domestic welfare.

Import volumes

Figure 2 provides a graphical example of the differences in terms of trade volumes resulting from alternative definitions of trade restrictiveness. We consider a partially decoupled set of policies that includes a tariff and a production quota fixed exactly at the same level of production which would have occurred under free trade.

In the quantity space of a two-good economy (y_1, y_2), *A* is the production bundle and *FT* is the consumption bundle under free trade. As a consequence of the introduction of the tariff-cum-quota set of policies, the consumption bundle shifts from *FT* to *TQ*, while the production quota y_2^ does not allow the production bundle to change. On the other hand, if we replace the tariff-cum-quota with a tariff-equivalent in terms of welfare (that is, the type of counterfactual experiment used in the construction of the TRI), the economy will produce at *D* and consume at *TE*. Clearly, in the latter case both imports (TE-C < TQ-B) and exports (D-C < A-B) are lower than under the tariff-cum-quota case, although the economy is on the same indifference curve U^1.

It is possible to draw the tariff-equivalent in terms of the volume of trade for the tariff-cum-quota set of policies, obtaining the point *E* and *M* where, by construction, M-H = TQ-B and H-E = B-A. In this case, however, the level of welfare achieved by the two policies is different, with $U^2>U^1$.

The Mercantilistic Trade Restrictiveness Index (MTRI) relies on the idea of evaluating trade policy using trade volume as the reference standard. The interest is in the extent to which trade distortions limit imports from the rest of the world, so that the aggregation procedure answers the following question: *what is the equivalent uniform tariff that if imposed to home imports would leave aggregate imports unchanged*?

The MTRI is defined by Anderson and Neary (2003) in terms of the uniform tariff τ^μ that yields the same volume (at world prices) of tariff-restricted imports as the initial vector of (non-uniform) tariffs. This can be expressed with import demand functions *M*, while holding constant the balance of trade function at level B^0:

(41) $\tau^\mu : M\left[P^\mu, P^0, B^0\right] = M^0\left(P^0, P^*, B^0\right)$, with $P^\mu \equiv P^*\left(1+\tau^\mu\right)$.

where P^* denotes the international prices (P_k^*) vector of the *K* goods $k = (1,\ldots,K)$, M^0 is the value of aggregate imports (at world prices) in the reference period, and P^0 is the initially distorted price vector.

Define the scalar import demand as:

(42) $M(P, P^*, B) \equiv \sum_{i=1}^{N} \sum_{k=1}^{K} P_{i,k}^* I_{i,k}^m (P, B)$

where $I_{i,k}^m$ denotes the uncompensated (Marshallian) import demand function of good k from country i. Accordingly, the MTRI uniform tariff τ^μ would lead to the same volume of imports (at world prices) as the one resulting from the uneven tariff structure, denoted by the Nx(N-1) bilateral tariffs matrix T whose elements are $t_{i,k}$:

(43) $\sum_{i=1}^{N} \sum_{k=1}^{K} P_{i,k}^* I_{i,k}^m \left[P^\mu, B^0\right] = \sum_{i=1}^{N} \sum_{k=1}^{K} P_{i,k}^* I_{i,k}^m \left[P^0, B^0\right]$

Even if the MTRI is a general equilibrium index, also in this case it is possible to define a partial equilibrium approximation. Bureau and Salvatici (2004b and 2005) assume that the overall basket of goods can be partitioned into K aggregates denoted $k=1,\ldots K$, and the utility function of the representative consumer can be written as:

(44) $U = \varphi(u_1(x_1),\ldots\ldots,u_k(x_K))$

where φ is continuous, twice differentiable, and strictly quasi concave, and the u_k are continuous, twice differentiable functions, homogeneous of degree one (Lloyd, 1975). When focusing on the K sectoral MTRIs, a convenient (albeit restrictive) assumption is to assume φ to be a Cobb-Douglas function (implying that the expenditure function is also a Cobb-Douglas one in prices with utility entering multiplicatively), in order to avoid the issue of allocation of consumer expenditure across sectors which, in general equilibrium models, is affected by tariffs within a particular aggregate k.

Another issue arising in partial equilibrium applications is that the import volume function is homogenous of degree zero in the prices of traded goods. As a consequence, the MTRI cannot be calculated unless there is a designated 'reference good', so that the price vectors refer to prices relative to this good.[19]

The empirical implementation by Bureau and Salvatici follows Bach and Martin (2001) modeling import demand through a Constant Elasticity of Substitution (CES) functional form. Kee et al. (2005), on the other hand, estimate the MTRI uniform tariff (calling it "Overall Trade Restrictiveness Index") assuming linear import demands. In such a case, the import-volume-equivalent uniform tariff is defined implicitly by the equation (Anderson and Neary, 2005):

(45) $\sum P_k^* \left[\alpha_k - \beta_k \left(1+\tau^\mu\right) P_k^*\right] = \sum P_k^* \left[\alpha_k - \beta_k \left(1+\tau_k\right) P_k^*\right].$

Solving for τ^μ gives:

(46) $\tau^\mu = \sum z_k \tau_k$.

[19] More generally, Neary (1998) shows how the failure to select a reference untaxed good leads to misleading results in the theory of trade policy.

This has the same linear form as the trade-weighted average tariff τ^a, but the same weights as the welfare-equivalent uniform tariff τ^Δ.

Kee et al. (2005) and Antimiani and Salvatici (2005) compute the MTRI uniform tariff bilaterally, to capture the trade restrictiveness that countries impose on each other. Accordingly, in equation (45), instead of summing over *k* and *i*, one would only sum over *k* to obtain a bilateral uniform tariff MTRI (τ_i^μ) defined as follows:

(47) $\tau_i^\mu : M_i\left[p^*\left(1+\tau_i^\mu\right), B^0\right] = M_i^0,$

where M_i^0 is the value of aggregate imports (at world prices) from country *i* in the reference period.

As in the case of the TRI, a "local approach" can be envisaged estimating changes in μ resulting from the different patterns of tariff reductions (Anderson et al., 1995). Looking at the definitions of the MTRI in implicit form provided in equations (46), it appears that proportional changes in the indexes can be expressed as weighted averages of the proportional changes in domestic prices, that is

(48) $$\dot{\mu} = \sum_{k=1}^{K}\left(\frac{\frac{\partial M}{\partial P_k}P_k}{\sum_{k'=1}^{K'}\frac{\partial M}{\partial P_{k'}}P_{k'}}\right)\dot{P}_{k'}$$

where the point above a variable denotes a proportional change.

Bureau et al. (2000) compute the rate of change of the agricultural MTRI due to the implementation of the Uruguay Round Agreement both for the EU and the US. These changes can be interpreted as follows. Due to the tariff reduction due to the WTO commitments, there is a move from a protected structure ($P_k^0 > P_k^*, \forall k$) to a less protected structure where $P_k^0 \geq P_k^1 \geq P_k^*, \forall k$. In order to compensate for the change in the tariff structure, it is necessary to impose a uniform tariff surcharge (equal to the inverse of μ) which would raise prices to the point that would restore the volume of imports to its initial level (that is, before the change in the tariff structure). This means that the reduction in market protection is signalled by a reduction in the MTRI.

An important extension of the MTRI definition allows the calculation of the index in models with endogenous world prices. Such an extension is proposed by Anderson and Neary (2005), while bilateral MTRI for the EU are computed by Antimiani and Salvatici (2005) using a multiregional CGE model (GTAP).

Finally, it is worth mentioning that in addition to the MTRI, other indexes based on the "volume-of-trade" equivalence criterion can be conceived. Anderson and Neary (2005) propose the "compensated MTRI" – i.e., the uniform tariff that yields the same volume of trade as the initial tariff structure, subject to the constraint that utility is held constant – and the "uniform border barrier" – i.e., the compensated MTRI uniform tariff that yields the same domestic value of international trade. Kee et al. (2005) focus on the distortions that the rest of the world imposes on each country export bundle, using export value as the relevant metric. This is the "Market Access Overall Trade Restrictiveness Index", which answers the following question: what is the uniform tariff that if imposed by all trading partners on exports of country I would leave exports of country c unchanged?

Effective protection

Anderson (1998) defines a Distributional Effective Rate of Protection (DERP) of sector *k* (E^k) in general equilibrium as the uniform tariff which exert on the return to specific factor *k* an effect which is equivalent to the initial tariff structure. That is:

(49) $E^k = 1/D^k - 1$

where

(50) $D^k(P^1; P^0, v, \chi) \to D \Big| g_\chi^k(P^1/D, v, \chi) = g_\chi^k(P^0, v, \chi),$

The function, *D* is the distance function applied in the tariff distorted price space. Accordingly, D^k is the uniform output price deflator which maintains profits in *k* constant. Since *D* is equal to the inverse of a uniform tariff factor, E^k is equal to the uniform tariff on distorted goods, which has the same effect on the profits of sector *k* as the initial tariff vector. In a special case, that of partial equilibrium with fixed coefficients of production, the formula implied by the new definition is identical to the usual effective rate of protection formula; with variable coefficients but still in partial equilibrium, the formula is a simple variant of the traditional effective rate of protection formula.

Sector specific factor income changes are a product of two elements: the level of protection given to the sector (and this is what the old effective protection concept tried to measure) and the rate at which the level of protection is translated into sector-specific factor's income. Differences in income changes across sectors arise from the differences in both elements of the product, and the new concept gives a precise measure of the "level" of protection in this context. In other words, the main difference refers to the concepts of effective protection and tariff escalation: these two concepts, even if correlated, are different because the former refers "only" to the tariffs, while the latter takes into account the structure of production. The traditional effective rate of protection captures only the tariff escalation, while the new index tries to compute all the effects on the production function arising from the tariff structure.

Anderson (1998) computes the DERP for the US agriculture, while Antimiani et al. (2003) use this index to assess the effective protection granted to the EU agrifood sector. The latter application is implemented using a CGE model with endogenous world prices. Accordingly, Antimiani et al., follow up a suggestion of Anderson (1998) relaxing the small country assumption in the DERP definition. If the vector P is a function of the tariff vector τ, equation (49) becomes:

$$(51)\quad D^{k}(P^{1};P^{0},v,\chi)\rightarrow D\Big|g_{\chi}^{k}\left[P^{1}(\tau^{1}/D),v,\chi\right]=g_{\chi}^{k}(P^{0},v,\chi)$$

<u>Output effective protection</u>

The same approach can be used to define an index which is able to measure the impact of protection on the ability of sectors to compete with other industries in factor markets: the Output Effective Rate of Protection (OERP). This index is based on the uniform tariff on all distorted sectors which produces the same level of output, sector by sector, as does the initial differentiated tariff structure (Anderson, 1998). Output variations across sectors reflect both the structure of protection (which the old effective protection concept tried to measure) and differences in the production structure of the economy. The two questions, 'how much protection is given' and 'how much does supply change as a result' are distinct, and the OERP gives a precise answer to the latter.

The output effective rate of protection pr_k of sector k in general equilibrium is defined as the uniform tariff which exerts on the output of k an effect which is equivalent to the initial tariff structure. That is:

$$(52)\quad pr_k : Y_k\left[P_k^{pr},w^{pr}\left(p_k^{pr},v\right)\right]=Y_k^{0}\left(P^{0},w^{0}\right),\ \text{with}\ P_k^{pr}\equiv P_k^{*}\left(1+pr_k\right).$$

where Y_k is k supply function, and w is the vector of competitive factor prices (w is function of the price vector P and of the fixed factor supply v).

The previous definition is based on the "small country" assumption. If we want to allow for endogenous world prices, we need to define the vector P^{*} as a function of the tariff vector (t). Equation (52) becomes:

$$(53)\quad pr_k^{w} : Y_k\left[\left(1+pr_k^{w}\right)P_k^{*}(t),w^{pr}\left(\left(1+pr_k^{w}\right)P_k^{*}(t),v\right)\right]=Y_k^{0}\left[\left(\left(1+t_k^{0}\right)P_k^{*}(t),w^{0}\left(\left(1+t_k^{0}\right)P_k^{*}(t),v\right)\right)\right]$$

where (pr_k^{w}) is the OERP uniform tariff with endogenous world prices. The latter definition is used by Antimiani and Salvatici (2005) in order to compute the index for the EU sectors.

Quantity space

Some policies, such as import quotas, are easier to handle in the volume dimension, since this would not require the conversion to a price measure. Quantity-based equivalent measures represent a measure of trade policy based on the deviations of observed trade flow from what they would have been had the economy been trading freely.

The coefficient of trade utilization (CTU) originally introduced by Debreu (1951) is implemented by Anderson and Neary (1989) as the uniform contraction factor applied to free trade quantities which is equivalent in welfare to the actual quota vector. In order to define the coefficient of trade utilization, Deaton's (1979) distance function concept is used to relate a reform value of the trade policy to the current level of the distorted trade utility function.

By definition, the index takes on the value one if and only if the actual resource utilization is optimal (free trade). Anderson and Neary (1989) show under what conditions the Debreau coefficient is a reliable welfare measure for a one-consumer economy. Anderson and Neary (1991) define a partial coefficient of trade utilization for trade reform in one sector and applies it to cheese.

Related to the CTU is the Trade Restrictiveness Quantity Index (TRQI) proposed by Chau et al. (2003) which also aims to provide a general equilibrium welfare measure. The definition of the TRQI combines a production inefficiency index and a consumption inefficiency index.

Regarding output inefficiency, the Paasche quantity index (Q_O^P) measures the maximum GDP divided by the observed net supply, evaluated at world prices (*P**):

(54) $$Q_0^P(P^*, y^*, y, v) = \frac{\sum_{i=1}^M P_i^* y_i^*}{\sum_{i=1}^M P_i^* y_i} = \frac{g(P^*, v)}{P^* y}$$

Turning to consumption inefficiency, the Paasche quantity index (Q_C^P) measures the minimum expenditure divided by the observed consumption vector, evaluated at international prices (*P**):

(55) $$Q_c^P(P^*, x^*, x, u) = \frac{\sum_{i=1}^M P_i^* x_i^*}{\sum_{i=1}^M P_i^* x_i} = \frac{e(P^*, u)}{P^* x}$$

The TRQI captures any policy induced inefficiencies in a small open economy combining the two previous indexes

(56) $\text{TRQI} = Q_O^P / Q_C^P$.

By the definition of the revenue and the expenditure functions, $Q_O^P \geq 1$ and $Q_C^P \leq 1$. Hence, the TRQI takes on values between 1 and $+\infty$. Changes in the TRQI depend on the changes in the distorted producer and consumer prices, and the relative impact of these changes in turn depends on the own- and cross-price elasticities, weighted by their shares in GDP. It is worth noting that the TRQI, even if it is essentially the "dual" of the TRI, enjoys some peculiar properties. For example, being homogeneous of degree 0 in anyone of the price vectors, it is independent of the choice of the *numeraire*.

In terms of empirical applications, the compelling feature of the TRQI is its relationship to the efficiency measurement literature. This means that several well-established tools of efficiency measurement could be readily used in order to estimate the TRQI: Bureau et al. (2002), for example, estimate the production component of the TRQI to evaluate the effects of EU agricultural policies using a parametric frontier model.

Scalar measures

As it has been mentioned with respect to the TRI, trade liberalization may imply changes of the index in different directions according to the policy under consideration. Moreover, all the indexes discussed above range from 0 to +∞. We may want to define indexes of trade restrictiveness on the continuum of the closed interval [0, 1] with well defined end points are well defined: 0 when there is no international trade and 1 when there is completely free trade.

Several measures, which have these properties, are obtained by Lloyd and MacLaren (2002) taking transformations of τ^{Δ}. One is the following measure:

$$(57) \quad L = 1 - \frac{\tau^{\Delta}}{\bar{\tau}^{\Delta}}$$

where $\bar{\tau}^{\Delta}$ is the uniform tariff rate that would eliminate international trade with other countries: in other terms, $\bar{\tau}^{\Delta}$ is the maximum value of τ^{Δ} in the hypothetical situation in which all trade ceases. By construction, $L \in [0, 1]$.

Another possible transformation suggested by Lloyd and MacLaren (2002) is:

$$(58) \quad M = \frac{1}{\left(1+\tau^{\Delta}\right)^{\lambda}}, where\, \lambda > 0.$$

$M \in [0, 1]$ and the use of higher powers makes the measure move up and down the unit interval more rapidly as τ varies.

A third measure proposed by Lloyd and MacLaren (2002) is:

$$(59) \quad N = \frac{Q}{\tilde{Q}},$$

where Q is the index of the volume of trade in the current situation and $\tilde{Q}$ is the index of the volume of trade in the (hypothetical) free trade situation. As the volume of trade in a restricted trade situation is lower than in the free trade situation, N $\in$ [0, 1]. This measure is appropriate when one is interested in the extent to which the volume of trade has been restricted, then is more in the spirit of the MTRI.

5. *A comparison of the different approaches*

Both incidence and outcome measures have theoretical shortcomings, and are pragmatic rather than theoretical measures. Incidence measures are solid in one sense: they depend directly and only on policy actions. Although not without interest, they present several weaknesses.

First of all, they take no account of the special features of the country or sector being studied. Moreover, they are not able to give any indication that trade is more restricted by the increases in the tariff of high-elasticity goods. Measures based on a subjective assessment have the least intrinsic plausibility: these subjective measures, although sometimes the analysts do not have much choice, should be handled with care.

The significant differences that we observe between results in terms of equivalence and incidence indexes suggest that models relying on aggregate tariffs constructed as simple averages use poor estimates of the actual tariff structure. This bias is likely to affect a large number of studies, as it is common practice to construct aggregate tariffs as simple averages of the detailed tariffs applied by custom officers, who sometimes work at a level of detail corresponding to the 8 or 10-digit level (or even 14-digit in the case of the EU).

In the case of outcome measures, the key issue is choosing which weights should be used. However, any fixed set of weights, even if computed or estimated, as in the case of free-trade imports, would ignore elasticity effects and substitution possibilities resulting from trade protection.

Both in the case of equivalence and outcome measures, uniform tariffs represent weighted averages of individual commodity tariff rates. However, in the case of the equivalence measures, the weights represent the effects of the tariffs according to a fundamental economic structure. This is not true for the weights used in the outcome measures, though some of these measures might be interpreted as fixed-weight approximations to theoretically based (i.e., equivalence) indexes. For example, the relationship between the trade-weighted average and the true average tariff is identical to that between the Laspeyres price index and the Konüs true cost-of-living index in consumer theory. This is the reason why in Table 3 we consider the trade-weighted average as an example of indexes based on an equivalence criterion, but not using any counterfactual data in the computation. On the other hand, we can also think of outcome measures requiring counterfactual data for their computation, but without any interpretation in terms of equivalence criteria: this is the case of the generalized or substitution-weighted tariff-moments (Anderson and Neary, 2005).

Coming to the equivalence measures, though there are several different concepts of restrictiveness, they all have in common that each of them defines a reference situation as a yardstick which makes it possible to determine both the relative and absolute degree of restrictiveness. The relative property allows us to compare national policies (or tariff reforms) with each other; the absolute measurement allows the scaling, in the sense that one can say, for example, that protection has doubled from one situation to another.

The major weakness is that they cannot be computed relying on observable data only. Consequently, they inherit the limitations of the assumptions as well as the defects of the model that determine the counterfactual data required by the index definition. In computing indexes such as the MTRI or TRI, several restrictive assumptions are often introduced. This is obviously the case for the small country assumption. But also the factor markets assumptions used by many modellers are often rather simplistic: full employment before and after the policy shock, few if any skill differentials or sector-specific skills, costless adjustment to shocks, and often no minimum wages or any other factor market distortions. The theoretical assumptions underlying the construction of the trade balance functions (single utility-maximising consumer, competitive markets) are often made, but are nonetheless restrictive. Some of these shortcomings could be overcome using more sophisticated economic models.

Efficiency measures, such as the TRI or the TRQI, are defined on the basis of the distance from an arbitrary point in the tariff or quantity space to an arbitrary general equilibrium utility contour. Paralleling Hicks, there are "compensating variation" (the distance from the new policy to the old utility contour) and "equivalent variation" (the distance from the old policy to the new contour) measures of the total trade restrictiveness. The purpose of any compensating variation index number of border policies is to consistently map some alternative setting of tariffs and quotas into a uniform tariff and quota setting which supports the base level of utility.

However, the fact that welfare-equivalent indexes are related to the total welfare cost does not imply that they convey the same information as the cost of protection measures. Welfare costs do not permit comparisons over space and time. Unscaled welfare losses would be biased upward for large countries in cross-country comparisons and for later periods in intertemporal comparisons. As a consequence, several varieties of scale have been attempted, such as fractions of national income or trade expenditure. However, this biases the measure downward in cross-country comparisons for less open economies.

Looking at trade negotiations, incidence measures are clearly preferred since they do not take into account variables which cannot be completely controlled, such as the weights of outcome measures or the results of the model to be used in the calculation of equivalence indexes. This is especially true in the case of the aggregation across products: it is quite difficult, indeed, to envisage the actual use of outcome or equivalent measures in order to express overall targets for tariff reduction commitments.

The situation is quite different in the case of aggregation across policy instruments. In this case, incidence indexes do not provide adequate answers if, for example, it is necessary to compute an AVE: the methodology recently adopted for the calculation of AVEs in the case of agricultural specific tariffs is based on a price-gap approach which is an example of outcome index. There is also a chance that an equivalent approach may be used for the calculation of the tariff-rate quota expansion that would be required in order to compensate for the "deviation" from the formula cut commitments in the case of sensitive products. The EU proposal on this issue, as a matter of fact, is similar to the approach proposed by Sharma (2006) that was presented in section 3.3.

However, even if theoretically sound indexes are not explicitly used to express commitments, they can provide a benchmark for evaluating more readily computable tariff indexes. In this respect, results show that the trade-weighted average tariff factor reduction could be a proxy for assessing market access improvements, especially when the number of commodities considered is small, and when the dispersion of tariffs is low. However, when we aggregate a large number of tariffs, or when the dispersion is large, the approximation is not very satisfactory and often leads to an underestimation of the trade restrictiveness.

Finally, from a methodological point of view, most of the applications are based on CGE models. This is a tool that is becoming more common due to the improvement of computers' processing capacity and the development of software that are much easier to use. However, there is still no comparison between the level of detail of trade policies and the aggregation level at which CGE models work.

The alternative is to follow a partial equilibrium approach. This approach is less demanding in terms of data and parameters, and allows to work with greater detail. This comes at a cost, namely the need to specify a tariff aggregator function, which also requires restrictive assumptions.

6. Conclusion

Attempting a summary measure of the total impact of trade barriers for a the whole economy or even a single sector is a formidable project, and attempting to construct such a measure that would be comparable across countries and time is even more forbidding. Nevertheless, given the importance of the subject, measures of various kinds have been proposed. In the face of seemingly insurmountable difficulties, there has been considerable theoretical progress over the past decade. Much of it was achieved with the various works of Anderson and Neary, who proposed indicators for measuring trade restrictiveness and effective protection and, more importantly, made clear that the economic interpretation of each index is strictly linked to its definition.

In order to classify the large number of indexes covered in our review, we have proposed a typology based on three categories: incidence, outcome and equivalence.

Incidence measures are relatively easy to compute and for this reason they are traditionally used for policy commitments. Anyway they have no theoretical ground so that they raise interpretation problems. Outcome measures do not raise inescapable problems of calculation, but their theoretical consistency is also in doubt.

On the other side, equivalence measures are more complex to compute, since they require counterfactual weights. They are theoretically consistent and do not raise interpretation problems, but there can be problems of implementation. As a consequence, usually, they are not used for policy commitments though they can be very useful for policy analyses.

A clear and comprehensive empirical picture of the protectionist impact of applied duties, either in terms of preferential tariffs, or in terms of antidumping and countervailing duties, is the ultimate goal of the literature in this area, but much more work is required before this assessment can be made with confidence. In particular, there is still a lot of work to be done in terms of providing quantitative assessment of the non-tariff barriers.

More generally, it is quite obvious that no index can be better than the model used to compute it. Empirical knowledge is lagging behind, and the overall picture which emerges of the quality and reliability of the models remains somewhat bleak. Practical implementation of the theoretical indexes as proposed by the authors requires using general equilibrium models that do not allow for the degree of detail necessary to take into account the considerable tariff dispersion existing in reality. Partial equilibrium approximations of the equivalence measures included in this review have been carried out assuming simple functional forms and *ad hoc* elasticities of substitutions. Clearly, with these drawbacks there is no chance of providing satisfactory results in all possible cases.

Last, but certainly not least, data remains a significant problem, notwithstanding the progress that has been made. There is a need for a "public good" dataset that would comprise tariffs, including those under preferential agreements, NTBs, and trade flows. Because it is useful to compute bilateral tariffs, in order to take into account the complex preferential agreements, the approach followed in the MacMaps dataset is promising. Nevertheless, only very ample use of a dataset will make it possible to identify all the errors and caveats. From this point of view, the policy of international organizations that either restrict access to data or price imperfect data at a rather high rate prevents widespread dissemination, and thus the necessary improvement of the data (Bureau and Salvatici, 2004b).

The different protection measures that have been reviewed do not seem to yield a coherent way to measure the degree of protection for any particular country or sector. Looking at the actual figures there are large differences in protection measures for each country or sector. This leads one to ask whether there are any coherent patterns to these various figures. Unfortunately, the answer appears to be negative: there is no satisfactory way of choosing between these alternative measures since there is no single measure which dominates all other measures.

Different measures can behave in different ways and numerical measures of the degree of protection can therefore be hard to interpret. The interpretation of such measures as well as whether different measures are appropriate for different circumstances thus become the issues. There is the tendency of the casual reader, as a matter of fact, to read more significance than warranted into the reported levels of the indicators. In many cases, protection indicators should be thought of as building blocks for models and evaluations, not as an end in themselves. Then, we cannot conclude the survey of the literature with a glowing recommendation for a single measure of protection. Trade restrictiveness is not a simple undifferentiated concept and different dimensions of trade policy need different indexes to be pinpointed.

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FIGURE 1: ***Structure of the review***

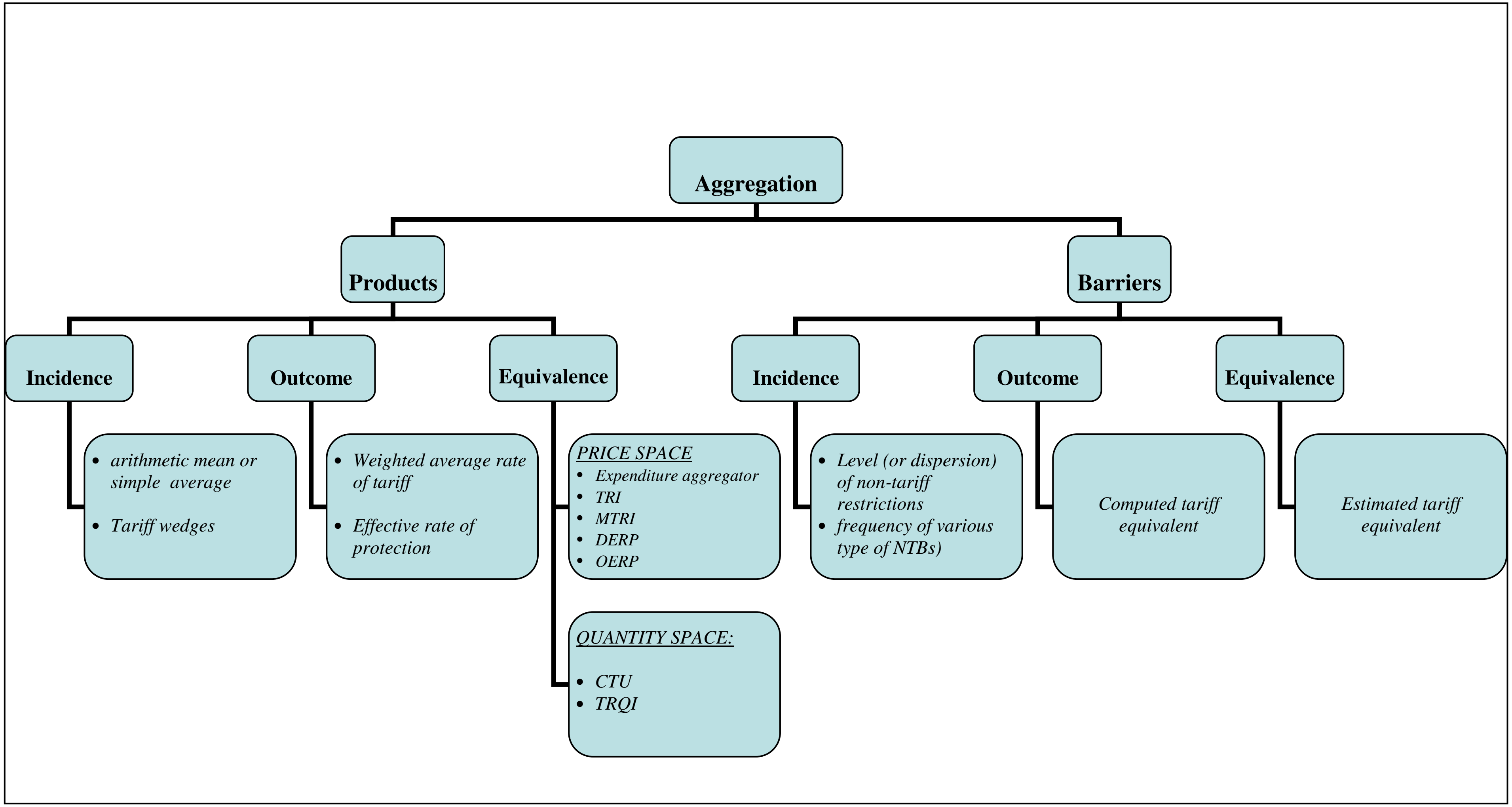
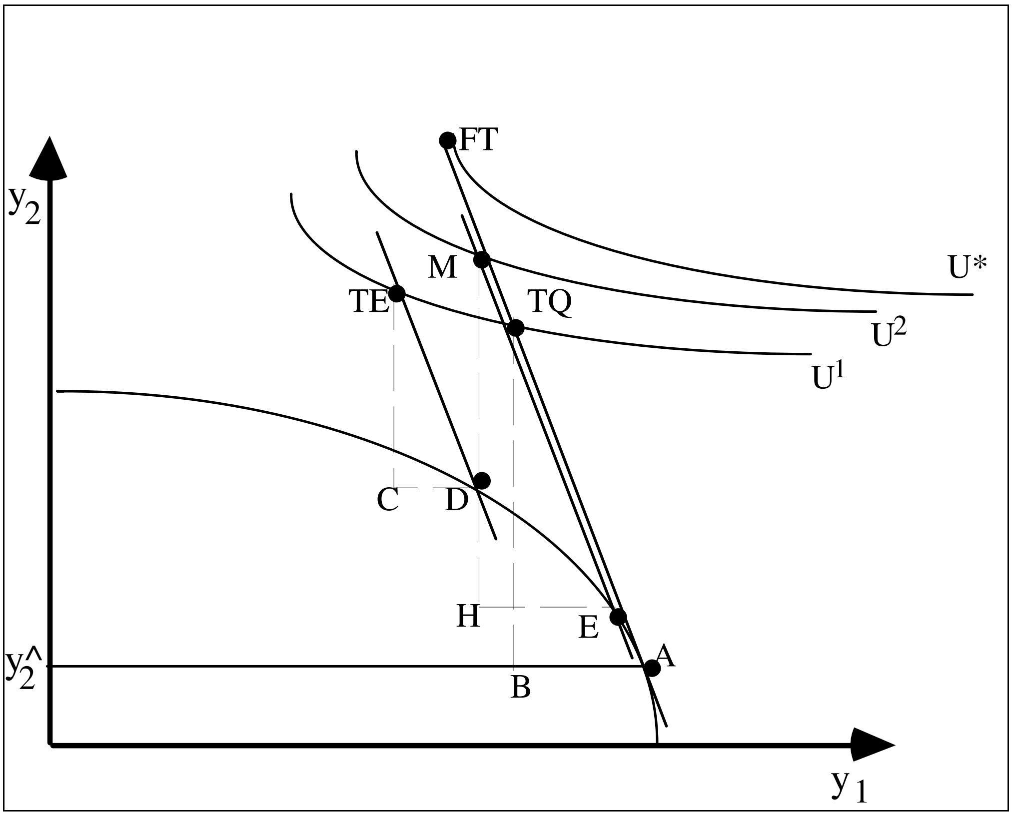


FIGURE 2: Comparison between different tariff-equivalents



Source: Salvatici et al. 1999

TABLE 1: Classification grid

Source	Year	Trade Policy Index	Metrics	Country Coverage (EU)	Sectors (agriculture)	Period	Policy Coverage	Data source	Methodology	Type (incidence, outcome and equivalence)
Anderson	1991	Coefficient of trade utilization	Quantity space	USA	Dairy	1965-1979 (single years)	Quotas	USDA census data	Partial equilibrium	Equivalence
Anderson	1995	Trade Restrictiveness Index	Price space	-	-	-	-	-	General equilibrium	Equivalence
Anderson	1998a	Trade Restrictiveness Index (Trade- Weighted average tariff)	Price space	27	-	1984-1991 (single years)	Tariff barriers	UNCTAD TRAINS database	General equilibrium	Equivalence
Anderson	1998b	Distributional effective rate of protection	Price space	US	10 (3)	1982	Tariff barriers	USDA/ERS AGE model	General equilibrium	Equivalence
Anderson, Neary	1990	Coefficient of Trade Utilization	Quantity space	-	-	-	-	-	General equilibrium	Equivalence
Anderson - Neary	1994 1996	Trade Restrictiveness Index (Trade-Weighted Average Tariff; Coefficient of variation)	Price space	US, Mexico Colombia	-2(1)	1989-90	Tariffs Quotas	-	Partial equilibrium General equilibrium	Equivalence
Anderson - Neary	2003	Mercantilistic Trade Restrictiveness Index (Trade-Weighted Average Tariff)	Price space	27	-	Various (single) years 1984-1991	Tariff barriers	UNCTAD TRAINS database	General equilibrium	Equivalence
Anderson - Neary	2005	Weighted tariff moments	Price space	-	-	-	-	-	General equilibrium	Outcome
Ando and Fujii	2001	NTM price gap	Tariff equivalent	13 APEC countries	Agricultural and food processing sectors	Various years	NTBs	UNCTAD TRAINS database	Partial equilibrium	Equivalence
Ando and Fujii	2001	NTB frequrncy	Frequency Index	13 APEC countries	Agricultural and food processing sectors	Various years	NTBs	UNCTAD TRAINS database	-	Incidence
Bacchetta and Bora	2001	Export-weighted average tariff	Price space	140 Members of the WTO	Agricultural and fishery products; mineral and fuels; Manufactures	Various years	Applied, bound and MFN Tariffs	WTO Integrated Database and the UNCTAD TRAINS database.	-	Outcome
Bacchetta and Bora	2001	Frequency index	Frequency Index	140 Members of the WTO	Agricultural and fishery products; mineral and fuels; Manufactures	Various years	Quantity control measures, Finance measures and Price control measures.	WTO Integrated Database and the UNCTAD TRAINS database.	-	Outcome
Bach-Martin	2001	Expenditure aggregator	Price space	-	-	-	-	-	General equilibrium	Equivalence
Bach-Martin	2001	Tariff revenue aggregator	Price space	-	-	-	-	-	General equilibrium	Equivalence
Balassa	1965	Effettive rate of protection	Price space	-	-	-	-	-	-	Outcome

Barro-Lee	1994	Import-weighted ratio of tariff revenues	Price space	138 countries (24 European countries)	Industry	Five-year periods from 1960 to 1985	Duties and customs fees collected at national borders.	LEE'93 (Constructed from UNCTAD data)	-	Outcome
Barro-Lee	1994	Import weighted non-tariff frequency on capital goods and intermediates.	Price space	138 countries (24 European countries)	Industry	Five-year periods from 1960 to 1985	Core NTMs	LEE'93 (Constructed from UNCTAD data)	-	Outcome
Barro-Lee	1994	Barro-Lee's measure of trade restriction (FREETAR)	Price space	138 countries (24 European countries)	Industry	Five-year periods from 1960 to 1985	Duties and customs fees collected at national borders.	LEE'93 (Constructed from UNCTAD data	Econometric estimate	Outcome
Bouet at al.	2004	Trade weighted average	Price space	18 countries (EU15)	Agriculture Manufacture Textile	2001	Mixed tariffs, Tariff rate quotas	AMAD; Hemispheric Database; IDB; ITAS; MAcMap; OECD; Trains	-	Outcome
Bradford	2003	Ad valorem equivalent	price gap measure	Australia, Belgium, Canada, Germany, Japan, the United Kingdom and the United States.	Agricolture, Textiles-apparel, Industry	mid-1980's data	non-tariff barriers to goods trade	OECD data	-	Outcome
Bureau et al.	2004	Average tariff	Tariff	EU, US, Japan, South Africa	Agricultural and food sectors	2000-2002 for the EU, 1999-2001 for the other countries	Tariffs that have been agreed upon under the WTO negotiations.	WTO's IDB; AMAD, APEC and US International Trade Commission Datasets	-	Incidence
Bureau et al.	2004	(Adjusted) Trade weighted average tariff	Ad valorem equivalent	EU, US, Japan, South Africa	Agricultural and food sectors	2000-2002 for the EU, 1999-2001 for the other countries	Tariffs that have been agreed upon under the WTO negotiations.	WTO's IDB; AMAD, APEC and US International Trade Commission Datasets	-	Outcome
Bureau et al.	2004	Effective rate of protection	Price space	EU, US, Japan, South Africa	Agricultural and food sectors	Annual data from 1996 to 2002	MFN tariff, ACP tariff, GSP tariff EBA tariff, South Africa agreement tariff	WTO's IDB; AMAD, APEC and US International Trade Commission Datasets	-	Outcome
Bureau J.-C., Fulponi L., Salvatici L.	2000	TRI (rate of change)	Price space	USA-EU	Agriculture	2001	Bound tariffs	WTO schedules	Partial equilibrium (econometric estimation)	Equivalence
Bureau J.-C., Fulponi L., Salvatici L.	2000	MTRI (rate of change)	Price space	USA-EU	Agriculture	2001	Bound tariffs	WTO schedules	Partial equilibrium (econometric estimation)	Equivalence

Bureau J.-C., Salvatici	2004a	TRI	Price space	USA-EU	20 (19)	counterfactual	Bound tariffs	WTO schedules	Partial equilibrium (computed)	Equivalence
Bureau J.-C., Salvatici	2004b	TRI	Price space	USA-EU-Canada-Japan	20 (19)	counterfactual	Bound tariffs	WTO schedules	Partial equilibrium (computed)	Equivalence
Bureau J.-C., Salvatici	2004b	MTRI	Price space	USA-EU-Canada-Japan	20 (19)	counterfactual	Bound tariffs	WTO schedules	Partial equilibrium (computed)	Equivalence
Bureau J.-C., Salvatici	2006	MTRI	Price space	USA-EU	20 (19)	counterfactual	Bound tariffs	WTO schedules	Partial equilibrium (computed)	Equivalence
Bureau-Kalaitzandonakes	1995	Superlative Effective rate of protection	Price space	EU	Agriculture	From 1973 to 1989	-	-	Econometric estimate	Outcome
Chau N. H., R. Färe, S. Grosskopf.	2003	TRQI	Quantity space	-	-	-	-	-	General equilibrium	Equivalence
Chemingui and Dessus	2004	Tariff Equivalent	Price gap	Syria	All categories of merchandise	1999	NTBs	Food and Agriculture Organization (FAO) database	-	Outcome
Cline	2005	Total Tariff Equivalent	Tariff	Canada, European Union, Japan, United States.	textiles and apparel agricultural	2004	Tariffs; Core NTBs (Anti dumping; MFA Quotas; Agricultural TRQs; Prohibitions)	National authorities data and WTO notifications	-	Incidence
Cline	2002	Aggregate measure of protection across products and instruments	Tariff equivalent	Australia, Canada, the European Union, Japan, New Zealand, Norway, Switzerland, and the United States.	Textiles and apparel; other manufactures; agricultural goods	2000	tariffs, quota-rate tariffs, and subsidies tariff-equivalent	GTAP database; AMAD	Partial equilibrium	Equivalence
Corden	1966	Effettive rate of protection	Price space	-	-	-	-	-	-	Outcome
Dean et al.	2003	Tariff-equivalent (TE) of the domestic country's import quota	Tariff equivalent	18 regions/ countries (EU15; EFTA)	Apparel, hoes, and processed foods	2001	Import quota	EIU CityData; UNCTAD TRAINS ; USITC NTM Database.	Econometric estimate	Equivalence
Edwards	1998	Average import tariff on manufacturing	Price space	93 countries (18 European countries)	Manufacture	1982	Tariff barriers	UNCTAD (1982)	-	Incidence
Edwards	1998	Average coverage of Non Tariff Barriers	Price space	93 countries (18 European countries)	Manufacture	1982	Tariff barriers	UNCTAD (1982)	-	Incidence
Edwards	1998	Collected tariff ratios	Price space	93 countries	Manufacture	Five-year	Tariff	UNCTAD (1982)	-	Outcome

				(18 European countries)		periods from 1980 to 1985	barriers			
Estevadeordal	2000	R-index of trade restrictiveness	7-point scale	-	-	-	Tariff barriers	-	-	Incidence
Gehlhar-Wainio	2002	(Adjusted) Trade weighted average tariff	Tariff	country/region (29 individual countries and 11 geographical region, including EU-members).	Food sectors	2000	Tariff barriers	GTAP database	-	Outcome
Gibson et al.	2001	Average tariff	Tariff	America,Caribbean Islands, EU-15, Non-EU Europe, Africa, Asia.	Agriculture	1995-99	Agricultural tariffs and tariff-rate quotas	Agricultural Market Access Database (AMAD), UNCTAD TRAINS database	-	Outcome
Hoekman et al.	2001	Average tariff	Unweighted average in %	48 LDCs, USA , EU15, Japan, Canada	Industrial and agricultural sectors	1990s	Full duty and quota free access	WTO, UNCTAD TRAINS database	-	Incidence
IMF	2005	IMF-Trade Restrictiveness Ratio	5-point scale	-	-	-	Tariffs	UNCTAD TRAINS database	-	Incidence
IMF	2005	IMF-NTB Restrictiveness Index	3-point scale	-	-	-	NTBs	UNCTAD TRAINS database	-	Outcome
IMF	2005	IMF- Overall TRI	10-point scale	-	-	-	Tariffs NTBs	UNCTAD TRAINS database	-	Incidence
Kee, Nicita, and Olarreaga	2004	AVEs of NTBs	Price space	104 developed and developing countries, including european countries	Agriculture Manufacture	Various years	Core NTBs	UNCTAD TRAINS dataset	Partial equilibrium (econometric estimation)	Equivalence
Kee, Nicita, and Olarreaga	2004, 2005	Trade Restrictiveness Index (TRI)	Price space	117 (EU)	-	Most recent year between 2000 and 2004	Tariffs and NTBs	WITS + Kee, Nicita and Olarreaga (2004)	Partial equilibrium (econometric estimation)	Equivalence
Kee, Nicita, and Olarreaga	2005	Overall Trade Restrictiveness Index (OTRI): applied faced (MA-OTRI)	Price space	117 (EU)	-	Most recent year between 2000 and 2004	Tariffs and NTBs	WITS + Kee, Nicita and Olarreaga (2004	Partial equilibrium (econometric estimation)	Equivalence
Lindland	1997a	Effective rate of protection	Price space	EU, Japan, USA	Agriculture	1992-1994	Bound tariffs	FAOSTAT	-	Outcome
Lindland	1997b	Tariff wedges	Ad valorem tariff equivalents	EU, Japan, USA	Agriculture	1992-1994	Bound tariffs	FAOSTAT	-	Incidence
Lloyd, MacLaren	2002	Uniform Tariff Equivalent in terms of welfare	Price space	Australia and New Zealand, Canada, Mexico, United States, Japan, the European Union, Korea, Singapore, Taiwan, Hong	Agriculture, natural resources, food, textiles, clothing, light manufactures, heavy	1995	Tariffs	GTAP database version 4	General equilibrium	Equivalence

				Kong, Indonesia, Malaysia, Philippines, Thailand, China, Vietnam, and others.	manufactures, transport, machinery and equipment, utilities, and services.					
Manole-Martin	2005	Expenditure aggregator	Price space	8 countries	-	2004	Tariff	WITS	General equilibrium	Equivalence
Manole-Martin	2005	Tariff revenue aggregator	Price space	8 countries	-	2004	Tariff	WITS	General equilibrium	Equivalence
Nash	1993	Tariff-equivalent of import restrictions	Price space	31 African countries	Foods, textiles, manufactures	1980-1992	Import licensing arrangement, tariffs	BESD and IMF data. Pritchett, L. 1987. World Bank Trade Policy Division	Econometric estimate	Equivalence
O'Rourke	1997	Trade Restrictiveness Index	Price Space	France, UK	-	1841-1854-1881	Tariffs Quotas	Nye (1991)	General equilibrium	Equivalence
Pritchett	1996	Weighted average rate of tariff charges	Tariff	89 LDCs	Food; Manufacturing; Agriculture and Resources.	1985	Tariff barriers	UNCTAD (1988)	-	Outcome
Pritchett	1996	Weighted percent of tariff-code lines covered by various types of non-tariff barriers	Price space	89 LDCs	Food; Manufacturing; Agriculture and Resources.	1985	Licenses, quotas, prohibitions	UNCTAD (1988)	-	Outcome
Sandrey	2000	Relative Tariff Ratio Index	Price space	Australia, Canada, Chile, China, EU, Indonesia, Japan, Korea, Mexico, Malaysia, New Zealand, Taiwan, US.	Agricultural and textile sectors	1998	Tariff barriers	World Trade Atlas4. European Union.	-	Outcome
Sharma	2006	Tariff-quota equivalent	Quantity space	WTO members	Agriculture and Food	2005	Tariffs; quotas	WITS database	Partial equilibrium	Equivalence
Yue et al.	2005	Tariff Equivalent of TBT	Price space	US, Japan	Apple	2000-2004	TBT	Monthly Statistics of Agriculture Forestry & Fisheries and Monthly Statistics of Japan.	Econometric estimate	Equivalence

TABLE 2: ***Trade Control Measures considered in the review***

TARIFF MEASURES	**QUANTITY CONTROL MEASURES**
MFN DUTIES	NON-AUTOMATIC LICENSING
TARIFF QUOTA DUTIES	QUOTAS
SEASONAL DUTIES	PROHIBITIONS
PREFERENTIAL DUTIES UNDER TRADE AGREEMENTS	EXPORT RESTRAINT ARRANGEMENTS
	TECHNICAL MEASURES
PRICE CONTROL MEASURES	TECHNICAL REGULATIONS
ADMINISTRATIVE PRICING	PRE-SHIPMENT INSPECTION
VOLUNTARY EXPORT PRICE RESTRAINT	SPECIAL CUSTOMS FORMALITIES
VARIABLE CHARGES	RETURN OBLIGATION
ANTIDUMPING MEASURES	
COUNTERVAILING MEASURES	

Source: Ferrantino, OECD (2006)

TABLE 3: ***Synoptic table***

EQUIVALENCE CRITERION / COUNTERFACTUAL APPROACH	**YES**	**NO**
YES	Equivalence: e.g., trade restrictiveness index	Outcome (estimated weights): e.g., generalized moments
NO	Outcome (approximations): e.g., trade-weighted average tariff	Incidence / Outcome: e.g., simple average tariff

TABLE 4: ***Measures of trade protection***

AGGREGATION ACROSS POLICY INSTRUMENTS
- Incidence Measures Frequency Type: *coverage ratios* (% of goods or import transactions affected by selected group of quantitative restrictions) **- Outcome Measures** Frequency Type: *Weighted average of quantitative restrictions* *Import coverage ratios* IMF-NTB Restrictiveness Index

Ad Valorem Equivalents: *Overall level of protection* *AVE of NTBs provided by price wedge* **- Equivalence Measures** Price-based measures: *Measures of price impacts of NTBs* Quantity-based measures: *Changes in tariff equivalents of quantitative restrictions on imports* Quota-equivalent for deviations in tariff cuts
AGGREGATION ACROSS PRODUCTS
- Incidence Measures Tariff moments: *Unweighted average tariff* *Unweighted Standard Deviation of tariffs* *Coefficient of variation of tariffs* *TRI-IMF* *R-index of restrictiveness* Tariff escalation: *Tariff wedge* **- Outcome Measures** Observed weights Weighted moments: *Weighted average rate of tariffs charges* (import shares; production shares; etc) Effective rate of protection: *Effective rate of protection* Counterfactual weights Regression Analyses: *Barro-Lee's tariff restriction measure* Generalized moments: *Generalized or substitution-weighted tariff moments* **- Equivalence Measures** Price Space Expenditure:

Expenditure aggregator-"true average tariff" (τ^{δ})

Cline's "adjusted import weighting"

Tariff revenue:

Tariff aggregator- CES tariff aggregator (τ^{R})

Welfare:

Trade Restrictiveness Index-TRI (as the inverse of the uniform tariff factor)

Welfare-equivalent uniform tariff

Welfare-equivalent index with endogenous world prices.

Import volumes:

Mercantilistic Trade Restrictiveness Index-MTRI

MTRI- Overall Trade Restrictiveness Index

Compensated MTRI uniform tariff

Effective protection:

Distributional Effective Rate of Protection-DERP

Output effective protection:

Output Effective Rate of Protection-OERP

Quantity Space

Quantity-based equivalent measures:

Coefficient of trade utilization-CTU

Trade Restrictiveness Quantity Index-TRQI

Scalar Measures

TABLE 5: ***European protection in Agricultural sector***

Aggregate level of protection:		Applied and multilateral protection		Applied and multilateral protection	
applied by EU on imports	faced by EU on exports	by applied tariff (Ad Valorem)	by applied tariff (Ad V. Eq. of Specific Comp.)	by MNF tariff (Ad Valorem)	by MNF tariff (Ad V. Eq. of Specific Comp.)
17,90%	18,60%	4,90%	12,90%	6,50%	17,00%

Source: Bouet et al. 2004

TABLE 6: Comparison of different border policies

	Policy change	TRI change	Trade volume change	Welfare change
Import tax (Δ<1)	-	+	+	+
Export subsidy (Δ<1)	-	+	-	+
Import subsidy (Δ>1)	-	-	-	+
Export tax (Δ>1)	-	-	+	+

Source: Salvatici et al. 1999