CHAPTER 3: Macro-analysis of the trade effects of non-tariff measures

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A. Overview and learning objectives

This chapter first provides a conceptual discussion on the effects of non-tariff measures (NTMs) on macroeconomic dimensions such as quantities exchanged domestically and internationally or prices either domestic or prevailing on international markets. For that purpose, a basic supply and demand theoretical framework and its graphically representation are used. It then surveys the main existing empirical analyses. It is crucial to keep in mind that trade analysis does not disentangle the impact of NTMs on each agent (consumers, producers, etc.). To obtain this specific impact, a welfare analysis should be conducted as discussed in chapter 5. To date, perhaps as a result of the rise in trade complaints related to NTMs, many empirical assessments have been mercantilist in nature, assuming that NTMs had necessarily a dampening impact on trade flows. Indeed, they focus on measuring the extent of forgone trade rather than attempting to identify the effects of NTMs on other macroeconomic dimensions (e.g. prices). This chapter reviews the different approaches used to assess these price effects either directly or indirectly discussing in detail any possible weakness and limitation of each of them. Ad valorem equivalents of NTMs (i.e. their price effect equivalent) must be used with extreme caution especially in the context of simulations with Applied General Equilibrium models.[29] The chapter offers the possibility to verify practically all these elements with a set of computational exercises described in detail.

In this chapter you will learn how to assess the trade impact of NTMs using the gravity model of international trade. You will also learn how to calculate the ad valorem tariff equivalent of an NTM using different methods such as the direct or price-gap method based on observed prices and the indirect method based on trade effects.

B. Analytical tools

1. Issues and empirical methods

All NTMs – even the non-protectionist ones – may have an impact on trade. However, this trade impact is ambiguous. NTMs may facilitate trade, i.e. foster domestic demand for foreign products by increasing the products' quality or by signalling the products that are safe to consumers. However, NTMs may also increase production costs and therefore be trade-impeding. Some (non-complying) varieties may be excluded from the market. Some firms, especially small producers from developing countries, may also be excluded from the market if they are not able to cover the NTM compliance costs. Negative trade effects are exacerbated if NTMs differ among countries and/or if they are implemented in a way that favours domestic industry. The effect of an NTM also depends on the stringency of NTMs in other markets. Since different NTMs may be enforced in different markets, exporters may prefer to minimize production costs by supplying only markets with less restrictive

[29] These models are set to run ex-ante policy evaluations based on a set of theoretical assumptions linking to each other the various production sectors and economic actors under some conditions of general equilibrium to ensure accounting consistency within the economic system under consideration (e.g. a country, a continent, the world). See UNCTAD-WTO (2012) for a general introduction to the use of these models for the simulation of trade reforms.

NTMs. In such cases, the multiplication of standards across countries reduces trade flows. To limit these effects, SPS and TBT Agreements call for the harmonization of regulations on an international basis. However, since harmonization reduces the number of varieties of goods available on the market, it does not necessarily promote trade (Korinek *et al.*, 2008).

Conceptually, the trade effects of NTMs can be investigated through shifts in supply and demand curves.[30] As mentioned, NTMs affect traded quantities and prices, and their implementation leads to a supply shift induced by changes in the production costs and a demand shift due to changes in consumption behaviour. Figure 12 provides graphical analysis of these shifts. A market for a specific good is considered and several assumptions are made. The market good is homogeneous (i.e. all varieties of the good represented are perfectly substitutable with one another) except for a characteristic potentially dangerous to consumers. Only a foreign good carries this characteristics and domestic consumers may or may not be aware of it. Demand is derived from quadratic preferences[31] and domestic and foreign supplies from a quadratic production cost function. S represents the total (domestic and foreign) supply, and S_F the foreign one. The left panel of Figure 12 illustrates the internalization of the harm to consumers. In that case, the demand curve shifts to the left (from D to D') independently of whether or not an NTM is implemented. Following this internalization, demand and price decrease (respectively from q_A *to* q_A' – due to a decrease in imports – and from p_A *to* p_A') and the new equilibrium is A_1'. In the right panel of Figure 12, an NTM is adopted by public authorities in order to exclude an unsafe foreign good from the domestic market. The implementation of the NTM by foreign producers increases their production costs and reduces their supply. Foreign supply curves shift from S_F' to S_F''. Following implementation of the NTM, the domestic price increases (from p_A' to p_A''), imports decrease, and therefore domestic consumption also decreases (from q_A' to q_A''). Compared to the initial equilibrium (A_1), the overall effects of internalization of the harm and implementation of the NTM is a reduction in the quantity consumed (q_A'' is clearly smaller than q_A) and an indefinite impact on the equilibrium price (p_A'' is above p_A' but p_A' is below p_A).

Empirically, the trade effects of NTMs can be quantified in two ways:[32] (1) by estimating their observed impact on trade (ex-post analysis) or (2) by predicting their potential yet unobserved impact on trade (ex-ante analysis). In the current literature, the trade effects of NTMs are mainly quantified through ex-post estimations. Almost all analyses use gravity-based models (see Box 1). Although ex-post studies provide useful results, they suffer from some weaknesses. First, they usually focus on a point in time and do not capture the dynamic responses of producers and exporters to changes in NTMs (Korinek *et al.*, 2008). Over time producers may be better able to adapt to the introduction of a new NTM, and the investments undertaken to meet the new NTM may have positive effects on producers (e.g. by improving efficiency or product quality). The prevalence of analyses in a static framework (i.e. relying on cross sectional data only) largely result from the absence of time series data on NTMs. Second, as highlighted by Beghin (2009), many estimations do not compute the full marginal effect of NTMs and only report the impact on existing

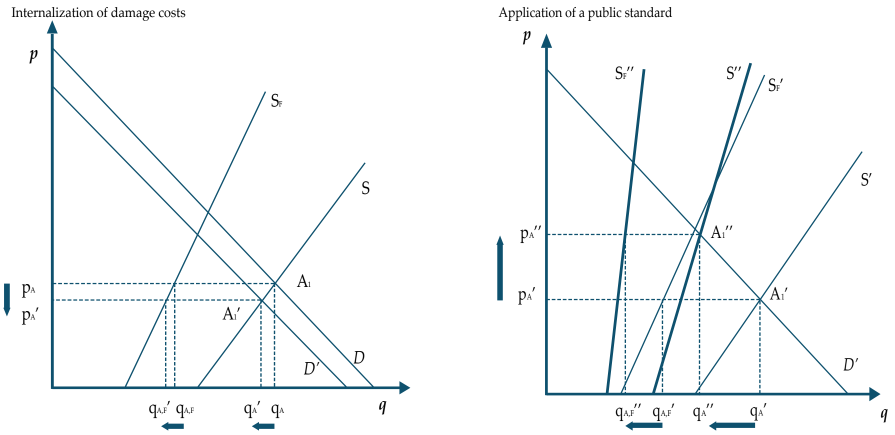
[30] See de Melo and Shepherd (2018) for a comprehensive review of such effects in standard demand and supply analytical framework.

[31] This special form of preferences function implies that satisfaction from consumption increases at a decreasing rate. Moreover, quadratic preferences give rise to linear relationships between prices and demanded quantity.

[32] Case studies may also be undertaken, but results are not easily generalized.

trade relationships. However, trade may also be affected if following implementation of the NTM a new bilateral relationship is established between countries that did not trade with each other in the past. Lastly, ex-post estimations do not disentangle the supply and demand shifts associated with the implementation of NTMs.

Figure 12: Supply and demand shifts due to NTM implementation: graphical analysis



Source: Fugazza (2013).

The alternative approach to measuring the trade effects of NTMs is ex-ante analyses. This approach aims to predict the likely trade impact of an NTM before its implementation. Ex-ante analyses involve the simulation of consumers' and producers' behavioural responses following a price change induced by the introduction of the NTM. The mechanism is as follows: the implementation of the NTM raises the domestic price (higher transaction costs) relative to the world price. To estimate the additional price gap (or price wedge), economists compute an ad valorem equivalent of the NTM (see section C.2). This calculation should of course control for other reasons that may influence the price gap, such as distribution costs or quality differences. Demand and supply shifts are then simulated. The sum of all economic agents' responses to the price change provides the expected trade impact of the NTM.

Box 1: Using the gravity model of international trade flows to estimate the impact of non-tariff measures

Based on an analogy with Newton's law, the gravity equation applied to trade is one of the most robust empirical relationships in economics. In its simplest form, the gravity equation relates bilateral trade flows to the economic size of countries and the geographical distance between them. This distance, used as an approximation of the transaction costs that affect the trade relationship, is usually measured between the main economic centres or the capitals of the countries considered.

Researchers usually augment the gravity variables by extra variables to capture certain specificities of the bilateral relationship, such as the sharing of a land border or a common language, to name the most common. It is among these complementary variables that the indicators capturing the effects of NTMs on trade are introduced. Tariff barriers should also be included in the gravity estimation. Otherwise, one cannot distinguish the impact of NTMs on trade from that of tariffs. Several empirical works suffer from such bias.

How can one measure and include NTMs in the gravity equation? Different measures that can be employed include the level of the NTM itself, the frequency index or the coverage ratio (see chapter 2), and the ad valorem equivalent.

The gravity equation can be implemented at the industry or product level. Its general specification is as follows:

$$ln(x_{sij,t}) = \varphi_{sij,t}\, ln(1 + tar_{sij,t}) + \gamma' NTM_{sij,t} + \beta' z_{ij} + \mathrm{fe}_{si} + \mathrm{fe}_{sj} + \mathrm{fe}_{t} + \varepsilon_{sij,t}$$

where *s* is the sector, *i* is the exporting country, *j* is the importing country, *t* is the year, *x* represents the bilateral export (or import) flow, *tar* measures the bilateral applied protection, *z* stands for the bilateral gravity variables (distance, etc.), and *fe* are different sets of fixed effects. These fixed effects incorporate size effects, but also the price and number of varieties within a sector of the exporting country and the size of sector demand and the price index of the importing country.

As highlighted in the New Trade Theory, exports are affected by some sunk costs, which influence firms' export probability. A Heckman model (Helpman *et al.*, 2008) or the Poisson pseudo maximum likelihood estimator (Santos Silva and Tenreyro, 2006) can be used to control for this potential selection bias.

Two drawbacks may affect the gravity estimation. First, some endogeneity may arise between NTMs and trade flows or between applied tariffs and trade. Second, predicted trade flows are sensitive to model assumptions.

A discussion and illustration of the issue is available in the UNCTAD-WTO (2012) Practical Guide to Trade Policy Analysis. Yotov and al. (2016) in their Advanced Guide to Trade Policy Analysis further illustrate the issue and provide an empirical solution based on the most recent advances in the literature.

2. Empirical assessment of trade effects

Several studies have investigated the trade effects of NTMs. This section presents and discusses some major empirical results.

2.1 Trade effects across sectors

Moenius (2004) investigates the trade effects of import-specific NTMs across sectors. Using a gravity equation for 12 developed countries and 471 Standard International Trade Classification (SITC) four-digit sectors, the author finds a negative impact of NTMs on imports in non-manufacturing sectors (food, beverages, crude materials, and mineral fuels) but a positive effect on imports in manufacturing sectors (chemicals, manufacturing, and machinery). How can these sector differences be interpreted? By providing exporters with information about market preferences, NTMs reduce transaction costs even if they impose adaptation costs, and consequently may increase trade. In more differentiated sectors, such as certain manufacturing sectors, information costs may be higher, and NTMs, by reducing them, may enhance trade flows.

2.2 Trade effects across exporting countries

Disdier *et al.* (2008) study the trade effects of sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBTs) notified to the WTO. Their sample focuses on agri-food products and includes Organisation for Economic Co-operation and Development (OECD) importers, 183 OECD and developing exporters, and 690 HS six-digit products for 2004. Estimating a gravity equation and controlling for applied protection, the authors show that SPS measures and TBTs have a negative impact on trade flows. This result is observed whatever the measure used for these NTMs (a simple dummy, a frequency index, or an ad valorem equivalent). Interestingly, when the authors distinguish the impact across exporting countries, they highlight that SPS measures and TBTs have no significant impact on OECD exports but a negative and significant one on developing country exports. Adaptation costs are often too high for producers from these countries and impede their exports to OECD markets. When the estimation is restricted to European importers, the negative impact is even stronger.

2.3 Trade effects of non-tariff measures harmonization and mutual recognition

In the case of harmonization, both trading partners adopt a common NTM, while mutual recognition is limited to the reciprocal acceptance of the NTMs applied in both countries. By allowing some scale economies and more efficient resource allocation, both harmonization and mutual recognition are assumed to be trade-enhancing (Chen and Mattoo, 2008). However, harmonization is expected to boost trade more than mutual recognition. Indeed, a common NTM increases the homogeneity and substitutability between products, lowers information costs, and increases trust in the quality of imported products. Nevertheless, harmonization, by generating compliance costs that vary across countries, may impede exports of some countries. At the very least, the gains from harmonization are not equally distributed among trading countries. Such negative effects are avoided with mutual recognition, which does not induce adaptation costs and which provides equal distribution of gains from removing or reducing NTMs among countries.

According to the existing empirical literature, international coordination – through NTM harmonization or mutual recognition – has a positive effect on trade flows (Henry de Frahan and Vancauteren, 2006; and Moenius, 2004). In addition, the use of international standards (instead of domestic ones) seems to have a smaller negative trade effect, and in some cases, may increase trade. However, this last result is not confirmed by all studies. Otsuki *et al.* (2001) investigate the potential gap in the terms-of-trade impact of domestic versus international NTMs. In 1998, the European Union proposed a new and stringer harmonized aflatoxin standard on African exports. Aflatoxins are toxic compounds that contaminate certain foods. They can produce liver cancer in the human body. Otsuki *et al.* (2001) compare the trade effects of this regional standard with the effects induced by the international standard defined by the Codex Alimentarius. Their sample covers 15 importing countries from the European Union and nine African exporting countries (Chad, Egypt, The Gambia, Mali, Nigeria, Senegal, South Africa, Sudan, and Zimbabwe) between 1989 and 1998. Their simulations suggest that moving from the Codex Alimentarius standard to a more stringent uniform European standard would have decreased African exports of cereals, dried fruits, and nuts to Europe by 64 per cent (US$670 million), while the gains in terms of reducing health risks would have been very limited (approximately 1.4 deaths per billion population a year). However, the authors do not control for applied tariffs and this omission may bias their estimates.

2.4 Trade effects of non-tariff measures and regionalism

A growing number of regional trade agreements (RTAs) include provisions on NTMs.[33] These provisions usually deal with the harmonization or mutual recognition of NTMs between RTA member countries. However, they also affect non-member countries. Harmonized NTMs allow entry into the entire RTA market, not only to RTA members but also to countries outside the RTA with which the NTMs have not been harmonized. By contrast, mutual recognition may not provide access to third countries. In particular, RTAs involving mutual recognition and strict rules of origin are likely to have trade-diverting effects for third countries.

Chen and Mattoo (2008) investigate this issue by estimating a gravity equation for 42 countries at the three-digit level of manufacturing industries from 1986 to 2001. Their results suggest that NTM harmonization raises the probability and the volume of trade between RTA member countries, but decreases the probability and volume of imports from non-member countries. The impact of mutual recognition agreements depends on whether they include rules of origin. Mutual recognition agreements without rules of origin enhance the probability and volume of trade between member countries and the probability and volume of imports from non-member countries. By contrast, mutual recognition agreements with rules of origin increase the probability and volume of trade between member countries but at the expense of imports from third countries. The authors also show that third countries with higher GDP per capita are less affected by mutual recognition agreements including rules of origin, while mutual recognition agreements without rules of origin

[33] Around 60 per cent of RTAs include such provisions. Detailed information about such provisions is provided in the WTO RTA-database consultable on http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx.

boost more exports of third countries with lower GDP per capita because they impose less stringent requirements. These results are robust to alternative specifications controlling for the potential endogeneity of NTM harmonization or mutual recognition.

Disdier *et al.* (2015) focus on the trade effects of TBT provisions included in North-South RTAs. The adoption by developing countries of stringent international or domestic TBTs imposed by Northern markets can raise the quality of their products but at a cost. The effect of TBT harmonization on Southern exports to their Northern RTA partners is therefore ambiguous. If developing producers are able to adapt their production, this harmonization fosters their exports to Northern RTA partners. Otherwise, exports may be reduced. Furthermore, TBT harmonization within North-South RTAs may also affect trade flows between Southern countries. Better product quality can raise the demand and exports of Southern RTA members to other Southern markets. However, this better quality also increases the price of such products, and exporters may therefore be excluded from other Southern markets.

Disdier *et al.* (2015) estimate a gravity equation using a sample of 43 North-South RTAs over the 1989–2006 period. Their results show that TBT harmonization increases Southern exports to Northern RTA markets, but only if the RTA promotes the use of international TBTs. When the harmonization is done on the basis of Northern domestic (stringer) standards, then its effects on Southern exports to Northern RTA partners is negative. In addition, the North-South TBT harmonization has a negative impact on South-South export flows. Indeed, TBT harmonization is costly and raises the price of products, possibly pricing them out of other Southern countries. All in all, these results would suggest that North-South TBT harmonization has a negative impact on the trade integration of Southern countries into the world economy and favours the emergence of a hub-and-spoke trade structure which may be harmful for Southern countries.

3. Ad valorem equivalents of non-tariff measures

The trade impact of NTMs may also be investigated through the computation of AVEs. As previously mentioned, NTMs are very diverse in terms of objectives and impact, and a simple metric cannot be used to investigate their trade effects. AVEs partially solve these issues. The AVE corresponds to the tariff equivalent that has the same impact on trade. The AVE measures the gap in the product's price with and without the NTM. In the case of a protectionist NTM, the AVE is equivalent to the tariff that reduces the imports of a product within the same proportions and increases its price on the domestic market. As an illustration, assume that the price of a product without an NTM is equal to 100 and that the AVE of the NTM is 5 per cent. Then, the product price with the NTM is 105.

Using AVEs, one should in principle be able to detect which products, sectors, or exporting countries are the most affected by NTMs. AVEs also provide information on importing countries that impose the most trade reducing NTMs.

Two methods can be applied for the computation of AVEs. The first one, the direct method, is based on prices. The second one, the indirect method, assumes that NTMs affect trade flows between countries. As prices and quantities are linked, the two methods should normally provide similar results. The choice between the two methods is often driven by data availability. Data harmonized among countries are easily available.

3.1 Computation of ad valorem equivalents using the direct method based on prices

Under this method, the AVE is measured as the difference on the domestic market between the price of the good with and without an NTM. The main issue is that the price without the NTM often cannot be observed. Alternatives are therefore used, such as the world price, the price at the border, or the price of a similar good not affected by NTMs. The AVE can be calculated as follows:

$$AVE_{NTM} = \left({p_d}/{p_w} \right) - \left(1 + \tau + c\right) \qquad (3.1)$$

where p_d is the domestic price (net of retailers' margins), p_w is the world price (net of producers' and exporters' margins), τ is the ad valorem tariff, and c represents all other costs such as transport or insurance costs. If all determinants influencing prices other than the NTM are well controlled for, then the residual – the remaining gap between the world and domestic prices – represents the AVE of the NTM.

Two approaches are usually used for the computation of the NTM AVE under this direct method. The first – the "handicraft" approach – consists of collection of precise and detailed data on all factors other than the NTM influencing the domestic price of a product. Once all these factors are removed from the domestic price, one gets a precise NTM AVE. However, the collection of very detailed data limits the use of this method to small samples of countries or products. Breaux *et al.* (2014) apply this approach. Contrary to the existing literature, they account for quality differences between domestic and foreign products, and for extreme values in AVEs. Their results show that NTMs increase the prices of imported products. However, the authors still encounter difficulties in explaining heterogeneity across countries and sectors.

The second approach to computing the NTM AVE under the direct method is based on econometrics and generalizes the "handicraft" approach as it can be implemented for much larger set of countries. The domestic price of a good is regressed on the world price, on some importing country's characteristics, and on tariffs and NTMs. A simple dummy or a frequency index is usually used for the measure of the NTMs. The estimated coefficient on this NTM variable represents the AVE. This rather simple approach can be applied to a large sample of countries and products. However, AVEs using this approach are less precise than AVEs obtained with the handicraft approach. Using this approach on a sample of 1,260 observations defined at the country-product level, Cadot and Gourdon (2014) emphasize that SPS measures increase the prices of African agri-food products by 14 per cent. The most affected products are rice and other cereals, chicken, and edible oils.

Although simple in conceptual terms, the direct approach based on the price gap is rather difficult to implement in practice. Two main issues affect its implementation. The first is related to negative AVEs. If NTMs enhance domestic demand, then imports of foreign products may increase. This positive trade impact is easily conceivable. However, a negative price effect is less likely. According to the direct method based on prices, negative AVEs suggest that NTMs reduce trade unit values, which does not make much sense economically. As explained by Cadot and Gourdon (2016), a price-reducing effect can be observed if, for example, a large country imposes a quantitative restriction on a product. Then, the world demand and world price for that product will decrease.

However, the reduction in price is observed on the product's unit values for all country pairs, not just on the imports of the country imposing the restriction. Furthermore, in that case, this negative price effect will be captured by the product fixed effect included in the estimation and not by the NTM coefficient. Alternative cases where NTMs reduce trade unit values are less plausible. Thus, when negative AVEs for SPS measures and TBTs are obtained in the empirical literature, they are often seen as unrealistic and economically meaningless observations and are simply dropped or set to zero. Nevertheless, this approach may bias the results of the empirical analysis.

The second main issue affecting implementation of the direct approach based on the price gap is related to the availability and quality of price data. Retail prices – more easily observable – are often used, but they are not available for all primary and intermediate products, and include retailers' margins and transaction costs. Furthermore, the substitutability between domestic and foreign varieties is often imperfect due to quality differences, and results are sensitive to the econometric method used. In the case of multiple NTMs affecting the same product, only a global AVE can be computed, and the specific effect of each NTM cannot be disentangled. Finally, the treatment of non-protectionist NTMs remains unclear. Should a negative price gap be observed in that case?

Some statistical sources provide data on prices. National statistics can of course be used. Price data are also available from international organizations, such as the World Bank and its International Comparison Program (ICP)[34] or the FAO for agri-food products. Last but not least, the CEPII provides, through its Trade Unit Values Database, unit values in dollars per ton for 182 countries, 253 partners, and 5,000 products over the 2000–2012 period.[35]

Cadot and Gourdon (2016) investigate the impact of standard harmonization within RTAs on the AVEs of NTMs. They combine data on trade unit values from the CEPII, NTMs from the TBT Initiative, and RTAs. Their analysis is performed at the HS six-digit level over the 2000–2008 period and for 173 importing countries and 255 partners. The authors consider that the prices of some goods in some countries are "treated" (i.e. affected) by NTMs (SPS measures and/or TBTs), and some countries participate in RTAs involving NTM harmonization clauses. They investigate how the unit value of each product treated bilaterally is affected by the NTMs imposed by the importing country (direct price effect) and whether deep integration (through RTAs and NTM coordination) dampens the price-raising effect of NTMs. Their estimations control for importer characteristics (factor endowments, income), tariffs, and other bilateral trade determinants (distance, common language, etc.). They run product-by-product estimations. For products not subject to NTMs, AVEs are set to zero. Only estimated coefficients significant at the 10 per cent level are kept (others are set to zero). The negative estimated AVEs (15 per cent of observations) are seen as aberrations and replaced by missing values. Finally, extreme AVEs (22 per cent of observations) are capped at 100 per cent. Results may be sensitive to these assumptions.

[34] Information on the ICP is available at http://icp.worldbank.org.

[35] Unit values are computed using the tariff lines database of the United Nations Statistical Division, corresponding to the values and quantities of trade declared by individual countries to the United Nations. Unit values are computed for each reporter, partner, and product at the highest level of disaggregation reported. Data are accessible at http://www.cepii.fr/CEPII/fr/bdd_modele/presentation.asp?id=2.

The results show that AVE estimates are lower in the presence of a RTA. This suggests that RTAs reduce the price-raising effect of NTMs. For example, AVEs of SPS measures are cut in absolute value by 3.1 percentage points for animal products and 4 percentage points for fats and oils. AVEs of TBTs are cut by 3.8 percentage points for vegetables and by 3.1 percentage points for beverages and tobacco. On average, RTAs reduce AVEs of SPS measures by 0.6 percentage points (from 2.8 to 2.2 per cent) and those of TBTs by 1.5 percentage points (from 5.6 to 4.1 per cent). Three potential explanations are suggested by the authors. First, NTM convergence within RTAs induces a reduction in compliance costs. Second, RTAs tend to reduce the home bias (i.e. the fact that internal trade is disproportionally larger than international trade) among member countries and provide better information to consumers. This translates into an increase in the demand for RTA products and lowers the price impact of NTMs. Finally, RTAs reduce protectionism-motivated distortions in the design of NTMs.

In the second part of their empirical analysis, Cadot and Gourdon (2016) examine whether the decrease in AVEs observed within RTAs is mainly due to the harmonization versus mutual recognition of regulations, the harmonization versus mutual recognition of conformity assessment procedures, or the transparency requirements. They highlight that mutual recognition of conformity assessment – which is the easiest step toward the coordination of NTMs – has a stronger cost-reducing effect than harmonization.

3.2 Computation of ad valorem equivalents using the indirect method based on quantities

NTMs affect international trade. Thus, comparing trade flows with and without NTMs allows calculate the AVEs of NTMs. This indirect method includes two steps. The first consists of determining the quantity impact of NTMs. To do so, a trade equation providing predicted flows is estimated. Deviations between predicted flows (without an NTM) and real flows (with an NTM) provide the quantity impact of the NTM. In a second step, this impact is converted into an AVE using import demand elasticities which reflect the responsiveness of demand for foreign goods to changes in their price. This approach has been developed at the World Bank by Kee *et al.* (2009) and is increasingly used in the empirical literature. In contrast with the direct method, it requires relatively few data (mainly trade data).

However, some weaknesses must be noted. As already underlined, data on NTMs are not always precise and complete (e.g. some countries do not notify all their measures to the WTO). Furthermore, trade data are often in value and not in volume. NTMs may also be endogenous and need to be instrumented, which raises the question of the choice of instruments. In terms of import demand elasticities, data from Kee *et al.* (2008) are usually used. However, these data are not relevant for some samples focusing on specific countries and/or time periods. Finally, as for the direct method, the treatment in many studies of non-protectionist NTMs, which may enhance trade, could be questioned.

The sample used by Kee *et al.* (2009) includes 78 countries and 4,575 products. They run product-by-product estimations, and the dependent variable in the first step is total imports at the importing country-product level. They control for countries' characteristics, tariffs, and agricultural subsidies.

In the second step, they convert the quantitative trade effect into an AVE using the import demand elasticities computed in previous research (Kee *et al.,* 2008). Their estimated equations are as follows:

First step equation:

$$ln(m_{n,c}) = \alpha_n + \sum_k \alpha_{n,k} C_c^k + \beta_{n,c}^{NTM} NTM_{n,c} \beta_{n,c}^{AgS} ln(AgS_{n,c}) + \varepsilon_{n,c} ln(1 + \tau_{n,c}) + \mu_{n,c} \quad (3.2)$$

Second step equation:

$$AVE_{n,c}^{NTM} = \frac{e^{\beta_{n,c}^{NTM}} - 1}{\varepsilon_{n,c}} \quad (3.3)$$

where n is the product, c is the country, m is total imports, C_c^k and k are variables that provide countries' characteristics (relative factor endowments, GDP, etc.), NTM is the dummy set to one if country c imposes at least one NTM on product n (zero otherwise), t is the tariffs, *AgS* is agricultural subsidies, ε is import demand elasticities, and μ is the error term.

Kee *et al.* (2009) find significant AVEs. For the entire sample, the simple average AVE of NTMs equals 12 per cent. If the average is weighted by imports, the average AVE is 10 per cent. If the computation is done only for product lines with at least one NTM, the average AVEs are much higher (45 per cent for the simple average AVE and 32 per cent for the trade-weighted average AVE). The authors also highlight strong variations in the AVEs of NTMs across countries: from 0 to 51 per cent for the simple average AVE and from 0 to 39 per cent for the trade-weighted average AVE. However, there is no clear link between the AVEs of NTMs and the level of development of countries as measured by GDP per capita. Finally, Kee *et al.* (2009) show that for 55 per cent of product lines subject to NTMs, the NTM AVE is higher than the tariff. Niu *et al.* (2018) present some more recent results based on a similar approach. Their findings suggest that while trade restrictiveness of NTMs in agriculture has been fluctuating, with a sharp rise post-2008, the manufacturing sector has experienced a steady increase in the average AVE of NTMs. Within manufacturing, textiles, footwear, machinery and electrical equipment, and rubber and plastics are subject to the most trade restrictive NTMs.

The trade-impeding impact of NTMs and their price-raising effects are confirmed by other studies. For example, Hoekman and Nicita (2011) suggest that reducing AVEs of NTMs by half (from 10 to 5 per cent) would increase trade by 2 to 3 per cent. Andriamananjara *et al.* (2004) investigate the price impact of NTMs by sector. According to their results, prices in the United States, European Union and Canada are, respectively, 15 per cent, 66 per cent, and 25 per cent higher because of NTMs. NTMs on leather shoes raise prices in Japan by 39 per cent and in Mexico by 80 per cent. Last but not least, NTMs on vegetable oils and fats raise prices in Mexico by 30 per cent, in Southeast Asia by 49 per cent, and in South Africa by 90 per cent.

Table 1: Ad valorem equivalents: results with trade-enhancing non-tariff measures

HS section codes	HS section names	Simple frequency ratio of NTMs	AVE of NTMs all HS6 lines (mean)		AVE of NTMs if NTM=1 (mean)	
			Unconstrained estimation[a]	Constrained estimation[b]	Unconstrained estimation[a]	Constrained estimation[b]
I	Live animals, animal products	0.209	0.018	0.128	0.084	0.609
II	Vegetable products	0.223	0.028	0.128	0.126	0.574
III	Fats and oils	0.202	0.067	0.145	0.333	0.717
IV	Prepared foodstuffs, beverages, spirits, tobacco	0.259	0.013	0.157	0.049	0.608
V	Minerals	0.054	0.027	0.046	0.5	0.846
VI	Chemicals, allied industries	0.134	0.033	0.088	0.244	0.657
VII	Plastics, rubber	0.121	0.052	0.094	0.432	0.774
VIII	Hides, leather, furskins	0.074	0.029	0.056	0.395	0.763
IX	Wood and wood articles	0.105	0.051	0.077	0.486	0.732
X	Pulp of wood, paper, printing	0.096	0.039	0.071	0.404	0.744
XI	Textiles, apparel	0.097	0.033	0.068	0.339	0.695
XII	Footwear, headgear	0.103	0.025	0.064	0.241	0.622
XIII	Stone, cement, ceramic articles, glass	0.081	0.055	0.074	0.681	0.917
XIV	Pearls, precious metals and stones	0.003	0.002	0.002	0.732	0.732
XV	Base metals and articles	0.085	0.044	0.067	0.516	0.796
XVI	Machinery, electrical and video equipment	0.129	0.083	0.114	0.648	0.887
XVII	Vehicles, aircraft, vessels	0.109	0.035	0.08	0.317	0.73
XVIII	Optical, photo., medical instr.	0.096	0.042	0.074	0.441	0.775
XIX	Arms, ammunition	0.044	0.008	0.021	0.182	0.474
XX	Miscellaneous (furniture, toys, others)	0.108	0.062	0.1	0.57	0.925
	All sections	0.121	0.044	0.088	0.362	0.729

Source: Beghin *et al.* (2016).

Note: AVE = ad valorem equivalent; HS = Harmonized System; NTM = non-tariff measure.

[a]: Unconstrained estimation means that impact of technical regulation NTMs on trade is not restricted in the econometric estimation.

[b]: Constrained estimation means that technical regulation NTMs are constrained to have a non-positive impact on trade in the estimation.

However, the method developed by Kee *et al.* (2009) suffers from one main limitation: AVEs of NTMs are constrained to be non-negative. In other words, NTMs can only have a negative impact on trade and raise prices. In practice, however, some NTMs can be trade-enhancing, due, for example, to the positive externalities they may have on demand.

In a recent study, Beghin *et al.* (2016) remove this constraint and allow AVEs of NTMs to be negative (i.e. NTMs to be trade-promoting). Using the same sample as in Kee *et al.* (2009) and focusing on technical regulations, their analysis underlines strong variations in the AVEs obtained in the constrained and unconstrained estimations. The authors find that about 39 per cent of product lines affected by technical regulations exhibit negative AVEs, suggesting a net trade-facilitating effect of these measures. Accounting for this effect significantly reduces the AVEs of NTMs. Table 1 presents their results for each HS section separately and on average. For each section, the AVE is computed as the mean over all importing countries and HS six-digit lines. Column (1) presents the frequency index, i.e. the share of HS six-digit lines within each HS section affected by NTMs. For example, within Section I ("Live animals, animal products"), 20.9 per cent of HS six-digit lines are affected by at least one technical regulation in at least one importing country. Agri-food products (Sections I to IV) are more affected by NTMs than manufactured products. Column (2) reports the mean AVE when the estimation is not constrained. The magnitude of the mean AVE varies significantly across sections, from 0.002 to 0.083. All sections exhibit a non-negative average AVE, indicating that technical regulation NTMs have, on average, a net negative impact on trade flows. However, these AVEs are much lower than those obtained in column (3) when the estimation is constrained (i.e. when AVEs can only be positive). On average, for all sections, the mean AVE is twice as high in column (3) as in column (2) (0.088 versus 0.044). Columns (4) and (5) replicate the exercise but focus on product lines affected by at least one technical regulation. In both columns and for all sections, the average AVE is always higher in absolute value than the one based on all HS six-digit lines. In addition, the mean AVE computed for all sections is again twice as high when the AVEs are constrained to be positive (0.729 versus 0.362).

3.3 Ad valorem equivalents and policy

The computation of AVEs of NTMs is complex and results heavily depend on the approach adopted, the time and country coverage, the level of data aggregation and the specific empirical techniques used. Future improvements could be expected. Nevertheless, AVEs of NTMSs are useful for the analysis of countries' trade policies. They can be used in the calculation of trade restrictiveness indices which aim to summarize all trade restrictions into a single measure. The indices represent the tariff equivalent of all restrictions that provide the same level of welfare (Kee *et al.*, 2009).

AVEs of NTMs have also been included in computable general equilibrium models and employed in the simulations of trade liberalization effects at the regional and/or multilateral levels. However, such an exercise is not necessarily straightforward, and results would have to be interpreted with caution.[36] Moreover, it is unclear how simulated changes in NTMs AVEs could match realistically policy options to be negotiated in a trade agreement. The only option that could be simulated with a relatively straightforward translation into AVEs changes is the mutual recognition of technical regulations in place. In that case, the simulation scenario would result in a reduction to zero of the AVE associated with the set of goods affected by the negotiation. Moreover, if AVEs are the only indicator of the effects of an NTM, these effects should be exclusively protectionist. As NTMs and in particular technical regulation are also expected to affect the cost of production and perhaps even the technology to be used AVEs could at best reflect the net impact of production and protectionist effects. In that context even mutual recognition should involve both a trade and production effect. This information, however, cannot be retrieved from AVEs estimates.

[36] See Fugazza and Maur (2008) for a detailed discussion and illustration.

Generally speaking, it may be extremely delicate to use AVEs as a basis for negotiation as they are not a transparent representation of NTMs effects. What would the reduction by 50 percent of AVEs represent in terms of changes in the regulation defining these NTMs? This is far from being straightforward and is likely to be subject to several even contrasting interpretations.

C. Applications

1. Trade effects of sanitary and phytosanitary measures and technical barriers to trade

This application partly replicates Disdier *et al.* (2008) but using more recent data. It focuses on agri-food products (HS Chapters 01 to 24) and investigates the trade effects in 2012 of SPS measures and TBTs on the exports of 189 countries to 23 OECD partners (20 European countries, Chile, Japan, and Mexico). The empirical application consists of the estimation of a gravity equation (see Box 1).

(a) Download the data

The database is available on the UNCTAD website and already includes the variables needed for the estimations. The NTM data are based on the TNT database. The trade data are extracted from the BACI database also provided by the CEPII. Other gravity variables, such as distance, contiguity, common language, and past colonial links, are also from the CEPII. Exporting and importing countries' size is proxied by GDP (sourced from the World Bank's World Development Indicators). Finally, we also control for the bilateral applied tariffs using the MAcMap version of the UNCTAD/TRAINS database. All variables are described in Chapter 2, B.1. The database is built at the HS four-digit level and two variables account for NTMs:

- A simple dummy variable set to one if the importing country notifies at least one SPS measure or TBT on one HS six-digit product within the HS four-digit sector (zero otherwise);
- A frequency index computed for each importing country and HS four-digit sector and defined as the number of HS six-digit lines affected by at least one SPS measure or TBT divided by the total number of HS six-digit lines within the HS four-digit sector.

Note that the bilateral tariffs at the HS four-digit level are computed as the simple mean of applied tariffs for all HS six-digit lines within the HS four-digit sector and for each country pair. Tariffs are for 2007. Finally, exporting countries are divided into two groups (OECD, developing exporters), and intra-European trade flows are dropped from the sample to avoid biases (within the European Union, tariffs are set to zero and mutual recognition is applied for NTMs).

(b) Open the data into Stata and finalize the dataset

To open the dataset in Stata, apply the command "use". Before running the estimations, we add some labels to the variables.

```
use dataset_final clear
label var lgdp_o "log GDP exporter"
label var lgdp_d "log GDP importer"
label var ldist "log distance"
label var mtariffs "mean bilateral tariffs (HS4, simple average)"
label var dum_spstbt_jk "= 1 if at least 1 SPS/TBT at the importer-HS6 level"
label var freq_spstbt_jk "frequency index for SPS/TBT by importer"
label var contig "common border"
label var comlang_ethno "common language (spoken by at least 9% of the pop in both countries"
label var colony "colonial links"
label var hs2 "HS 2-digit code"
label var hs4 "HS 4-digit code"
label var imp_hs2 "importer-HS2 fixed effects"
label var exp_hs2 "exporter-HS2 fixed effects"
label var imp_hs4 "bilateral HS4 imports"
label var limphs4 "log of bilateral HS4 imports"
label var oecd_d "=1 if importer is an OECD country"
label var oecd_o "=1 if exporter is an OECD country"
label var dc_o "=1 if exporter is a developing country"
label var eur_o "=1 if exporter is an EU country"
label var eur_d "=1 if importer is an EU country"
describe
```

(c) Run some basic estimations

We first run a set of basic estimations that include the GDPs of both partners (proxies of their size) and fixed effects defined at the HS two-digit level to control for unobservable sector characteristics. Error terms are clustered at the country-pair level. We also control for the heteroscedasticity with the "robust" option. Finally, as is usually done in the gravity literature, continuous variables are expressed in logs and the corresponding estimated coefficients can therefore be interpreted as elasticities. Our sample is restricted to strictly positive trade flows. Two commands are used in order to account for fixed effects, namely the "areg" command and the "reg2hdfe". The command "areg" fits a linear regression absorbing one categorial factor and results generated are comparable to results that would be obtained using the standard panel command "xtreg". The command "reg2hdfe" allows the inclusion of two sets of fixed effects without appealing to the inclusion of different sets of dummies. This module should be installed from within Stata by typing "ssc install reg2hdfe".

```
* Estimation #1: control only for tariffs but not for NTMs
xi: areg limphs4 lgdp_o lgdp_d ldist contig comlang_ethno colony mtariffs, absorb(hs2) cluster(groupbil)
robust

* Estimation #2: control for tariffs and include a dummy for SPS/TBTs
xi: areg limphs4 lgdp_o lgdp_d ldist contig comlang_ethno colony mtariffs dum_spstbt_jk, absorb(hs2)
cluster(groupbil) robust

* Estimation #3: control for tariffs and include a frequency index for SPS/TBTs
xi: areg limphs4 lgdp_o lgdp_d ldist contig comlang_ethno colony mtariffs freq_spstbt_jk, absorb(hs2)
cluster(groupbil) robust

* Estimation #4: focus on European imports and include a dummy for SPS/TBTs
xi: areg limphs4 lgdp_o lgdp_d ldist contig comlang_ethno colony mtariffs dum_spstbt_jk if eur_d ==
1, absorb(hs2) cluster(groupbil) robust

* Estimation #5: focus on European imports and include a frequency index for SPS/TBTs
xi: areg limphs4 lgdp_o lgdp_d ldist contig comlang_ethno colony mtariffs freq_spstbt_jk if eur_d ==
1, absorb(hs2) cluster(groupbil) robust
```

(d) Run fixed-effect estimations

We now replace countries' GDPs by two sets of fixed effects: one for the exporter and one for the importer (see Box 1). These fixed effects are interacted with HS two-digit fixed effects. We replicate the previous set of regressions.

```
* Estimation #6: control only for tariffs but not for NTMs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtariffs, id1(imp_hs2) id2(exp_hs2)
cluster(groupbil)

* Estimation #7: control for tariffs and include a dummy for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtariffs dum_spstbt_jk, id1(imp_hs2) id2(exp_
hs2) cluster(groupbil)

* Estimation #8: control for tariffs and include a frequency index for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtariffs freq_spstbt_jk, id1(imp_hs2) id2(exp_
hs2) cluster(groupbil)

* Estimation #9: focus on European imports and include a dummy for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtariffs dum_spstbt_jk if eur_d == 1, id1(imp_
hs2) id2(exp_hs2) cluster(groupbil)

* Estimation #10: focus on European imports and include a frequency index for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtariffs freq_spstbt_jk if eur_d == 1, id1(imp_
hs2) id2(exp_hs2) cluster(groupbil)
```

(e) Run fixed-effect estimations by group of exporters

As in Disdier *et al.* (2008), we now examine the potential difference in the trade impact of tariffs and NTMs across exporters. To do so, we interact the tariff and NTM variables with the two dummies identifying OECD and developing exporters.

```
* Interaction terms between tariff and SPS/TBT variables and groups of exporters
gen mtar_oecd = mtariffs * oecd_o
gen mtar_dc = mtariffs * dc_o
gen dumntm_oecd = dum_spstbt_jk * oecd_o
gen dumntm_dc = dum_spstbt_jk * dc_o
gen freqntm_oecd = freq_spstbt_jk * oecd_o
gen freqntm_dc = freq_spstbt_jk * dc_o

* Estimation #11: control for tariffs and include a dummy for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtar_oecd mtar_dc dumntm_oecd dumntm_dc,
id1(imp_hs2) id2(exp_hs2) cluster(groupbil)

* Estimation #12: control for tariffs and include a frequency index for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtar_oecd mtar_dc freqntm_oecd freqntm_dc,
id1(imp_hs2) id2(exp_hs2) cluster(groupbil)

* Estimation #13: focus on European imports and include a dummy for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtar_oecd mtar_dc dumntm_oecd dumntm_dc if
eur_d == 1, id1(imp_hs2) id2(exp_hs2) cluster(groupbil)

* Estimation #14: focus on European imports and include a frequency index for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtar_oecd mtar_dc freqntm_oecd freqntm_dc if
eur_d == 1, id1(imp_hs2) id2(exp_hs2) cluster(groupbil)
```

(f) Run fixed-effect estimations by groups of products

Finally, we study the impact of SPS measures and TBTs for three main groups of agri-food products:

- Animal products, defined as products included in HS two-digit sectors 01 to 05;
- Fruits and vegetables, defined as products included in HS two-digit sectors 06 to 14;
- Oil and prepared foodstuffs, defined as products included in HS two-digit sectors 15 to 24.

We first interact our two NTM variables (dummy and frequency index) with fixed effects defined for each group of products. Second, we run estimations for European imports with these interaction terms.

CHAPTER 3

```
* Define the products' groups
gen chapter = "animal" if hs2 == "01" | hs2 == "02" | hs2 == "03" | hs2 == "04" | hs2 == "05"
replace chapter = "vegetable" if hs2 == "06" | hs2 == "07" | hs2 == "08" | hs2 == "09" | hs2 == "10"
| hs2 == "11" | hs2 == "12" | hs2 == "13" | hs2 == "14"
replace chapter = "oil and prepared foodstuffs" if hs2 >= "15"

* Define the products' groups
gen chapter = "animal" if hs2 == "01" | hs2 == "02" | hs2 == "03" | hs2 == "04" | hs2 == "05"
replace chapter = "vegetable" if hs2 == "06" | hs2 == "07" | hs2 == "08" | hs2 == "09" | hs2 == "10"
| hs2 == "11" | hs2 == "12" | hs2 == "13" | hs2 == "14"
replace chapter = "oil and prepared foodstuffs" if hs2 >= "15"

* Interact NTM variables and fixed effects for products' groups
tab chapter, gen(fix)
gen dum_ntm_1 = dum_spstbt_jk * fix1
gen dum_ntm_2 = dum_spstbt_jk * fix2
gen dum_ntm_3 = dum_spstbt_jk * fix3
gen freq_ntm_1 = freq_spstbt_jk * fix1
gen freq_ntm_2 = freq_spstbt_jk * fix2
gen freq_ntm_3 = freq_spstbt_jk * fix3

* Estimation #15: focus on European imports and include a dummy for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtariffs dum_ntm_1 dum_ntm_2 dum_ntm_3 if
eur_d == 1, id1(imp_hs2) id2(exp_hs2) cluster(groupbil)

* Estimation #16: focus on European imports and include a frequency index for SPS/TBTs
reg2hdfe limphs4 ldist contig comlang_ethno colony mtariffs freq_ntm_1 freq_ntm_2 freq_ntm_3 if
eur_d == 1, id1(imp_hs2) id2(exp_hs2) cluster(groupbil)
```

2. Trade effects of non-tariff measures harmonization within North-South regional trade agreements

In this second application, we deal with North-South RTAs, and more precisely with the effects of NTM harmonization within RTAs on bilateral exports of Southern countries to Northern ones. This application is based on Disdier *et al.* (2015) and focuses on the harmonization of technical regulations. As previously mentioned in Section C.1, the target of this harmonization can be international standards or regional ones (i.e. the Northern standards, which are usually more trade restrictive than the international ones).

(a) Download the data

The database is available on the UNCTAD website and already includes the variables needed for the estimations. Our sample includes OECD importers (15 members of the European Union with Belgium and Luxembourg aggregated, Australia, Canada, Iceland, Japan, New Zealand, Norway, Switzerland, and the United States) and 142 exporters over the period 1990–2006. In the estimations, we examine whether Northern and Southern partners have signed a RTA and whether this RTA involves the harmonization of technical regulations. Finally, we examine the target of the harmonization (international versus regional standards). All these NTM-related variables are defined using dummy variables.

Our estimations use the gravity framework, and, contrary to the previous application, we account for the presence of zero flows by using the Poisson estimator (Santos Silva and Tenreyro, 2006). Our dependent variable is the total annual bilateral export flow, and we add various sets of fixed effects to control for all unobservable characteristics linked to the importing country, the exporting country, and the country pair. Finally, error terms are clustered at the country-pair level.

(b) Open the data into Stata and finalize the dataset

Once the data are downloaded, they can be opened in Stata. We first finalize the dataset, before turning to the estimations.


```
set maxvar 11000
set matsize 11000
use database_NorthSouth_UNCTAD, clear

* Rescale variables and take logs
gen tot2 = tot_imp / 1000000
replace manuf_imp = 0 if manuf_imp == .
gen manuf2 = manuf_imp / 1000000
gen gdp2_o = gdp_o / 1000000
gen gdp2_d = gdp_d / 1000000
gen lgdp_o = ln(gdp2_o)
gen lgdp_d = ln(gdp2_d)
gen ldist = ln(distw)

* Define fixed effects
* Importer-year fixed effects
egen imptime = group(ccode_d year)
* Exporter-year fixed effects
egen exptime = group(ccode_o year)
* Country-pair fixed effects
egen groupbil = group(ccode_d ccode_o)

* Label variables
label var gdp_o "GDP of the exporter"
label var gdp_d "GDP of the importer"
label var tot_imp "Total bilateral exports"
label var manuf_imp "Total manufactured bilateral exports"
label var n_s "Dummy set to 1 if both partners are members of same N-S PTA"
label var PTA_ns_name "Name of N-S PTA"
label var n_sXtechr_h "Dummy set to 1 if N-S PTA involves standards harmonization"
label var n_sXtechr_hXpromot_regio "= 1 if N-S PTA involves harm. & promotion of regional standards"
label var n_sXtechr_hXpromot_is "=1 if N-S PTA involves harm. & promotion of international standards"
```

(c) Run the estimations

We now run the estimations, all of which use the Poisson estimator. The first one includes countries' GDPs. We then replace those GDPs by importer-year and exporter-year fixed effects. We also include country-pair fixed effects in regressions (2)–(6). All time-invariant country-pair variables – bilateral distance, contiguity, common language, and colonial links – are therefore dropped. Regression (2) studies the basic effects of a RTA on the bilateral exports of Southern countries to Northern partners. We then restrict our sample to countries that have signed a North-South RTA. We investigate the impact of NTM harmonization (regression (3)) and the effect of NTM harmonization on regional versus international standards (regression (4)). Regression (5) is restricted to European importers, while regression (6) considers only bilateral exports of manufactured products.

```
* Regression #1
xi: poisson tot2 lgdp_o lgdp_d ldist contig comlang_off colony n_s i.ccode_o i.ccode_d i.year,
cluster(groupbil) difficult robust

* Regression #2 (this regression can be run only if your computer has enough memory)
xi: poisson tot2 n_s i.imptime i.exptime i.groupbil, cluster(groupbil) difficult

* For further regressions, we restrict our sample to observations for which N-S RTA == 1
keep if n_s == 1
* Regression #3
xi: poisson tot2 n_sXtechr_h i.imptime i.exptime i.groupbil if n_s == 1, cluster(groupbil) difficult robust

* Regression #4
xi: poisson tot2 n_sXtechr_hXpromot_regio n_sXtechr_hXpromot_is i.imptime i.exptime i.groupbil if
n_s == 1, cluster(groupbil) difficult robust

* Regression #5 on EU imports only
gen eu_d = 1 if ccode_d == "AUT" | ccode_d == "BEL" | ccode_d == "DEU" | ccode_d == "DNK" |
ccode_d == "ESP" | ccode_d == "FIN" | ccode_d == "FRA" | ccode_d == "GBR" | ccode_d == "GRC"
| ccode_d == "IRL" | ccode_d == "ITA" | ccode_d == "NLD" | ccode_d == "PRT" | ccode_d == "SWE"
replace eu_d = 0 if eu_d == .
xi: poisson tot2 n_sXtechr_hXpromot_regio n_sXtechr_hXpromot_is i.imptime i.exptime i.groupbil if
n_s == 1 & eu_d == 1, cluster(groupbil) difficult robust

* Regression #6 on manufacturing imports only
xi: poisson manuf2 n_sXtechr_hXpromot_regio n_sXtechr_hXpromot_is i.imptime i.exptime i.groupbil
if n_s == 1 , cluster(groupbil) difficult robust
```

3. Computation of ad valorem equivalents using the direct method based on prices

This application aims to compute AVEs of NTMs using the direct method based on prices. It is largely based on Cadot and Gourdon (2014).[37] We use their sample of 1,260 observations defined at the country-product level. The main variable, which will be the dependent variable in the

[37] The authors thank Olivier Cadot and Julien Gourdon for providing their data and do-file.

estimations, is the price of product k in country c. Five types of NTMs are considered in the analysis: SPS measures, TBTs, pre-shipment inspections, prices, and quantity measures. These NTM data are based on the TNT database. Finally, the database also includes a measure of the tariff applied by country c on product k.[38] We simply add a measure of GDP per capita in purchasing power parity (PPP) defined at 2005 constant prices to the sample. The final sample includes 30 countries and 42 products.

(a) Download the data and finalize the dataset

The database is available on the UNCTAD website and already includes the variables needed for the estimations, except a measure of GDP per capita in PPP. We first add this measure by simply merging our main dataset with a second dataset also available on the UNCTAD website and by providing a measure of GDP per capita. Once the data are downloaded, they can be opened in Stata.


```
use Data_PriceGap, clear
* Merge the dataset with a measure of PPP GDP per capita
sort country
merge country using gdpcap_ppp
tab _merge
drop _merge
rename rgdpch gni_pc
*Create a numeric group identifier
egen newproduct = group(icpcode)
*Define two panel dimensions: product and county
xtset newproduct country_index
```

(b) Construct the NTM variables and the interaction terms

Before turning to the estimations, we finalize the construction of the explanatory variables. We first define a dummy variable for each type of NTM (in addition to their frequency index and number already available in the database). We then interact our NTM variables with the GDP per capita variable. These interactions are computed for each type of NTM ((A) SPS measures, (B) TBTs, (C) pre-shipment inspections, (D) prices, and (E) quantity measures) and for each measure of NTMs (dummy, frequency index, and number of measures). As in Cadot and Gourdon (2014), the GDP per capita is measured in US$10,000 for the readability of coefficients.

We also define interaction terms between NTMs and geographical regions. Our sample includes five regions and coded as follows: 1: EAP (East Asia and the Pacific); 2: LAC (Latin America and the Caribbean); 3: MNA (Middle East and North Africa) ; 4: SAS (South Asia); 5: SSA (Sub-Saharan Africa).

All variables are computed using loops in Stata. Stata commands “foreach” allows to handle some common simple repetitive tasks. This application provides examples of how to use this command.

[38] For a precise description of the data and their sources, see Cadot and Gourdon (2014).

```
* NTM (dummy variable)
foreach j in A B C D E {
        gen bntm`j' = (ntm`j' != 0)
}

* NTM (number of measures)
foreach j in A B C D E {
        rename NumNtm`j' nntm`j'
}

* Interaction with PPP GDP per capita
foreach j in A B C D E {
        gen y_bntm`j' = gni_pc*bntm`j'/10000
}

foreach j in A B C D E {
        gen y_ntm`j' = gni_pc*ntm`j'/10000
}

foreach j in A B C D E {
        gen y_nntm`j' = gni_pc*nntm`j'/10000
}

* Interaction with regions
foreach j of numlist 1/5 {
        gen bA`j' = bntmA*region`j'
        gen bB`j' = bntmB*region`j'
        gen bC`j' = bntmC*region`j'
        gen bD`j' = bntmD*region`j'
        gen bE`j' = bntmE*region`j'
}

foreach j of numlist 1/5 {
        gen A`j' = ntmA*region`j'
        gen B`j' = ntmB*region`j'
        gen C`j' = ntmC*region`j'
        gen D`j' = ntmD*region`j'
        gen E`j' = ntmE*region`j'
}

foreach j of numlist 1/5 {
        gen nA`j' = nntmA*region`j'
        gen nB`j' = nntmB*region`j'
        gen nC`j' = nntmC*region`j'
        gen nD`j' = nntmD*region`j'
        gen nE`j' = nntmE*region`j'
}
```

(c) Run the baseline estimations

The baseline estimations replicate Tables 3 and 5 of Cadot and Gourdon (2014). Results are slightly different due to the small divergences in the measure of the PPP GDP per capita. However, Cadot and Gourdon (2014) main conclusions still hold. We first define country fixed effects. In the first estimation, NTMs are coded as dummy variables; in the second estimation, they are coded as frequency indexes. The third estimation uses the number of NTMs. In the three estimations, we add interaction terms with GDP per capita. Robust standard errors are clustered at the product level.

As in Cadot and Gourdon (2014), we observe significant pass-through of compliance costs (i.e. change in prices due to changes in compliance costs) for SPS measures (AVEs around 13 per cent). In the second estimation (using the frequency index), we also find a significant AVE for TBTs (of 12 per cent). In addition, the estimated coefficients on the interaction terms with GDP per capita are negative and significant, suggesting that the level of compliance costs decreases with a country's income.

In the last estimation (using the number of NTMs), AVEs are weaker. As mentioned by Cadot and Gourdon (2014), these results indicate that several measures of a given type do not add up to create a larger burden on traders.

```
* Baseline: interactions with PPP GDP per capita

* Define country fixed effects
tab country, gen(iso)

* NTM: dummy variable
xtreg lprice lnTariff y_bntmA y_bntmB y_bntmC y_bntmD y_bntmE bntmA-bntmE iso1-iso30, fe vce(cluster icpcode)

* NTM: frequency index
xtreg lprice lnTariff y_ntmA y_ntmB y_ntmC y_ntmD y_ntmE ntmA-ntmE iso1-iso30, fe vce(cluster icpcode)

* NTM: number of measures
xtreg lprice lnTariff y_nntmA y_nntmB y_nntmC y_nntmD y_nntmE nntmA-nntmE iso1-iso30, fe vce(cluster icpcode)
```

(d) Run the estimations at the regional level

Finally, we run estimations using interaction terms defined at the regional level. We replicate Table 4 of Cadot and Gourdon (2014). Regions are coded as follows: 1: EAP (East Asia and the Pacific); 2: LAC (Latin America and the Caribbean); 3: MNA (Middle East and North Africa) ; 4: SAS (South Asia); 5: SSA (Sub-Saharan Africa). As previously, we include country and product fixed effects. Robust standard errors are clustered at the product level.

The first regression uses dummies for NTMs, while the second regression uses a frequency index. Both estimations provide similar results. AVEs of NTMs vary substantially across regions, and SPS measures have a significant price-raising effect only for EAP and SSA. Furthermore, the effect is stronger in EAP than in SSA (around 19–20 per cent versus 13 per cent).

```
* Interactions with regions

* NTM: dummy variable
xtreg lprice lnTariff bA1-bE1 bA2-bE2 bA3-bE3 bA4-bE4 bA5-bE5 iso1-iso30, fe vce(cluster icpcode)

* NTM: frequency index
xtreg lprice lnTariff A1-E1 A2-E2 A3-E3 A4-E4 A5-E5 iso1-iso30, fe vce(cluster icpcode)
```

D. Exercises

1. Trade effects of non-tariff measures and fixed effects

    (i) Preliminaries

    a. Open the datafile "dataset_final.dta"

    b. Generate interaction terms between tariff and sps/tbt variables and groups of exporters

    (ii) HS2 versus HS4 sector definition

    a. Reproduce estimations 11 to 14 of application 1

    b. Reproduce estimations 11 to 14 of application 1 using crossed fixed effects at the HS4 level

    c. Generate a table reproducing the main coefficients estimates. What are the conclusions to be drawn?

    Hint: use esttab instead of outreg2

2. Harmonization of non-tariff measures

    (i) Preliminaries

    a. Install the *ppml_panel_sg* command

    b. Open the datafile "database_NorthSouth_UNCTAD.dta"

    c. Rescale variables and take logs as is done in application 2

    Hint: use ssc install

    (ii) Assess the impact of Harmonization

    a. Run regressions 1 to 6 of application 2 using ppml_panel_sq

    b. Generate a table reproducing the main coefficients estimates

    Hint: use the help command to implement a regression with ppml_panel_sq

3. Computation of ad valorem equivalents

(i) Preliminaries

a. Open the datafile "Data_PriceGap.dta"

b. Simplify the loops used to generate the NTM-related variables in application 3

c. Generate the NTM-related variables

d. Install the command *reghdfe*

Hint: use ssc install

(ii) Assess the impact of Harmonization

a. Run the three baseline estimations of application 3 and generate a table reporting the main coefficients estimates

b. Re-run the three baseline estimations of application 3 (i.e with the same set of fixed effects) using the *reghdfe* command and generate a table reporting the main coefficients estimates

c. Compare the two sets of results