A Practical Guide to the Economic Analysis of Non-Tariff Measures

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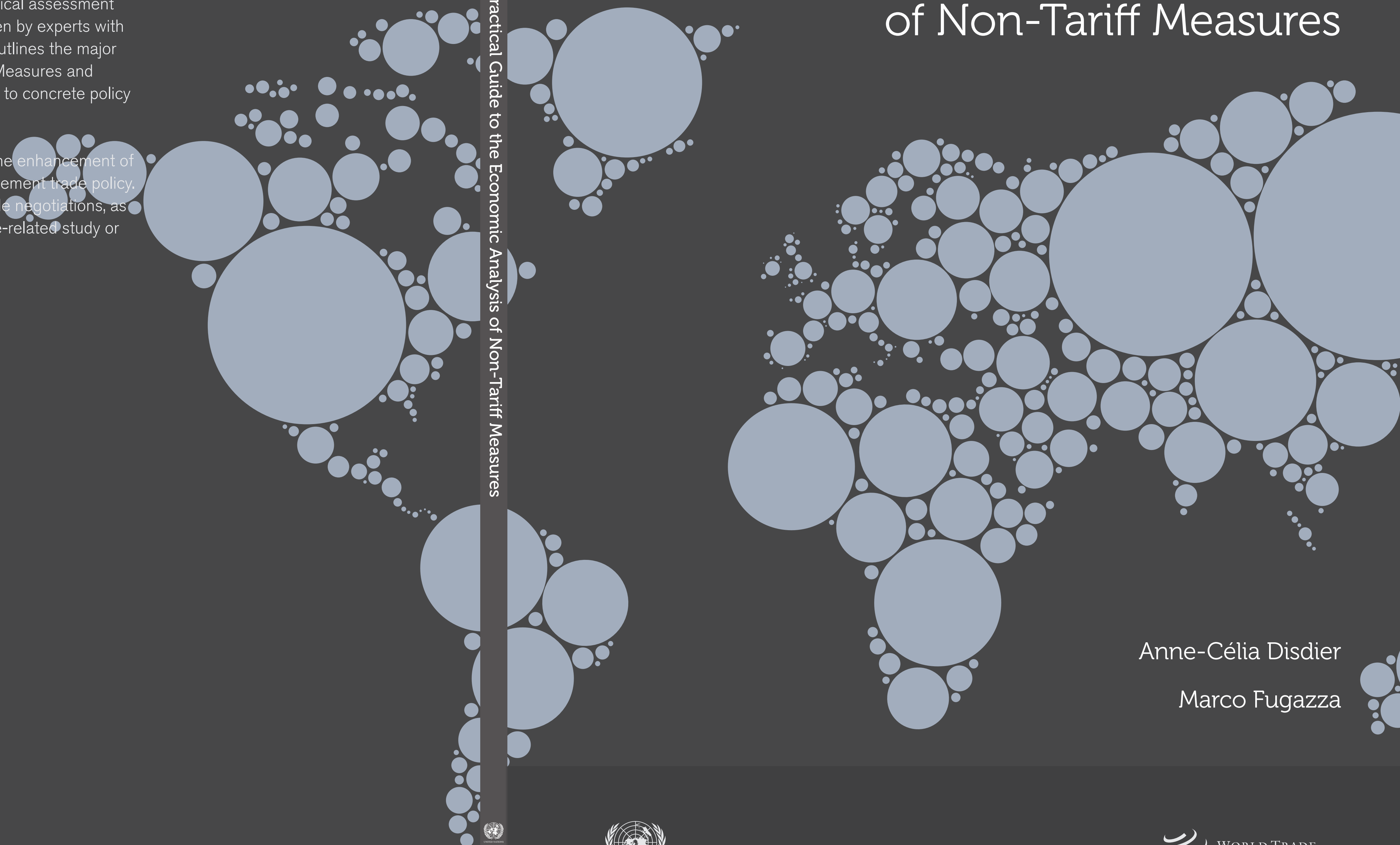

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A Practical Guide to the Economic Analysis of Non-Tariff Measures

A Practical Guide to the Economic Analysis of Non-Tariff Measures is the third volume of the series of *Practical Guides to Trade Analysis* co-published by the United Nations Conference on Trade and Development and the World Trade Organization. This volume provides the main tools for the analysis and empirical assessment of the trade effects of Non-Tariff Measures. Written by experts with practical experience in the field, this publication outlines the major concepts of the economic analysis of Non-Tariff Measures and contains practical guidance on how to apply them to concrete policy questions.

This Guide has been developed to contribute to the enhancement of developing countries' capacity to analyze and implement trade policy. It is aimed at government experts engaged in trade negotiations, as well as students and researchers involved in trade-related study or research.

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What is *A Practical Guide to the Economic Analysis of Non-Tariff Measures?*

A Practical Guide to the Economic Analysis of Non-Tariff Measures aims to help researchers and policymakers update their knowledge of quantitative economic methods and data sources for the economic analysis and empirical assessment of the trade effects of Non-Tariff Measures.

Using this guide

The guide explains analytical techniques, reviews the data necessary for analysis and includes illustrative applications and exercises.

Find out more

Website: http://vi.unctad.org/tpa

A Practical Guide to the Economic Analysis of Non-Tariff Measures

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ABBREVIATIONS

AVE	Ad Valorem Equivalent
BACI	Base pour l'Analyse du Commerce International
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales
FAO	Food and Agriculture Organization
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Output
HS	Harmonized System
ICP	International Comparison Program
LAIA	Latin American Integration Association
LDC	Least Developed Country
MAcMap	Market Access Map
MAST	Multi-Agency Support Team
NTM	Non-Tariff Measure
OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parity
RTA	Regional trade agreement
SPS	Sanitary and Phytosanitary
TBT	Technical Barriers to Trade
TNT	Transparency in Trade
TRAINS	Trade Analysis Information System
UN Comtrade	United Nations Commodity Trade Statistics
UNCTAD	United Nations Conference on Trade and Development
WHO	World Health Organization
WTO	World Trade Organization

Note: This report covers the WTO's activities in 2018 and early 2019. The word "country" is frequently used to describe WTO members whereas a few members are officially "customs territories", and not necessarily countries in the usual sense of the word.

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This publication is the third of a series of practical guides born from a collaboration between UNCTAD and the WTO in 2012 and initiated by Vlasta Macku former chief of UNCTAD's Virtual Institute. All volumes of the series can be downloaded from https://vi.unctad.org/tpa/. For any additional information refer to https://unctad.org/ntm and https://www.wto.org/english/res_e/reser_e/reser_e.htm.

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[1] All details of the last version of the course are available at https://vi.unctad.org/services/online-courses/980-virtual-institute-online-course-on-economic-analysis-of-non-tariff-measures-2018

DISCLAIMER

INTRODUCTION

A. Understanding non-tariff measures and their impact

Non-Tariff Measures (NTMs) are all policy interventions other than tariffs that can potentially affect the quantities and the prices of internationally traded goods.[2] Their measurement is more complex than any other trade policy instrument such as tariffs given their variety and the difficulty of assessing their restrictiveness.

NTMs very often carry a negative connotation. It is still not unusual to hear even in well informed policy circles the use of the term barrier when referring to policy instruments that by nature are dedicated to the protection of the health of the human, animal or plant population of a country. Barrier may not sound correct if the original intent of the implemented regulation is not to affect trade but rather certify the quality health-wise of a product. This apparently innocuous mis-designation may undermine the importance of quality in framing trade relationships and lead to profound political misunderstanding and eventually mistrust amongst trade partners.

A more precise and possibly systematic appreciation of the different types of measures beyond tariffs but closely related to trade flows is needed. This could be made possible only by a better understanding of the impact of these different types of measures on both prices and quantities of traded products. While quotas are expected to represent an obstacle to the exchange goods affected, sanitary and phytosanitary measures (SPS) primary objective is not to affect imports or exports but to protect the health of the human, animal and plant populations residing in given region or country. Quotas clearly increase imports prices and reduce imported quantities. Using trade related measures to protect health may have some trade effects but the latter are not necessarily negative. For instance, consumers could respond positively to the introduction of some measures that guarantee the quality of a product by increasing their demand of that specific product. This could affect positively the demand for imports that comply with the new regulatory elements. Eventually both imports prices and imported quantities may increase and the barrier effect does not exist anymore.

To disentangle protectionist policy interventions from genuine health related measures, analysists and policy makers should acquire a proficient view of the range, complexity and diversity of NTMs in practice. In the above example, analysists could conclude that both quotas and SPS measures

[2] Non-tariff measures can also apply to services. However, the empirical assessment of their impact goes beyond the scope of that guide as it would require an empirical set up and approach specific to services trade flows. We refer the reader to the OECD Services Trade Restrictiveness Index project for a comprehensive presentation and extensive treatment of issues related to regulatory frameworks in services and their impact on trade.

represent an obstacle to trade by looking at their respective price effects. However, including the quantity effect could lead to the opposite conclusion. It is only by considering the full spectrum of combinations of price and quantity effects that the nature of the impact can be determined. In other words, the tendency to rely on price effects as a reflection of trade impeding effects (e.g. by calculating ad valorem equivalents (AVEs) based on value effects) may be misleading and needs reconsideration.

This practical guide introduces the main empirical approaches used to assess the impact of NTMs on bilateral trade flows and possibly shed some light on their policy nature. It is intended for use by researchers from universities, research centres, and governmental and non-governmental institutions involved in the research and teaching of international trade and trade policy, interested in enhancing their quantitative skills and conducting policy-relevant research on NTMs as they relate to their countries.

B. Using this Guide

This Guide is targeted at economists with training and experience in applied research and analysis. On the empirical side, the prerequisite is some familiarity with work on databases and with the use of STATA software.[3] Some knowledge of modern trade theories would also facilitate the understanding of economic mechanisms framing the effects of NTMs on trade performance at the macro and micro level.

The Guide comprises five chapters. After a short introduction about the nature and scope of the NTMs that can be adopted by governments, we present some major sources of data on the various types of NTMs. We then take a close look at how the presence and incidence of NTMs can be measured. Following this discussion, we introduce some core econometric techniques that can be used to estimate the effects of NTMs on trade flows and prices at the country and sectoral levels. We also look at recent attempts to define and calculate the NTM trade restrictiveness indices based on estimated ad valorem equivalents. In recent years, the use of firm-level data has been facilitated by efforts by international organizations in collaboration with national authorities to collect information at a more micro level. We show how to use this type of data to assess the impact of NTMs on firms' export decisions and performance. The practical guide concludes with an illustration of how estimates of the impact of NTMs on trade flows and prices can be used, and how they can be complemented with health data to draw conclusions in terms of economic welfare. Chapters 2, 3 and 4 contain applications of the techniques discussed in the various sections using the Stata software. Exercises are also included to test the practical understanding of the reader. After reading this practical guide and after doing all practical exercises you will be able to perform an empirical analysis of the presence and incidence of NTMs and empirically assess their impact on the export performance and prices of traded goods at the country and firm level.

The software used to solve the proposed set of exercises is the STATA software. The files containing all STATA commands to solve these exercises of the practical applications are presented in the

[3] The reader may refer to UNCTAD-WTO (2012) for an introduction to the use of the STATA software to empirical trade and trade policy analysis.

chapters. These files and the relevant data can be found on the Practical Guide to Trade Policy Analysis website: http://vi.unctad.org/tpa and on the UNCTAD Trade Analysis Branch website: https://unctad.org/en/Pages/DITC/Trade-Analysis/TAB-Capacity-Building.aspx. A general folder entitled "Practical Guide to the Economic Analysis of Non-Tariff Measures" is divided into sub-folders which correspond to each chapter (e.g. "Practical Guide to the Economic Analysis of Non-Tariff Measures \Chapter2"). Within each of these sub-folders, the reader will find datasets, applications and exercises. Detailed explanations can be found in the file "readme.pdf" available on the website.

CHAPTER 1: Non-tariff measures: definitions and basic facts

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A. Overview and learning objectives

This chapter is an introduction to the types of non-tariff measures (NTMs) firms may have to face when producing domestically or when trying to export to some specific market and destination. It provides some definitions accepted by major international institutions and reviews the main multilateral agreements monitoring the use of technical regulations. Some figures about the prevalence and the perceived stringency at the firm level of NTMs are also discussed.

In this chapter you will learn what NTMs are and what types of NTMs governments can impose. You will also get some idea of their prevalence and stringency as perceived by firms.

B. Analytical tools

1. Definition of non-tariff measures

NTMs are policy measures, other than ordinary customs tariffs, that can potentially have an economic effect on international trade in goods, changing quantities traded, or prices or both.[4] NTMs are playing an increasing role in international trade because of the reduction in tariffs worldwide via successive agreements under the General Agreement on Tariffs and Trade/World Trade Organization (GATT/WTO), and due to growing consumer concerns about food safety and quality, and environmental protection.

NTMs include a wider set of measures than non-tariff barriers. Furthermore, the term "non-tariff barriers" is generally used to describe discriminatory (protectionist) measures, while NTMs do not necessarily reduce trade and welfare. As will be seen later in this practical guide, NTMs can in fact be trade and/or welfare-enhancing.

NTMs can be diverse and may target very different objectives. Import licenses or quotas aim to complement or substitute for tariffs, while sanitary and phytosanitary (SPS) measures or technical barriers to trade (TBT) often have non-trade objectives and aim to correct for market failures (e.g. health and consumer safety, and pollution and the environment). Despite the absence of trade objectives, SPS measures and TBTs may affect trade costs through associated procedural requirements.

What should be kept in mind, however, is that SPS measures and TBTs are in most circumstances adopted to regulate the domestic market. Most of these measures apply to both domestic and foreign goods indistinctly. What is often neglected is the impact this type of measures would have on domestic production and not only on imports. This dimension can not be easily treated mostly due to poor availability of relevant data.

[4] Non-tariff measures also apply to services and can affect trade flows as in the case of goods. In order to assess the impact of NTMs on trade in services, however, a specific empirical framework is necessary and, its study would require a distinct practical guide.

NTMs are complex instruments, and the analysis of their effect is also becoming increasingly difficult. NTMs act through multiple channels of influence and have multiple effects not only on trade but also on welfare and income distribution. Their impact may also interact with market structures because NTMs can segment markets and generate market power.

2. Non-tariff measures and the World Trade Organization: agreements on sanitary and phytosanitary measures and on technical barriers to trade

At the international level, NTMs are governed by two WTO agreements: the SPS and TBT Agreements. The SPS Agreement entered into force on 1 January 1995.[5] Implementation for developing countries was delayed by two years and for least developed countries by five years. The SPS Agreement pursues two main objectives. First, it recognizes the sovereign rights of WTO members to provide the level of health protection they deem appropriate. Second, it ensures that NTMs are not used as disguised restrictions on international trade. To achieve both objectives, the agreement encourages members to base their measures on international standards, guidelines, and recommendations, where they exist (Article 3.1). These organizations include, for food safety, the joint FAO/WHO Codex Alimentarius Commission; for animal health, the Office International des Epizooties; and for plant health, the FAO International Plant Protection Convention. If international standards, guidelines or recommendations do not exist, or if countries want to adopt measures that achieve a higher level of health protection, then they must be able to demonstrate that their measures are based on an "appropriate" risk assessment (Article 3.3). In cases where relevant scientific evidence is not available, a country may provisionally adopt measures on the basis of available pertinent information (Article 5.7). Furthermore, the measures should be applied only to the extent necessary to protect health, and arbitrary discrimination between countries where similar conditions prevail is forbidden (Article 2.3). Countries must notify all new or changed SPS regulations at a draft stage, publish regulations, and ensure that an enquiry point exists (Annex B).

The WTO Agreement on Technical Barriers to Trade ("TBT Agreement"), which entered into force in 1995, is the multilateral successor to the Standards Code, signed by 32 GATT contracting parties at the conclusion of the 1979 Tokyo Round of Trade Negotiations.[6] The purposes of the TBT Agreement can be broadly described as: (1) assuring that technical regulations, standards and conformity assessment procedures, do not create unnecessary obstacles to international trade, while (2) leaving Members adequate regulatory discretion to protect human, animal and plant life and health, national security, the environment, consumers, and other policy interests. Article 1.5 of the TBT Agreement excludes SPS measures from its scope meaning that a TBT measure cannot be an SPS measure and vice versa. However, the scope of the TBT Agreement is expected to be considered in relation to the SPS Agreement. The TBT Agreement defines three categories of measures: technical regulations, standards, and conformity assessment procedures. The main objectives of the TBT Agreement involve promoting the use of international standards (Article 2.4) and promoting mutual recognition of requirements and conformity assessment procedures between WTO members (Article 6.3). Furthermore, discrimination between countries where the

[5] For the text of the SPS Agreement, see https://www.wto.org/english/tratop_e/sps_e/spsagr_e.htm.

[6] For the text of the TBT Agreement, see https://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm.

same conditions prevail is forbidden, and the same requirements must be applied to domestic and imported goods. Finally, notifying countries must publish all their TBTs and establish enquiry points (Article 10.1). Although a clear distinction between SPS measures and TBTs is made in the agreements' texts, governments often draft and implement broad regulations that contain some requirements covered by the TBT Agreement and others by the SPS Agreement.

It is the purpose of a particular measure that determines whether that measure is subject to the disciplines of the SPS or the TBT Agreement, and not the particular product or category of product under consideration. Two examples provide an illustration of the distinction between SPS measures and TBTs: a regulation dealing with the treatment of imported fruit to prevent pests from spreading is classified as an SPS measure, while a measure focusing on the quality, grading, and labelling of imported fruit is a TBT measure. Similarly, a measure specifying the materials that can be used to make bottled water safe for human health, for instance to avoid contamination of the water by toxins in the material used, is covered by the SPS Agreement, while a measure describing the permitted sizes for the same bottle to ensure standard volumes falls under the TBT Agreement.

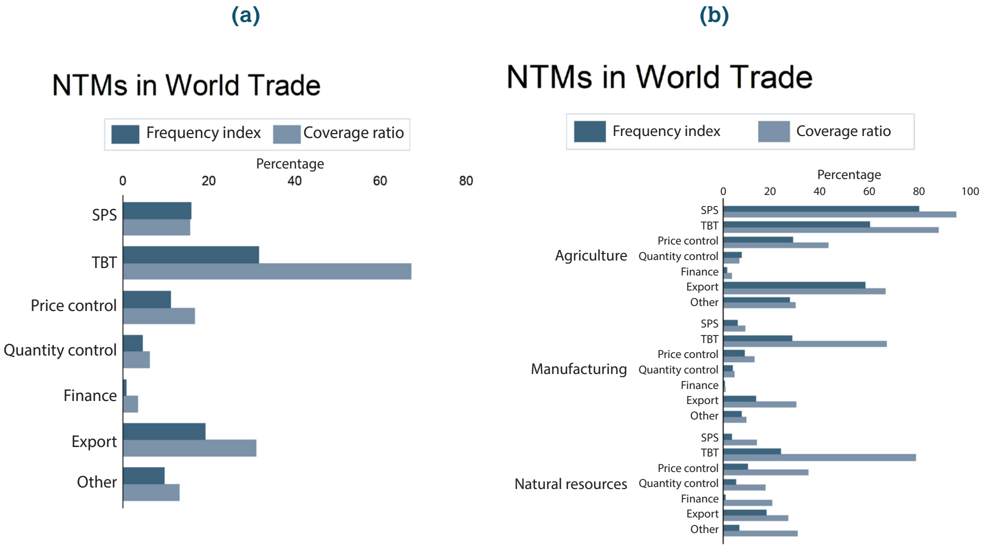
Both the SPS and TBT Agreements contain provisions on technical assistance as well as special and differential treatment to help developing countries implement the measures and take advantage of them. Despite this support, developing countries encounter difficulties in the implementation process.

3. Non-tariff measures: fact-finding

As discussed in the next Chapter, information about NTMs can be retrieved from several sources. All of them however suffer from some weakness that must be taken in consideration when analyzing facts and empirical results based on these various sources. Information about NTMs is often obtained from official national and international sources. It could also be obtained from more subjective sources such as specific surveys. The former type of information could allow us to identify the most prevalent types of measures applied in various countries and their predominance. The latter type of information could help us identify those measures representing possibly severe obstacles either to production or to trade or both. Impeding measures of this sort are often qualified as burdensome measures.

Information gathered from collected regulations prevailing around the world suggests that among the different types of NTMs, SPS measures and TBTs are the most predominant. Together, SPS measures and TBTs cover more products and trade value than price- and quantity-control measures. Furthermore, TBTs are more prevalent than SPS measures as shown in panel (a) of Figure 1 below: on average, they cover 30 per cent of a country's products and about 65 percent of imports, while SPS measures cover about 17 per cent of both products and imports. However, if we decompose them by product groups as reported in panel (b) of Figure 1, agri-food products are more affected by SPS measures than by TBTs. The opposite is observed for the Manufacturing and Natural resources sectors. Export measures are also frequently applied to imports in general and to agricultural products in particular.

Figure 1: Prevalence indicators of non-tariff measures, by type and broad product category



Source: UNCTAD secretariat calculations based on UNCTAD TRAINS I-TIP data.

Note: Data are based on multiple year observations the latest available year being 2015.

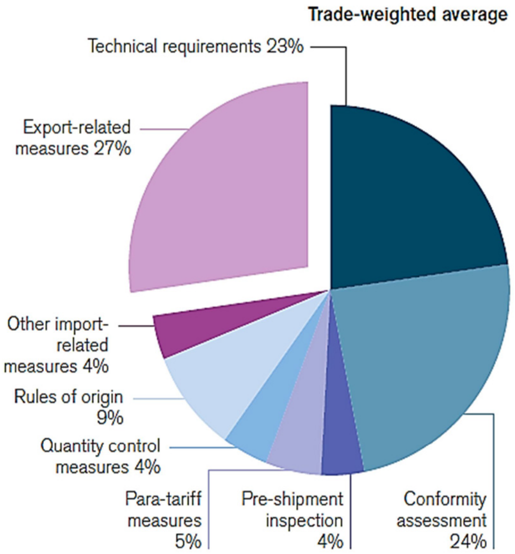
Figure 2 illustrates the importance of SPS measures and TBTs. It presents the breakdown of NTMs by type of measure. Data come from surveys conducted by the International Trade Centre (ITC) in 2010 among firms in 11 developing and least developed countries. Burdensome NTMs include measures applied both by importing countries and by exporters' home countries. The figure reports the trade-weighted average of NTMs and not the simple mean. The latter may give undue weight to smaller countries at the expense of larger ones. Indeed, some tiny country in terms of trade may be extremely restrictive as compared to a larger country absorbing a significant share of world trade. Taking the simple average would implies giving the same weight to a marginal country and to a country supposed to be more representative of the regulatory stringency affecting world trade. The trade-weighted average controls for this issue. The weights are the value of each country's exports in 2010. SPS measures and TBTs correspond to the sum of the categories "technical requirements" and "conformity assessment." They represent nearly half of all NTMs seen as burdensome by exporters in surveyed countries.

Interestingly, burdensome NTMs differ among export markets. For developed export markets, exporters from developing and least developed countries consider that SPS measures and TBTs represent three-quarters of burdensome NTMs. For developing export markets, this share is only one-half as shown in Figure 3.

ITC surveys are based on interviews with exporters in developing and least developed countries. The responses may therefore not represent the concerns and experiences of businesses in other countries. There have been some analyses on NTMs seen as burdensome by United States and

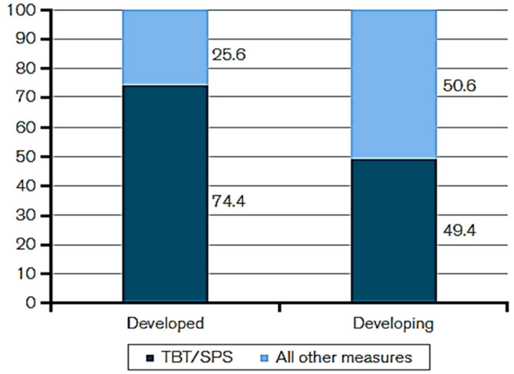
European exporters. According to WTO (2012), SPS measures and TBTs appear to be a major concern for European exporters (representing 52 per cent of all reported issues). For exporters in the United States, the equivalent share is much lower (22 per cent). The reason for this gap must be interpreted with care as interviews in both countries were not undertaken using precisely the same methodological approach especially in terms of sampling methods.

Figure 2: Burdensome non-tariff measures, by type of measure, 2010 (in per cent)



Source: WTO (2012).
Note: Based on business surveys by the International Trade Centre. The sample includes 11 developing and least developed countries.

Figure 3: Burdensome non-tariff measures, by type of country, 2010 (per cent share of SPS measures and TBTs in import-related non-tariff measures)



Source: WTO (2012).
Note: Based on business surveys by the International Trade Centre. The sample includes 11 developing and least developed countries.

CHAPTER 2: Data sources and incidence indicators

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A. Overview and learning objectives

This chapter first reviews the sources of information about non-tariff measures (NTMs). Although the availability of data on NTMs remains limited in terms of both time and country coverage, several sources of information exist. The data they contain do not necessarily share a common origin and it is crucial to understand as much as possible how possible differences can be observed. Once information has been collected several indicators can be used to assess the prevalence of each measure applied by some country to some product. This is an important step towards a precise appreciation of the possible impact measures could have on domestic production and especially on international trade. Formulas of some major indicators are presented and discussed. The most common indicators do not necessarily reflect any regulatory stringency and may need to be complemented by additional elements reflecting more qualitative dimensions of a specific measure. Using existing data, procedures and STATA commands are presented in detail in order to generate these indicators for some set of countries in some specific years.

In this chapter you will learn where to find NTM data and how those data are presented in the various databases available. You will all learn how to calculate several measures of the presence and incidence of NTMs and what biases are possibly involved in their calculation.

B. Analytical tools

1. Data sources

Information on NTMs can be used for several purposes. It allows the detection of the existence of different type of NTMs across countries and sectors. There is no database yet, however, that provides on a large and inclusive scale enough information to precisely assess the stringency either in absolute or relative terms, of any measure. The best that can be assessed is the heterogeneity in countries regulatory frameworks which should not be confused with relative regulatory strictness. NTMs information can also be used to assess trade effects of different types of measures. In order to do so, NTMs information must be associated with other trade-related information. Some description of sources of possibly relevant information is provided in the rest of the section.

Main NTMs databases

As discussed in Chapter 1 different sources provide information on NTMs implemented by countries. The type of information may vary with the source used. Surveys of firms may help determine the stringency of different NTMs and eventually their impact on their respective production and exports. Surveys of consumers may help assess the impact of regulations on their consumption choice. Information provided by sources where regulations related to NTMs are identified and classified can be used to assess the prevalence and incidence of the latter.

This section focuses on four of those sources. The oldest is the WTO notifications.[7] According to both the WTO SPS and TBT Agreements, countries must notify their NTMs to the WTO. Such

[7] The WTO's I-TIP database reports these notifications (https://i-tip.wto.org/goods/).

notifications were often used in the first papers investigating the trade impact of NTMs. However, these data suffer from two main weaknesses: first, some countries do not notify their measures to the WTO and therefore some notifications are missing; and second, the information provided for some notifications is rather scarce (in terms of products affected, etc.). Furthermore, not all NTMs should be notified to the WTO. Countries must notify only those measures that are new or have changed since 1995, that differ from international standards or represent situations where no international standards exist, and that may have a significant impact on trade. Finally, countries have no obligation to notify final NTMs; some notified measures may therefore have been amended before being implemented, or even not implemented at all.

Figure 4 provides the yearly SPS and TBT notifications to the WTO. One can observe an increasing trend over time in the number of NTMs for both types of measures. However, the mechanism underlying these increases (i.e. the increasing number of measures or increased compliance with WTO obligations) cannot be clearly identified.

A second source of data is the historical Trade Analysis Information System (TRAINS) database,[8] developed by the United Nations Conference on Trade and Development (UNCTAD). The historical TRAINS database uses the WTO notifications and other (national) sources and provides information on the notifying country (the importing country), the affected product (at the six-digit level of the Harmonized System – HS), and the NTM's classification code (six core categories). Data are available for the period 1992–2010. However, for some countries, data are available only for a subset of NTM categories and/or a subset of years. Therefore, the coverage of the database is only partial, and for blank cells, the database does not distinguish clearly between missing data or the real absence of NTMs.

To address the weaknesses of the two first sources, a new data collection approach has recently been developed and initiated by UNCTAD. In a global and coordinated effort international organizations, including the African Development Bank, ITC, UNCTAD, the World Bank (forming the Transparency in Trade (TNT) Initiative) in cooperation with other international and regional organizations collect NTMs data. The aim is to accelerate and unify NTM data collection and create a global information source. A Multi-Agency Support Team (MAST)[9] initiated by UNCTAD's Secretary General developed a new classification of NTMs, the International Classification of NTMs shown in Figure 5, with the main novelty of being much more disaggregated on so called technical measures (i.e. SPS measures and TBT). The new classification develops a tree branch structure: NTMs are classified into 16 chapters depending on their scope and/or design (from A to P). Each chapter is further divided into sub-groups (up to three digits) to allow a finer classification of the regulations affecting trade. All chapters (except chapter P, which deals with exports) reflect the requirements of the importing country with regard to its imports.[10] The trade effect of NTMs

[8] For more information on the TRAINS database, see https://unctad.org/ntm and https://trains.unctad.org/.

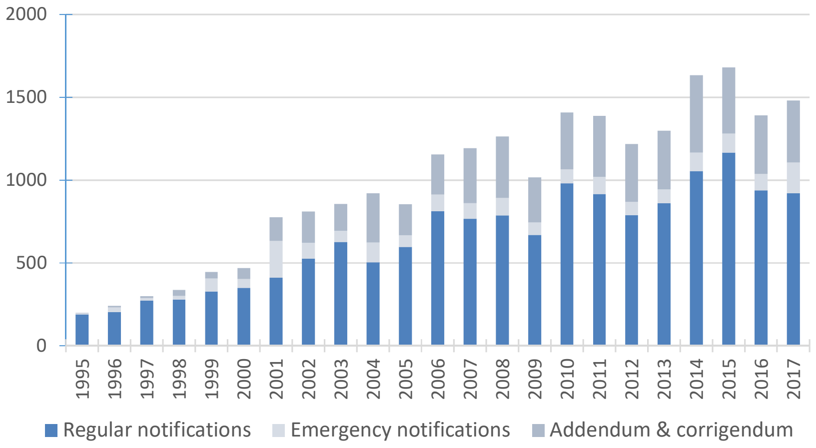
[9] Eight international organizations are member of MAST: FAO, IMF, ITC, OECD, UNCTAD, UNIDO, World Bank, WTO, see https://unctad.org/en/Pages/DITC/Trade-Analysis/Non-Tariff-Measures/MAST-Group-on-NTMs.aspx.

[10] For a detailed inventory by country of available NTMs, see https://unctad.org/en/Pages/DITC/Trade-Analysis/Non-Tariff-Measures/NTMs-Data.aspx.

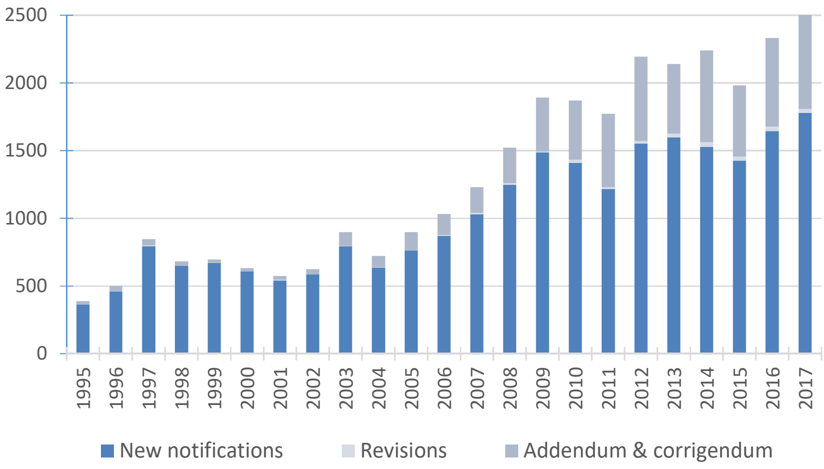
varies across chapters. NTMs in some chapters have clearly restrictive effects, while others have ambiguous trade effects. The Classification is deliberately neutral.

Figure 4: World Trade Organization SPS and TBT notifications, 1995–2017

(a) SPS measures



(b) TBTs



Source: WTO http://spsims.wto.org/en/ and http://tbtims.wto.org/en/.

Note: New notifications refer to a new proposed technical regulation or conformity assessment procedure. New notifications can be associated with a previously notified measure (e.g. amending or supplementing an adopted measure or replacing a withdrawn or revoked measure). Revisions are submitted to indicate that a notified measure has been substantially re-drafted prior to adoption or entry into force. A revision replaces the original notification. Addendum and Corrigendum refer to notifications providing additional information related to a notification or the text of a notified measure or to correct minor administrative or clerical errors which do not entail any changes to the meaning of the content of a notified regulation.

Figure 5: Non-tariff measures classification in the Transparency in Trade Initiative

Import-related measures	**Technical measures**	A	Sanitary and phytosanitary (SPS) measures
		B	Technical barriers to trade (TBT)
		C	Pre-shipment inspections and other formalities
	Non-technical measures	D	Contingent trade-protective measures
		E	Non-automatic licensing, quotas, prohibitions and quantity-control measures
		F	Price-control measures, including additional taxes and charges
		G	Finance measures
		H	Measures affecting competition
		I	Trade-related investment measures
		J	Distribution restrictions
		K	Restrictions on post-sales services
		L	Subsidies (excluding export subsidies)
		M	Government procurement restrictions
		N	Intellectual property
		O	Rules of origin
Export-related measures		P	Export-related measures

Source: UNCTAD (2017).

Note: SPS = sanitary and phytosanitary; TBT = technical barriers to trade.

The MAST initiative also introduces "procedural obstacles," i.e. issues related to the process of NTM implementation (e.g. a slow or costly certification). Nine broad categories of procedural obstacles are considered: (a) administrative burdens, (b) information/transparency issues, (c) inconsistent or discriminatory behaviour of officials, (d) time constraints, (e) payment, (f) infrastructural challenges, (g) security, (h) legal constraints, and (i) others. Information on these obstacles is collected through surveys or mechanisms that record complaints.

Using the UNCTAD TRAINS data on NTMs, the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) has built various indicators measuring the incidence of such measures.[11] These indicators are computed for each country at different levels of aggregation and cover the first five categories of NTMs listed in Figure 5.[12]

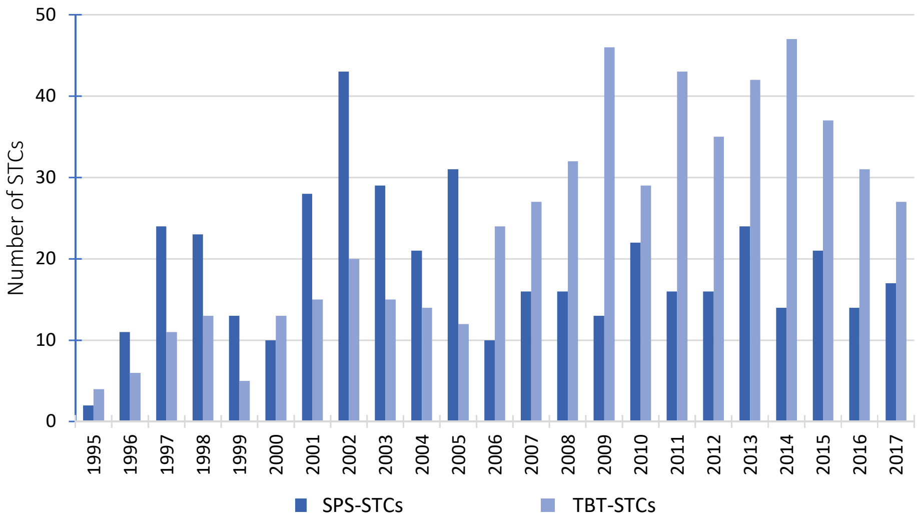
[11] For more information on the CEPII mapping, http://www.cepii.fr/CEPII/fr/bdd_modele/presentation.asp?id=28.

[12] Based on recently updated data, UNCTAD has also calculated similar indices. For more information see unctad.org/ntm and https://trains.unctad.org/Forms/Analysis.aspx.

Finally, the last source of information on NTMs implemented by countries deals with what are called specific trade concerns (STCs).[13] Countries can indeed raise concerns at the WTO's SPS and TBT Committees about measures put in place by other countries and deemed to restrict trade. However, not all concerns raised relate to perceived trade restrictions, as countries sometimes only seek clarification on a measure adopted by a partner, or remind a partner of missing notifications.

Between 1995 and 2017, 434 SPS-STCs and 548 TBT-STCs were raised at the WTO. Figure 6 shows the numbers of concerns raised between 1995 and 2017. This figure shows an increase in the number TBT-STCs raised to the WTO over time. As to SPS-STCs the trend is more mitigated with clear ups but also clear downs. This increase may signal an increasingly adverse effect of measures or an increasing participation of countries in the specific trade concern mechanism. The figure does not allow to disentangle between these two potential explanations.

Figure 6: **SPS-specific and TBT-specific trade concerns, 1995–2017**



Source: WTO http://spsims.wto.org/en/ and http://tbtims.wto.org/en/.

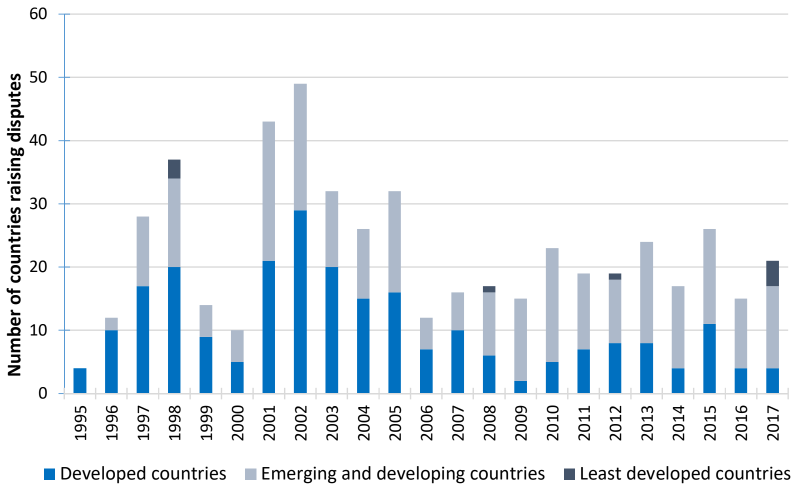
Note: We consider only new STCs; those already raised in the past are not included in the calculations.

Figure 7 shows the number of countries raising trade concerns about SPS measures and TBTs by income group. An issue can be raised by more than one country and each country is counted separately. Therefore, the number of complainants is larger than the number of issues (Figure 6). Developed countries participate more in the trade concerns mechanism than developing and least developed ones. However, the number of issues raised by developing countries is increasing over time, meaning that these countries are becoming important users of the mechanism. The number of issues raised by least developed countries is still marginal.

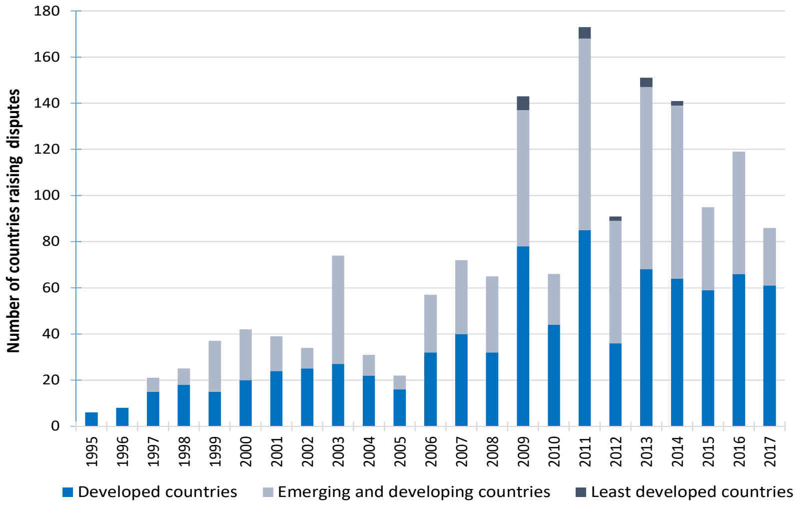
13 Information on these trade concerns is available in the WTO I-TIP database at https://i-tip.wto.org/goods.

Figure 7: Specific trade concerns presented by countries, by development level, 1995–2017

(a) SPS measures



(b) TBTs



Source: WTO http://spsims.wto.org/en/ and http://tbtims.wto.org/en/.
Note: the number of countries raising STCs is larger than the number of STCs shown in Figure 6 because an STC can be raised by more than one country. The European Union is aggregated into one country.

Other trade policy databases

Tariff data can be extracted from the UNCTAD TRAINS database (through WITS), or from the Market Access Map (MAcMap) database developed by the ITC.[14] The TRAINS database provides MFN applied tariffs and preferential tariffs at the HS 6-digit level including ad valorem equivalent (AVE) tariffs for specific and compound duties for almost all countries from 1988 to 2017. WITS also includes bound rates (WTO CTS database) and statistics on tariffs such as simple and trade weighted averages and number of duty free lines. The MAcMap database provides the AVE of applied border protection at the HS six-digit level. It covers almost all countries but few years (2001, 2004, and 2007). MAcMap covers all regional trade agreements (RTAs) in force and, incorporates tariff rate quotas and AVEs of specific duties. In addition, it uses an original aggregation method based on reference groups, which limits endogeneity issues.[15]

Trade agreements are not exclusively about preferential tariff cuts. Member countries of any trade agreement can not only undertake additional obligations in policy areas covered by the WTO such as customs administration or contingent protection. But they can also commit to policy reform in domains that are not regulated by the WTO, such as investment and competition policy. Information on RTAs (trade agreements based on reciprocal concessions) and PTAs (trade agreements based on non-reciprocal concessions) notified to the WTO is available in a raw format in the WTO-RTA[16] and WTO-PTA[17] databases. A mapping of the content of these agreements has been conducted by a team at the World-Bank and reported in a specific database publicly available. The "Content of Deep Agreements" dataset[18] maps 52 provisions in 279 agreements notified at WTO signed between 1958 and 2015. It also includes information about legal enforceability of each provision.

Merchandise trade flows databases

The above data can be used to assess the impact of NTMs on trade flows and on prices of traded goods. In order to do so NTM data could be merged with trade, tariffs, and other types of data in order to analyse their trade impact. The main sources for trade data are the United Nations Commodity Trade Statistics (UN Comtrade) database[19] and the CEPII world trade database (*Base*

[14] The TRAINS database can be accessed through UNCTAD-TRAINS at https://trains.unctad.org/, the World Integrated Trade Solution at wits.worldbank.org and the Market Access Map database can be accessed at either http://www.macmap.org/ or http://www.cepii.fr/anglaisgraph/bdd/macmap.htm.

[15] In the "reference-group" method, each country is assigned to one of the five world regions (the reference groups) that share similar characteristics, using hierarchical clustering analysis. The weight for the flow is ultimately the share of good k in imports of the entire reference group originating from country i, scaled by the size of country j's imports in its reference group. The main interest of such weights, compared to a simple weighting scheme, is to take into account at least part of the prohibitive level of certain transaction costs: a measure that would completely prevent trade would result in a null contribution to a trade-weighted average, whereas it would imply a positive contribution to the reference-group-weighted aggregate (Bouët *et al.*, 2004).

[16] RTAs contents are accessible at http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx.

[17] PTAs contents are accessible at http://ptadb.wto.org/.

[18] The dataset is accessible at https://datacatalog.worldbank.org/dataset/content-deep-trade-agreements.

[19] The UN Comtrade database is available at http://comtrade.un.org/.

pour l'Analyse du Commerce International - BACI).[20] The UN Comtrade statistics provide bilateral import and export flows for all countries at the product level (six-digit level of the HS classification) from 1962 until 2017. Despite its large coverage, this dataset suffers from some quality issues. In particular, one cannot disentangle between zero flows and missing observations. The CEPII BACI dataset solves this issue. It uses original procedures to harmonize data: evaluation of the quality of country declarations to average mirror flows, evaluation of cost, insurance and freight (CIF) rates to reconcile import and export declarations, etc. The BACI data are available at the product level (HS six-digit) and for all countries over the 1995–2016 period.

Databases on other relevant variables

Finally, some authors estimate a tailored gravity model[21] to investigate the trade effects of NTMs (see chapter 3). In such applications, countries' size and wealth may be proxied using gross domestic product (GDP) and GDP per capita from the World Bank's World Development Indicators.[22] Other traditional gravity variables, such as geographical distance, common border, common language, and colonial links, may be obtained from the CEPII.[23] Administrative, environmental, legal system, and corruption data are available from the World Bank's Doing Business Report[24] or the Worldwide Governance Indicators Project.[25]

2. Incidence indicators

What is the share of products and trade affected by NTMs? Different incidence indicators help answer this question. However, no ideal indicator exists. They all suffer from some weaknesses and their respective strengths often complement each other. This implies that analyzing the incidence of NTMs should rely on more than one indicator to be able to draw meaningful insights. This section focuses on three of them: the frequency index, coverage ratio, and prevalence ratio. They are relatively easy to compute, and their precision depends on the disaggregation level of information used for the computation. If they are updated on a regular basis, they can help keep track of the evolution of the relative incidence of different types of NTMs.

[20] The BACI database is available at http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=1.

[21] The gravity model of international trade is the canonical empirical model used to identify the components of bilateral trade as well as to estimate the effects of some policy reform or instrument. An extensive presentation and discussion is provided in Chapter 3 of UNCTAD-WTO (2012) practical guide.

[22] The World Bank's World Development Indicators are available at http://data.worldbank.org/data-catalog/world-development-indicators.

[23] Available from CEPII at http://www.cepii.fr/CEPII/en/bdd_modele/bdd.asp.

[24] Available at http://www.doingbusiness.org/.

[25] The Worldwide Governance Indicators Project can be accessed at:
http://info.worldbank.org/governance/wgi/#home

The frequency index provides the share of products affected by one or more NTMs. Formally, the frequency index of NTMs imposed by country *j* is:

$$F_j = \left[\frac{\sum_i D_i M_i}{\sum_i M_i} \right] * 100 \tag{2.1}$$

where D_i is a dummy variable reflecting the presence of one or more NTMs on product *i* (i.e. it takes the value one if at least one NTM is imposed on product *i* and zero otherwise), and M_i is a dummy variable indicating whether there are imports of product *i*. The frequency index suffers from two main drawbacks. First, it accounts only for the presence of NTMs and not for their stringency;[26] second, it does not indicate the effects of NTMs on prices, production of exporters, and international trade. Moreover, the index may suffer from a downward bias if imports drop to zero because of the measure itself. This could happen if the implementation of the regulation would lead to a prohibitive increase in production costs.

The coverage ratio reports the share of imports affected by one or more NTMs in total imports. Formally, the coverage ratio of NTMs applied in country *j* can be written as:

$$C_j = \left[\frac{\sum_i D_i V_i}{\sum_i V_i} \right] * 100 \tag{2.2}$$

where D_i is defined as previously, and V_i is the value of imports of product *i*. Two weaknesses affect its computation. First, it may suffer from endogeneity: if NTMs reduce imports, the coverage ratio is downward-biased. Moreover, it does not indicate the effects of NTMs on prices, production of exporters, and international trade.

Finally, the prevalence ratio, which is used less often, accounts for the fact that a large number of products have more than one regulatory measure applied to them. This ratio captures the average number of NTMs affecting an imported product. Formally, the prevalence ratio for NTMs applied in country *j* is:

$$P_j = \left[\frac{\sum_i N_i M_i}{\sum_i M_i} \right] * 100 \tag{2.3}$$

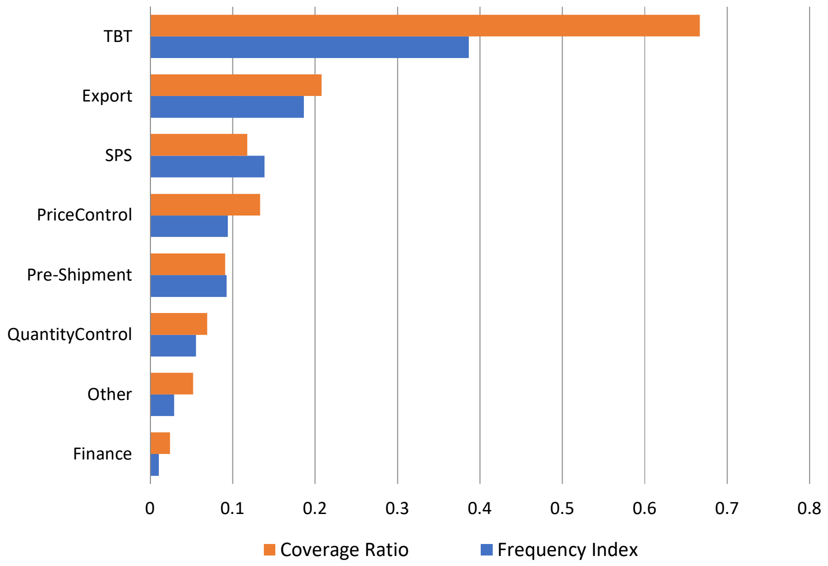
where N_i is the number of NTMs on product *i*, and M_i is defined as previously. The prevalence ratio is a trade-free indicator and thus would not suffer form any downward bias. However, it should

[26] The stringency of a measure refers to the strictness imposed by the regulation for instance on pesticides Maximum Residue Levels (MRLs) legally tolerated in or on food or feed. A more stringent measures can be expected to increase the costs of production.

not be interpreted as an indicator of stringency although a larger number of measures applying to the same product could reflect a stricter regulatory framework. This may be the case if one compares prevalence ratios across products within a broad sector and within the same country. An interpretation of differences in prevalence ratios across countries may not be that straightforward as they may express divergence in the regulatory approach.

Figure 8 reports the frequency index and coverage ratio by NTM category. The figure comes from the World Bank and UNCTAD (2018). The sample includes 109 countries. Data are disaggregated at the six-digit level of the HS classification (more than 5,000 products). The figure shows the distribution of NTMs across eight categories of NTMs for all countries pooled together. It suggests that TBTs are the most widely used NTMs, with about 40 per cent of products and about 67 per cent of trade affected by them. For SPS measures, these percentages are around 12–14 per cent. The large incidence of SPS measures and TBTs raises concerns for developing countries' exports. These measures may impose quality and safety standards that often exceed international standards. Even if they are not protectionist per se, these measures may exclude small developing country producers from the export market (because of adaptation costs that are too high). Pre-shipment inspections affect approximately 10 per cent of trade and products. Price-control measures affect a small share of goods. These measures are largely related to anti-dumping and countervailing duties. Finally, quantity controls affect 6 per cent of products and 7 per cent of trade. Today, these measures often involve non-automatic licensing. They used to take the form of quotas and export restrictions, but this is no longer the case because most of these quantitative restrictions are now prohibited by WTO rules.

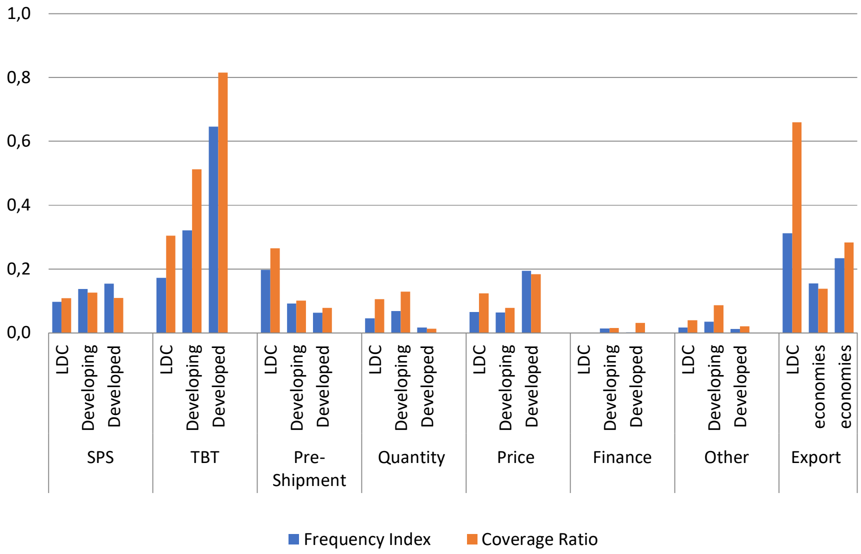
Figure 8: Frequency index and coverage ratio, by non-tariff measure category, various years between 2014 and 2018 (share)



Source: World Bank and UNCTAD (2018) based on UNCTAD TRAINS-NTMS.
Note: UNCTAD's NTM data includes 109 countries, covering 90 per cent of global trade.

Figure 9 describes the frequency index and coverage ratio by NTM category and income group. We observe some differences in the incidence of each type of NTM across income groups. While developed countries use more intensively TBTs than developing countries and LDCs, the incidence of SPS measures is similar across country groups. Pre-shipment inspections appear to be more present in LDCs. While price control measures are intensively implemented by developed countries this is not the case for other types of countries which would rather use quantity controls. Export measures are also quite present amongst LDCs as compare to developed and other developing countries. Looking at the details of data presented in Figure 9 reveals that SPS measures and TBTs are extensively used by countries in Latin America, Africa, and high-income countries. They are less used by Asian countries. Latin American and African countries also employ a large number of quantitative restrictions, with African countries tending to regulate their imports relatively more than other countries. According to Nicita and Gourdon (2013), these SPS and TBT regulations may originate in part from an effort to harmonize African regulations with those of their main trading partner (the European Union). Pre-inspection shipments are also widely applied. These measures are often implemented to fight corruption and facilitate customs procedures.[27]

Figure 9: Frequency index and coverage ratio, by non-tariff measure category and region, 2010 (share)



Source: World Bank and UNCTAD (2018) based on UNCTAD TRAINS-NTMS.
Note: UNCTAD's NTM data includes 109 countries, covering 90 per cent of global trade.

In Figures 8 and 9, frequency index and coverage ratio provide similar conclusions. However, coverage ratios are often larger than frequency indices. Two reasons may explain this result. First,

[27] See Anson, Cadot and Olarreaga (2006) for a theoretical treatment and empirical assessment of the possible relationship between pre shipment inspections and the occurrence of fraud.

this result may come from an import composition effect. Countries (especially developing ones) often import larger volumes of products (agriculture) for which NTMs are more extensively used. Second, NTMs may be applied to products that are most traded. This is often observed in developed countries.

3. Complementarity versus substitutability between tariffs and non-tariff measures

Do countries implementing high tariffs also apply NTMs more frequently? Do tariffs and NTMs complement or substitute for each other as trade policy instruments? If a positive relationship emerges between the use of NTMs and the level of tariffs, this may suggest that the instruments complement one another.[28] However, the existing literature provides mixed results.

According to Bagwell and Staiger (2001), Bajona and Ederington (2009), Copeland (1990), and Ederington (2001), as tariffs are reduced NTMs may become attractive tools to replace them and to protect import-competing industries. Broda *et al.* (2008) also show that due to contraints on the use of tariffs imposed by the GATT/WTO commitments, the United States set significantly higher NTMs in import-competing sectors. Using Colombian data for the mid-1980s and early 1990s, Goldberg and Pavcnik (2005) find a positive correlation between tariffs and NTMs, suggesting some complementarity between the two trade policy instruments. On the other hand, Kee *et al.* (2009) find some evidence of substitution between tariffs and NTMs. Using data for 91 countries in the early 2000s, the authors report that the overall level of protection decreases with GDP per capita. However, the average AVE of NTMs increases with GDP per capita. Similarly, Limao and Tovar (2011) also report some substitution effects. Using Turkish data, they underline that the reductions of tariffs imposed via multilateral and preferential commitments increase the probability of the use of NTMs. Nevertheless, this substitution is not perfect: tariff cuts are partially but not totally offset by higher NTMs.

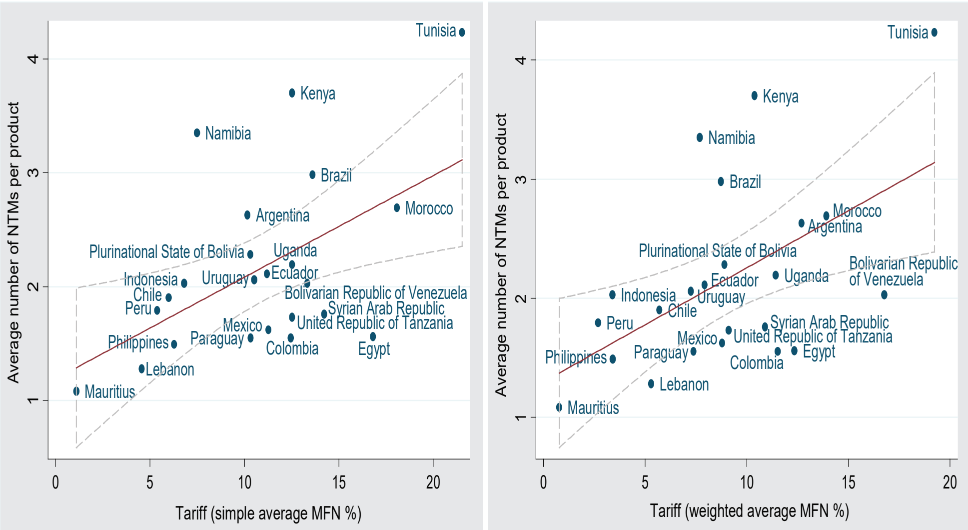
Nicita and Gourdon (2013) investigate the policy complementarity between NTM prevalence and most-favoured-nation (MFN) tariffs at the country level (Figure 10 panel (a)) and at the sector level (Figure 11) using the UNCTAD TRAINS databases. At the country level, the authors find a positive relationship between the average number of NTMs per product and tariffs. The correlation is rather strong, suggesting that countries where tariffs are high also apply a large number of NTMs per product. An analysis based on more recent NTMs data that include a lager country coverage, suggests that the positive relationship does not hold any more and is even reverted when prevalence, corresponding to the average number of NTMs per product is considered, as reported in Figure 10 panel (b).

At the sector level as depicted by Figure 11, Nicita and Gourdon (2013) find that the correlation is rather weak and largely driven by four agricultural product groups (live animals, vegetables, fats and oils, and prepared food).

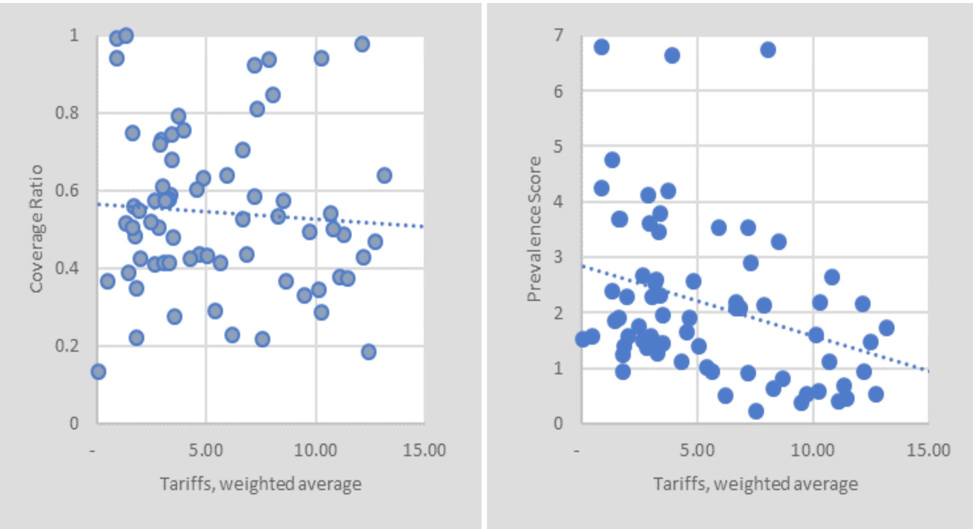
[28] Note that concluding for a positive relationship would require an empirical investigation that goes beyond the computation of simple correlation coefficients. Econometric techniques should be used to identify precisely a causal link between tariff levels and NTM incidence indicators.

Figure 10: Prevalence of non-tariff measures versus most-favoured-nation tariffs

(a)

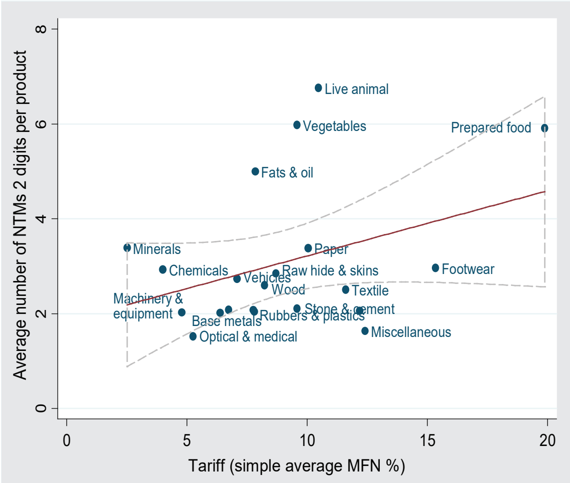


(b)



Source: Panel (a) Nicita and Gourdon (2013); Panel (b) UNCTAD-World Bank (2018).
Note: MFN = most-favoured-nation.

Figure 11: Correlation between the prevalence of non-tariff measures and most- favoured-nation tariffs, by product



Source: Nicita and Gourdon (2013).
Note: MFN = most-favoured-nation; NTM = non-tariff measure.

C. Applications

1. Computing prevalence indicators

This application aims to perform graphical analyses of NTMs and compute descriptive statistics. It uses some datasets presented in Section B.1 and the incidence indicators described in Section B.2. The last part of the technical application investigates the substitutability versus complementarity of NTMs and tariffs discussed in Section C.1.

(a) Download the data

The data needed for the technical application can be downloaded from the UNCTAD website. Explanations on the construction of the datasets used here are provided in Gourdon (2014).

Download the two files "NTM-MAP_Country.dta" and "NTM-MAP HS-Section.dta". The first file reports the data at the country level, while the second reports data at the country and HS section levels. The sample includes 63 countries, of which 24 are European countries, and deals with the five categories of NTMs defined in the TNT classification (SPS measures, TBTs, pre-shipment inspections, price controls, and quantity control measures; see Figure 5).

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

To open the dataset at the country level in Stata, apply the command "use". Before running the graphs and reporting the descriptive statistics, we finalize the dataset. First we average all European countries. Second we define a "continent" variable, which groups countries included in the dataset by continent (Latin America, Africa, Asia, Middle East and North Africa, developed countries). The latter group includes both the European Union and Japan.

```
* Dataset defined at the country level

use NTM-MAP_Country, clear

* Average all European countries
gen EU = 1 if isor == "AUT" | isor == "BEL" | isor == "CYP" | isor == "CZE" | isor == "DEU" | isor
== "DNK" | isor == "ESP" | isor == "EST" | isor == "FIN" | isor == "FRA" | isor == "GBR" | isor ==
"GRC" | isor == "HUN" | isor == "IRL" | isor == "ITA" | isor == "LTU" | isor == "LUX" | isor =="LVA" |
isor=="NLD" | isor == "POL" | isor=="PRT" | isor=="SVK" | isor == "SVN" | isor == "SWE"

replace isor = "EUR" if EU == 1
collapse HSline Num* Pres* Cov* Freq* , by(isor)
* Define continent
gen continent = "Lat_America" if isor == "ARG" | isor == "BOL" | isor == "BRA" | isor == "CHL" | isor
== "COL" | isor == "CRI" | isor == "ECU" | isor == "GTM" | isor == "MEX" | isor == "PER" | isor ==
"PRY" | isor =="VEN" | isor == "URY"
replace continent = "Africa" if isor == "BDI" | isor == "BFA" | isor == "CIV" | isor == "GIN" | isor ==
"KEN" | isor == "MDG" | isor == "MUS" | isor == "SEN" | isor == "TZA" | isor == "UGA" | isor == "ZAF"

replace continent = "Asia" if isor == "BGD" | isor == "IND" | isor == "LKA" | isor == "NPL" | isor ==
"PAK" | isor == "CHN" | isor == "IDN" | isor == "KHM" | isor == "LAO" | isor ==" PHL"

replace continent = "MENA" if isor == "EGY" | isor == "LBN" | isor == "MAR" | isor == "SYR" | isor
== "TUN"
replace continent = "Dvlped" if isor == "EUR" | isor == "JPN"
save temp_NTM_country, replace

* Dataset defined at the country-HS section level
use "NTM-MAP HS-Section", clear
* Sections' label
gen Section_label = "Live animals" if Section == 1
replace Section_label = "Vegetable products" if Section == 2
replace Section_label = "Fats and oils" if Section == 3
replace Section_label = "Processed food" if Section == 4
replace Section_label = "Mineral products" if Section == 5
replace Section_label = "Chemicals" if Section == 6
replace Section_label = "Rubber and plastics" if Section == 7
replace Section_label = "Rawhide and skins" if Section == 8
replace Section_label = "Wood" if Section == 9
replace Section_label = "Paper" if Section == 10
```

```
replace Section_label = "Textile" if Section == 11
replace Section_label = "Footwear" if Section == 12
replace Section_label = "Stone and Cement" if Section == 13
replace Section_label = "Pearls" if Section == 14
replace Section_label = "Base metals" if Section == 15
replace Section_label = "Machinery and electrical equipment" if Section == 16
replace Section_label = "Motor vehicles" if Section == 17
replace Section_label = "Optical and medical instruments" if Section == 18
replace Section_label = "Arms and ammunition" if Section == 19
replace Section_label = "Miscellaneous" if Section == 20
replace Section_label = "Works of Art" if Section == 21

* Average all EU countries
gen EU = 1 if isor == "AUT" | isor == "BEL" | isor == "CYP" | isor == "CZE" | isor == "DEU" | isor ==
"DNK" | isor == "ESP" | isor == "EST" | isor == "FIN" | isor == "FRA" | isor == "GBR" | isor == "GRC"
| isor == "HUN" | isor == "IRL" | isor == "ITA" | isor == "LTU" | isor == "LUX" | isor == "LVA" | isor ==
"NLD" | isor == "POL" | isor == "PRT" | isor == "SVK" | isor == "SVN" | isor == "SWE"

replace isor = "EUR" if EU == 1
collapse Num* Pres* Cov* Freq* , by(isor Section Section_label)

* Define continent
gen continent = "Lat_America" if isor == "ARG" | isor == "BOL" | isor == "BRA" | isor == "CHL" | isor
== "COL" | isor == "CRI" | isor == "ECU" | isor == "GTM" | isor == "MEX" | isor == "PER" | isor ==
"PRY" | isor == "VEN" | isor == "URY"

replace continent = "Africa" if isor == "BDI" | isor == "BFA" | isor == "CIV" | isor == "GIN" | isor ==
"KEN" | isor == "MDG" | isor == "MUS" | isor == "SEN" | isor == "TZA" | isor == "UGA" | isor == "ZAF"
replace continent = "Asia" if isor == "BGD" | isor == "IND" | isor == "LKA" | isor =="NPL" | isor ==
"PAK" | isor == "CHN" | isor == "IDN" | isor == "KHM" | isor == "LAO" | isor =="PHL"

replace continent = "MENA" if isor == "EGY" | isor == "LBN" | isor == "MAR" | isor == "SYR" | isor
== "TUN"
replace continent = "Dvlped" if isor == "EUR" | isor == "JPN"
save temp_NTM_section, replace
```

(c) Generate graphs and descriptive statistics

We now generate graphs using the different incidence indicators (frequency index, coverage ratio, and prevalence ratio). These graphs can be done for all countries, by continent, for some specific countries and/or continents, for all NTMs, by type of NTMs, etc. We provide different examples below.

- Frequency index and coverage ratio, by broad type of NTMs

```
use temp_NTM_country, clear
collapse FreqA-FreqE CovA-CovE NumA-NumE

graph bar Freq*, legend(label(1 "SPS") label(2 "TBT") label(3 "Pre-shipment") label(4 "Price control")
label(5 "Quantity control")) title("Frequency Index, by broad type of NTMs") ytitle("Value")

graph bar Cov*, legend(label(1 "SPS") label(2 "TBT") label(3 "Pre-shipment") label(4 "Price control")
label(5 "Quantity control")) title("Coverage Ratio, by broad type of NTMs") ytitle("Value")
```

- Frequency index, coverage ratio, and prevalence ratio of NTMs, by continent

```
use temp_NTM_country, clear

collapse FreqNTM CovNTM NumNTM, by(continent)

graph bar FreqNTM CovNTM, over(continent) legend(label(1 "Freq. Index (all NTMs)") label(2
"Coverage ratio (all NTMs)")) title("Frequency Index and Coverage Ratio, by continent") ytitle("Value")

graph bar NumNTM, over(continent) legend(label(1 "Prevalence Ratio (all NTMs)")) title("Prevalence
Ratio, by continent") ytitle("Value")
```

- Frequency index, coverage ratio, and prevalence ratio of NTMs, by African countries

```
use temp_NTM_country, clear

graph bar FreqNTM CovNTM if continent == "Africa", over(isor) legend(label(1 "Freq. Index (all NTMs)")
label(2 "Coverage ratio (all NTMs)")) title("Frequency Index and Coverage Ratio, by African country")
ytitle("Value")
graph bar NumNTM if continent == "Africa", over(isor) legend(label(1 "Prevalence Ratio (all NTMs)"))
title("Prevalence Ratio, by African country") ytitle("Value")
```

- Frequency index and coverage ratio, by continent and broad type of NTMs

```
use temp_NTM_country, clear

collapse FreqA-FreqE CovA-CovE, by(continent)

graph hbar Freq*, over(continent) legend(label(1 "SPS") label(2 "TBT") label(3 "Pre-shipment") label(4
"Price control") label(5 "Quantity control")) title("Frequency Index, by continent & type of NTMs")
ytitle("Value")
graph hbar Cov*, over(continent) legend(label(1 "SPS") label(2 "TBT") label(3 "Pre-shipment") label(4
"Price control") label(5 "Quantity control")) title("Coverage Ratio, by continent & type of NTMs")
ytitle("Value")
```

- Share of product lines (defined at the HS six-digit level) with at least one NTM, one SPS measure, and one TBT

```
use temp_NTM_country, clear
gen shr_NTM = PresNTM/HSline * 100
gen shr_SPS = PresA/HSline * 100
gen shr_TBT = PresB/HSline * 100
label var shr_NTM "Share of HS6 lines with at least one NTM (%)"
label var shr_SPS "Share of HS6 lines with at least one SPS (%)"
label var shr_TBT "Share of HS6 lines with at least one TBT (%)"
* average share over the whole sample of countries
sum shr_*
```

(d) Generate graphs and descriptive statistics by economic sector

We now account for the sector dimension by adding the HS section dimension in our graphs and descriptive statistics.

- Frequency index of NTMs across economic sectors

```
use temp_NTM_section, clear
collapse FreqNTM, by(Section Section_label)
browse Section Section_label Freq
```

- Frequency index of NTMs across economic sectors, by continent

```
use temp_NTM_section, clear
collapse FreqNTM , by(Section Section_label continent)
reshape wide FreqNTM, i(Section Section_label) j(continent) string
rename FreqNTMAfrica Freq_Africa
rename FreqNTMAsia Freq_Asia
rename FreqNTMDvlped Freq_Dvlped
rename FreqNTMLat_America Freq_LatAmerica
rename FreqNTMMENA Freq_MENA
label var Freq_Africa "Freq. Index, Africa & all NTMs"
label var Freq_Asia "Freq. Index, Asia & all NTMs"
label var Freq_Dvlped "Freq. Index, Dvlped countries & all NTMs"
label var Freq_LatAmerica "Freq. Index, Latin America & all NTMs"
label var Freq_MENA "Freq. Index, MENA & all NTMs"
browse Section Section_label Freq*
```

- Frequency index across economic sectors, by broad type of NTMs

```
use temp_NTM_section, clear
collapse FreqA-FreqE, by(Section Section_label)
rename FreqA Freq_SPS
rename FreqB Freq_TBT
rename FreqC Freq_PreShip
rename FreqD Freq_PriceC
rename FreqE Freq_QtyC
label var Freq_SPS "Freq. Index, SPS"
label var Freq_TBT "Freq. Index, TBT"
label var Freq_PreShip "Freq. Index, Pre-shipment"
label var Freq_PriceC "Freq. Index, Price Control"
label var Freq_QtyC "Freq. Index, Quantity control"
browse Section Section Freq*
```

- Frequency index across economic sectors for African countries, by broad type of NTMs

```
use temp_NTM_section, clear
collapse FreqA-FreqE CovA-CovE, by(Section Section_label continent)
rename FreqA Freq_SPS
rename FreqB Freq_TBT
rename FreqC Freq_PreShip
rename FreqD Freq_PriceC
rename FreqE Freq_QtyC
label var Freq_SPS "Freq. Index, SPS"
label var Freq_TBT "Freq. Index, TBT"
label var Freq_PreShip "Freq. Index, Pre-shipment"
label var Freq_PriceC "Freq. Index, Price Control"
label var Freq_QtyC "Freq. Index, Quantity control"
browse Section Section_label Freq* if continent=="Africa"
```

2. Calculating complementarity/substitutability between tariffs and non-tariff measures

We now explore the complementarity versus substitutability between tariffs and NTMs (see Section C.1). Tariff data come from the TRAINS database (see Section B.1). For each country, we use the trade-weighted average MFN tariff applied on all products and all partners. Data are for 2009 for almost all countries; if the 2009 tariff is not available, we use 2008 data. The data extracted from TRAINS are reported in "Tariffs_country.txt" available on the UNCTAD website. We first merge the tariff and NTM data.

(a) Study complementarity/substitutability at the country level

```
clear
insheet using Tariffs_country.txt, name
sort isor
save Tariffs_country, replace

use NTM-MAP_Country, clear
* Finalize the dataset: Average all EU countries
gen EU = 1 if isor == "AUT" | isor == "BEL" | isor == "CYP" | isor == "CZE" | isor == "DEU" | isor ==
"DNK" | isor == "ESP" | isor == "EST" | isor == "FIN" | isor == "FRA" | isor == "GBR" | isor == "GRC"
| isor == "HUN" | isor == "IRL" | isor == "ITA" | isor == "LTU" | isor =="LUX" | isor == "LVA" | isor ==
"NLD" | isor == "POL" | isor == "PRT" | isor == "SVK" | isor == "SVN" | isor == "SWE"
replace isor = "EUR" if EU == 1
count
collapse HSline Num* Cov* Freq* , by(isor)
sort isor
merge isor using Tariffs_country
drop _merge
keep isor mfn_tariffs name CovNTM FreqNTM NumNTM
gen FreqNTM_pc = FreqNTM*100
gen CovNTM_pc = CovNTM*100
```

Using the different incidence indicators (frequency index, coverage ratio, and prevalence ratio), we now investigate the complementarity versus substitutability between tariffs and NTMs at the country level. A linear prediction plot and its confidence interval are added to the graphs.

```
* Using a frequency index of NTMs
twoway lfitci FreqNTM_pc mfn_tariffs || scatter FreqNTM_pc mfn_tariffs, mlabel (isor) legend(off)
xtitle(Tariffs (MFN, weighted average %)) ytitle(Frequency index of NTMs (%)) title("Frequency index
vs. tariffs, by country")

* Using a coverage ratio of NTMs
twoway lfitci CovNTM_pc mfn_tariffs || scatter CovNTM_pc mfn_tariffs, mlabel (isor) legend(off)
xtitle(Tariffs (MFN, weighted average %)) ytitle(Coverage ratio of NTMs (%)) title("Coverage ratio vs.
tariffs, by country")

* Using a prevalence ratio of NTMs
twoway lfitci NumNTM mfn_tariffs || scatter NumNTM mfn_tariffs, mlabel (isor) legend(off) xtitle(Tariffs
(MFN, weighted average %)) ytitle(Prevalence ratio of NTMs (%)) title("Prevalence ratio vs. tariffs, by
country")
```

(b) Study complementarity/substitutability at the sector level

Finally, we study the complementarity and substitutability at the sector level. Our tariff data still come from the TRAINS database, but are now defined at the sector level. They are included in "Tariffs_section.txt" available on the UNCTAD website. We still use the trade-weighted applied MFN tariff for 2009. We first finalize the dataset and merge tariff and NTM data.

```
clear
insheet using Tariffs_section.txt, name
sort section
save Tariffs_section, replace

use NTM-MAP HS-Section, clear
* Finalize the dataset
* 1/ Sections' label
gen Section_label = "Live animals" if Section == 1
replace Section_label = "Vegetable products" if Section == 2
replace Section_label = "Fats and oils" if Section == 3
replace Section_label = "Processed food" if Section == 4
replace Section_label = "Mineral products" if Section == 5
replace Section_label = "Chemicals" if Section == 6
replace Section_label = "Rubber and plastics" if Section == 7
replace Section_label = "Rawhide and skins" if Section == 8
replace Section_label = "Wood" if Section == 9
replace Section_label = "Paper" if Section == 10
replace Section_label = "Textile" if Section == 11
replace Section_label = "Footwear" if Section == 12
replace Section_label = "Stone and Cement" if Section == 13
replace Section_label = "Pearls" if Section == 14
replace Section_label = "Base metals" if Section == 15
replace Section_label = "Machinery and electrical equipment" if Section == 16
replace Section_label = "Motor vehicles" if Section == 17
replace Section_label = "Optical and medical instruments" if Section == 18
replace Section_label = "Arms and ammunition" if Section == 19
replace Section_label = "Miscellaneous" if Section == 20
replace Section_label = "Works of Art" if Section == 21

* 2/ Average all EU countries
gen EU = 1 if isor == "AUT" | isor == "BEL" | isor == "CYP" | isor == "CZE" | isor == "DEU" | isor ==
"DNK" | isor == "ESP" | isor == "EST" | isor == "FIN" | isor == "FRA" | isor == "GBR" | isor == "GRC"
| isor == "HUN" | isor == "IRL" | isor == "ITA" | isor == "LTU" | isor == "LUX" | isor == "LVA" | isor ==
"NLD" | isor == "POL" | isor == "PRT" | isor == "SVK" | isor == "SVN" | isor == "SWE"
replace isor = "EUR" if EU == 1
collapse NumNTM CovNTM FreqNTM, by(isor Section Section_label)

* 3/ Average all countries within each section
collapse NumNTM CovNTM FreqNTM, by(Section Section_label)
rename Section section
sort section
merge section using Tariffs_section
* _merge =1: for some sections, tariff is missing in Trains
drop _merge
gen FreqNTM_pc = FreqNTM * 100
gen CovNTM_pc = CovNTM * 100
```

We report below the command that should be run to obtain a graph on the complementarity versus substitutability between tariffs and NTMs at the sector level. A linear prediction plot and its confidence interval are added to the graphs.

```
* Using a frequency index of NTMs
twoway lfitci FreqNTM_pc mfn_tariffs || scatter FreqNTM_pc mfn_tariffs, mlabel (Section_label) legend(off) xtitle(Tariffs (MFN, weighted average %)) ytitle(Frequency index of NTMs (%)) title("Frequency index vs. tariffs, by product")

* Using a coverage ratio of NTMs
twoway lfitci NumNTM mfn_tariffs || scatter NumNTM mfn_tariffs, mlabel (Section_label) legend(off) xtitle(Tariffs (MFN, weighted average %)) ytitle(Prevalence ratio of NTMs (%)) title("Prevalence ratio vs. tariffs, by product")
```

D. Exercises

1. Comparing incidence ratios
   - (i) Preliminaries
     - a. Open the data file "NTM-MAP_Country.dta"
     - b. Generate a continent variable following the definition used in application 1 but keeping EU countries disaggregated
   - (ii) Incidence per country and continent
     - a. For each continent generate a graph including the three measures of incidence reported in the dataset at the country level
     - b. Identify in each continent the country with the highest frequency index, the highest coverage ratio and the highest prevalence ratio
2. Investigating the relationship between tariffs and non-tariff measures
   - (i) Preliminaries
     - a. Open the data file "NTM-MAP_Country.dta"
     - b. Generate a variable EU like the variable generated in application 2
     - c. Generate a continent variable based on the definition used in application 1
   - (ii) Merging with tariff data keeping EU countries separated
     - a. Merge with tariff data but keeping each EU country represented in the dataset

       Hints: Rename the isor and EU variables
     - b. Express incidence indicators in percentage points when necessary
   - (iii) Generate graphs by continent
     - a. Generate graphs of the relationship between tariffs and coverage ratios by continent
     - b. Generate graphs of the relationship between tariffs and prevalence ratios by continent

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

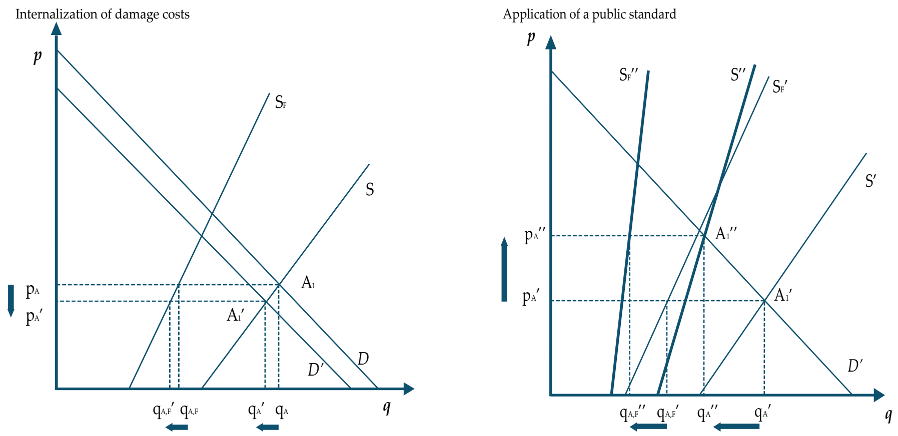
[30] See de Melo and Shepherd (2018) for a comprehensive review of such effects in standard demand and supply analytical framework.

[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:

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

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.

```
* 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"
```

CHAPTER 3

(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

CHAPTER 4: Micro-analysis of the trade effects of non-tariff measures

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CHAPTER 4

A. Overview and learning objectives

Most existing evidence on the impact of non-tariff measures (NTMs) on trade flows is based on sector level observations. However, a precise understanding of their impact would require more disaggregated information that is at the firm level. For instance, working with firm level data allows identify heterogeneous patterns of NTMs effects on production and trade flows. Ideally the all universe of firms should be included in the empirical analysis. In this context it would be possible to identify the effects of any measure on all trade margins. In practice, the most accessible data are trade data as collected by customs. This implies that only firms which have been able to reach some foreign market can be considered. This creates a *de facto* selection bias and limits the scope of the empirical set up. Nonetheless this is still an important first step in a more detailed assessment of NTMs effects. This Chapter discusses the details of such assessment exercises and reviews the existing empirical results. Based on real firm level export data some practical assessment is also included.

In this chapter you will learn how to assess the impact of NTMs on the margins of trade using firm-level observations.

B. Analytical Tools

1. Firm level analysis

To date, little evidence has been provided in the literature on the effects of NTMs on individual firms and their export decisions. NTMs may affect both the extensive margin (i.e. the probability of export) and the intensive margin of trade (i.e. the volume of trade per firm). Overall, firm-level studies show a negative effect of NTMs on both trade margins. Two potential reasons may explain this result. First, firm-level analyses focus on restrictive NTMs. Second, NTMs may be particularly trade restrictive for small firms and outsourcing firms.

NTMs, and in particular SPS measures and TBTs, impose product characteristics that are usually synonymous with additional inputs and consequently, an increase in the cost of producing and shipping the good facing these regulations. The implementation of an NTM may represent an additional fixed cost, as it may require some product or production process adaptation. For instance, a TBT may impose a requirement to use environmentally friendly equipment. If the producer does not possess this type of equipment, buying or even renting it will increase the cost of production independently of the quantity produced. That is, it will increase the fixed cost of production.

An increase in fixed costs may translate into an increase in the cost of entry into the good's export market. Those producers that are unable to buy the required equipment in order to meet the NTM's requirements will not be able to export at all. Firms with lower productivity are more likely to be excluded from the export market.

NTMs may also represent a variable cost whenever they affect the access per se to an export market, as in the case of shipment inspections. In that context, an NTM would affect domestic and foreign producers differently. And, although it would equally affect exporters of different sizes, it would have a lesser effect on exporters of high-quality products as these are characterized by higher mark-ups. All in all, exporters' and products' characteristics are crucial in determining the effect of shocks from NTM-related fixed and variable costs.

Although there are clear theoretical results on the respective effects of changes in fixed cost and variable costs of producing and exporting, it is difficult to test these findings empirically. The main reason, as usual, is accessibility to relevant and usable data.

Which kind of data can be used to investigate these issues? The quantification of the fixed costs induced by product adaptation can be calculated through surveys of firms. To examine whether the market share of large exporters increases, these survey data can be merged with customs data providing the value and quantity exported by each firm to each destination and for each product. Similarly, the potential exclusion from the international market of less productive firms may be analysed using customs data. If a firm exports a given product to a given destination in a given year and not the year after, then one can conclude it has exited from the export market. Variable costs related to the systematic inspections of shipments can also be measured through firms' surveys. The heterogeneous impact of these inspection costs on domestic and foreign producers is however hardly observable. To study this differentiated effect, one needs information on domestic value added and imports based on the same product classification. On the other hand, customs data are useful to analyse whether NTM-related variable costs equally affect exporters of different sizes. Finally, to observe whether exporters of high-quality products are less affected by NTM-related variable costs, one can check whether the quality and unit value of exported products differ across exporters.

Previous theoretical insights assumed that NTMs are necessarily enforced. However, it is not always the case, and this may affect the impact of NTMs from both a theoretical and empirical points of view. Therefore we may want to include some indication of the uncertainty of NTM enforcement to identify more precisely the effects of NTMs in an empirical set-up. Relevant information can be found in firms' surveys containing questions regarding the procedural obstacles they face. "Border alerts," such as those reported by the European Rapid Alert System for Food and Feed, could also be used to establish some specific identification strategy. The existence of border alerts protocols can be related explicitly to the probability of enforcement.

2. Impact of non-tariff measures on firms' export decisions

Fontagné *et al.* (2015) investigate the impact of these NTMs on individual firms' export decisions (whether or not to export, and how much to export) and pricing behaviour in export markets. Their focus is on SPS measures, and more precisely on "restrictive SPS measures," i.e. those that have been raised as concerns in the WTO SPS Committee. They work with French firm export data at the HS four-digit level and cover 10 years (1996–2005). Their sample is restricted to extra-European export flows and to firms that export a certain product to a certain market for at least four years within the 1996–2005 period. The authors also exclude small destinations (i.e. destinations below the median in terms of export flows received from France). Their estimations control for firm size and firm visibility on the export markets.

Results suggest that SPS concerns reduce the probability of export by 4 per cent and the number of exporting firms by 8 per cent. Results remain unchanged if SPS measures in the form of an import ban are excluded from the sample. SPS concerns also increase the probability that firms exit a given product-destination market by 2 per cent. Adaptation costs may be too high for some firms, which are excluded from the market. It does not necessarily mean that these firms stop exporting in general; they may re-orient their exports to another product destination market. On the other hand, tariffs do not affect the exit probability. Export costs associated with SPS measures seem therefore to be more important than variable export costs (e.g. tariffs). At the intensive margin, SPS concerns reduce the export values for firms staying in the market by 18 per cent. Overall, the quantification exercise by the authors suggests an expected lost sales figure from SPS measures at the firm level of 43 per cent. The extensive margin accounts for one-third of this total effect and the intensive margin for two-thirds. The effects of SPS concerns are however heterogeneous across firms, and big players are less affected than small firms at both the extensive and intensive margins. In other words, because of SPS concerns, small firms are more likely to participate less in the export market, to exit this export market, and to export smaller trade volumes than large firms. Last but not least, SPS concerns increase average prices of exported goods by 6 to 9 per cent. This last result can be explained by the fact that SPS measures increase production costs and act as barriers to entry. Thus, market shares are redistributed about remaining firms, which increase their prices.

Fernandes *et al.* (2015) focus on the impact of pesticide standards on firm exports of agricultural products across countries and time. Their results show that pesticide standards significantly influence the foreign market access of affected products. More restrictive standards (i.e. imposing a lower legally tolerated level of a pesticide residue in products) in the importing country, relative to the exporting country, lower the probability that firms will export as well as their export values and quantities. They also find evidence of heterogeneous effects among exporters. Smaller exporting firms are more negatively affected than larger ones, in their market entry and exit decisions, by the relative stringency of standards.

Disdier *et al.* (2018) show that the introduction of SPS measures and TBTs in foreign markets increase the probability of exporting, as well as the value of exports, of the most productive French exporters, while reducing the exporting probability of the least productive French firms.

Fugazza *et al.* (2018) combine data on tariffs and NTMs imposed by Latin American importers with firm-level export data from Peruvian customs during the period 2000-2014 to examine the impact of market-access barriers in Latin America on Peruvian exporters. While Disdier *et al.* (2018) rely on a cross-section of SPS measures and TBTs imposed by France's trading partners, this dataset allows to identify the impact of the introduction and withdrawal of different types of NTMs. They find that the average impact varies depending on the type of trade barrier. Some market-access barriers, such as tariffs and TBTs, hurt the average exporter more than other measures, such as price controls. They also find that the impact of market-access barriers is not homogeneous across exporters. Small exporters are affected by market-access barriers more negatively than large exporters are. Interestingly, very large exporters tend to benefit, rather than lose, from the imposition of more restrictive market-access barriers in destination markets. The case of Peruvian exports to other Latin American Integration Association (LAIA) partners is interesting because of two apparently contradicting trends. While the share of Peruvian exports directed to LAIA countries has been growing since 2000, the number of Peruvian exporters to the region has been declining during the same period. While the intensification of exports to LAIA countries could be associated with the economic and trade integration process at work in the region over the last fifteen years, the increasing concentration of firms in the export sector is puzzling. The econometric analysis reveals that while tariffs were being bilaterally reduced within LAIA, there was a growing implementation of NTMs, and in particular technical regulations, which hurt small Peruvian exporters, while benefitting large exporters to the region.

3. Impact of non-tariff measures on export diversification

Firm-level data can also be used to examine export diversification. Using data for 619 firms from 17 developing countries exporting to five developed ones, Chen *et al.* (2008) study firms' export performances over two dimensions: (a) their export propensity (i.e. their overall export share), and (b) their market diversification (i.e. the number of export markets served). The authors use data on NTMs based on surveys in which firms are asked whether technical regulations affect their ability to export products.

Results highlight that TBTs affect developing exporters' entry into developed markets; firms claiming that technical regulations are obstacles to trade also export to fewer markets. More interestingly, Chen *et al.* (2008) show that each type of regulation has a differentiated trade impact. Quality standards and labelling requirements increase firms' average export propensity and market diversification, while certification procedures reduce firms' average export diversification.

Shepherd (2015) studies the impact of NTMs and their harmonization on export diversification. His focus is on textiles, clothing, and footwear – three sectors associated with the early stages of industrialization in many countries. Using information on European regulations from the World Bank's European Union Standards Database and detailed European import data between 1995 and 2003, Shepherd shows that NTMs negatively affect the export diversification of developing countries. For an average developing country, the elasticity of export variety with respect to the total number of European standards is –0.6. On the other hand, harmonization mitigates the effect. A one percentage point increase in the proportion of European NTMs harmonized with international NTMs is associated with a growth in export variety of 0.8 per cent. Thus, international NTM harmonization can be an effective way of supporting developing countries' export diversification.

C. Application

Estimating trade effects of non-tariff measures at the firm level

This application uses firm-level data for some unspecified country. It examines the impact on firms' exports of SPS measures and TBTs implemented by the European Union (14 countries; Luxembourg is missing). SPS and TBT data are from the dataset described in chapter 2, B.1 and the firm data are from a developing country. Firm data are available for various years, but NTM data are cross-section data. We therefore focus on 2011 and run cross-section estimations.

(a) Download the data

Both the firm-level data and NTM data are available on the UNCTAD website.[39]

(b) Open the data into Stata and finalize the firm-level dataset

The data should first be downloaded and then be opened in Stata. The programme below finalizes the construction of the dataset by merging firm and NTM data. We first restrict our sample of firms' exports to 2011 and clean the data by dropping incorrect product codes and domestic trade. We also keep only export flows to the European Union. Finally, we expand the dataset of firm exports and generate zero export flows. To do so, we create one European destination for each firm product observation. In other words, we assume that for each product exported by a given firm, the flow can be potentially observed for each European destination. If it is not observed, then it is a zero flow with a value and a quantity set to zero. For non-zero observations, we merge our observations with the initial firm data in order to get the value and the quantity exported by the firm.

```
set memory 800M
set matsize 4000

use "FIRMS", clear
rename y year
* For many countries, NTMs data are for 2011. We decide to work with the 2011 exports of firms
keep if year == 2011
* Drop incorrect HS product codes
gen l = length(hs)
tab l
drop if l != 6
drop l
rename hs hs6
rename d ccode_d
* drop domestic trade
drop if ccode_d == "XXX"
rename c ccode_o
rename f firm
order ccode_o firm year hs6 ccode_d
sort ccode_o firm year hs6 ccode_d
count
* Focus on export flows to EU15
gen eu15_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 eu15_d = 0 if eu15_d == .
keep if eu15_d == 1
sort firm hs6 ccode_d
save temp_firmdata, replace
```

[39] We use the 2014 version of the NTM dataset. The full dataset can be downloaded from the CEPII website at http://www.cepii.fr/cepii/fr/bdd_modele/presentation.asp?id=28.

CHAPTER 4

```
* Expand the dataset: create for each firm-product combination, all destinations (i.e. the potential number of destinations: 14 EU countries - Luxembourg is missing)
* We first keep one observation per firm-hs6 code
keep firm hs6
bys firm hs6 : gen obs = _n
keep if obs == 1
drop obs
codebook hs6, compact
codebook firm, compact
egen fp = group(firm hs6)
* for each fp, we create 14 observations: one for each potential EU destination
expand 14
bys fp : gen obs_expand = _n

gen ccode_d = "AUT" if obs_expand == 1
replace ccode_d = "DEU" if obs_expand == 2
replace ccode_d = "DNK" if obs_expand == 3
replace ccode_d = "FIN" if obs_expand == 4
replace ccode_d = "FRA" if obs_expand == 5
replace ccode_d = "GBR" if obs_expand == 6
replace ccode_d = "GRC" if obs_expand == 7
replace ccode_d = "IRL" if obs_expand == 8
replace ccode_d = "ITA" if obs_expand == 9
replace ccode_d = "NLD" if obs_expand == 10
replace ccode_d = "PRT" if obs_expand == 11
replace ccode_d = "SWE" if obs_expand == 12
replace ccode_d = "ESP" if obs_expand == 13
replace ccode_d = "BEL" if obs_expand == 14
drop obs_expand fp
sort firm hs6 ccode_d
save temp_firmdata_expand, replace

* Merge with temp_firmdata to get information on exported quantity and value for strictly positive flows
merge firm hs6 ccode_d using temp_firmdata
tab _merge
drop _merge
replace ccode_o = "SEN" if ccode_o == ""
replace year = 2011 if year == .
replace v = 0 if v == .
replace q = 0 if q == .
save database, replace

erase temp_firmdata.dta
erase temp_firmdata_expand.dta
```

(c) Add information on NTMs

We now deal with NTM data. We first restrict our data to (A) SPS measures and (B) TBTs implemented by European countries. We then merge the firm data with the NTM data and define two NTM variables: a simple dummy "Pres_SPSTBT" set to one if the European Union applies at least one SPS measure or TBT on a given HS six-digit product (0 otherwise). The second NTM variable ("num_SPSTBT") represents the total number of SPS measures and TBTs applied by the European Union on a given product.

```
use "Base_Mast_Oct2014", clear
* Focus on SPS and TBTs
keep isor product numA numB PresA PresB
rename isor ccode_d
gen eu15_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 eu15_d = 0 if eu15_d == .
keep if eu15_d == 1
codebook ccode_d, compact
count
gen hs6 = string(product)
gen l = length(hs6)
tab l
replace hs6 = "0"+ hs6 if l == 5
drop product l
sort ccode_d hs6
save temp_NTM, replace

* Merge firm-level data with NTM data
use database, clear
sort ccode_d hs6
merge ccode_d hs6 using temp_NTM
tab _merge
drop if _merge == 2
drop _merge
replace numA = 0 if numA == .
replace numB = 0 if numB == .
replace PresA = 0 if PresA == .
replace PresB = 0 if PresB == .
* Define two variables for SPS and TBTs
* First variable: a simple dummy
gen Pres_SPSTBT = 1 if PresA == 1 | PresB == 1
replace Pres_SPSTBT = 0 if Pres_SPSTBT == .
* Second variable: the total number of SPS and TBTs at the product-importer level
gen num_SPSTBT = numA + numB
drop PresA PresB numA numB
save database, replace

erase temp_NTM
```

(d) Run the estimations using a simple dummy variable for NTMs

Below we run our first set of estimations. To keep zero flows in our regressions, we use the Poisson estimator. Our estimations also include various sets of fixed effects: HS two-digit, firm, and importing-country fixed effects to control for all unobservable characteristics at the sector, firm, and destination levels that may influence the bilateral exports of firms. Note that our sample contains just one exporting country and therefore the importer fixed effect is equivalent to a country pair fixed effect.

In this first set of estimations, we just include a simple dummy for NTMs controlling for the presence versus the absence of SPS measures or TBTs at the product destination level. We consider three different dependent variables: the value of the export flow (regressions (1) and (2)); the exported volume (regressions (3) and (4)); and the unit value of the flow (regression (5)). Regressions (1) and (3) include all flows, while regressions (2), (4), and (5) are restricted to strictly positive export flows.

```
use database, clear
gen hs2 = substr(hs6, 1 , 2)

* Dependent variable: exports value
* Regression #1: all flows
xi: poisson v Pres_SPSTBT i.hs2 i.ccode_d i.firm, difficult robust
* Regression #2: only strictly positive exported values
xi: poisson v Pres_SPSTBT i.hs2 i.ccode_d i.firm if v > 0, difficult robust

* Dependent variable: exports quantity
* Regression #3: all flows
xi: poisson q Pres_SPSTBT i.hs2 i.ccode_d i.firm, difficult robust
* Regression #4: only strictly positive exported volumes
xi: poisson q Pres_SPSTBT i.hs2 i.ccode_d i.firm if q > 0, difficult robust

* Dependent variable: unit value of exports
* Regression #5: only strictly positive unit values
gen uv = v / q
xi: poisson uv Pres_SPSTBT i.hs2 i.ccode_d i.firm if uv > 0, difficult robust
```

(e) Run the estimations controlling for the number of NTMs

We replicate the first set of estimations, but instead of using a simple dummy for NTMs, we now include the total number (in logs) of SPS measures and TBTs notified by European importers on each HS six-digit product. We therefore deal only with importer product observations for which this number is strictly positive.

```
* Log number of SPS/TBT measures at the importer-product level
gen lnum_SPSTBT = ln(num_SPSTBT)

* Dependent variable: value of exports
* Regression #1: all flows
xi: poisson v lnum_SPSTBT i.hs2 i.ccode_d i.firm if num_SPSTBT > 0, difficult robust
* Regression #2: only strictly positive exported values
xi: poisson v lnum_SPSTBT i.hs2 i.ccode_d i.firm if num_SPSTBT > 0 & v > 0, difficult robust

* Dependent variable: quantity of exports
* Regression #3: all flows
xi: poisson q lnum_SPSTBT i.hs2 i.ccode_d i.firm if num_SPSTBT > 0, difficult robust
* Regression #4: only strictly positive exported volumes
xi: poisson q lnum_SPSTBT i.hs2 i.ccode_d i.firm if num_SPSTBT > 0 & q > 0, difficult robust

* Dependent variable: unit value of exports
* Regression #5: only strictly positive unit values
xi: poisson uv lnum_SPSTBT i.hs2 i.ccode_d i.firm if num_SPSTBT > 0 & uv > 0, difficult robust
```

D. Exercises

1. Trade at the firm level
   - (i) Preliminaries
     - a. Open the datafile “FIRMS.dta”
     - b. Drop incorrect HS product codes and domestic trade as in the application
   - (ii) Average and total exports
     - a. Compute the average size of export relationships by destination and year
     - b. Draw the kernel density of average sizes for each year
     - c. Compute total exports by destinations and year
     - d. Draw the kernel density of total exports for each year

   Hint: use the collapse and kdensity commands
   - (iii) Number of exporting firms
     - a. Compute the number of exporting firms per year
     - b. Identify destinations with the largest number of exporters each year
2. Trade effects of non-tariff measures on firms’ exports
   - (i) Preliminaries
     - a. Open the datafile “database.dta”
     - b. Generate an HS 2-digit and HS 4-digit variable
     - c. Generate the log number of SPS/TBT measures at the importer-product level

(ii) Trade effects of NTMs

a. Run the estimations controlling for the number of NTMs as in the application

b. Control for HS4 digit fixed effects. Do you see any difference with results obtained in a)?

c. Rerun previous regressions using the *ppml_panel_sg* command

Hints: use the ssc install command. The "ppml_panel_sg" command has been in Yotov et al. (2016)

CHAPTER 5: Beyond trade effects

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A. Overview and learning objectives

Studies aiming at investigating the trade effects of NTMs provide useful results. However, they offer an incomplete understanding of the actual effects of these NTMs on all economic agents concerned – not only producers but also consumers, importers, and governments. Some NTMs may restrict trade but improve welfare if they address market failures. It is therefore important to gain an insight into the impact of NTMs on the well-being of all these economic agents. The welfare impact of NTMs is also of crucial importance for developing countries. It is one thing for them to complain about the trade-reducing effect of NTMs if these NTMs also reduce welfare in the importing country. But their approach to NTMs would have to be very different if it were shown that these NTMs actually raise welfare in the importing country, and possibly by more than they lower it in the developing exporting country. This chapter presents an extension of the framework discussed in Chapter 3 able to provide insights in terms of welfare effects. It then reviews some major contributions to this strand of the literature.

In this Chapter you will learn how to use trade-effect estimates to compute some welfare effects induced by the implementation of an NTM.

B. Analytical tools

1. Welfare impact: conceptual presentation

On the production side, compliance with the NTM usually induces an increase in firms' production costs (changes in input requirements and production schemes, certification, labelling, etc.). However, compliance with the NTM may also force firms to upgrade their facilities and thus reduce their marginal production costs. NTMs therefore have an ambiguous effect on production. Supply may decrease or increase. On the consumption side, the likely effect of meeting the NTM is an increase in demand. Following the improvement of the quality of a good and/or available information on food safety, consumers in the export market increase their consumption.

By showing the supply and demand shifts, simulations provide an evaluation of the welfare effects that are likely to have an impact on consumers and producers following implementation of the NTM. Some weaknesses in this approach should however be acknowledged, including the fact that it does not account for the changes in the demand and supply elasticities and in the complementarity/substitutability of products and varieties of the same product (Korinek *et al.*, 2008).

Renewed analysis of the welfare effects of NTMs has been taken up by van Tongeren *et al.* (2009), who provide a conceptual framework extending the simulations of the welfare effects into a cost-benefit analysis taking into account the market imperfections and market failures affecting the economic agents. Three types of imperfections and failures are analysed: externalities affecting consumers (e.g. imperfect information on food safety), externalities affecting producers (e.g. an animal disease outbreak), and common global issues (e.g. the preservation of ecosystems). These imperfections and failures generate inefficient market outcomes that justify government intervention to bring about improved outcomes from the perspective of society.

The framework offers a comparative assessment of the costs and benefits associated with different regulatory measures (e.g. standards, import bans, etc.) that could be applied by policymakers to address the market failure or imperfection. Furthermore, van Tongeren *et al.* (2009) distinguish the economic agents affected by the market failure or imperfection from those who are not affected, and assess the costs and benefits for each category of agents.

Some assumptions are made by van Tongeren *et al.* (2009) in order to keep their welfare analysis relatively simple. The market good is assumed to be homogenous (i.e. all varieties of similar goods have the same quality attributes) except for a specific characteristic that is potentially dangerous to consumers. This dangerous characteristic pertains to foreign goods only. Therefore, only foreign producers are *de facto* concerned by the reinforcement of an NTM selected by the domestic regulator for reducing consumer risk. This is an analytical simplification that allows a sharper focus on the international implications of NTMs. If the domestic product had that characteristic domestic producers would be equally affected by the reinforcement of the regulation. The harm is not internalized by consumers. On the supply side, a perfectly competitive industry comprised of domestic and foreign firms with price-taking firms is assumed.

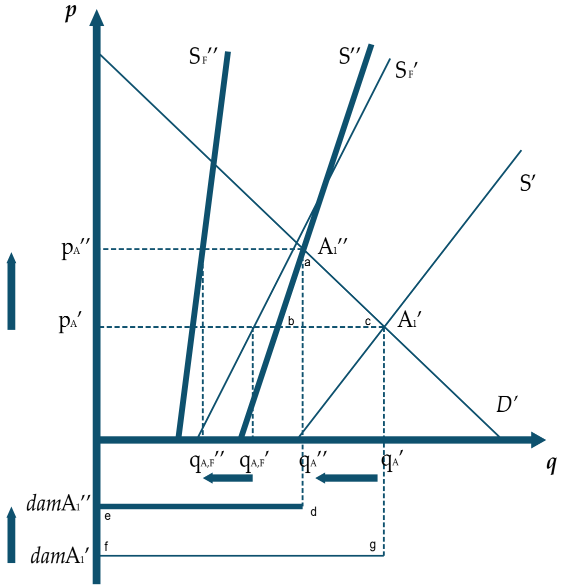
A stricter NTM has two major effects on foreign firms. First, it reduces the proportion of foreign products entering a market because of tougher inspections linked to stricter thresholds. Second, compliance with the stricter NTM brings about an increase in marginal costs and sunk costs (linked to investments that are sunk once undertaken). An increase in marginal costs leads producers to reduce the quantities supplied for each given price. In their analysis, van Tongeren *et al.* (2009) focus only on the first effect, i.e. the reduction in the share of foreign products entering the market.

Figure 13 provides a graphical illustration of the welfare analysis. It shows the domestic demand (D'), foreign supply (S_F'), and total supply (S') (domestic supply is omitted for clarity). The price, p, is located on the vertical axis and the quantity, q, is shown along the horizontal axis. The harm linked to foreign products is not internalized by consumers and therefore does not affect demand. However, the harm should be accounted for in the welfare calculations. Domestic welfare is the sum of domestic producer profits and consumer surplus minus the harm. International welfare is the sum of domestic welfare and foreign producers' profits.

With this initial situation preceding the reinforcement of the regulation, the parameters of the model are calibrated in such a way as to replicate prices and quantities over a period. When a regulation is reinforced, the market allocation is modified, as represented in Figure 13 by new foreign supply S_F'' and total supply S''.

A stringent NTM reduces the proportion of foreign products entering the domestic market. The supply shifts upward from (S') to (S''). The stricter policy increases the price with $p_A'' > p_A'$ and decreases the quantity with $q_A'' < q_A'$. It also reduces the probability of having unsafe products and the overall harm to unaware consumers. The net welfare effect of a stricter NTM – i.e. the comparison between initial domestic welfare and new domestic welfare – suggests a reduction in the harm, illustrated by the move from $damA_1'$ to $damA_1''$. This reduction results from a fall in the probability of consumption of unsafe products following implementation of the NTM. The triangle *abc* represents the standard deadweight loss. As long as the "savings" in the cost of the harm are larger than the deadweight loss, the net welfare impact remains positive, that is, as long as the area defined by $q_A'q_A''defg$ (the reduction in the cost of the harm) remains larger than the area *abc* (deadweight loss).

Figure 13: Welfare analysis: graphical analysis



Source: Fugazza (2013).

An important issue in this welfare approach is the evaluation of failures and imperfections. Consumer valuations could be computed using either of two methods: the willingness to pay approach, or the quality adjusted life years (QALYs) method. The former allows for an assessment of consumer reaction to an NTM by revealing their willingness to pay to avoid harm/illness or to obtain a good with particular qualities. The QALY approach evaluates the monetary benefits associated with an NTM that reduces mortality or morbidity. Producer valuations could be obtained from studies assessing the costs associated with invasive species or the impact of pests and diseases on agriculture and the costs of managing them. Some studies have also tried to combine economic and epidemiological approaches to evaluate the costs of outbreaks and policies (such as quarantine) aiming to address them. Common global issues are more difficult to evaluate. Citizens and governments of various countries usually agree to address such issues but disagree on the methods to be used.

Turning to the empirical evidence, there are as yet only a few studies that investigate the welfare effects of NTMs. The OECD conducted a case study on the welfare effects of border measures protecting human health against contaminants (in particular antibiotics) found in shrimp (van Tongeren *et al.,* 2010). The study focuses on OECD imports of shrimps from three Asian countries that are among the world's main shrimp producers (India, Indonesia, and Viet Nam) and uses the cost-benefit framework described above. Over the last decade, OECD countries have rejected several import shipments of shrimp on health and safety grounds, imposed temporary import bans, and asked for stronger health and safety controls. OECD countries' NTMs and requirements, motivated by consumer protection, obviously affect developing countries' production and exports of shrimp.

The study investigates the economic costs of such NTMs on shrimp production. It also examines whether such NTMs could be an incentive, given the size of OECD countries' demand for shrimp, for producing countries to adapt and improve their production. The analysis focuses exclusively on the supply side and estimates the gain for shrimp producers associated with four different scenarios: (a) no change in the production process, (b) an import ban by OECD countries, (c) improved production methods through the implementation of better management practices, and (d) both better management practices and production of a more disease-resistant shrimp variety.

The results suggest that if OECD countries were to ban imports, a substantial profit incentive would exist for producers to adopt improved production methods. Moreover, the adoption of better management practices in combination with the introduction of a disease-resistant shrimp variety (that yields a lower market price at higher production costs) would increase producer profits in Viet Nam and Indonesia. In India, the larger supply elasticity reduces the incentive to adopt better management practices.

Maertens and Swinnen (2009) evaluate the impact of European SPS measures for fresh fruits and vegetables on employment and poverty in Senegal. Since the 1990s, exports of fresh fruits and vegetables from Senegal to the European Union have risen significantly. The authors show that the European measures increase the vertical coordination with buyers and suppliers, and induce a shift from contract farming with smallholders to large-scale integrated estate farms. However, poor households are not excluded from this development and participate as farm workers. This participation allows an increase of their incomes and a reduction in poverty.

2. Welfare impact: an empirical assessment

The welfare quantification of NTMs can be performed through a cost-benefit analysis. Such analysis examines the NTMs' impact on each type of agent (consumers, producers, government, etc.). To precisely measure the welfare effects of NTMs, a proper distinction should be made between supply and demand responses to NTMs in both the exporting and importing countries (Beghin, 2009; Korinek *et al.*, 2008; and Beghin and Xiong 2018). The welfare analysis can of course be performed ex ante. In that case, supply and demand shifts induced by the introduction of NTMs are simulated. Although the studies that develop a welfare analysis of NTMs provide interesting insights, they completely overlook the trade effects of such measures. In a recent contribution, Disdier and Marette (2010) bridge the gap by combining both mercantilist and welfare approaches to exhibit their complementarities. This section describes their empirical analysis and main results. In a context where data linked to border inspections are extremely difficult to collect, the analytical approach used by Disdier and Marette (2010) suggests how to combine the results of a gravity equation with a partial equilibrium model to determine the welfare impact of NTMs.

Disdier and Marette (2010) measure the impact of new NTMs capping residues of chloramphenicol, which is an antibiotic often used in seafood farms in developing countries. It is toxic for human health. The authors evaluate past policies (over the period 2001–2006) but also a future policy with an ex-ante analysis linked to a stringent NTM eliminating all antibiotic residues in seafood. Such a policy could be introduced in the coming years (Ababouch *et al.* 2005). Disdier and Marette (2010) made several assumptions, derived from van Tongeren *et al.* (2009), for their analysis. They assume that the market good is homogenous except for a given characteristic, which is dangerous for consumers. The harm is not internalized by consumers. The NTM aims to eliminate unsafe products from the market and only targets foreign products.[40] A stringent NTM therefore reduces their probability of entering the domestic market.

The empirical analysis is carried out in two steps. First, the authors estimate a gravity equation, where the dependent variable is the log of bilateral imports of the United States, Canada, the European Union, and Japan from all exporters over the 2001–2006 period. The NTM on chloramphenicol, measured as the maximum residue level in parts per billion applied by each importer since 2001, is included among the explanatory variables. The estimated coefficient on the NTM variable therefore measures the forgone trade. The relative variation of exports value linked to the NTM can be rewritten as

$$\frac{\mathrm{d}p}{p} + \frac{\mathrm{d}q}{q} = \beta \mathrm{d}NTM \tag{5.1}$$

where p is the price of imports, q the quantity imported and β is the coefficient on the NTM variable estimated in step 1.

In discrete terms and referring to Figure 13 notation we thus have,

$$\frac{p_A'' - p_A'}{p_A'} + \frac{q_{A,F}'' - q_{A,F}'}{q_{A,F}'} = \beta \Delta NTM \tag{5.2}$$

In the second step, this coefficient is integrated in a partial equilibrium model. The two core theoretical equations are the domestic consumer's utility function and the foreign firm profit function. Only foreign firms are considered as the assumption made is that health hazards only concerns imported quantities. The utility function writes,

$$U(q_F, q_D, w) = a(q_F + q_D) - \frac{b(q_F^2 + q_D^2 + 2\theta q_F q_D)}{2} - I\gamma r q_F + w \tag{5.3}$$

where q_F and q_D are the respective consumptions of foreign and domestic products. The parameters $a,b > 0$ allow the capture of the immediate satisfaction from consuming foreign and domestic products and w is the numeraire good. The parameter θ measures the degree of substitutability between foreign and domestic products, with $\theta = 0$ for independent products and $\theta = 1$ for perfect substitutes. The expected damage linked to the foreign products is captured by the term $I\gamma r q_F$. The parameter $r \geq 0$ is the per-unit damage and γ is the probability of having a contaminated product with $0 \leq \gamma \leq 1$. Thus, the probability that there is no damage is given by $(1-\gamma)$. The parameter I represents

[40] Chloramphenicol was already banned in many OECD countries before 2001.

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the consumer's knowledge regarding the specific characteristic brought by the foreign product. If the consumer is not aware of the specific characteristic, then $I = 0$, and the cost of ignorance, $\gamma r q_F$, is negatively taken into account in the welfare. In other words, the value $-\gamma r q_F$ disappears from the utility (4) when $I = 0$, but is taken into account in the welfare by a regulator accounting for all the characteristics linked to a product. Conversely, $I = 1$ means that the consumer is aware of the specific characteristic and negatively internalizes the damage in her/his consumption.

$$\pi_F = \frac{p}{1+\tau}\lambda q_F - g_F q_F - \frac{c_F q_F^2}{2} - K_F \tag{5.4}$$

where, c_F and g_F are the variable cost parameters and K_F is the sunk cost linked amongst others to the firm's market entry and compliance with regulations (K_F is usually set to zero for the sake of simplicity). The parameter λ is the proportion of foreign products entering the domestic market when an output q_F is offered before the border inspection. This proportion $0 \leq \lambda \leq 1$ depends on the standard and the inspection policy. Under the assumption of rational expectations, the expected proportion taken into account by the producer corresponds to the effective proportion linked to the policy. The more stringent the standard and the inspection policy, the lower the proportion of products entering the market. The parameter τ is the ad-valorem tariff on imports, implying a price ($p/(1+\tau)$) received by the foreign producers when domestic consumers pay p. Again, in order to simplify calculations but without loss of generality tariffs are set to zero.

Maximization of utility by consumers and profits by firms defines a partial equilibrium supply and demand framework whose graphical representation is comparable to the one discussed in section 1. The model is then calibrated to represent supply and demand for crustaceans.

The calibrated model allows for measuring the impact of a stricter NTM on both foreign exporters' profits and domestic welfare (defined as the sum of domestic producers' profits and consumers' surplus). While the impact of the NTM on trade may be negative, its impact on domestic and/or international welfare may be positive because of a significant reduction in harm. In other words, NTMs can be trade-restricting but welfare-enhancing.

Parameters of the model are initially calibrated so as to replicate prices and quantities for the year 2001 and 2006 in the United States, Canada, Japan and the European Union. The baseline scenario that is before the reinforcement of the standard is characterized by an initial probability of contamination γ of 1 and initial proportion of foreign products entering the domestic λ of 1. The value of the per-unit damage r is obtained using results from Lusk, Norwood, and Pruitt (2006) who elicited consumers' willingness-to-pay (WTP) in order to avoid antibiotics. For each country, the authors apply the domestic price used for the initial calibration, which means that the per-unit damage is equal to $r = 0.767p'_A$ for each country and leads to the cost of ignorance. For a given variation of the Maximum Residue Level (MRL) with ΔNTM = Δ*MRL* , equation (5.2) is solved to determine λ linked to the shift of the foreign supply.

Table 2 presents the ex-post estimations of the relative annual international welfare variation in the United States, the European Union, Canada, and Japan. It focuses on the impact of past MRL reductions specific to each country and observed between 2001 and 2006 (for each country Δ*MRL* is indicated in the second column of the table). To measure different possibilities regarding the efficiency of the policy characterized by ΔMRL, two cases are distinguished: Case 1, with a probability of contamination $\gamma = 3/4$ (i.e. three-quarters of foreign products are unsafe); and Case 2, with a probability $\gamma = 1/2$. International welfare includes both domestic welfare and foreign producers' profits.

Results show that the profit variation for foreign producers is always negative despite the price increase, since the quantities sold by producers are strongly reduced. For Canada and the European Union, the domestic welfare increase outweighs the foreign producers' losses, leading to an increase in international welfare. Domestic consumers benefit from the reduction in the harm that outweighs the negative effects coming from the price increase linked to the import restrictions. Domestic producers benefit from the increase in the domestic price. The more efficient the regulation (i.e. γ lower), the higher both domestic and international gains linked to the regulation. For the United States, the foreign producers' losses outweigh the domestic welfare increase, leading to a decrease in international welfare. The variations are similar for both columns, since the large variations in MRL lead to the full elimination of foreign imports, which corresponds to a drastic standard. Japan did not change its import standard between 2001 and 2006, leading to the absence of welfare variation. Note that the cost of regulation and inspection linked to the NTM is not accounted for. This cost could be subtracted from international welfare in order to obtain the net social benefit of regulation and inspection.

Table 2: Annual international welfare change linked to a reduction in the maximum residue level in parts per billion between 2001 and 2006 (in per cent, relative variation compared to the baseline scenario)

	ΔMRL (parts per billion, 2001 → 2006)	**$\gamma = 3/4$**	**$\gamma = 1/2$**
United States	ΔMRL= -4.7 (5 → 0.3)	-12.5%	-12.5%
Canada	ΔMRL= -2.2 (2.5 → 0.3)	7.2%	13.1%
Japan	ΔMRL= 0 (50 → 50)	0%	0%
European Union	ΔMRL= -1.2 (1.5 → 0.3)	23.4%	45.3%

Source: Disdier and Marette (2010).

Note: The parameter γ represents the probability of contamination.

Table 3 reports some ex-ante estimations of the welfare effects for 2006 with a MRL equal to zero. The variation to reach zero tolerance is $\Delta MRL = -0.3$ for countries, except for Japan ($\Delta MRL = -50$). Note that as not all the products are inspected two new cases regarding the value of γ are considered. Case 1: $\gamma = 1/2$; Case 2: $\gamma = 1/4$.

Results show large domestic welfare gains for the United States, Canada, and the European Union. Reinforcing the standard towards zero tolerance brings a large gain for consumers via the reduction in harm, while the price effect linked to the import restriction following enforcement of the NTM is relatively low. For Japan, the large adjustment for some foreign producers not complying with pre-existing stringent standards in other countries makes the new regulation costly and explains the decline of international welfare. The variations are similar for both columns, since the large

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variations in MRL lead to the full elimination of foreign imports, which corresponds to a drastic standard.

Table 3: Ex-ante simulations (in per cent, relative international welfare change for 2006 with a potential maximum residue level equal to zero)

	γ = 1/2	γ = 1/4
United States (ΔMRL= -0.3)	15.3%	32.7%
Canada (ΔMRL= -0.3)	8.1%	16.5%
Japan (ΔMRL= -50)	-52.0%	-52.0%
European Union (ΔMRL= -0.3)	15.0%	31.9%

Source: Disdier and Marette (2010).

Note: The parameter γ represents the probability of contamination.

The approach adopted in Disider and Marette (2010) highlights the importance of examining both the trade and welfare effects of NTMs. First, the gravity estimation determines whether or not a specific NTM really impacts trade by eliciting a statistically (non)- significant effect. Second, the integration of a statistically significant effect in a calibrated model provides a transparent and unambiguous welfare measure of the measure under consideration.

These results for estimating welfare variations particularly help assess the impacts of ex ante regulatory measures, that is to say, before the effective implementation of food, environmental or health policies. The gravity and experimentation/survey results are a basis for anticipating market reactions and help anticipate the regulatory adjustments on markets and achieve quantified analyses directly usable by the public decision-maker when there is a conflict over NTMs.

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