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Non-tariff measures at the border, a GTAP level analysis

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Abstract

Non-tariff measures can significantly increase trade costs and distort trade flows. This study uses the GTAP model to assess the impact of reducing compliance costs associated with border non-tariff measures on trade and other economic indicators. The purpose of this paper is to present some illustrative statistics on border non-tariff measures, introduce the new GTAP 11 Satellite Database, which provides ad-valorem equivalents for border measures, and demonstrate how it can be applied in the GTAP model to assess the general equilibrium effects of cost reductions. Although the GTAP simulations are not directly linked to specific policy actions, this research provides valuable insights into how reducing border non-tariff measure costs could enhance trade flows and promote regional integration strategies.

Key words

Trade policy, non-tariff measures, ad-valorem equivalents, GTAP

United Nations

Contents

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1. Introduction

From a development perspective, no matter what trade policies a country uses to pursue its development objectives, it is often in the national interest of countries to minimize trade costs (Moïsé and Le Bris, 2013, Hoekman and Nicita, 2011). For instance, trade costs that reflect red-tape or a lack of transparency of prevailing regulatory requirements, uncertainty and unpredictability regarding the way goods will be treated by customs officials, redundant or duplicative administrative procedures, corruption and so forth, all generate social waste and do not promote economic or social development. Efforts to reduce these trade costs, exemplified by the WTO Agreement on Trade Facilitation, aim to enhance trade efficiency and lower transaction costs for exporters and importers, and more generally on firms of developing nations therefore making them more internationally competitive (Saslavsky and Shepherd, 2014). While previous trade agreements often focused on reciprocal market access, reducing trade costs has become central to many newer regional trade agreements including major ones such as the United States-Mexico-Canada Agreement (USMCA), the African Continental Free Trade Area (AfCFTA), the Comprehensive and Progressive Agreement for Trans-pacific Partnership (CPTPP), and the Regional Comprehensive Economic Partnership (RCEP).

There are many reasons why trade costs may be unnecessarily high. The trade policies of a country, those of trading partners, the quality of transport infrastructure, and weaknesses in economic governance all influence how much it costs for a firm to engage in international markets. In this context, an important aspect in addressing trade costs is to differentiate between measures serving public policy objectives and those adding costs without generating significant benefits. Non-tariff measures (NTMs) that unnecessarily escalate expenses during border transactions present tangible targets for policy intervention (UNCTAD, 2018).[1] By streamlining procedures and reducing bureaucratic hurdles associated with these measures, policymakers can effectively mitigate the financial burdens imposed on traders (Cadot et al., 2012). Addressing costs associated with border NTMs not only increases cross-border trade but also enhances the overall efficiency of the trading process, benefiting both domestic and foreign businesses.

[1] NTMs, such as Sanitary and Phytosanitary (SPS) standards and Technical Barriers to Trade (TBT), are often essential for protecting public health, safety, and the environment. However, some of the additional costs they impose on cross-border transactions, for example due to inefficiencies at the border, can be unnecessary. These unnecessary costs present opportunities for policy interventions, often in terms of trade facilitation mechanisms.

Moreover, by levelling the playing field between domestic and foreign firms, efforts to minimize border-related costs uphold the foundational principle of non-discrimination enshrined within the WTO framework. Consequently, reducing these costs serves to promote a more open and competitive trading environment, conducive to fostering innovation, productivity, and economic growth on a global scale.

From a firm perspective, NTMs related costs often contribute to both the border costs of entering foreign markets (Fontagné et al., 2015; Disdier et al., 2016) and the expenses associated with imported inputs (Ferrantino, 2012). In the latter case, trade costs associated with NTMs can cause efficiency losses by undermining the competitiveness of domestic firms involved in global value chains. For example, high costs of imported intermediate inputs can diminish the global competitiveness of firms operating in downstream sectors. Numerous studies have emphasized the importance of identifying these costs and implementing trade facilitation programs to reduce them (Taglioni and Winkler, 2016; Hoekman and Nicita, 2018; Gonzales and Sorescu, 2019).

There have been several papers that have used the GTAP[2] computable general equilibrium model to analyse the impact of NTMs on world trade.[3] Some papers have specifically analysed NTMs effect within the GTAP model with the use of ad-valorem equivalents (AVEs). A few examples are Andriamananjara et al. (2003), Winchester (2009), Beckman and Arita (2017), Vanzetti et al. (2018), Walmsley and Strutt (2021). Kravchenko et al. (2022) provide bilateral estimates of the AVEs of technical and non-technical NTMs at the Harmonized System (HS) six-digit level estimated using a price-based approach, that can be used to run GTAP model simulations[4].

A paper more closely linked to our analysis is by Fernández-Amador et al. (2024), which studies the impact of changes in bilateral regulatory differences and regulatory stringency of technical regulations using a structural gravity model to identify ad-valorem equivalents of NTMs and then simulating the effects of NTMs reduction in the GTAP model (Corong at al. 2017). They find that aggregate effects are relatively modest, but regulatory changes can have sizeable effects for individual countries, comparable to leaving or concluding a deep preferential trade agreement (PTA). Another relevant paper is Webb et al. (2020), which looks at the effects of reduction of various types of NTMs in ASEAN countries using the ImpactECON model (Walmsley and Minor, 2016), which extends the GTAP model for agent-specific import sourcing.

[2] The Global Trade Analysis Project (GTAP) is a global network of researchers and policymakers conducting quantitative analysis of international policy issues. GTAP is coordinated by the Center for Global Trade Analysis in Purdue University's Department of Agricultural Economics.

[3] Walmsley and Strutt (2021) provide an overview on methodologies and approaches used in the integration of NTMs in computable general equilibrium models.

[4] Berden and Francois (2015) give a detailed comparison of several alternative price-based and quantity-based approaches to estimating the ad-valorem equivalents of NTMs.

Their paper shows that partial liberalization of the most distorting NTMs in ASEAN countries increases the GDP and welfare of all countries, with the effect particularly pronounced for the ASEAN economies themselves and for agri-food sectors. Egger et al. (2015) use AVE estimates of non-trade barriers from a gravity model in a computable general equilibrium model to calculate the impact of TTIP. However, their estimate of the non-trade barriers effects of trade agreements corresponds to the joint impact of PTAs conditional on tariffs and the depth of PTAs—therefore they are not using data on NTMs imposed outside of agreements (Felbermayr et al., 2022, use a similar PTA-based approach to estimate the effects of Brexit).

This paper focuses on the NTMs applied at the border (border NTMs), which include custom controls, quota licensing, pre-shipment inspections, additional fees paid at customs, among many others. Compliance with these requirements is often financially costly and/or time-consuming. The aim of this paper is to provide an overview of the incidence of border NTMs, the costs associated with them, as measured by ad-valorem equivalent, and finally provide a data-driven assessment of reducing these costs using the GTAP computable general equilibrium model (Corong et al., 2017). The paper also simulates the potential impact of lowering border costs that could be achieved by further facilitating trade within some regional trade agreements. While the GTAP simulations are not directly tied to specific policy actions, this research offers valuable insights into how reducing border NTM costs could enhance trade flows and support regional integration strategies. Importantly, the study utilizes the new GTAP 11 Satellite Database on ad-valorem equivalents provided by UNCTAD and illustrates how to incorporate it into GTAP-level analysis.

The findings of this paper indicate that NTMs significantly raise trade costs across sectors and regions, with agriculture and food sectors being the most affected. A GTAP simulation of a global 50 per cent reduction in NTM costs projects a 0.4 per cent increase in global GDP and US$ 330 billion in welfare gains, driven largely by trade growth arising from efficiency gains associated with improvements in border NTMs. Regions like East Asia and Southeast Asia stand to benefit the most, while other regions such as Western Europe experience smaller gains due to already low border costs related to NTMs. The study also provides estimates on the effects of reducing border costs within some RTAs, indicating that cost reductions associated with NTMs can lead to significant intra-regional trade increases, while also resulting in trade diversion effects, where non-member countries face welfare losses due to a reduced relative competitiveness. Overall, the results emphasize that NTM reductions, and initiatives aimed at reducing border costs within regional agreements, can significantly boost trade and welfare, though the benefits vary across regions and sectors.

The remainder of this paper is organized as follows. Section 2 discusses border NTM, their use and incidence, and provides some estimates on their ad-valorem equivalents based on the existing literature. Section 3 illustrates a set of scenarios using the GTAP model where NTMs at the border are reduced and compares the effects with those originating from tariff reductions. Section 4 concludes.

2. Non-Tariff Measures at the border

Border non-tariff measures are to be understood as measures that generate costs or other limitation to trade. These include traditional quantitative restrictions, price control measures as well as other NTMs such as border procedures, customs' administrative requirements, licensing, processing and inspections. Some of these NTMs are bilateral in nature, targeting specific products from specific partner countries. Compliance with these requirements generally results in higher costs for traders. The definition of border measures used here aligns with the category of "Customs Regulations" as defined by Ederington and Ruta (2016), which is based on the international classification of non-tariff measures by UNCTAD (see Annex I for details). Focusing on border measures makes the analysis more consistent for cross-country comparisons of trade costs, without confounding it with issues related to production and distribution costs, which often depend on local factors.[5] Additionally, this focus allows for a clearer link to policy reforms, such as simplifying customs procedures or reducing red tape related to customs clearance. Since many international trade agreements prioritize reducing border costs, this focus is highly relevant to current trade negotiations and policy discussions. In an analytical setting, border measures are customs regulations for which the associated cost can be interpreted similarly to transport costs or tariffs as they drive a wedge between world prices and domestic prices.[6] Moreover, concentrating the analysis only on border measures ensures consistency the treatment of trade costs within CGE models.

[5] Therefore, the AVEs used in this analysis do not fully capture the effects of standards, as these measures often impact not trade directly, but rather production and distribution costs. Moreover, focusing solely on border measures to manage trade avoid issues related to standards harmonization and their potentially positive effect on trade (Beghin et al. 2015; Dolabella, 2020).

[6] The world price of the good represents the international trading price outside of the importer's borders (namely the free on board -f.o.b.- price). The domestic price represents the tradeable price of the good right inside the country's borders.

2.1 Incidence: descriptive statistics on border NTMs

To describe the incidence of border NTM requirements, we use the UNCTAD TRAINS database and provide three indicators (de Melo and Nicita, 2018). First, *frequency index* (see equation 1) captures the share of traded product lines subject to at least one NTM. Second, *coverage ratio* (see equation 2) is the share of trade value subject to NTMs. Third, *prevalence score* (see equation 3) shows the average number of distinct NTMs applied to regulated products.

These indicators are often calculated on overall trade, considering all types of NTMs, but they are also suited to illustrate the incidence of particular NTMs on specific groups of products, for example, the average number of border measures applied on products in a GTAP sector. For each region r and sector s they are calculated as follows:

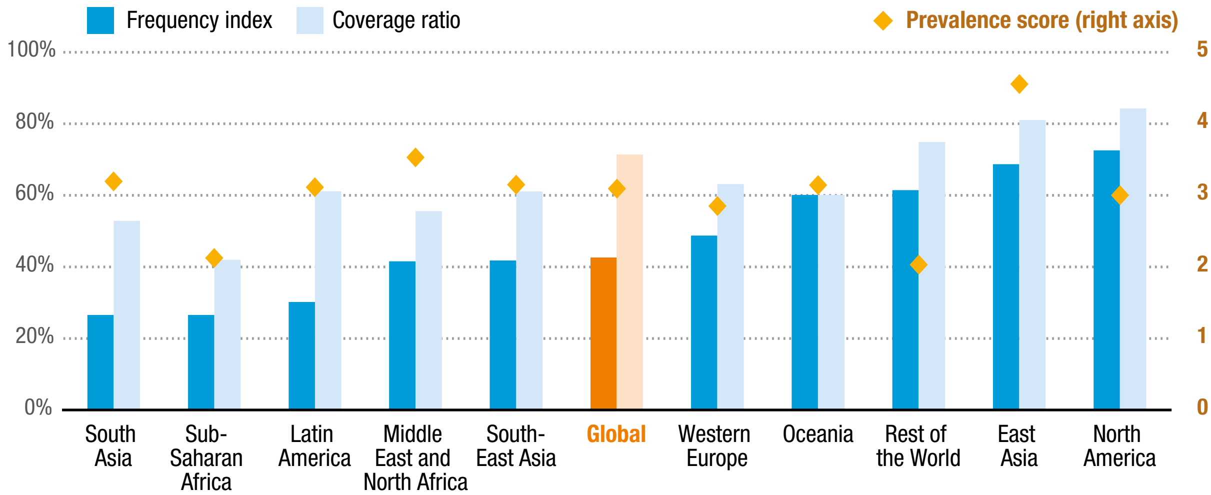
$$FI_{r,s} = \frac{\sum_{\{k\in s, i\in r\}} NTM_{ik} D_{ik}}{\sum_{k=1}^{hs} D_{ik}} \cdot 100 \quad (1)$$

$$CR_{r,s} = \frac{\sum_{\{k\in s, i\in r\}} NTM_{ik} X_{ik}}{\sum_{k=1}^{hs} X_{ik}} \cdot 100 \quad (2)$$

$$PS_{r,s} = \frac{\sum_{\{k\in s, i\in r\}} \#NTM_{ik} NTM_{ik}}{\sum_{k=1}^{hs} NTM_{ik}} \cdot 100 \quad (3)$$

where subscript k denotes product and i country imposing the NTMs, and where NTM_{ik} is a dummy variable denoting the presence of a border NTM at the HS6 aggregation level, $\#NTM_{ik}$ denotes the number of border NTMs, X_{ik} is the value of imports, and D_{ik} is a binary variable taking the value 1 when country i imports any quantity of product k, and zero otherwise. The first expression in the numerator, $\sum_{\{k\in s, i\in r\}}$ denotes the summation over all products k belonging to sector s and all countries i belonging to region r.

Figure 1
Frequency index, coverage ratio, and prevalence score of border NTMs by region



Source: Authors' computation.
Note: Regional groupings are those defined by the GTAP 11 aggregation facility and described in Annex II. The regional averages do not consider GTAP service sectors.

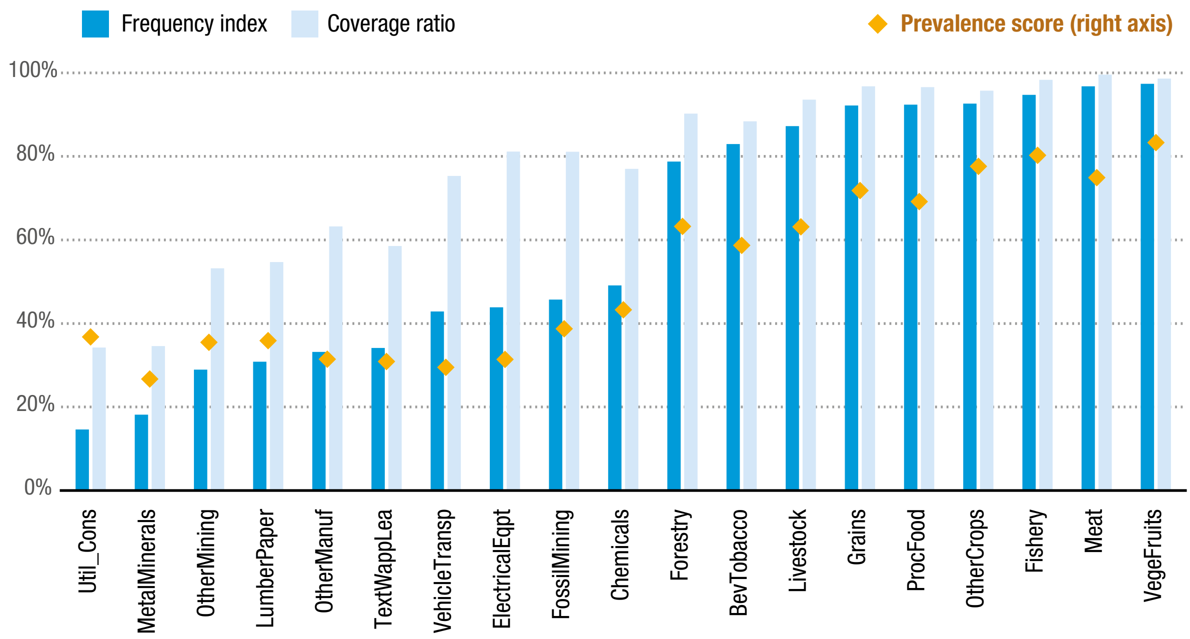
Figure 1 shows that border NTMs requirements cover a significant amount of world trade. The global frequency rate of NTMs is above 40 per cent, meaning that almost half of all world's traded products are subject to some type of border NTM. However, this number varies substantially by region. South Asia and Sub-Saharan Africa have NTMs covering less than 30 per cent of all products they import, while products imported by East Asia and North America are covered at about 70 per cent. In general, the use of NTMs is correlated with the development status of countries, with developed countries often having a larger number of border measures. Such differences are driven by the fact that developed countries tend to apply more NTMs for reasons such as higher standards for safety and quality and greater emphasis on environmental and social protection (Disdier et al., 2008). Developed economies also typically have more complex economic structures with advanced industries that require detailed regulations. Moreover, developed countries have the institutional capacity to design, implement, and enforce a wide range of NTMs, as well as more developed custom administration procedures based on the use of border NTMs (UNCTAD, 2018; WTO, 2012). Finally, developed countries have built extensive regulatory frameworks over time, and therefore tend to have a larger number of regulatory measures (Cadot et al., 2012).[7]

The percentage of trade covered by border NTMs (coverage ratio) is generally larger than the percentage of products covered by border NTMs (frequency index). This implies that large trade flows tend to be more likely covered by NTM provisions compared to smaller trade flows. This can happen for a variety of reasons, including managing risks to imports in key sectors (Beghin and Bureau, 2001; Disdier et al., 2008), protection of domestic market (Baldwin, 2000), and administrative capacity considerations (Maskus et al., 2001). Globally, the coverage ratio is about 70 per cent, i.e. more than two thirds of the world trade value is subject to border NTMs. The coverage ratio varies across regions for reasons similar to those discussed for the frequency index. Sub-Saharan Africa has the lowest trade coverage of all regions, at only 40 per cent, while North America has the highest trade coverage, at close to 85 per cent.

Finally, the prevalence score also significantly varies geographically, on average being about 3 NTMs per product. Regions comprising Sub-Saharan Africa and the Rest of the World (which consists mostly of former economies in transition) have only 2 measures per product on average. Middle East and North Africa (MENA) and East Asia regions, on the contrary, have more NTMs per product than global average, especially East Asia, where the prevalence score is as high as 4.5. As we explain below, incidence of non-tariff measures also varies significantly across sectors, therefore differences across regions can be explained not only by differences in the use of non-tariff measures across countries, but also by differences in the sectoral composition of imports and exports of different regions.

[7] This also is shown in the notifications at the WTO: https://eping.wto.org/en/FactsAndFigures/Notifications.

Figure 2
Frequency index, coverage ratio, prevalence score of border NTMs by GTAP sector



Source: Authors' computation.
Note: Sectoral aggregates are those defined by GTAP 11 aggregation facility and described in Annex II.

GTAP sectors differ substantially in terms of exposure to border NTMs (Figure 2). Sectors least affected by border NTMs are utilities, metals, minerals, other mining, and lumber and paper. Sectors related to agriculture and food, on the contrary, have very high frequency and coverage rates by border NTMs, often exceeding 90 per cent. They also typically have more than 5 NTMs per product – almost twice as many as manufacturing and natural resources. These differences are driven by the diverse safety, quality, and health implications related to the importation of these goods. For example, food products are highly regulated due to their direct impact on consumer health and safety. They often face stringent sanitary and phytosanitary measures to ensure they are safe for consumption and free from contaminants, diseases, or pests. NTMs for food products may include health inspections, quarantines, and certifications of origin to verify compliance with health standards. Chemicals can also pose significant health and environmental risks, leading to strict regulations. NTMs in this sector include safety data sheets to be produced at the border, and special procedures for hazardous substances to ensure safe handling and transport. On the other hand, metals and natural resources generally face fewer NTMs compared to other products. These commodities are often homogeneous and pose fewer direct public health or safety concerns.

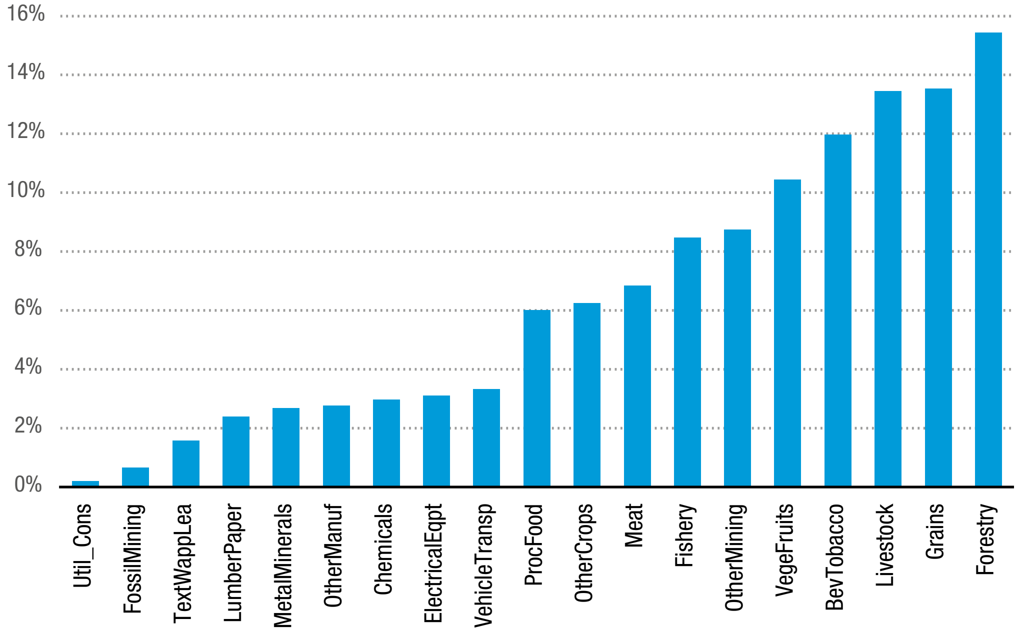
2.2 Cost estimates of border NTMs

The incidence indicators described above are valuable for depicting the landscape of non-tariff measures (NTMs) across various sectors and regions. However, they do not provide information on their impact on trade costs. The effects of NTMs on trade costs depend on several factors. While the magnitude of the effects is often related to the type, design, and implementation of the NTM, the same NTM can have varying impacts on different firms and countries of origin. For instance, many NTMs increase fixed costs rather than marginal costs, meaning that larger firms with greater volumes of trade may absorb these costs more easily than smaller firms. Furthermore, the similarity of regulatory environments often plays a crucial role. For example, differences in customs regulations and the degree of regulatory harmonization can lead to additional and costly requirements at customs. On the other hand, countries that are part of a regional trade agreement often face lower costs of compliance because of more streamlined custom procedures. Finally, the impact of NTMs can differ significantly based on how they are enforced. For example, strict enforcement at customs may lead to higher compliance costs due to testing and certification requirements, while lenient enforcement might mitigate some of the administrative burdens associated with NTMs. In practice, the cost associated with NTMs are case specific and are estimated using econometric methods and information on the presence of NTMs (UNCTAD, 2018; Ghodsi et al., 2019).

The costs of NTMs are generally measured by their ad-valorem equivalents (AVEs). AVEs express the impact of NTMs as a percentage of the value of the goods being traded. This approach translates the effects of NTMs into an equivalent tariff rate, making it easier to compare and analyze their impact on trade costs. The AVEs of border non-tariff measures used in this paper are those in the GTAP version 11 NTM satellite database, which are estimated based on Kee and Nicita (2022) and made consistent with the GTAP version 11 Data Base (Aguiar et al., 2022). These AVEs can be directly used as shocks to the GTAP model (Corong et al., 2017). The AVEs used in this paper are aggregated from the GTAP NTM satellite database to cover 19 GTAP sectors. For the analysis of this paper, countries are aggregated into 10 GTAP importers and 10 exporters' geographic regions. This results in about 1900 aggregated AVEs—one for each combination of importer, exporter and sector—that capture average bilateral sector specific border costs associated with border NTMs. Some details on AVEs estimation are provided in Annex III.

The costs related to border NTMs vary significantly between countries and across sectors. In terms of sectors, trading natural resource commodities usually incurs lower border NTM costs. In contrast, many agricultural commodities face higher border costs because of heightened concerns about quality and safety. The AVEs of manufactured goods are generally between those of agricultural product and those of natural resources. Among manufactured goods, textiles and apparel have relatively low AVEs, while vehicle transportation has the highest AVEs. Figure 3 shows the average AVEs for the 19 aggregated GTAP sectors utilized in this analysis. Moreover, bulk-traded products like fossil fuels and minerals generally have lower AVEs due to fixed costs being spread across large volumes.

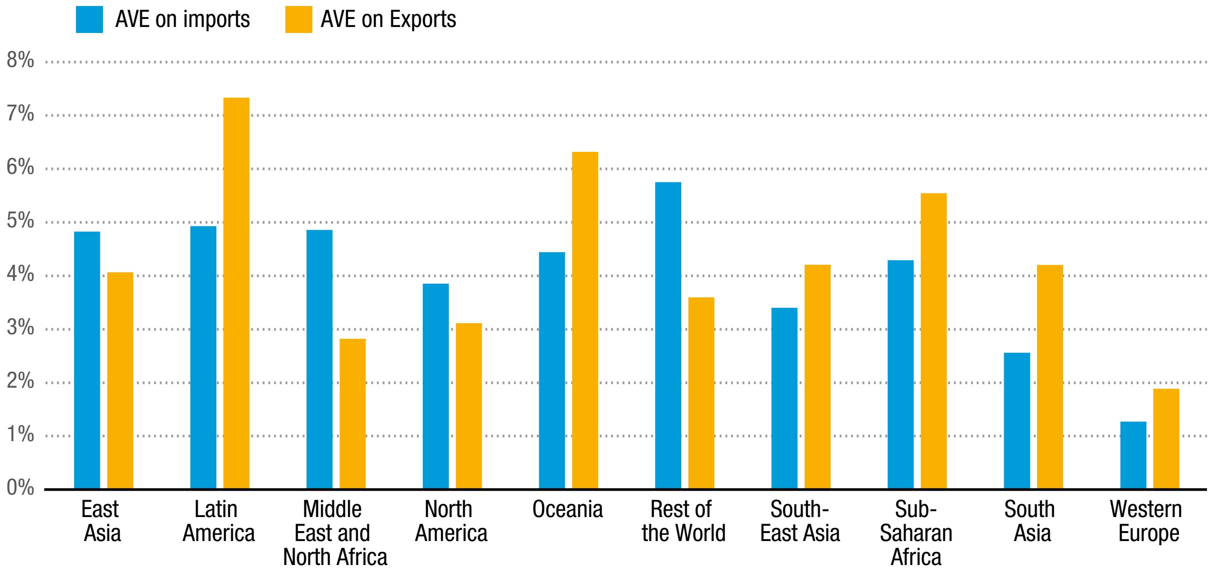
Figure 3
Ad-valorem equivalent of border NTMs by GTAP sector



Source: Authors' computation.
Note: Sectoral aggregates are those defined by GTAP 11 aggregation facility and described in Annex II.

AVEs also vary across geographic regions. Overall, the costs associated with border NTMs are lower for imports into South Asia and Western Europe, while they are relatively higher for imports into East Asia, Latin America, the Middle East and North Africa (Figure 4). From the perspective of exporters, the AVEs imposed by the importing country show even greater variance across regions. Exporters from different regions often face varying AVEs, due to both the composition of their export baskets and the presence of bilateral NTMs. On average, the AVEs tend to be higher for exports from Latin America, Oceania and Sub-Saharan Africa, as exports from these regions has a significant share of agricultural commodities. On the contrary, the NTMs costs faced by exports of the Middle East and North Africa region are relatively low because their exports are highly concentrated in oil and petroleum products.

Figure 4
Ad-valorem equivalent of border NTMs by importing and exporting region



Source: Authors' computation.
Note: Regional groupings are those defined by the GTAP 11 aggregation facility and described in Annex II. Averages AVE do not consider GTAP service sectors.

AVEs also vary considerably at the bilateral level, with AVEs being higher when bilateral trade consists of mostly agricultural products and lower when trade flows are mainly related to natural resources, especially energy products. Bilateral differences also reflect the presence of deep trade agreements and other custom harmonization initiatives. Table 1 shows that AVEs across the GTAP 11 regions found to be higher for the exports of Sub-Saharan Africa and Latin America to the Rest of the World region, approximately 14 per cent. The lowest bilateral costs are observed in trade originating from the Middle East and North Africa region. Notably, costs related to border NTMs are not generally lower for intra-regional trade, except for trade within Europe and within North America, largely due to the presence of regional trade agreements facilitating border crossing.

Table 1
Matrix of ad-valorem equivalent of border NTMs by GTAP regions

Exporters \ Importers	East Asia	Latin America	MENA	North America	Oceania	Rest of World	Southeast Asia	South Asia	Sub-Saharan Africa	West Europe
East Asia	**4.6**	3.4	4.2	5.2	3.1	5.4	2.6	1.9	2.8	3.6
Latin America	6.7	**8.1**	11.5	7.1	7.7	13.7	11.8	4.5	5.6	5.4
MENA	2.0	3.6	**4.6**	2.6	3.8	7.8	2.7	2.5	4.1	1.9
North America	5.5	4.6	5.0	**1.8**	5.1	4.9	3.3	4.2	5.5	3.1
Oceania	5.8	5.1	8.2	10.7	**8.0**	8.7	7.8	1.6	5.2	7.5
Rest of World	2.8	2.8	6.5	2.9	4.2	**6.5**	2.9	2.9	6.7	2.1
Southeast Asia	4.0	3.4	6.2	3.9	4.8	5.6	**3.9**	3.4	5.7	5.2
South Asia	4.0	5.0	5.0	5.9	2.6	5.9	6.2	**2.7**	3.2	2.4
Sub-Saharan Africa	7.7	4.1	5.4	4.4	5.3	13.7	6.6	2.7	**7.3**	3.2
West Europe	6.0	4.2	4.2	5.0	5.6	4.8	3.0	2.0	3.6	**0.3**

Source: Authors' computation.
Note: Regional groupings are defined in the GTAP 11 aggregation and described in Annex II. Averages AVE do not consider GTAP service sectors.

In the simulation exercise presented in Section 3, the AVE estimates are incorporated into the GTAP model to simulate and illustrate the impact of reducing border NTMs on trade flows and other economic indicators. This approach allows for an assessment of the overall importance of border-related costs in affecting global trade patterns, delving into the effects on trade between regions and sectoral trade. Specifically, the model will help identify which sectors and regions stand to benefit the most from such reductions.

2.2.1 The cost of border NTMs and regional trade agreements

In general, the costs associated with border NTMs tend to be lower for transactions occurring under Regional Trade Agreements (RTAs).[8] This is not surprising, as many RTAs have specific provisions aimed at streamlining customs procedures and trade facilitation mechanism for reducing cross-border transaction costs. Indeed, multilateral negotiations are mainly about harmonizing, simplifying, or mutually recognizing non-tariff measures (Ederington, 2001).

More comprehensive RTAs often include additional provisions aimed at simplifying and harmonizing customs regulations, which lead to even lower costs and more efficient processing times at borders. These deeper agreements might also allow for mutual recognition of standards and other forms of regulatory cooperation, and more effective trade facilitation measures such as infrastructure development, transparency and risk mitigation mechanisms, thereby greatly reducing the administrative costs on businesses engaged in international trade. Overall, these comprehensive agreements create a more predictable and transparent trading environment, which further contributes to lowering the costs linked to NTMs, including those applied at the border.

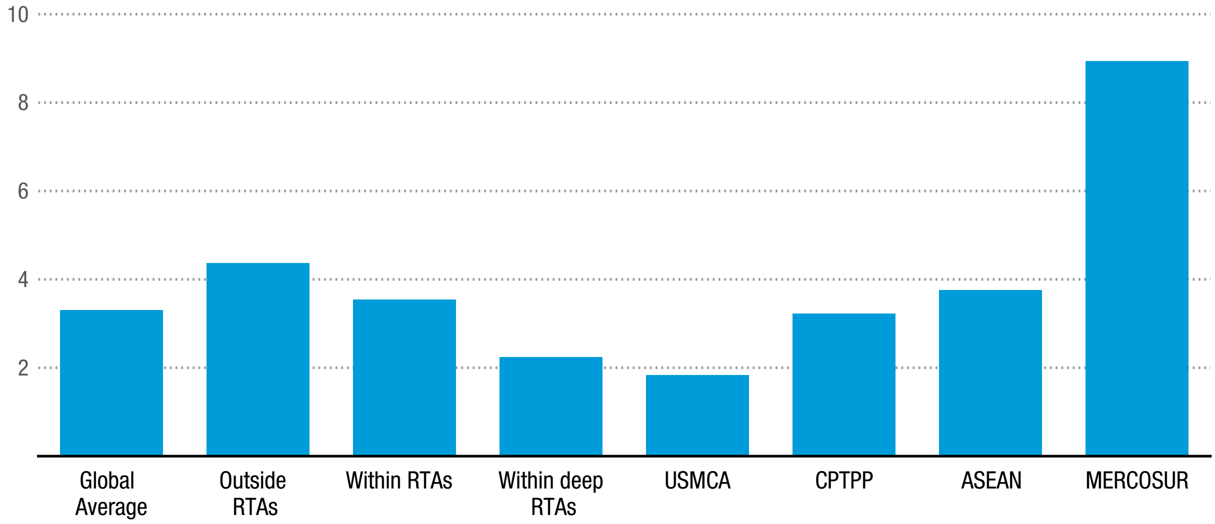
Figure 5 provides an illustration of AVEs within and outside RTAs. As measured by the AVEs, the overall costs of border NTMs incurred by global trade are in the order of about 3.3 per cent.[9] However, these costs are relatively higher for trade not occurring under any form of RTAs (about 4.4 per cent) than these under shallow RTAs (about 3.5 per cent), and the average costs of border NTMs for trade occurring under deep RTAs is even lower (about 2.2 per cent). Moreover, there are very large differences among RTAs. While some of the differences are a result of the composition of trade, specifically whether the trade is mainly agriculture, some are due to the type RTAs. For instance, the AVEs for countries in the USMCA agreement is approximately 1.8 per cent, whereas within the MERCOSUR (Mercado Común del Sur) it is around 9 per cent. As previously mentioned, these disparities are influenced by trade composition and the extent to which an RTA is effective in reducing border costs.[10]

[8] RTAs can be broadly differentiated into two categories: deep and shallow. A shallow RTA primarily focuses on reducing or eliminating tariffs and quotas on goods traded between member countries. These agreements aim to facilitate trade by making it cheaper and easier to exchange goods across borders, they may contain some trade facilitation measures, but they do not typically address broader regulatory or non-tariff barriers. A deep RTA goes beyond tariff reductions to include comprehensive provisions aimed at integrating the economies of member countries more thoroughly. These agreements address a wide range of issues, including non-tariff barriers, regulatory harmonization, services, investment, intellectual property, competition policy, and more. The categorization used in this paper is based on Mario Larch's Regional Trade Agreements Database (Egger and Larch, 2008).

[9] This estimate includes intra-European Union trade for which the AVE of border NTMs is zero.

[10] Since the Regional Comprehensive Economic Partnership (RCEP) and the African Continental Free Trade Area (AfCFTA) were not signed or implemented in 2017, which is the base year for the GTAP 11 database, the trade values recorded in the database do not account for the effects of the trade facilitation measures introduced by these agreements. As a result, the database does not reflect the potential changes in tariffs, non-tariff barriers, or other trade policies that these agreements aim to address. Therefore, the impact of RCEP and AfCFTA on trade flows and economic outcomes will be modelled through simulations in the next section, allowing for an analysis of how these agreements might alter trade patterns compared to the pre-agreement baseline.

Figure 5
Average ad-valorem equivalents of border non-tariff measures for RTAs
(per cent)



Source: Authors' computation.
Note: Averages exclude GTAP service sectors. ASEAN stands for: Association of Southeast Asian Nations; CPTPP stands for: Comprehensive and Progressive Agreement for Trans-Pacific Partnership; MERCOSUR stands for Mercado Común del Sur; and USMCA stands for United States of America, Mexico, Canada Agreement.

2.2.2 An assessment of border costs in AfCFTA and RCEP agreements

As discussed above, many RTAs have a stated objective to reduce costs associated with border NTMs. Among two of the most recently signed trade agreements comprising a large number of countries, the Regional Comprehensive Economic Partnership (RCEP) aims to increase customs performances by setting requirements in areas such as customs procedures and processes, quarantine and technical standards.[11] Similarly, the African Continental Free Trade Area (AfCFTA) contains specific protocols on customs cooperation, mutual administrative assistance, trade facilitations and non-tariff barriers.[12]

Table 2 describes the incidence of border NTMs in the RCEP and AfCFTA agreements, showing that border NTMs are widespread in both agreements, especially in certain sectors. RCEP members apply a higher number of NTMs, which is consistent with the general trend of more advanced countries applying more measures to their trade. Trade among RCEP members tends to be more subject to border NTMs than trade within AfCFTA, as shown by the higher frequency and coverage of trade affected by these measures. These differences are particularly pronounced in the manufacturing and natural resources sectors, where the frequency and coverage under AfCFTA rarely exceed 30 per cent, which is well below the global average. Overall, RCEP members face a larger number of border NTMs that apply to a greater share of products and trade compared to AfCFTA.

[11] See: https://mag.wcoomd.org/magazine/wco-news-96/rcep-from-a-customs-perspective/

[12] https://lrs.org.za/wp-content/uploads/2023/06/AfCFTA-Protocol-on-Trade-in-Goods.pdf

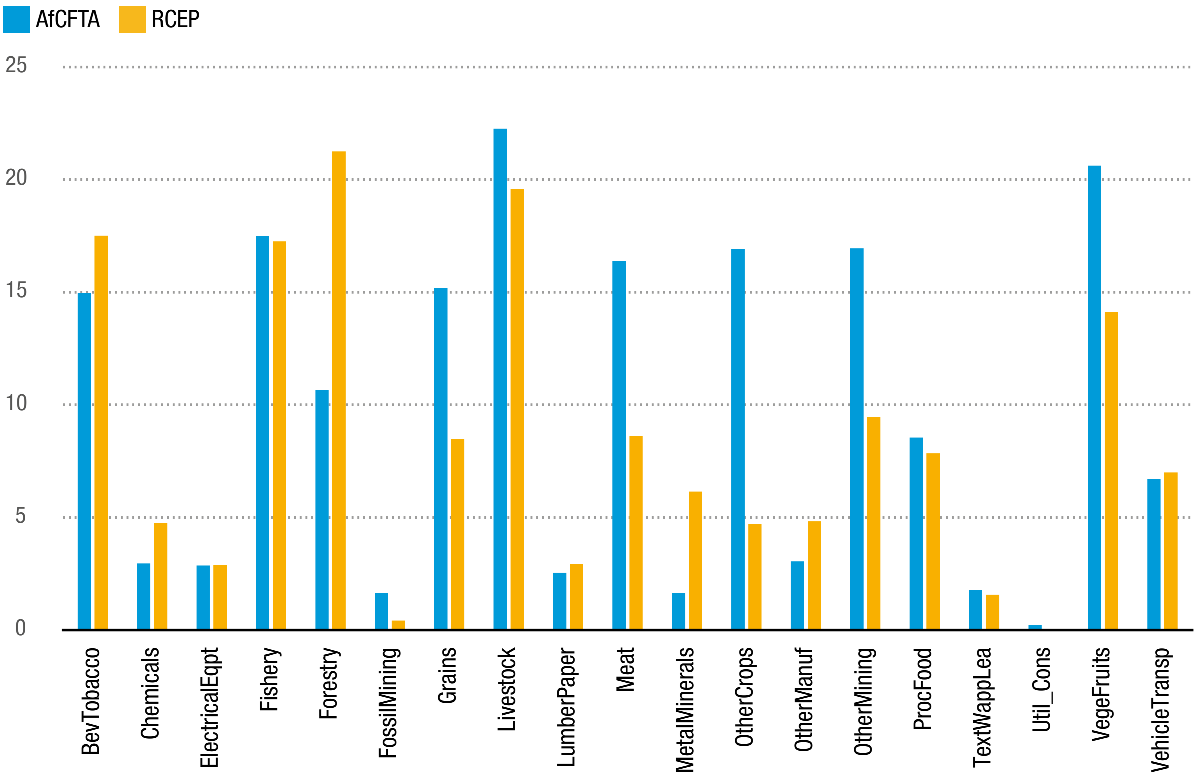
Table 2
Summary statistics of border NTM within AfCFTA and RCEP by GTAP sector

	Frequency index		Coverage ratio		Prevalence score	
	AfCFTA	RCEP	AfCFTA	RCEP	AfCFTA	RCEP
Util_Cons	11%	0%	3%	0%	1.3	na
MetalMinerals	5%	35%	6%	47%	1.3	2.2
OtherMining	13%	44%	26%	71%	2.0	2.7
LumberPaper	24%	45%	16%	60%	1.5	3.1
OtherManuf	15%	46%	19%	65%	1.4	3.0
TextWappLea	21%	35%	34%	29%	1.3	2.7
VehicleTransp	34%	60%	51%	83%	1.7	2.9
ElectricalEqpt	32%	57%	44%	81%	1.3	3.1
FossilMining	30%	62%	11%	84%	1.3	2.8
Chemicals	31%	63%	46%	82%	2.0	4.0
Forestry	69%	89%	33%	92%	2.2	5.1
BevTobacco	81%	96%	66%	81%	2.5	5.3
Livestock	75%	86%	89%	91%	2.2	5.2
Grains	85%	93%	92%	100%	2.9	5.6
ProcFood	90%	99%	90%	99%	3.2	5.9
OtherCrops	89%	98%	88%	98%	3.2	6.3
Fishery	84%	97%	95%	96%	4.5	6.5
Meat	92%	100%	93%	100%	3.7	6.5
VegeFruits	98%	100%	98%	100%	3.4	6.2

Source: Authors' computation.
Note: Sectoral aggregates are those defined by GTAP 11 aggregation facility and described in Annex II.

The costs related to border NTMs that members of the RCEP and AfCFTA incur can be summarized by the AVEs used in this paper. The AVEs in the GTAP database were estimated using data from the year 2017 to ensure compatibility with the GTAP model. Consequently, the data does not account for the presence of RTAs that were not fully implemented before 2017. The AVEs for the trade among countries that are now part of these agreements was at about 6.5 per cent for the AfCFTA and at about 4 per cent for the RCEP. Figure 6 provides a detailed breakdown of the AVEs across various GTAP sectors within these two agreements, offering insights into the sector-specific costs that were in place before the anticipated reductions from these recent RTAs took effect.

Figure 6
Average ad-valorem equivalents of non-tariff measures for AfCFTA and RCEP by GTAP sector
(per cent)



Source: Authors' computation.
Note: Sectoral aggregates are those defined by GTAP 11 aggregation facility and described in Annex II.

The sectoral AVEs of border NTMs generally show similar patterns across the two agreements. However, there are notable differences, particularly in the agricultural sectors, where costs are significantly higher for the AfCFTA compared to the RCEP. Analyzing the differences is beyond the scope of this paper and left to specialized studies that can provide a deeper understanding of the underlying causes. Specifically, this paper aims to provide an example of how to compute the trade effects for members of RTAs when removing costs associated with border NTMs using the GTAP model, thereby offering an assessment of the potential benefits of trade facilitations mechanisms of these agreements. These will be discussed in Section 3.2.

3. Effects on global trade of a 50 per cent reduction in the costs associated with border NTMs

In this section, we present the results from GTAP simulations assessing a reduction of border NTMs globally and within two recently signed regional trade agreements, the AfCFTA and RCEP. The objective of this exercise is to demonstrate how the new GTAP 11 Satellite Database on ad-valorem equivalents of border NTMs can be used in the GTAP model to calculate the effects of border NTM reduction. This analysis does not focus on estimating the impacts of specific potential or actual trade policies targeted at particular sectors or measures. Instead, it simulates the effects of a generalized policy change—namely, a broad-based reduction in the costs of border NTMs—to showcase the working mechanisms of the model in relation to border NTMs and the general magnitude of the effects. With this framework, future research can build on this illustrative exercise and use the ad-valorem equivalents data and the GTAP model to explore more tailored policy questions.

In all scenarios, the simulations apply a 50 percent reduction in the costs of border NTMs, quantified using ad-valorem equivalents (AVEs). It's important to underscore that this reduction is limited to border NTMs, which can include unnecessary expenses related to cross-border transactions, and therefore it can be feasible and desirable to reduce the cost of these measures. More specifically, we simulate the following three scenarios:

1. World: 50 per cent reduction in the AVE of border NTMs on all countries.
2. AFCFTA: 50 per cent reduction in the AVE of border NTMs among AFCFTA member countries.
3. RCEP: 50 per cent reduction in the AVE of border NTMs among RCEP member countries.

We implement the reduction in trade costs using the GTAP model's iceberg trade cost mechanism, which simulates import-augmenting technical improvements as the costs of border NTMs are reduced. In this model, the "iceberg" variable represents the trade cost, reflecting the idea that a portion of the goods "melts away" during transportation or border crossings, similar to how trade barriers reduce the effective quantity of imports. In the GTAP model, this iceberg variable is applied in the second-level Armington CES (Constant Elasticity of Substitution) function, which defines the commodity-specific import demand for each trading partner. In this framework, each importing or destination country (denoted as d) maximizes its utility (Uc,d) from the imports (Qc,s,d) of commodity c from exporter or source s. The degree to which the importer substitutes between different sources of the same commodity is controlled by the substitution parameter ($\rho_{c,d}$), and elasticity of substitution ($\sigma_{c,d}$) derived as $\sigma_{c,d} = 1/(1-\rho_{c,d})$, subject to a budget constraint ($V_{c,d}$) based on the commodity- and source-specific import price ($P_{c,s,d}$) and quantity ($Q_{c,s,d}$):

$$U_{c,d} = [\textstyle\sum_{s=1}^{n} (Q_{c,s,d})^{-\rho_{c,d}}]^{1/\rho_{c,d}} \tag{4}$$

$$V_{c,d} = \textstyle\sum_{s=1}^{n} P_{c,s,d} Q_{c,s,d} \tag{5}$$

The optimal demand for commodity imports from source s to destination d is:

$$Q_{c,s,d} = Q_{c,d}\, [\frac{P_{c,s,d}}{P_{c,d}}]^{-\sigma_{c,d}} \tag{6}$$

Adding the iceberg variable, tc,s,d, the optimal demand for imports becomes:

$$\frac{Q_{c,s,d}}{\tau_{c,s,d}} = Q_{c,d}\, [\frac{P_{c,s,d} \cdot \tau_{c,s,d}}{P_{c,d}}]^{-\sigma_{c,d}} \tag{7}$$

Converting to linear per centage change form:

$$q_{c,s,d} - \tau_{c,s,d} = q_{c,d} - \sigma_{c,d}[p_{c,s,d} - \tau_{c,s,d} - p_{c,d}] \tag{8a}$$

In the GTAP model code, the above equation is written as:

$$qxs_{c,s,d} - ams_{c,s,d} = qms_{c,d} - ESUBM_{c,d}[pmds_{c,s,d} - ams_{c,d} - pms_{c,d}] \tag{8b}$$

With commodity-specific average weighted import price:

$$pms_{c,d} = \textstyle\sum_{s} MSRHS_{c,sd}\, [\, pmds_{c,s,d} - ams_{c,d}] \tag{9}$$

Where MSHRS is the value share of commodity c from source s to destination d at basic (i.e., tariff-inclusive) prices:

$$MSRHS_{c,s,d} = [\frac{VMSB_{c,s,d}}{\sum_{ss} VMSB_{c,ss,d}}] \tag{10}$$

As can be seen in Equations 8b and 9, the iceberg parameter, *ams*, represents the negative decay on imports of commodity or service c from exporting region s to importing destination d. When *ams* is reduced by 50 per cent, we observe both a quantity and a price effect— for instance 50 per cent more of the imported commodity becomes available to domestic consumers given the same level of exports from source country s, while import prices also fall by 50 per cent. Indeed, Equation 8b shows that the *ams* parameter has two corresponding effects.

The expansion effect reduces the effective quantity of imports to satisfy a given level of demand. This is because the reduction in trade costs allows a greater effective quantity of the product to be delivered. The substitution effect reduces the price of imports, thereby inducing substitution towards the relatively cheaper source and away from the more expensive supplier. Note that these two effects work in opposite directions. Nonetheless, the substitution effect is larger than the expansion effect because GTAP Armington elasticities (which represent the degree to which consumers can substitute between different sources of the same good) are always greater than 1. As a result, when the costs associated with NTMs are reduced through the iceberg mechanism, import prices decrease, leading to a stronger preference for cheaper imported goods. This causes an overall increase in the demand for imports, as the lower prices make imports more attractive relative to domestic alternatives.

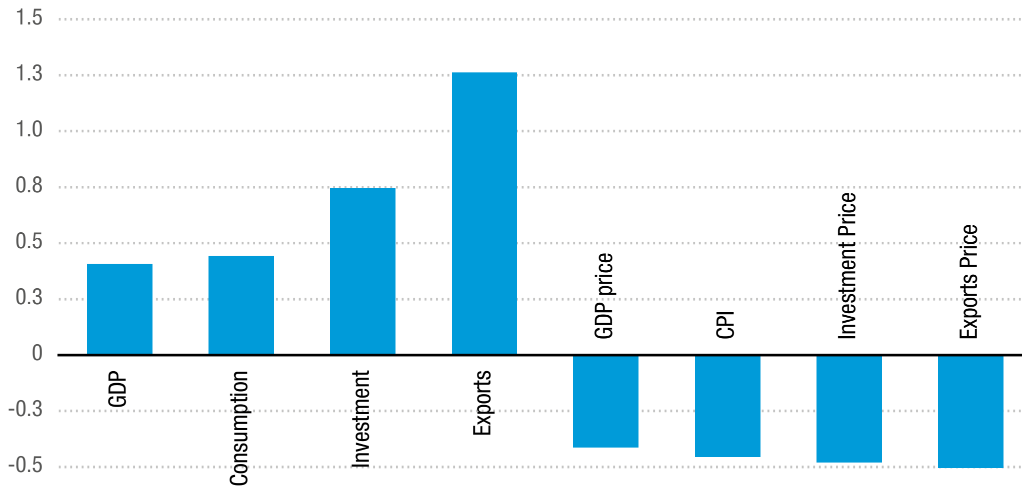
In the next section, we discuss the results from the global simulation and present some key metrics to understand the economic impacts of border NTMs improvements. We begin with the gross domestic product (GDP) to analyze the economic impact at the global level. We also present equivalent variation to provide a money metric welfare equivalent associated with border NTM changes for each region. The trade impacts are then presented, since they are key to understanding economic reallocation arising from trade creation and trade diversion effects. We then provide some results for the simulations concerning the two RTAs.

The next section discusses the results from the global simulation and presents some key metrics to assess the economic impacts of reduction in the costs associated with border NTMs. We begin by showing the changes in gross domestic product (GDP) to understand the overall economic effects. Additionally, we present consumption and investment effects, which are crucial for understanding the economic reallocation driven by trade creation and trade diversion effects. Finally, we present the trade effects resulting from the two simulations regarding the reduction in the costs of NTMs withing the AfCFTA and RCEP trade agreements.

3.1 Results of a global reduction of border NTM-related costs

The overall impact of reducing the cost of global border NTMs by 50 per cent, simulated using the GTAP model, is summarized in Figure 7. Global real GDP is projected to increase by 0.4 per cent when all countries reduce the AVE of border NTMs by half. These GDP changes are primarily driven by export growth, as trade facilitation reduces export prices by 0.5 per cent, boosting demand for exports (1.3 per cent), investment (0.8 per cent), and consumption (0.4 per cent). Figure 7 also highlights the price effects. Export prices are expected to decline by approximately 0.5 per cent, and prices for investment, consumption, and GDP are projected to fall by a similar magnitude. Overall, global welfare is anticipated to increase by around US$ 330 billion, while global trade is expected to rise by about US$ 300 billion.

Figure 7
Global effects from a 50 per cent global reduction in the AVE of NTMs



Source: Authors calculation using GTAP model with GTAP11 Data Base.

In United States dollar terms, the largest welfare gains are expected in East Asia and North America, as these regions comprise some of the world's largest exporters. Welfare in East Asia is projected to increase by almost US$ 118 billion, with exports expected to rise by 2.6 per cent. The reduction in the costs associated with NTMs is also anticipated to have significant effects in Sub-Saharan Africa and Latin America, where exports are projected to increase by approximately 2 per cent. In contrast, the reduction in the costs associated with NTMs will have a relatively smaller impact on the exports of the Oceania and Western Europe. The lower welfare gains in Western Europe are primarily due to the absence of border NTMs within the European Union, limiting the scope for further reductions.

Table 3
Regional welfare and exports effects of a 50 per cent global reduction in the AVE of border NTMs

GTAP region	Welfare ($US billions)	Exports (per cent)
East Asia	118.0	2.6
Latin America	20.9	2.1
Middle East and North Africa	28.4	1.8
North America	55.2	1.3
Oceania	10.3	0.9
Southeast Asia	13.6	1.8
South Asia	25.1	1.3
Sub-Saharan Africa	11.1	2.1
West Europe	38.0	0.2
Rest of World	13.6	1.8
Total	**334.2**	**1.3**

Source: Authors calculation using GTAP model. Note: Regional groupings are defined by the GTAP 11 aggregation facility and described in Annex II.

Table 4 reports the results on bilateral trade following a 50 per cent global reduction in the AVE of NTMs. In general, bilateral trade increases across all regions, with a few notable exceptions. Specifically, trade within North America and Western Europe is projected to decline. This is due to the already low AVEs of border NTMs for intra-regional trade in these areas, meaning that a reduction in the AVE of NTMs would have minimal impact on reducing trade costs. As a result, trade diversion occurs, favouring bilateral trade between regions where border NTMs are higher (e.g., between North America and Europe). In contrast, the trade gains from reducing the costs associated with border NTMs are expected to be high within Latin America, with an increase of approximately 5 per cent. Additionally, above-average gains are anticipated for Sub-Saharan exporters to East Asia and within Sub-Saharan Africa.

Table 4
Bilateral trade effects of a 50 per cent global reduction in the AVE of border NTMs (per cent)

	Importers									
Exporters	East Asia	Latin America	Middle East and North Africa	North America	Oceania	Rest of World	South Asia	Southeast Asia	Sub-Saharan Africa	West Europe
East Asia	**3.2**	1.4	0.9	3.4	-0.6	1.2	1.0	-0.1	1.2	4.2
Latin America	-1.3	**5.1**	2.2	2.7	4.2	4.3	5.3	3.8	-1.1	2.0
Middle East and North Africa	1.1	2.1	**3.2**	0.3	3.3	2.9	-0.8	2.2	3.2	1.9
North America	5.1	3.6	2.0	**-2.2**	5.2	2.8	2.9	4.2	4.0	3.3
Oceania	2.1	-4.7	-3.5	0.0	**2.7**	-1.1	-0.3	-4.4	-2.5	-0.2
Rest of World	-0.3	-2.2	0.8	-1.4	3.4	**3.8**	-0.1	0.0	2.8	2.7
South Asia	0.7	-0.9	3.3	-2.4	1.2	-0.8	**2.0**	1.1	1.4	5.4
Southeast Asia	0.1	3.2	1.1	3.4	0.4	-0.7	3.7	**-0.7**	0.2	1.3
Sub-Saharan Africa	8.2	1.6	-2.3	-1.9	-1.2	0.4	-0.6	-2.4	**3.9**	0.1
West Europe	6.1	3.0	1.4	2.9	4.9	1.3	2.7	2.4	2.3	**-1.6**

Source: Authors calculation using GTAP model. Note: Regional groupings are as defined by the GTAP 11 aggregation facility and described in Annex II.

Table 5 presents the results of a 50 per cent global reduction in the costs associated with border NTMs at the sectoral level, further disaggregated by GTAP exporting regions. Overall, the largest increases in trade are expected in the agricultural and food sectors. This is unsurprising, as agricultural sectors typically face the highest border costs; thus, a 50 per cent reduction would lead to relatively larger cost declines. Specifically, global trade is projected to increase by about 8 per cent in the grains and meats sectors and by around 5 per cent in the livestock and forestry sectors. Conversely, global impacts are expected to be lower for mining, fossil fuels, and services, where increases are driven by secondary effects from higher consumption and investment. The other mining sector shows a decline in global trade, likely due to already low AVEs of border NTMs and substitution effects with other materials. Among manufacturing sectors, global trade is projected to increase by between 0.6 per cent (textiles, apparel, and leather) and 2 per cent (for other manufacturing).

When examined at the regional level, the sectoral effects display considerable variation. For example, grain exports are expected to increase significantly in percentage terms for many developing regions, but to a lesser extent in North America, while declining in Western Europe and Oceania. Another notable case is electrical equipment: a 50 per cent reduction in border NTM costs is projected to substantially boost exports from East Asian regions while reducing them in North America and Western Europe.

Table 5
Sectoral trade effects of a 50 per cent global reduction in the AVE of border NTMs
(per cent)

	Exporters										
GTAP Sector	Global	East Asia	Latin America	Middle East and North Africa	North America	Oceania	Rest of World	South Asia	Southeast Asia	Sub-Saharan Africa	West Europe
Beverage and Tobacco	0.4	-0.8	6.9	1.6	-1.7	6.2	0.5	-1.4	-1.0	1.7	-0.2
Electrical Equipment	1.4	5.3	-3.2	5.5	-1.8	-7.6	11.0	1.8	3.2	2.9	-4.4
Fishery	0.6	8.5	-2.4	0.0	-1.4	-3.0	10.5	5.7	2.6	5.3	-0.8
Forestry	5.6	10.7	14.5	0.7	-2.4	4.0	8.1	-0.3	-3.7	25.2	-1.0
Fossil Fuels	0.1	-1.1	1.7	-0.1	0.2	-0.9	0.2	2.1	43.3	-0.5	0.7
Grains	8.4	25.4	27.9	105.5	9.4	-3.3	5.0	93.1	24.9	63.1	-5.9
Livestock	5.4	15.3	20.3	20.2	12.4	-0.3	26.7	22.1	27.0	-0.5	-0.9
Lumber and Paper	1.6	4.3	-1.3	4.9	1.2	4.3	13.2	2.1	2.0	-1.3	0.0
Meat	7.9	0.2	17.4	21.8	13.6	13.5	22.7	-1.0	50.0	10.0	-0.8
Metals and Minerals	1.9	1.5	1.4	3.2	1.1	15.1	-1.7	1.1	1.8	7.1	1.2
Motor Vehicles and Transport	1.6	1.3	5.5	4.4	0.5	2.6	6.4	1.8	3.2	1.6	1.7
Other Crops	1.3	7.6	-1.8	24.8	2.0	7.8	25.3	2.1	1.6	-0.2	-2.3
Other Manufacturing	2.0	3.0	0.5	2.4	3.4	3.4	8.1	6.7	0.2	13.9	0.0
Other Mining	-2.4	1.3	-1.5	-1.2	-1.5	-5.5	-0.9	-1.8	-3.1	-2.6	-1.2
Other Services	0.2	-1.0	-2.1	0.0	1.3	-3.8	-0.7	-2.1	-0.8	-2.1	0.8
Processed Food	3.0	4.2	8.9	10.0	0.2	3.0	3.8	6.8	9.2	7.1	-1.1
Rubber, Chemicals, and Plastic	1.5	1.9	6.6	3.0	2.8	3.4	2.1	0.5	0.1	2.4	0.5
Textile, Wearing Apparel and Leather	0.6	-0.4	-2.0	2.5	4.4	2.7	8.5	-1.7	2.2	-0.7	1.7
Trade and Transportation	0.8	-0.1	-0.7	0.7	1.7	-2.6	0.6	-0.6	0.9	-0.9	1.5
Utilities and Constructions	0.5	0.2	-1.0	0.9	1.2	-4.0	-0.9	-1.2	0.1	-1.2	1.1
Vegetables and Fruits	1.3	13.7	-5.1	6.1	2.7	-0.9	11.3	-0.3	14.5	-0.1	-2.5

Source: Authors calculation using GTAP model. Note: Regional groupings are as defined by the GTAP 11 aggregation facility and described in Annex II.

3.2 Results of a reduction in the border NTM-related costs in the AFCFTA and RCEP

This section assesses the trade effects of a selective 50 per cent reduction in the costs associated with border NTMs among members of either the RCEP or the AfCFTA trade agreement. For clarity, in the simulations concerning each of these two RTAs, the AVEs of border NTMs are set to remain at the observed level for non-member countries.

A reduction of the costs associated with border NTMs within AfCFTA would result in welfare gains of approximately US$ 3.6 billion for AfCFTA members, alongside a loss of about US$ 1.1 billion for non-members. The welfare gains for AfCFTA countries are driven by trade creation effects, while the losses are attributed to trade diversion effects in other countries, which are not part of AfCFTA. Similarly, reducing the cost of existing border NTMs by half in RCEP countries results in welfare gains of about US$ 74 billion for RCEP members and losses of around US$ 16 billion for non-members due to trade diversion effects negatively impacting non-RCEP countries.

Regarding trade, intra-AfCFTA trade is expected to expand by approximately 10.8 per cent as improvements in border NTMs lead to trade creation effects.[13] However, exports from AfCFTA to other trading partners are projected to contract by about 1 per cent due to trade diversion. Imports by AfCFTA members from non-members are also expected to decrease by about 0.6 per cent. A similar pattern is observed for RCEP countries: a 50 per cent reduction in the AVE of border NTMs is projected to increase intra-RCEP trade by around 5.4 per cent, while imports from and exports to non-member countries would fall by about 2 per cent.

Table 6 provides further details on the changes in inter- and intra-regional trade resulting from a 50 per cent reduction in border NTM costs within the two RTAs. As seen in the global results, the largest trade gains occur in the agri-food sectors, with smaller gains in mining, minerals, and other natural resources. For example, within AfCFTA, the largest increases are in grains (96 per cent) and meats (66 per cent). In RCEP, the greatest gains are in meats (28 per cent), forestry (26 per cent), and other crops (21 per cent). In the manufacturing sector, intra-AfCFTA trade in other manufacturing increases by 14 per cent, while in RCEP, the motor vehicle sector sees an 11 per cent increase. Trade within member countries also rises substantially for rubber and chemicals in both AfCFTA and RCEP.

[13] The general finding on the importance of non-tariffs measures for intra Africa trade are also highlighted by Sanjuán López et al (2021).

Table 6
Sectoral trade effects of a 50 per cent global reduction in the AVE of border NTMs within AfCFTA and RCEP
(per cent)

GTAP Sector	within AFCFTA	Nonmembers imports	Nonmembers exports	within RCEP	Nonmembers imports	Nonmembers exports
Beverage and Tobacco	6.9	-0.5	-2.3	6.3	-1.1	-1.6
Electrical Equipment	11.2	-1.7	-0.1	4.3	-1.4	-3.7
Fishery	8.1	-1.0	-2.0	6.8	-1.7	-5.1
Forestry	14.4	-1.3	-6.9	26.7	-3.0	-5.7
Fossil Fuels	14.2	-0.6	-7.3	2.2	-3.0	-0.2
Grains	96.6	-2.2	-2.2	16.7	-2.8	-0.6
Livestock	22.4	-1.0	-7.0	15.7	-1.8	-6.9
Lumber and paper	8.5	-1.2	-0.5	5.5	-2.4	-0.8
Meat	66.1	-2.4	-2.0	27.9	-3.7	-4.5
Metals and Minerals	2.3	-1.0	0.1	8.8	-2.3	-3.4
Motor Vehicles and Transport	15.9	-0.9	-0.6	11.3	-1.8	-2.9
Other Crops	20.9	-1.4	-5.3	21.0	-2.3	-0.9
Other Manufacturing	13.4	-1.6	-0.3	9.7	-2.7	-3.6
Other Mining	2.2	-0.1	-4.8	0.4	-0.9	-0.9
Other Services	-0.5	-1.1	0.6	-0.8	-2.4	1.8
Processed Food	18.7	-0.7	-2.2	10.1	-1.8	-3.9
Rubber, Chemicals and Plastic	8.8	-0.4	-0.7	6.1	-1.7	-2.5
Textile, Wearing Apparel and Leather	6.2	-1.7	0.3	1.6	-2.1	0.2
Trade and Transportation	-0.5	-1.0	0.6	-1.0	-2.4	1.6
Utilities and Constructions	-0.1	-1.0	0.6	-0.2	-2.2	2.2
Vegetables and Fruits	23.6	-1.1	-5.3	10.2	-1.7	-6.5
Total	**10.8**	**-0.9**	**-0.6**	**5.4**	**-2.0**	**-1.5**

Source: Authors calculation using GTAP model.
Note: Regional groupings are as defined by the GTAP 11 aggregation facility and described in Annex II.

4. Conclusions

This paper uses non-tariff measures data collected by UNCTAD to illustrate the incidence of border non-tariff measures, along with their ad-valorem equivalents, also estimated by UNCTAD, to assess the potential effects of reducing the costs associated with border NTMs on welfare and trade using the general equilibrium framework of the GTAP model. The paper first highlights the significant presence of border non-tariff measures and their variability across different sectors and geographic regions. The paper then presents the costs associated with NTMs, measured by ad-valorem equivalents, as provided in the GTAP satellite database. Descriptive statistics in the paper reveal significant differences in these costs across sectors, regions, and RTA membership. Finally, the paper presents simulations of cost reductions at both the global and regional levels, using the standard GTAP model to estimate the effects of these reductions on trade and welfare.

The paper's simulations show that a 50 per cent reduction in the costs of border non-tariff measures (from 3.3 per cent to 1.6 per cent in ad-valorem equivalents) would increase global welfare by approximately US$ 330 billion and boost global trade by US$ 300 billion. Regionally, the impact would vary, with North America seeing a 1.3 per cent increase and Latin America and Africa experiencing up to 2.1 per cent growth. However, trade diversion effects would lead to negative impacts on some regions. Sectorally, the largest benefits would be seen in agriculture and food sectors, particularly in grains and meats, with over a 7 per cent increase in trade. Sectors like mining, fossil fuels, and services would see smaller gains due to their already low border NTM costs, while manufacturing sectors would experience moderate gains, with variations across regions. Additionally, reducing border non-tariff measures costs within regional trade agreements like AfCFTA and RCEP would lead to substantial benefits for member countries, including welfare gains and increased intra-regional trade, though trade diversion would negatively affect non-members.

Overall, the findings of this paper highlight the significance of trade facilitation mechanisms and customs reforms in reducing the costs associated with border-related non-tariff measures. By minimizing unnecessary expenses related to cross-border transactions, for example by reducing red tape, customs inefficiencies, and costly administrative requirements countries can lower trade costs, and enhance trade efficiency. Lowering these costs not only stimulates global trade and economic growth but can also facilitate the integration of low-income countries—particularly those that export products facing higher border-related costs, such as agriculture—into international and regional markets, ultimately supporting their broader economic development. Policymakers will naturally prioritize cost reductions based on what is feasible and desirable within their specific contexts. Nonetheless, this paper highlights the importance of addressing trade costs associated with many border-related NTMs, as these measures are often neither optimized nor efficiently implemented—making their reform both necessary and achievable. In this regard, the methods outlined in this paper provide valuable tools for identifying sectors where border NTMs are particularly burdensome and for quantifying the impact of reducing the costs of sector- and country-specific NTMs, whether through trade facilitation agreements or targeted customs reforms. We leave this area for future research.

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ANNEX I. International classification of non-tariff measures. Measures covered.

AVEs capture the effects of border measures defined as “Customs regulations” in *Ederington and Ruta (2016).* These are customs regulations and include traditional quantitative restrictions, price control measures as well as other NTMs such as traceability, licensing, processing and inspections. The world price of the good represents the international trading price outside of the importer’s borders (namely the free on board -f.o.b.- price). In practice, customs regulations are to be intended similarly to transport costs or tariffs as they drive a wedge between world prices and domestic prices. The domestic price represents the tradeable price of the good right inside the country’s borders. The border measures are categorized under the following codes of the international classification of non-tariff measures (UNCTAD, 2019).

Border measures include many categories under different chapters of the classification. In detail, they include the codes: A14, A140, A15, A150, A81, A810, A84, A840, A85, A850, A851, A852, A853, A859, A86, A860, A89, A890, B14, B140, B15, B150, B81, B810, B84, B840, B85, B850, B851, B852, B853, B859, B89, B890, C00, C000, C10, C100, C20, C200, C30, C300, C40, C400, C90, C900, E10, E100, E11, E110, E111, E112, E113, E119, E12, E120, E121, E122, E129, F40, F400, F60, F600, F61, F610, F62, F620, F63, F630, F64, F640, F65, F650, F67, F670, F80, and F800.

ANNEX II. GTAP concordances

Table A1
Country codes and GTAP region aggregates

ISO3 code	GTAP region	ISO3 code	GTAP region	ISO3 code	GTAP region	ISO3 code	GTAP region	ISO3 code	GTAP region
AFG	SouthAsia	CRI	LatinAmer	KHM	SEAsia	PRI	LatinAmer	UZB	RestWorld
ALB	RestWorld	DOM	LatinAmer	KOR	EastAsia	PRY	LatinAmer	VEN	LatinAmer
ARE	MENA	DZA	MENA	KWT	MENA	PSE	MENA	VNM	SEAsia
ARG	LatinAmer	ECU	LatinAmer	LAO	SEAsia	QAT	MENA	XAC	SSA
ARM	RestWorld	EGY	MENA	LBN	MENA	RUS	RestWorld	XCA	LatinAmer
AUS	Oceania	ETH	SSA	LKA	SouthAsia	RWA	SSA	XCB	LatinAmer
AZE	RestWorld	EUN	WestEurope	MAR	MENA	SAU	MENA	XEA	EastAsia
BEN	SSA	GAB	SSA	MDG	SSA	SDN	SSA	XEC	SSA
BFA	SSA	GEO	RestWorld	MEX	NAmerica	SEN	SSA	XEE	RestWorld
BGD	SouthAsia	GHA	SSA	MLI	SSA	SGP	SEAsia	XEF	WestEurope
BHR	MENA	GIN	SSA	MNG	EastAsia	SLV	LatinAmer	XER	RestWorld
BLR	RestWorld	GNQ	SSA	MOZ	SSA	SRB	RestWorld	XNA	NAmerica
BOL	LatinAmer	GTM	LatinAmer	MUS	SSA	SWZ	SSA	XNF	MENA
BRA	LatinAmer	HKG	EastAsia	MWI	SSA	SYR	MENA	XOC	Oceania
BRN	SEAsia	HND	LatinAmer	MYS	SEAsia	TCD	SSA	XSA	SouthAsia
BWA	SSA	HTI	LatinAmer	NAM	SSA	TGO	SSA	XSC	SSA
CAF	SSA	IDN	SEAsia	NER	SSA	THA	SEAsia	XSE	SEAsia
CAN	NAmerica	IND	SouthAsia	NGA	SSA	TJK	RestWorld	XSM	LatinAmer
CHE	WestEurope	IRN	MENA	NIC	LatinAmer	TTO	LatinAmer	XSU	RestWorld
CHL	LatinAmer	IRQ	MENA	NOR	WestEurope	TUN	MENA	XTW	RestWorld
CHN	EastAsia	ISR	MENA	NPL	SouthAsia	TUR	MENA	XWF	SSA
CIV	SSA	JAM	LatinAmer	NZL	Oceania	TWN	EastAsia	XWS	MENA
CMR	SSA	JOR	MENA	OMN	MENA	TZA	SSA	ZAF	SSA
COD	SSA	JPN	EastAsia	PAK	SouthAsia	UGA	SSA	ZMB	SSA
COG	SSA	KAZ	RestWorld	PAN	LatinAmer	UKR	RestWorld	ZWE	SSA
COL	LatinAmer	KEN	SSA	PER	LatinAmer	URY	LatinAmer		
COM	SSA	KGZ	RestWorld	PHL	SEAsia	USA	NAmerica		

Note: MENA stands for Middle East and North Africa, SEAsia stands for Southeast Asia, and SSA stands for Sub-Saharan Africa.

Table A2
GTAP sectoral codes and aggregates

GTAP code	Sector Aggregate	GTAP code	Sector Aggregate	GTAP code	Sector Aggregate
AFS	TransComm	**HHT**	OthServices	**OXT**	OtherMining
ATP	TransComm	**INS**	OthServices	**PCR**	ProcFood
BPH	Chemicals	**I_S**	MetalMinerals	**PDR**	Grains
B_T	BevTobacco	**LEA**	TextWappLea	**PFB**	OtherCrops
CHM	Chemicals	**LUM**	LumberPaper	**PPP**	LumberPaper
CMN	TransComm	**MIL**	ProcFood	**P_C**	Chemicals
CMT	Meat	**MVH**	VehicleTransp	**RMK**	Livestock
CNS	Util_Cons	**NFM**	MetalMinerals	**ROS**	OthServices
COA	FossilMining	**NMM**	MetalMinerals	**RPP**	Chemicals
CTL	Livestock	**OAP**	Livestock	**RSA**	OthServices
C_B	OtherCrops	**OBS**	OthServices	**SGR**	ProcFood
DWE	OthServices	**OCR**	OtherCrops	**TEX**	TextWappLea
EDU	OthServices	**OFD**	ProcFood	**TRD**	TransComm
EEQ	ElectricalEqpt	**OFI**	OthServices	**VOL**	ProcFood
ELE	ElectricalEqpt	**OIL**	FossilMining	**V_F**	VegeFruits
ELY	Util_Cons	**OME**	OtherManuf	**WAP**	TextWappLea
FMP	MetalMinerals	**OMF**	OtherManuf	**WHS**	TransComm
FRS	Forestry	**OMT**	Meat	**WHT**	Grains
FSH	Fishery	**OSD**	OtherCrops	**WOL**	Livestock
GAS	FossilMining	**OSG**	OthServices	**WTP**	TransComm
GDT	Util_Cons	**OTN**	VehicleTransp	**WTR**	Util_Cons
GRO	Grains	**OTP**	TransComm		

ANNEX III. Brief overview on the estimation of AVEs

The ad-valorem equivalents of NTMs provided in this database are based on the estimation method detailed in Kee and Nicita (2022), which in turn, builds on the seminal work of Kee, Nicita and Olarreaga (2009). As with most of the econometric literature estimating AVEs, the effects of NTMs on international trade are isolated using incidence measures of NTMs as explanatory variables. Following Kee and Nicita (2022), the AVEs are computed as the equivalent tariff that would be necessary to impose in order to obtain the same proportionate change in quantity imported due to the presence of NTMs. In short, the estimation method seeks to identify the instantaneous semi-elasticity of trade with respect to differences in the observed tariffs and apply this elasticity to the estimated effects of NTMs on the quantity of trade. Bilateral variations in the AVEs estimates are calculated on the assumption that the trade costs associated with NTMs are a function of importers' and exporters' market power. While details on the estimation are to be found in Kee and Nicita (2022), the general estimating equation takes the form:

$$\ln E(Q_{nij}|X) = \beta_n + \beta^t_{nij}\hat{t}_{nij} + \beta^{NTM}_{nij} NTM_{nij} + \gamma Z_{ij} + e_{nji}$$

where $\beta^t_{nij} = \beta^t_n + \beta^t_1 share_{nj} + \beta^t_2 share_{nij} + \beta^t_3 share_{ni}$

and $\beta^{NTM}_{nij} = \beta^{NTM}_n + \beta^{NTM}_1 share_{nj} + \beta^{NTM}_2 share_{nij} + \beta^{NTM}_3 share_{ni}$

where Q denotes quantities, t tariffs, and *NTM* the presence of an NTM, and where n denotes products, i importing country and j exporting country. Bilateral variation of AVEs is provided by interaction terms (shares) and consists of three terms: absolute market power of the exporter ($export_{jK}/wld\_trade_K$); relative market power of the exporter in the importer market ($import_{ijK}/export_{jK}$); and importer market power ($import_{iK}/wld\_trade_K$). Z_{ij} are gravity-type variables. In this setup the elasticity of trade with respect to tariff is:

$$\hat{\beta}^t_{nij} = \frac{\partial \ln (E(Q_{nij}|X)}{\partial t_{nij}},$$

and the AVE measuring the ad-valorem tariffs that induce the same proportionate change in quantity as the presence of an NTM is:

$$AVE^{NTM}_{nij} = \frac{\exp(\hat{\beta}^{NTM}_{nij}) - 1}{\exp(\hat{\beta}^t_{nij}) - 1} \cong \frac{\hat{\beta}^{NTM}_{nij}}{\hat{\beta}^t_{nij}} \quad \text{for small } \hat{\beta}^t_{nij} \text{ and } \hat{\beta}^{NTM}_{nij}.$$

In more intuitive terms, to measure the AVEs of NTMs, Kee and Nicita (2022) estimate the proportionate change in quantity imported due to the presence of NTMs, and then use the elasticity of trade with respect to a one percentage point increase in the tariff to convert the proportionate change in quantity imported due to NTMs in terms of ad valorem equivalents. A feature of this approach is that it allows the calculation of AVE when there is no bilateral trade. In this case the AVEs will be based on the coefficient on the dummy NTM variables and the average elasticity.

For the purpose of this paper, the estimates are rerun to increase compatibility with the GTAP 11 database. In short, the base year has been fixed to 2017, while the estimation makes use of increased and improved availability of NTM data.

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