ERIA-DP-2023-02

ERIA Discussion Paper Series

No. 474

Divergence in Non-Tariff Measures and the Quality of Traded Products

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May 2023

Abstract: *Non-tariff measures (NTMs) constitute a grey area where trade policy meets public policy goals. NTMs comprise a diverse set of regulatory policy measures, including testing and certification, rather than traditional international trade policy measures such as tariffs or tariff-rate quotas. Regulatory NTMs protect plants, animals, humans, and consumers from imported harmful products containing diseases; regulate the use of hazardous substances in production; ensure conformity with common standards; and protect the environment. Trade literature has focused on the impact of NTMs on trade flows, whereas few studies address the potential welfare-improving effects of these measures. This paper fills this gap by examining the relationship between NTM applications and the quality of traded products. Two questions are addressed. First, do more or additional burdens of NTMs in the foreign market incur a higher quality of exported products? Second, is the quality impact of NTMs in different sectors different between food and other manufacturing goods? We adopt a recently developed indicator to capture the additional requirements for exporters stemming from importers' imposition of NTMs, and a quality estimator that controls for price. Our empirical results indicate that, overall, divergence in sanitary and phytosanitary (SPS) measures between the two trading partners reduces the quality of traded goods. Furthermore, while the divergence in SPS measures reduces the quality of traded goods in the manufacturing sector, the divergence in technical barriers to trade shows no statistically significant impact on the quality of traded goods between the two trading partners. The results imply that additional costs from technical barriers to trade are negligible compared with those from SPS measures in the manufacturing sector.*

Keywords: additional compliance requirements indicator, international trade, non-tariff measures, quality of traded goods

JEL classification: F13, F14

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1. Introduction

Non-tariff measures (NTMs) comprise a diverse set of regulatory policy measures, including testing and certifications, rather than traditional trade policy measures such as tariffs or tariff-rate quotas. Regulatory NTMs protect plants, animals, humans, and consumers from imported goods that contain contaminating diseases; regulate the use of hazardous substances in production; ensure conformity with common standards and regulations; protect the environment; and maintain national security, amongst others. Trade literature has focused on the impact of NTMs on trade flows, whereas few studies address the potential welfare-improving effects of these measures. NTMs constitute a grey area where trade policy meets public policy goals. As such, NTMs may improve welfare (Beghin, Disdier, and Marette, 2015) where the market fails to address such negative externalities. However, by incurring procedural costs and compliance costs, NTMs can hamper the competitiveness of some exporting firms and, consequently, impede trade flows (Fontagné and Orefice, 2018; Olarreaga and Fugazza, 2018; Hoekman and Nicita, 2008; Kee, Nicita, and Olarreaga, 2009).

The impact of NTMs on trade values, volumes, unit values, and quality has been studied in numerous papers in the literature (Bora, Kuwahara, and Laird, 2002; Ferrantino, 2006; Fugazza and Maur 2008; Kee, Nicita, and Olarreaga, 2009; Beghin, Disdier, and Marette, 2015; Cadot and Gourdon, 2016; Cadot, Gourdon, and van Tongeren, 2018; Jafari and Britz, 2018; Liu et al., 2019; Webb et al., 2020; Gourdon, Stone, and van Tongeren, 2020; Ghodsi and Stehrer, 2022; Ghodsi, forthcoming). The impact of regulatory convergence and similarity in NTMs on trade values and volumes have been also analysed in several studies in the literature (Piermartini and Budetta, 2009; Cadot et al., 2015; Cadot and Ing, 2015; Knebel and Peters, 2019; Nabeshima and Obashi, 2021; Inui et al., 2021). This paper fills this gap by examining the relationship between divergence in NTM application and the quality of traded products. Two main questions are addressed in this paper.

First, do divergence or the additional burden of NTMs in the importing market incur a higher quality of exported products? NTMs are divided into two groups: regulatory and non-regulatory measures. Non-regulatory measures (e.g. price measures or import licensing) are more related to traditional restrictions on international trade (e.g. tariffs and tariff quotas). However, here the focus is on regulatory NTMs – sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBTs) – which are mandatory regulatory measures set by the government on the import of goods. According to UNCTAD (2019), regulations and NTMs are two different measures. Regulations refer to the documents that contain product requirements, such as decrees or laws, whereas an NTM refers to the corresponding requirements. Therefore, we strictly distinguish NTMs from regulations and standards, but use NTMs and regulatory measures interchangeably throughout the paper.

Second, is the quality impact of regulatory divergence in NTMs different across food and other manufacturing sectors? Does the impact of NTMs in different sectors show different outcomes? NTMs imposed in the manufacturing sector may have a larger impact on trade costs than NTMs imposed in the food sector, as manufacturing goods undergo multiple production procedures relative to food. Furthermore, the burden of NTMs might be different for developed versus developing economies. Thus, we analysed whether the additional burden of NTMs in foreign markets incurs a different quality of exported products across different country groupings.

We extend the paper by Ghodsi and Stehrer (2022) on the adoption of NTMs to quality upgrading across broad country and product categories. While it used the quality index developed by Feenstra and Romalis (2014), this paper constructs the quality estimate of an imported good following the methodology provided by Henn et al. (2020). The imported unit value is simply the import value divided by the import volume, which often reflects the price of each imported good. We distinguish the quality by constructing the price-controlled quality estimator of Henn et al. (2020) and compare the results with unit price (unit value). The empirical results indicate that, overall, divergence in SPS measures decreases the quality of traded goods, particularly in the manufacturing sector.

Furthermore, this study contributes to the related literature on the impact of NTMs on the quality of traded goods in two ways. First, we employ newly released NTM panel data from the United Nations Conference on Trade and Development (UNCTAD) Trade Analysis Information System (TRAINS) database.[1] The cross-sectional version of these data has been used widely for studies on the trade impact of NTMs (Bratt, 2017; Cadot et al., 2015; Cadot and Gourdon, 2016; Kee, Nicita, and Olarreaga, 2009). This is the first panel version of the data published by UNCTAD.[2] This new version of the database overcomes a major constraint of previous versions of the data in earlier studies on NTMs, which is comprehensiveness across countries and time dimensions. The global database covers all official regulatory measures at reporter-partner-product-NTM-year level in force at the time of data collection. Such comprehensive coverage allows us to measure the dissimilarity in the NTM structures across

[1] See UNCTAD (n.d.-a) for more details.

[2] Niu et al. (2018) constructed the panel data by tracking the start date of each regulatory measure. However, this approach fails to consider regulatory measures that expired before the data collection.

countries, which is our key explanatory variable in the empirical model. In addition, the longitudinal aspect of the data allows us to observe the changes in NTM patterns and its potential impact on quality.[3]

To mitigate problems with aggregation, we conduct the analysis at the most detailed Harmonized System (HS) level. Our data cover 4,951 products at the six-digit level of the HS revision (HS 2007).[4] Unlike tariffs, aggregation of NTMs is not straightforward. First, differences in NTM intensity partly arise from the characteristics of products. For example, food is more likely to be regulated by SPS measures. TBTs, on the contrary, account for most regulatory measures on manufactured goods, machinery, and electronics. Without proper aggregation methods, NTM indicators may simply reflect the heterogeneity in trade patterns rather than the stringency of NTMs (de Melo and Nicita, 2018). Moreover, a single regulation can affect only one HS six-digit product, such as a fumigation requirement on imported car seats, or hundreds of products, as in the case of generic import licensing. Accordingly, summing up the number of NTMs across products poses the risk of overestimating the prevalence of NTMs.

Second, and most importantly, we use a novel indicator to measure the regulatory divergence between trading partners following Nabeshima and Obashi (2021) and Nabeshima, Obashi, and Kim (2021). In particular, the additional burden of NTMs imposed by the importing country that the exporting country does not impose is calculated according to the NTM Multi-Agency Support Team (MAST) classification of types of NTMs. In fact, we consider whether a requirement is imposed by the importing country that is not imposed by the exporting country on the same product. NTMs cover a wide array of policy instruments with diverse design and objectives, thus they exert distinguished impacts on product quality. For example, a labelling requirement is not directly comparable to a requirement on production processes. Then, what matters is not the mere presence of regulatory measures in the foreign market but rather how different the NTMs imposed on the foreign market are compared with the domestic market. Different NTMs incur additional costs and hence affect the quality of products traded. We construct heterogeneity in the regulatory structure for each SPS measure and TBT to distinguish the divergence of NTM subgroups within these two major types.

[3] See de Melo and Nicita (2018) for a detailed discussion on the advantages and weaknesses of existing NTM databases. The UNCTAD TRAINS database has missing information on non-World Trade Organization (WTO) members.

[4] Among more than 5,000 HS six-digit products, our sample from import statistics covers 4,951 products.

The rest of the paper is organised as follows. We present a literature review in Section 2. Section 3 describes the data sources and our empirical strategy. Section 4 discusses the key findings, and Section 5 concludes the paper with policy implications.

2. Literature Review

Unlike tariffs, NTMs are complex policy instruments which fulfil multiple purposes. Traditional NTMs, such as quotas, anti-dumping, and voluntary export restraints, are considered as non-tariff barriers that are commercial policy tools, aiming explicitly at restricting international trade. However, the majority of current NTMs are regulatory measures designed primarily to protect the health and safety of consumers, ensure the welfare of animals, preserve the environment, and address concerns about national security and violation of cultural values. These NTMs legitimately serve as a welfare-improving tool to correct for information asymmetry-driven market failures.[5] Leland (1979) and Ronnen (1991) suggested minimum quality constraints as a possible solution to adjust asymmetric information; minimum quality standards alleviate the price competition and generate positive externalities, improving social welfare. Leonardi and Meschi (2016) showed that NTMs alleviate the negative employment effect deriving from import exposure.

Apart from the UNCTAD TRAINS NTM database, the World Trade Organization (WTO) NTM database collects official notifications from WTO members, which are obliged by the WTO agreements to notify their NTMs to the WTO. The WTO notifications data can be downloaded through the WTO Integrated Trade Intelligence Portal (I-TIP), and are used in many other studies such as Bao (2014); Bao and Qiu (2012); Fontagné and Orefice (2018); Fontagné et al. (2015); Ghodsi (2020a); Ghodsi et al. (2017); and Navaretti et al. (2018). In this research, however, we adopt the UNCTAD TRAINS NTM database. Incorporating the documented information on NTMs, the UNCTAD TRAINS database presents detailed, comprehensive, and more observations at the reporter-partner-product-NTM imposition-year level compared with other databases. The reporters and partners represent the regulation-imposing country (importers) and their corresponding trading partners (exporters), respectively.[6]

[5] See Akerlof (1970) for more details on the relationship between quality and uncertainty.
[6] NTM analysis using the UNCTAD TRAINS database corresponds to analysing the official documents of each country. Professionals and specialists from each country accumulated and reported the information on NTMs based on government documents to construct the UNCTAD TRAINS NTM database.

Lively policy debates have taken place at both the national and international levels on tackling NTMs and whether trade-restrictive NTMs should be eliminated (Doan, Rosenow, and Buban, 2019). To assist policymakers in formulating appropriate policy responses, analysis on the impact of NTMs on trade policies and whether NTMs restrict trade or pursue any legitimate regulative aim is necessary. Following the traditional literature on trade, trade restrictions may induce welfare losses (Baldwin, 1989; Irwin, 2010), while positive externalities associated with NTMs may improve welfare (Beghin, Disdier, and Marette, 2015). NTMs are legitimate public policy tools to address market failures, and disregarding the necessity of regulations leads to the common misconception of regulations merely as a disguised trade barrier. Nevertheless, empirical evidence on the potential welfare-improving aspect of NTMs is scarce.

The majority of empirical analyses find significant trade-distorting impacts of NTMs. From the side of producers, the procedural costs and compliance costs arising from NTM application inevitably reduce both the varieties of traded goods and the number of foreign firms serving the domestic market. For consumers, by decreasing varieties and the price increment of the remaining goods, NTMs may exert a negative welfare impact similar to that of ad valorem tariffs. Andriamananjara et al. (2004) and Vanzetti, Knebel, and Peters (2018) implemented a computable general equilibrium (CGE) model to evaluate the impact of NTMs; Andriamananjara et al. (2004) stressed the importance of NTM removal for global welfare gains and Vanzetti, Knebel, and Peters (2018) placed weight on the harmonisation of NTMs for the benefit of Association of Southeast Asian Nations (ASEAN) exporters. Hoekman and Nicita (2008) and Liu and Yue (2009) conducted country-level analyses to estimate the impact of NTMs on international trade. Hoekman and Nicita (2008) reviewed the trade restrictiveness index developed by the World Bank and the overall trade restrictiveness index following Kee, Nicita, and Olarreaga (2009). Their results suggest that adverse effects of both tariffs and NTMs on low-income countries are explicit. Liu and Yue (2009) suggested that the removal of Japanese NTMs on cut flowers would increase Japanese imports of cut flowers. They employed the combined effects of SPS and administrative customs procedures as regulations to emphasise the significance of incorporating product quality changes when estimating the impact of SPS measures. Disdier, Fontagné, and Mimouni (2007); Essaji (2008); and Ghodsi et al. (2017) implemented both HS four- and six-digit level analysis to show the negative impact of NTMs on international trade. Disdier, Fontagné, and Mimouni (2007) measured the ad valorem equivalents (AVEs) of SPS measures and TBTs on agricultural trade under the gravity setting. The results indicated that NTMs negatively influence the exports of developing and least developed countries. Moreover, imports of the European Union (EU) suffered severely from TBTs and SPS measures relative to other Organisation for Economic Co-operation and Development (OECD) members. Essaji (2008) indicated that NTMs exacerbated the situation in poor countries. The weak capacities of firms in poor countries to meet the NTMs of their export counterparts will eventually alienate them from more regulated industries. Similarly, Ghodsi (2020b) found evidence that Chinese TBTs have stimulated imports of manufacturing products from advanced economies, while least developed countries' trade has been negatively affected.

While the literature on international trade has mostly focused on the observable aspects of international transactions, research regarding the quality of traded goods is scarce. Only a handful of studies examines the potential positive role of regulations in shaping product quality. A series of papers positively links developed countries with higher-quality goods exports, compared with those of developing nations (Hallak, 2006; Schott, 2004). While the impact of conventional trade costs on the quality of exported goods lacks theoretical ground, Amiti and Khandelwal (2013) examined the impact of import tariffs on the quality of goods by revising the conventional estimator of quality, which is the unit value, using percentiles. They showed that import tariffs have mixed results on the quality of goods traded: products closer to the frontier take advantage of low tariffs and vice versa for products distant from the frontier. They analysed the impact of import competition, proxied by tariffs, on the quality of the products traded. Lower tariffs contribute to quality upgrading of products closer to the frontier due to competition effects. On the contrary, the effect on the quality of products distant from the frontier is negative, since these products need protection to induce quality upgrading. Ramos, Bureau, and Salvatici (2010) addressed the sensitive product bias in explaining the trade composition effects of tariffs. Adopting the similar distance to the frontier framework, Olper, Curzi, and Pacca (2014) showed that diffusion of standards, on average, can enhance the product quality-upgrading rate. Using the Heckman selection model, Blind, Petersen, and Riillo (2017) showed that standards and regulations have opposite impacts on innovation. Standards with low uncertainty incur lower innovation, whereas regulations with low uncertainty incur higher innovation, and vice versa for high uncertainty. Disdier, Gaigné, and Herghelegiu (2020) developed a model of firm heterogeneity and trade which incorporates product quality. Using French firm data, they found that the adoption of quality standards drives low-quality firms out of domestic markets. Facing higher competition amongst high-quality incumbents, low-productivity firms also exit the market (Melitz, 2003). The enactment of quality standards assures minimum quality, but average quality improvement does not necessarily occur. Ghodsi and Stehrer (2020) focused on commoditisation and commodity traps in economic development. They showed that compliance with NTMs reduces the commoditisation impact on their terms of trade based on a gravity framework. Using the data on the quality of products estimated by Feenstra and Romalis (2014), Ghodsi and Stehrer (2022) found evidence that depending on the sectors, TBTs and SPS measures have diverse effects on the quality of traded products. Using similar data, Ghodsi and Stehrer (2019) found that TBTs and SPS measures imposed by the EU on the imports of poultry affect the quality and prices of imports diversely from different exporters.

Since one major purpose of NTMs is to ensure the health and safety of consumers, well-designed regulatory measures can keep substandard and fraudulent products out of the market (Movchan, Shepotylo, and Vakhitov, 2020). Consequently, conformity with regulatory measures can act as a signal for product quality upgrading, thus enhancing the competitiveness of products on the market (Hudson and Jones, 2003; Navaretti et al., 2018; Olper, Curzi, and Pacca, 2014). In addition, regulations reduce the information asymmetry, enhance the observability of product quality, and generate higher demand for better-quality products (Disdier, Gaigné, and Herghelegiu, 2020; Leland, 1979; Yang, Honda, and Otsuki, 2019). By shifting demand, NTMs may encourage the quality upgrading of firms.

On the other hand, regulatory measures may not generate the expected positive effects. This is particularly the case if the regulations incur high compliance costs for producers. To meet the new requirements of product quality, firms may need to adopt product and process innovation, which, in turn, implies an increase in capital investment. Specifically, quality upgrading could involve a switch to a new and more costly source of intermediate inputs (Chakraborty, 2017). Rising adjustment costs discourage firms from trading. This burden falls disproportionately on small firms that face resource constraints. Consequently, firms may simply divert their trade to less restrictive markets or stop exporting (Beestermöller, Disdier, and Fontagné, 2018; Fontagné and Orefice, 2018; Olarreaga and Fugazza, 2018; Melitz, 2003; Melo et al., 2014). Moreover, regulations designed with protectionist intent could further impede competition and discourage the innovation of firms (Swinnen and Vandermoortele, 2011). Ghodsi and Stehrer (2022) analysed the quality impact of NTMs (i.e. TBTs and SPS measures) notified to the WTO during 1995–2011 on globally traded products. They showed both positive and negative impacts of regulations on the imports – negative on the flows to the EU and China, and positive on the flows to the United States. Furthermore, Ghodsi and Stehrer (2022) pointed out that although TBTs and SPS measures both induce a higher quality of goods, accumulated flows of TBTs and the existence of SPS measures affect the quality of traded goods the most.

While the recent literature has gradually become abundant in analysing the impact of regulative NTMs on trade flows, it still lacks conclusive evidence on the role of divergence in the application of these NTMs on the quality of traded products between two trading partners. Thus, this paper contributes to the literature by using a panel data set of NTMs collected by UNCTAD TRAINS and assessing the impact of regulatory divergence in TBTs and SPS measures on the quality of traded products at the six-digit level of the HS during 2012–2018.

3. Methodology and Data

3.1. Data

NTM data

We use the panel database on NTMs developed by UNCTAD in collaboration with regional think tanks and universities, covering 2010–2018.[7] The combined database contains NTMs derived from all trade regulations in 92 countries at the reporter-year-partner-product-NTM level. The data reflect documented regulations that were in force at a certain point in time that could be even prior to the data collection. Data include unilateral NTMs, recording measures applied to all countries in the world, and bilateral NTMs applied to selected countries. Depending on the time of data collection, products are defined at different HS six-digit versions. Conversely, NTMs are defined in the three-digit MAST Classification M3 or M4 (UNCTAD, 2019). For consistency, we convert all HS nomenclatures to the HS 2007 classification using concordance tables from the United Nations Trade Statistics and MAST classification from M3 to M4 using an internal concordance table.

We keep data on 77 countries from 2012 to 2018 that report HS 2007-level trade data to concord with other databases.[8] Additionally, the data of five Latin American countries (Costa Rica, El Salvador, Guatemala, Honduras, and Panama) show an abrupt increase in the number of products affected between 2015 and 2016 due to changes in HS classification.[9] To construct consistent data, we drop observations before the sudden increase in the number of NTM product pairs for the above five economies; 2017 and 2018 observations are available for these countries (Appendix, Table A). EU members are grouped into one single trade partner to follow the structure of UNCTAD's NTM database.[10]

[7] The data can be downloaded from UNCTAD (n.d.-b). The data collection time varies across countries.
[8] We dropped the observations for the first 2 years (2010 and 2012) as only data on the EU are available.
[9] These countries adopted different HS classifications between 2015 and 2016.
[10] The EU includes the United Kingdom as the data only go up to 2018.

As noted earlier, NTMs cover a wide range of policy tools serving various purposes, some of which are unrelated to product regulations. Therefore, we focus on the regulatory NTMs – SPS measures and TBTs – equivalent to NTM Chapters A and B by MAST version M4. A and B cover SPS measures and TBT on imports, respectively. However, we exclude A11 (prohibitions for SPS reasons) and A12 (geographical restrictions on eligibility) for Chapter A because imports and exports are, by definition, explicitly prohibited upon the implementation of these measures.[11]

Product quality data

To estimate product quality, we extract bilateral import data from the United Nations Commodity Trade Statistics Database (UN Comtrade) at the six-digit level of the HS 2007 classification covering 2012–2018. To control for outliers in trade data, we drop bilateral trade flow, whose quantity is missing. By using quantity token information from the World Bank,[12] we adjust quantity information by dropping the quantity value less than one unit under quantity tokens five, six, and 10. They represent the number of items, number of pairs, and number of packages, which is difficult to interpret when these quantities are less than one.[13]

In addition to import statistics, including both trade value and quantity, we use other variables from the standard gravity model. We use the nominal gross domestic product (GDP) per capita of exporting and importing countries, extracted from the World Development Indicators (WDI). A dummy variable on the existence of a preferential trade agreement is retrieved from the WTO's Regional Trade Agreement (RTA) database.[14] To measure distance, we use capital cities as the milestones.[15] Other variables, including a common coloniser, a colonial relationship, a common language relationship, and contiguity, are taken from research and expertise on the world economy.[16]

[11] See Table B in the Appendix for more details. It provides a list of countries and years with available data.
[12] See World Bank (2010) for more details.
[13] For members of the EU, extra-EU trade is constructed. In so doing, the sum of import statistics of 28 individual EU members with each of their non-EU trade counterparts is calculated to construct import value and quantity for the EU as a single unit.
[14] The FTA variable is constructed by the authors using data from the WTO RTA database. See WTO (n.d.) for details.
[15] For the EU, we use the distance to Brussels as the benchmark, as Brussels is home to several significant European institutions. For standard gravity determinants (e.g. contiguity, common language), the variable takes the value of one if any of the 28 EU members possessed a corresponding relationship with partner countries.
[16] Mayer and Zignago (2011) described the distance measurements. See Table B in the Appendix for more detailed sources of the data.

Tariff data

We first extract the AVEs of both the most favoured nation (MFN) and preferential tariff rates from the World Bank's World Integrated Trade Solutions (WITS). We then adopt the lowest value between the MFN and preferential trade tariff rates, assuming that exporters use the lowest tariff rates available when exporting. If tariff data are missing in a specific year, we use the nearest past value as the reference to fill in the missing value. Table C in the Appendix presents the summary statistics.[17]

3.2. Methodology

Measurement of NTM indicator

Due to its technical complexity, quantification of NTMs is notoriously challenging. Counting the number of NTMs is straightforward. However, the NTM count of each country does not reflect differences or divergence in the NTM structure between the two trading partners.[18] Even though two countries have the same number of NTMs on HS 6-digit products, the type of NTMs can be different. Then, what matters for the quality of traded goods is not only the mere presence of regulatory measures in the foreign market, but also how different the regulations imposed on the importing market are compared with the exporting market. To evaluate the divergence of NTMs, we construct an additional compliance requirements indicator (ACRI) as follows. We follow Nabeshima and Obashi (2021) and Nabeshima, Obashi, and Kim (2021) to construct the ACRI. The indicator stems from past efforts to measure the proximity of regulatory measures implemented between bilateral trading partners (Branstetter, 2006; Cadot et al., 2015; Jaffe, 1986; Nabeshima and Obashi, 2019). The index compares the bilateral product-type NTM combinations in force by two trade partners.

An exporter might be more likely to adopt quality upgrading if the importing country imposes a different set of NTMs than the exporting country. If the exporting and importing countries apply the same NTMs on the product of interest, quality upgrading due to NTMs in foreign markets is less likely to happen as the product already complies with similar regulations in the exporting country. On the other hand, assume that the country of an exporting firm imposes a maximum tolerance limit (i.e. SPS category A21) but does not require another type of regulation like hygienic practices during production (i.e. SPS category A42). Then, when

[17] Variables do not show a notable correlation. We can provide the correlation table upon request.
[18] This measure of NTM intensity is based on the assumption that all regulations have equal weight, whilst the extent of stringency amongst regulations is diverse. This is a common problem for the count measure (Swann, Temple, and Shurmer, 1996).

the importing country imposes stricter regulations on A21 on that product, the exporter is more likely to comply with the new maximum limit in its production as it already had some experience with the regulation; thus, the exporter upgrades the quality of its product to that market. However, if the importing country imposes regulatory measures on A42 because the exporting firm has had no previous experience with the regulation, it completely stops exporting to that country and the quality upgrading does not happen. These two opposing implications will be tested in our analysis.

We construct two separate ACRIs using Chapters A and B of the MAST classification, as explained earlier. In principle, NTMs should be applied without discrimination between domestic products and imported products. In other words, regulatory measures on imports are indicative of domestic regulations. As a result, aside from export measures, exporters must comply with import regulations in their own countries.

To construct the ACRI, we first define the domestic regulatory vector *D* implemented by exporting country i on product p at time t as

$$D_{ipt} = \left(D_{ipt1}, \dots, D_{iptm}, \dots, D_{iptM}\right), \tag{1}$$

where D_{iptm} is the number of NTM sub-group measure *m* under the two-digit NTM group M for each exporter i, product p, at time t. Accordingly, each element of vector D_{ipt} takes an integer value from zero to 10.[19] Table D in the Appendix includes detailed information on the two-digit NTM grouping *M*. Overall, the NTM sub-group measure consists of two-digit, three-digit, and four-digit NTMs. We use three-digit and four-digit NTMs as components of the two-digit NTM group when constructing the vector. Furthermore, as A11 (Prohibitions for SPS reasons) and A12 (Geographical restrictions on eligibility) are explicit prohibitions of international trade, we construct the ACRI without A11 and A12.

Next, we calculate the number of bilateral regulatory vectors imposed by importing country *j* against product p from exporting country i at time t as

$$F_{ijpt} = \left(F_{ijpt1}, \dots, F_{ijptm}, \dots, F_{ijptM}\right), \tag{2}$$

[19] See UNCTAD (2019) for a detailed classification.

which shows regulatory requirements that exporters must comply with before entering each importing market. As we assume that exporters need to fulfil both the domestic and foreign regulatory measures, we calculate the total number of necessary regulatory vectors as

$$T_{ijpt} = \left(D_{ipt1} + F_{ijpt1}, \ldots, D_{iptm} + F_{ijptm}, \ldots, D_{iptM} + F_{ijptM}\right). \quad (3)$$

Then, we calibrate cosine similarity between the domestic regulatory vector of exporter i (D_{ipt}) and the total number of the necessary regulatory vector (T_{ijpt}). We define the ACRI as the result of cosine similarity subtracted from one:

$$Cos(\theta)_{ijpt} = \frac{D_{ipt}.T_{ijpt}{}'}{\parallel D_{ipt} \parallel \parallel T_{ijpt} \parallel}, \quad (4)$$

$$ACRI_{ijpt} = 1 - Cos(\theta)_{ijpt}. \quad (5)$$

$ACRI_{ijptc}$ indicates the ACRI of regulatory measures that exporting country i needs to comply with before entering each importing market j, where it lies between zero and one. A larger value ACRI implies more additional requirements to be met before entering the foreign market or shows the divergence in the regulatory measures of trading partners. If importing country j does not impose any NTMs on product p but exporting country i does, or if two countries have identical regulation vectors, $ACRI_{ijpt}$ equals zero, which also suggests full convergence in regulatory measures. In this case, no additional compliance requirement exists for exporters. On the contrary, when the exporting country does not impose any NTMs on product p but the importing country does, $ACRI_{ijpt}$ equals one.[20]

Construction of quality index

Product quality is not observed directly, and thus needs to be estimated. Unit values, defined as the ratio of trade value over volume for each traded product, are observable and often used in earlier studies (Hummels and Klenow, 2005; Schott, 2004). Notwithstanding its simplicity, unit value may be driven by factors other than quality. For example, higher prices do not necessarily reflect better quality but can result from higher transaction costs. To control for this possibility, recent studies have introduced more sophisticated measurement of quality

[20] The coefficient of the ACRI should be interpreted cautiously, however, as it only reflects heterogeneity in the type of NTMs used but not the stringency of such NTMs. For example, two countries may both impose a regulation on the maximum residual limit, coded A21 by MAST version M4, on the same product (e.g. mangos), but the extent of strictness can be different. In general, developed countries tend to impose stricter regulations than developing ones (Cadot et al., 2015). Due to data limitations, we leave this issue for future research.

based on microeconomic foundations (Feenstra and Romalis, 2014; Khandelwal, 2010). However, in this paper, in addition to the traditional unit value, we employ the framework of Henn et al. (2020) to estimate the quality of traded goods in a cross-country framework using bilateral trade data.[21]

Henn et al. (2020) modified Hallak (2006) and assumed the bilateral unit value (u_{ijpt}) as a function of quality, GDP per capita, and distance between trade partners as follows:

$$\ln u_{ijpt} = \alpha_0 + \alpha_1 \ln Q_{ijpt} + \alpha_2 \ln y_{it} + \alpha_3 \ln Dist_{ij} + \varepsilon_{ijpt}, \quad (6)$$

where Q_{ijpt} is the unobservable quality of product p exported from country i to country j at time t. y_{it} is the income per capita of exporter i at time t. $Dist_{ij}$ is the geographical distance between i and j on product p. u_{ijpt} is the bilateral unit value, or the bilateral trade value over quantity. Here, we use the unit value (u_{ijpt}) as a proxy for price. ε_{ijpt} is the error term vector, including both time-variant and time-invariant error terms. Along with the bilateral unit value, the quality-augmented gravity equation is defined as

$$\ln trade_{ijpt} = \beta_1 \ln Dist_{ij} + \beta_2 Gravity_{ijt} + \beta_3 \ln Q_{ijpt} \ln y_{jt} + FE_i + FE_j + \xi_{ijpt}, \quad (72)$$

where $Gravity_{ijt}$ is a set of vectors that includes gravity determinants such as the free trade agreement (FTA) relationship, contiguity, common language, common colony, and colonial relationship. FE_i and FE_j are exporter and importer fixed effect, respectively. $trade_{ijpt}$ is the nominal value of import of j from i.

To obtain product-specific quality estimates by country pair, we conduct two-stage least squares (2SLS) estimations for 4,951 products. The estimation equation is

$$\ln trade_{ijpt} = \beta_1 \ln Dist_{ij} + \beta_2 Gravity_{ijt} + \frac{\beta_3}{\alpha_1} \ln u_{ijpt} \ln y_{jt} - \frac{\beta_3 \alpha_2}{\alpha_1} \ln y_{it} \ln y_{jt} - \frac{\beta_3 \alpha_3}{\alpha_1} \ln Dist_{ij} \ln y_{jt} + FE_i + FE_j - \frac{\beta_3 \alpha_0 + \beta_3 \varepsilon_{ijpt}}{\alpha_1} \ln y_{jt} + \xi_{ijpt}. \quad (8)$$

ε_{ijpt} is a component of $\ln u_{ijpt}$, indicating a possible correlation between regressor $\ln u_{ijpt} \ln y_{jt}$ and the disturbance term $-\frac{\beta_3 \alpha_0 + \beta_3 \varepsilon_{ijpt}}{\alpha_1} \ln y_{jt} + \xi_{ijpt}$. To mitigate the

[21] Unit value refers to the trade value divided by quantity.

endogeneity issue, we use $\ln u_{ijp,t-1} \ln y_{j,t-1}$ as an instrument of $\ln u_{ijpt} \ln y_{jt}$, following Henn et al. (2020). While they used $\ln u_{ijp,t-1} \ln y_{jt}$ as a proxy for $\ln u_{ijpt} \ln y_{jt}$, we use the lagged value of the income of importing countries to further control for possible heteroskedasticity.

Multiplying β_3 and replacing the parameters and fitted value calculated from the 2SLS equation (8), we get

$$\ln \hat{Q}_{ijpt} + \frac{\beta_3 \alpha_0}{\alpha_1} = \frac{\beta_3}{\alpha_1} \ln \hat{u}_{ijpt} - \frac{\beta_3 \alpha_2}{\alpha_1} \ln \hat{y}_{it} - \frac{\beta_3 \alpha_3}{\alpha_1} \ln \widehat{Dist}_{ij} \tag{9}$$

where we further normalize the quality index $\ln \hat{Q}_{ijpt} + \frac{\beta_3 \alpha_0}{\alpha_1}$ with the 90th percentile.

We normalize the left-hand side quality index with the 90th percentile, which captures the mixed effect of quality ($\ln \hat{Q}_{ijpt}$) and the preference of importers (β_3). High product prices may not genuinely reflect high quality but rather explain high production costs. By controlling for price, the quality estimate captures the demand-side consideration of the quality of traded goods. Henn et al. (2020) also suggested that the series of steps that they carried out control the price effects embedded in the traditional quality indices, which is the unit value. As Lawless and Whelan (2007) showed, the intensive margin of international trade tends to be positively affected by longer distances. The price of incumbent goods rises as exporters need to compensate for higher costs coming from longer distances.

The impact of NTMs on quality

We examine the relationship between divergence in the adoption of regulatory measures and the quality of traded products. As the theoretical grounds between the regulations and the quality of traded goods are scarce, we employ an NTM-augmented reduced form equation. Suppose the quality of imported goods from exporter *i* at time *t* for product *p* is the function of trade policy τ_{ijpt}, where

$$\tau_{ijpt} = f\big(ACRI(NTM_{ijpt}), T_{ijpt}, FTA_{ijt}\big). \tag{10}$$

Trade policy τ_{ijpt} is the function of the ACRI of regulatory measures (NTM_{ijpt}), tariffs (T_{ijpt}), and trade agreements such as FTAs (FTA_{ijt}). By decomposing τ_{ijpt}, the quality of imported goods is then shown as

$$Quality_{ijpt} = \gamma_0 + \gamma_1 ACRI(SPS)_{ijpt} + \gamma_2 ACRI(TBT)_{ijpt} + \gamma_3 ln(T+1)_{ijpt} + \gamma_4 FTA_{ijt} + I_{ipt} + I_{jpt} + I_{ijt} + \epsilon_{ijpt}, \quad (11)$$

$$\ln u_{ijpt} = \varsigma_0 + \varsigma_1 ACRI(SPS)_{ijpt} + \varsigma_2 ACRI(TBT)_{ijpt} + \varsigma_3 ln(T+1)_{ijpt} + \varsigma_4 FTA_{ijt} + I_{ipt} + I_{jpt} + I_{ijt} + \epsilon_{ijpt}, \quad (12)$$

where $Quality_{ijpt}$ and u_{ijpt} indicate the quality estimated in (9) ($\ln \hat{Q}_{ijpt} + \frac{\beta_3 \alpha_0}{\alpha_1}$) and the unit value, respectively. $ACRI(SPS)_{ijpt}$ and $ACRI(TBT)_{ijpt}$ are proxies for divergence in NTM_{ijpt} types, which identify the additional burden of exporter *i* when entering the importer's market *j* at time *t* with product *p* in each of these two NTM types. $ln(T+1)_{ijpt}$ is the natural logarithm of bilateral tariffs.[22] FTA_{ijt} is a dummy variable denoting the existence of a bilateral FTA relationship. If the bilateral or multilateral FTA relationship exists, the variable takes the value of one, otherwise zero. I_{ipt}, I_{jpt}, and I_{ijt} are corresponding fixed effects for exporter-product-year, importer-product-year, and exporter-importer-year to control for multilateral resistance terms (Head and Mayer, 2014; Yotov et al., 2016).[23][24]

We estimate the analysis using the full sample, including both manufacturing goods and the food sector. The food sector includes products under HS Chapters 1–24, while HS Chapters 28–92 cover other manufacturing goods. Furthermore, we distinguish the effects between different country groups of countries. Developing versus developed countries are considered as the two main country groups. We follow the country income group according to the World Bank to disaggregate the sample into developing and developed countries.[25] Low-income, lower middle-income, and upper middle-income countries belong to developing countries in this analysis. High-income economies are the developed countries. Information on the trade sample for developing to developed, developing to developing, developed to developed, and developed to developing are provided in Table A of the Appendix, where the first group is the exporting country and the second group is the importing country group. Furthermore, in a robustness check, the NTM variables are interacted with the FTA variables. Their results are presented in Table E of the Appendix.

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[22] Specifically, log of ((tariff/100) +1) where the tariff is the percentage of the ad valorem ratio.
[23] The estimation results with a less restrictive set of fixed effects on year, sector, and country yield more robust estimators. Those results are available upon request. However, to follow the literature controlling for multilateral resistance, the benchmark results include a full set of high-dimensional fixed effects.
[24] Variables do not show a notable correlation. We provide the correlation table upon request.
[25] See World Bank (n.d.) for more details.

4. Results and Discussion

Table 1 presents the estimation results on the impact of divergence in regulatory NTMs on the quality of traded goods during 2012–2018 following equations (11) and (12). The three main columns in this table have an estimation sample for all traded goods, goods in the food sector, and goods in other manufacturing sectors. Table 2 shows the coefficients of the ACRI for the north–south relationship. The results emphasise three important implications.

First, divergence in SPS measures overall affects the quality of goods (quality estimate) negatively for all goods and manufacturing goods, while it shows a statistically insignificant impact on the price (unit value) and quality of goods in the food sector. The additional SPS-related burden that the exporters must comply with inevitably forces them to export cost-effective goods which are of low quality. While NTMs serve as legitimate tools to ensure the safety of consumers and the environment, exporters may use cost-effective hazardous inputs that are not supervised by NTM requirements, which incur additional costs. These cost-effective and hazardous inputs may not only degrade the quality of the imported goods but also become a threat to consumers and the environment. In other words, additional costs arising from SPS measures produce a contrary result, particularly in the manufacturing sector, due to the additional costs exporters have to bear.

Second, engaging in preferential trade relationships (e.g. FTAs) increases the price of all goods traded and manufacturing goods, while it decreases the price of food products significantly, whereas FTAs show a statistically insignificant result on the quality of traded goods. As FTAs alleviate trade costs between or amongst the member countries, the ratification of FTAs significantly decreases the price of imported goods in the food sector. In other words, an FTA decreases the price of traded goods in the food sector by about 6%. This may imply that FTAs contribute to the facilitation of total trade value more than the quantity traded.

Third, the divergence in SPS measures decreases the quality of manufacturing goods but not the quality of food. SPS measures cover hygiene issues related to the health of humans, consumers, plants, animals, and the planet, while TBTs cover technical issues regarding product quality, metrics and specifications, labelling, packaging, conformity assessments, etc. Therefore, one could expect SPS measures to be more related to goods in the food sector and TBTs to be more related to non-edible manufacturing goods. The results, however, show that divergence in TBTs has a statistically insignificant impact on the quality of traded goods, whereas divergence in SPS measures influences manufacturing goods. The result implies that sanitary issues are critical for exporters of manufacturing goods. While additional costs related to TBTs are negligible for exporters, as they already have infrastructure to easily shift their production methodology, divergence in SPS measures may require a large shift in production methodology that exporters of manufacturing goods may not have considered. Table E in the Appendix presents the estimation results when regulatory divergence in NTMs is interacted with the FTA variable. It is observed that in those specifications, divergence in TBTs increases the quality of food products, which is statistically significant at 10%. Moreover, signing an FTA agreement may reduce the quality impact of TBTs on traded food products, which is again statistically significant at the 10% level.

Table 1: Divergence of NTMs on the Quality of Traded Goods

	(1)	(2)	(3)	(4)	(5)	(6)
	Total		Food		Other manufacturing	
Variable	**QE**	**Unit**	**QE**	**Unit**	**QE**	**Unit**
ACRI (SPS)	-0.028**	-0.006	-0.042	-0.008	-0.028**	-0.009
	(0.013)	(0.010)	(0.030)	(0.019)	(0.012)	(0.014)
ACRI (TBT)	0.009	-0.001	0.031	0.014	0.007	-0.003
	(0.009)	(0.005)	(0.024)	(0.015)	(0.010)	(0.005)
FTA	0.019	0.020***	0.060*	-0.060***	0.015	0.025***
	(0.013)	(0.007)	(0.033)	(0.022)	(0.015)	(0.008)
Tariff	-0.019	0.025	0.039	-0.089	-0.031	0.026
	(0.083)	(0.063)	(0.142)	(0.117)	(0.099)	(0.072)
Constant	0.359***	2.861***	0.378***	1.436***	0.354***	3.030***
	(0.009)	(0.006)	(0.026)	(0.016)	(0.010)	(0.006)
FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,387,330	3,387,330	238,578	238,578	2,979,315	2,979,315
R-squared	0.964	0.938	0.982	0.938	0.960	0.935
Adj R-squared	0.928	0.876	0.954	0.843	0.921	0.873

ACRI = additional compliance requirements indicator, Adj = adjusted, FE = fixed effect, FTA = free trade agreement, NTM = non-tariff measure, QE = quality estimate, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Tariff refers to the natural logarithm of ((tariff/100)+1) where the tariff is the percentage of the ad valorem ratio. FE includes Importer*Product*Year fixed effect, Exporter*Product*Year fixed effect, and Importer*Exporter*Product fixed effect. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.
Source: Authors.

Furthermore, as shown in Tables 2–5, the burden of additional costs stemming from NTMs shows mixed results for north–south trade. The results may imply that the impact of divergence in NTMs is not stringent for specific income groups (developing and developed in this analysis), but a cross-national phenomenon around the world. However, the divergence in TBTs for north–south analysis does not show a statistically significant result. Amongst NTMs, divergence in SPS measures decreases the quality of traded goods while divergence in TBTs shows no statistically significant result on the quality of traded goods.

Table 2: Divergence of NTMs on the Quality of Traded Goods (Developing to Developed)

	(1)	(2)	(3)	(4)	(5)	(6)
	Total		Food		Other manufacturing	
Variable	**QE**	**Unit**	**QE**	**Unit**	**QE**	**Unit**
ACRI (SPS)	–0.012	0.044	–0.005	0.032	–0.019	0.062*
	(0.027)	(0.028)	(0.069)	(0.057)	(0.029)	(0.034)
ACRI (TBT)	–0.034	–0.022	–0.030	–0.010	–0.033	–0.024
	(0.022)	(0.015)	(0.042)	(0.048)	(0.025)	(0.016)
FTA	0.019	–0.001	0.012	–0.031	0.019	0.004
	(0.026)	(0.018)	(0.061)	(0.045)	(0.030)	(0.020)
Tariff	0.385	0.477**	0.029	0.006	0.439*	0.518**
	(0.238)	(0.188)	(0.568)	(0.596)	(0.262)	(0.201)
Constant	0.336***	2.642***	0.257***	1.316***	0.347***	2.827***
	(0.019)	(0.013)	(0.045)	(0.036)	(0.021)	(0.015)
FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	561,983	561,983	51,866	51,866	482,069	482,069
R-squared	0.982	0.961	0.992	0.956	0.980	0.959
Adj R-squared	0.939	0.872	0.969	0.823	0.936	0.865

ACRI = additional compliance requirements indicator, Adj = adjusted, FE = fixed effect, FTA = free trade agreement, NTM = non-tariff measure, QE = quality estimate, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Tariff refers to the natural logarithm of ((tariff/100)+1) where the tariff is the percentage of the ad valorem ratio. FE includes Importer*Product*Year fixed effect, Exporter*Product*Year fixed effect, and Importer*Exporter*Product fixed effect. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.
Source: Authors.

Table 3: Divergence of NTMs on the Quality of Traded Goods (Developing to Developing)

	(1)	(2)	(3)	(4)	(5)	(6)
	Total		Food		Other manufacturing	
Variable	**QE**	**Unit**	**QE**	**Unit**	**QE**	**Unit**
ACRI (SPS)	–0.058***	–0.003	–0.075	–0.038	–0.047**	0.005
	(0.021)	(0.021)	(0.058)	(0.044)	(0.020)	(0.027)
ACRI (TBT)	0.030	–0.017*	0.018	0.023	0.032	–0.018*
	(0.025)	(0.010)	(0.047)	(0.039)	(0.027)	(0.010)
FTA	0.052	0.006	0.116	0.074	0.051	0.004
	(0.039)	(0.021)	(0.089)	(0.072)	(0.044)	(0.023)
Tariff	–0.052	–0.051	0.017	–0.322	–0.059	–0.036
	(0.161)	(0.123)	(0.500)	(0.338)	(0.180)	(0.135)
Constant	0.276***	2.499***	0.319***	1.180***	0.265***	2.609***
	(0.031)	(0.017)	(0.081)	(0.062)	(0.034)	(0.019)
FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,043,498	1,043,498	52,766	52,766	937,731	937,731
R-squared	0.967	0.937	0.982	0.942	0.966	0.935
Adj R-squared	0.925	0.858	0.947	0.831	0.925	0.855

ACRI = additional compliance requirements indicator, Adj = adjusted, FE = fixed effect, FTA = free trade agreement, NTM = non-tariff measure, QE = quality estimate, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Tariff refers to the natural logarithm of ((tariff/100)+1) where the tariff is the percentage of the ad valorem ratio. FE includes Importer*Product*Year fixed effect, Exporter*Product*Year fixed effect, and Importer*Exporter*Product fixed effect. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.
Source: Authors.

Table 4: Divergence of NTMs on the Quality of Traded Goods (Developed to Developed)

	(1)	(2)	(3)	(4)	(5)	(6)
	Total		**Food**		**Other manufacturing**	
Variable	**QE**	**Unit**	**QE**	**Unit**	**QE**	**Unit**
ACRI (SPS)	–0.077	–0.054	–0.090	0.033	–0.124*	–0.110**
	(0.057)	(0.034)	(0.112)	(0.061)	(0.074)	(0.050)
ACRI (TBT)	0.013	0.026*	0.103	–0.018	0.003	0.024
	(0.027)	(0.015)	(0.067)	(0.047)	(0.031)	(0.016)
FTA	–0.030	0.012	0.003	–0.053	–0.041	0.014
	(0.040)	(0.022)	(0.076)	(0.080)	(0.043)	(0.023)
Tariff	–0.882*	0.064	–0.209	0.457	–0.980*	–0.030
	(0.493)	(0.298)	(0.738)	(0.785)	(0.541)	(0.320)
Constant	0.493***	3.366***	0.364***	1.738***	0.522***	3.556***
	(0.028)	(0.016)	(0.068)	(0.055)	(0.030)	(0.017)
FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	462,569	462,569	33,119	33,119	407,646	407,646
R-squared	0.974	0.968	0.991	0.966	0.972	0.966
Adj R-squared	0.900	0.876	0.949	0.814	0.895	0.872

ACRI = additional compliance requirements indicator, Adj = adjusted, FE = fixed effect, FTA = free trade agreement, NTM = non-tariff measure, QE = quality estimate, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Tariff refers to the natural logarithm of ((tariff/100)+1) where the tariff is the percentage of the ad valorem ratio. FE includes Importer*Product*Year fixed effect, Exporter*Product*Year fixed effect, and Importer*Exporter*Product fixed effect. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.
Source: Authors.

Table 5: Divergence of NTMs on the Quality of Traded Goods (Developed to Developing)

	(1)	(2)	(3)	(4)	(5)	(6)
	Total		**Food**		**Other manufacturing**	
Variable	**QE**	**Unit**	**QE**	**Unit**	**QE**	**Unit**
ACRI (SPS)	–0.042	–0.018	–0.105*	–0.019	0.009	–0.019
	(0.028)	(0.021)	(0.058)	(0.035)	(0.026)	(0.033)
ACRI (TBT)	–0.011	–0.010	–0.006	0.013	–0.012	–0.014
	(0.017)	(0.009)	(0.050)	(0.029)	(0.019)	(0.009)
FTA	0.011	–0.019	0.168**	–0.157***	0.001	–0.020
	(0.020)	(0.016)	(0.084)	(0.048)	(0.021)	(0.017)
Tariff	0.059	0.113	–0.001	0.148	0.065	0.033
	(0.124)	(0.119)	(0.194)	(0.172)	(0.157)	(0.145)
Constant	0.405***	3.235***	0.448***	1.637***	0.400***	3.407***
	(0.013)	(0.011)	(0.059)	(0.035)	(0.014)	(0.012)
FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	899,602	899,602	52,027	52,027	804,510	804,510
R-squared	0.963	0.945	0.985	0.949	0.960	0.943
Adj R-squared	0.914	0.873	0.956	0.852	0.910	0.870

ACRI = additional compliance requirements indicator, Adj = adjusted, FE = fixed effect, FTA = free trade agreement, NTM = non-tariff measure, QE = quality estimate, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Tariff refers to the natural logarithm of ((tariff/100)+1) where the tariff is the percentage of the ad valorem ratio. FE includes Importer*Product*Year fixed effect, Exporter*Product*Year fixed effect, and Importer*Exporter*Product fixed effect. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.
Source: Authors.

The harmonisation of NTMs amongst countries is necessary to take advantage of the original purpose of NTMs. As shown above, the imposition of NTMs could backfire on the developed economy's market as exporters from the developing economy might circumvent the NTMs by redirecting their exports to other markets which allows the use of cheaper, hazardous inputs. The effect could be magnified in the current fragmented production network, where goods face multiple NTMs during the intermediate stages.

5. Conclusion and Policy Implication

Using a novel comprehensive panel data set on NTMs covering about 5,000 products, this paper examines the impact of NTMs – SPS measures and TBTs – on the quality of traded products. We employ a new measure of regulative divergence in NTMs which considers the dissimilarity of regulatory structure on a given product traded between two trading partners. To measure regulative divergence, the ACRI designed by Nabeshima and Obashi (2021) and Nabeshima, Obashi, and Kim (2021) is used, which indicates the extent of additional regulatory requirements that exporters of a six-digit product face in the foreign market relative to their domestic market. The ACRI specifically captures the divergence of NTMs. We constructed two ACRIs specifying the divergence of SPS measures and TBTs, respectively.

Overall, by comparing the quality estimator following Henn et al. (2020) with the conventional unit value as unit price, we find a negative correlation between the divergence of SPS measures and the quality of goods, whereas we were not able to find a statistically significant relationship between the divergence of TBTs and the quality of traded goods. This may imply that amongst NTMs, the additional costs from complying with different SPS measures in the foreign market may act as a quality-upgrading measure for exporters to increase the quality of their goods.

Our study has several shortcomings. First, we were not able to distinguish between the trade costs arising from compliance with the regulations and the procedural costs due to implementation of the NTMs. Measuring procedural costs is challenging, as implementation may include a lengthy and complex process involving various government agencies. Second, due to data availability, we were only able to capture the structure of NTMs, not their stringency. For example, two trade partners may both apply a tolerance limit requirement on a specific product, but the extent of strictness can be different. By counting the number of NTMs, we assume that all NTMs receive the same weight. These issues should be kept in mind when interpreting the results.

The proliferation of NTMs has raised concerns that NTMs can be used as disguised trade barriers. In the new generation of FTAs, streamlining NTMs has become one of the key tasks to achieve deep integration. In this context, one common issue raised by policymakers is how to determine and eliminate non-tariff barriers. However, we would argue that in most cases, elimination is not desirable, since NTMs, in general, serve legitimate purposes. By setting regulations, NTMs ensure the rights of consumers and enhance their confidence in traded products. As such, the rising number of quality and safety regulations reflects legitimate concerns about the rights of consumers. NTMs also provide incentives for firms to invest in product and process innovation, since producers with better-quality products can also gain better market share. Therefore, instead of the trade-concession approach aimed at NTM reduction, harmonisation of regulations should be the goal.

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Appendix

Table A: NTM Data Availability

Country	Group	2010	2011	2012	2013	2014	2015	2016	2017	2018
ARE		.	..	.	.	.	A	.	.	.
ARG		.	..	A	A	A	A	A	A	A
ATG	D	.	..	.	.	.	.	A	.	.
AUS	D	.	.	.	.	.	A	A	.	.
BEN		.	.	.	.	A	.	.	.	.
BFA		.	.	A	.	.	.	.	.	.
BHR	D	.	.	.	.	.	A	.	.	.
BHS	D	.	.	.	.	.	A	.	.	.
BLR		.	.	.	.	.	.	.	A	.
BOL		.	.	A	A	A	A	A	A	A
BRA		.	.	A	A	A	A	A	A	A
BRN	D	.	.	.	.	.	A	.	.	A
BWA		.	.	.	.	.	.	.	A	.
CAN	D	.	.	.	.	.	A	.	A	.
CHE	D	.	.	.	.	.	A	.	.	.
CHL	D	.	.	A	A	A	A	A	A	A
CHN		.	.	.	.	.	.	A	.	.
CIV		.	.	A	.	.	.	.	.	.
CMR		.	.	.	.	.	A	.	.	.
COL		.	.	A	A	A	A	A	A	A
CPV		.	.	.	.	A	.	.	.	.
CRI		.	.	.	.	.	.	.	A	A
DZA		.	.	.	.	.	A	.	.	.
ECU		.	.	A	A	A	A	A	A	A
ETH		.	.	.	.	.	A	.	.	.
EUN	D	A	A	A	A	A	A	A	.	A
GMB		.	.	.	A	.	.	.	.	.
GTM		.	.	.	.	.	.	.	A	A
GUY		.	.	.	.	.	A	.	.	.
HKG	D	.	.	.	.	.	.	A	.	.
HND		.	.	.	.	.	.	.	A	A
IDN		.	.	.	.	.	A	.	.	A
IND		.	.	.	.	.	.	.	A	.
ISR	D	.	.	.	.	.	.	A	.	.
JAM		.	.	.	.	.	A	.	.	.
JOR		.	.	.	.	.	.	A	.	.
JPN	D	.	.	.	.	.	A	A	.	.
KAZ		.	.	.	.	.	.	.	A	.
KGZ		.	.	.	.	.	.	.	A	.
KHM		.	.	.	.	.	A	.	.	A

Country	Group	2010	2011	2012	2013	2014	2015	2016	2017	2018
KOR	D	.	.	.	.	.	.	A	.	.
KWT	D	.	.	.	.	.	A	.	.	.
LAO		.	.	.	.	.	A	.	.	A
LBN		.	.	.	.	.	.	A	.	.
LKA		.	.	.	.	.	.	A	.	.
MAR		.	.	.	.	.	.	A	.	.
MEX		.	.	A	A	A	A	A	A	A
MMR		.	.	.	.	.	A	.	.	A
MUS		.	.	.	.	.	.	.	A	.
MYS		.	.	.	.	.	A	.	.	A
NER		.	.	.	.	A	.	.	.	.
NGA		.	.	.	A	.	.	.	.	.
NIC		.	.	.	.	A	A	A	A	A
NPL		.	.	A	.	.	.	.	.	.
NZL	D	.	.	.	.	.	A	A	.	.
OMN	D	.	.	.	.	.	A	.	.	.
PAK		.	.	.	.	.	.	A	.	.
PAN		.	.	.	.	.	.	.	A	A
PER		.	.	A	A	A	A	A	A	A
PHL		.	.	.	.	.	A	.	.	A
PRY		.	.	A	A	A	A	A	A	A
QAT	D	.	.	.	.	.	.	A	.	.
RUS		.	.	.	.	.	.	A	.	.
SAU	D	.	.	.	.	.	.	A	.	.
SEN		.	.	A	.	.	.	.	.	.
SGP	D	.	.	.	.	.	A	.	.	A
SLV		.	.	.	.	.	.	.	A	A
SUR		.	.	.	.	.	A	.	.	.
TGO		.	.	.	.	A	.	.	.	.
THA		.	.	.	.	.	A	.	.	A
TTO		.	.	.	.	.	A	.	.	.
TUN		.	.	.	.	.	.	A	.	.
TUR		.	.	.	.	.	.	A	.	.
URY	D	.	.	A	A	A	A	A	A	A
USA	D	.	.	.	.	A	.	.	A	A
VNM		.	.	.	.	.	A	.	.	A
ZWE		.	.	.	.	.	.	.	A	.

NTM = non-tariff measure.

Notes: "A (Available)" indicates that NTM data for Chapters A, B, and P are available for the reporter in a given year. "." indicates missing NTM data. Country codes follow the United Nations ISO3 (United Nations Statistics Division (n.d.), Countries or Areas/Geographical Regions. https://unstats.un.org/unsd/methodology/m49/). "D" refers to developed countries; the rest are developing countries. We follow World Bank (n.d.), World Bank Country and Lending Groups. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

Source: Authors' calculation.

Table B: Sources of Data

Variable	Unit	Source
ACRI	Ratio from 0 to 1	UNCTAD TRAINS
NTM count	Sum of NTMs	UNCTAD TRAINS
Tariff	Percentage (%)	WITS
FTA	Dummy variable	WTO RTA database
Distance	km	CEPII
GDP per capita	US$	WDI
Export deterrent and promotion	Sum of NTMs	UNCTAD TRAINS

ACRI = additional compliance requirements indicator, CEPII = Centre d'Études Prospectives et d'Informations Internationales, FTA = free trade agreement, GDP = gross domestic product, km = kilometre, NTM = non-tariff measure, RTA = regional trade agreement, TRAINS = Trade Analysis Information System, UNCTAD = United Nations Conference on Trade and Development, US$ = United States dollar, WDI = World Development Indicators, WITS = World Integrated Trade Solution, WTO = World Trade Organization.
Source: Author.

Table C: Summary Statistics

Variable	(1) N	(2) Mean	(3) SD	(4) Min	(5) Max
Quality estimate	5,018,937	0.380	6.329	–1,259	3,003
ACRI	5,018,937	0.348	0.463	0	1
Count	5,018,937	2.127	3.586	0	34
Tariff (%)	5,018,937	4.486	8.269	0	800
FTA	5,018,937	0.547	0.498	0	1
Distance	5,018,937	8,390	5,491	111	19,812
GDP per capita (*i*) – US$	5,018,937	23,667	22,602	467	86,605
GDP per capita (*j*) – US$	5,018,937	16,040	17,195	482	82,081
Export deterrent	5,018,937	0.133	0.457	0	6
Export promotion	5,018,937	0.021	0.142	0	1

ACRI = additional compliance requirements indicator, FTA = free trade agreement, GDP = gross domestic product, SD = standard deviation, US$ = United States dollar.
Source: Author.

Table D: NTM Groupings

NTM measure group (NTM 2-digit)	Description	Maximum possible no. of measures within group	NTM measure sub-group
SPS			
A1	Restrictions for sanitary and phytosanitary reasons	4	A13, A14, A15, A19
A2	Tolerance limits for residues and restricted use of substances	3	A21, A22, A29
A3	Labelling, and packaging requirements	4	A31, A32, A33, A39
A4	Hygienic requirements	3	A41, A42, A49
A5	Elimination of plant and animal pests	4	A51, A52, A53, A59
A6	Other requirements for production	5	A61, A62, A63, A64, A69
A8	Conformity assessment	10	A81, A82, A83, A84, A851, A852, A853, A859, A86, A89
A9	SPS measure not elsewhere specified	1	A9
TBT			
B1	Import authorisation	3	B14, B15, B19
B2	Tolerance limits for residues	3	B21, B22, B29
B3	Labelling, and packaging requirements	4	B31, B32, B33, B39
B4	Production requirements	3	B41, B42, B49
B6	Product identity requirements	1	B6
B7	Product quality requirements	1	B7
B8	Conformity assessment	9	B81, B82, B83, B84, B851, B852, B853, B859, B89
B9	TBT not elsewhere specified	1	B9
Exporter			
P1	Export measures related to SPS and TBT	7	P11, P12, P13, P14, P15, P16, P19
P6	Export support measures	1	P6

NTM = non-tariff measure, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.

Note: The NTM classification and description follow UNCTAD (2019). We drop the NTM Measure Sub-group A11, A12, and P17 as they refer to explicit restrictions on trade. For detailed information on the NTM measure sub-groups, refer to UNCTAD (2019).

Source: Authors' calculation.

Table E: Divergence of NTMs on Quality of Traded Goods

	(1)	(2)	(3)	(4)	(5)	(6)
	Total		Food		Other manufacturing	
Variable	**QE**	**Unit**	**QE**	**Unit**	**QE**	**Unit**
ACRI (SPS)	–0.035**	–0.019*	–0.074*	0.011	–0.038**	–0.035**
	(0.014)	(0.011)	(0.039)	(0.026)	(0.015)	(0.016)
ACRI (TBT)	0.011	0.005	0.067*	–0.006	0.008	0.003
	(0.010)	(0.005)	(0.036)	(0.023)	(0.011)	(0.006)
FTA	0.018	0.021***	0.065*	–0.061***	0.013	0.024***
	(0.014)	(0.008)	(0.035)	(0.022)	(0.015)	(0.008)
SPS*FTA	0.015	0.026***	0.045	–0.027	0.024	0.063***
	(0.015)	(0.010)	(0.031)	(0.024)	(0.021)	(0.016)
TBT*FTA	–0.003	–0.012**	–0.054*	0.029	–0.001	–0.013**
	(0.010)	(0.006)	(0.032)	(0.025)	(0.011)	(0.006)
Tariff	–0.019	0.025	0.041	–0.089	–0.032	0.026
	(0.083)	(0.063)	(0.142)	(0.117)	(0.099)	(0.072)
Constant	0.359***	2.860***	0.375***	1.437***	0.355***	3.030***
	(0.009)	(0.006)	(0.027)	(0.016)	(0.010)	(0.006)
FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,387,330	3,387,330	238,578	238,578	2,979,315	2,979,315
R-squared	0.964	0.938	0.982	0.938	0.960	0.935
Adj R-squared	0.928	0.876	0.954	0.843	0.921	0.873

ACRI = additional compliance requirements indicator, Adj = adjusted, FE = fixed effect, FTA = free trade agreement, NTM = non-tariff measure, QE = quality estimate, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.

Notes: Tariff refers to the natural logarithm of ((tariff/100)+1) where the tariff is the percentage of the ad valorem ratio. FE includes Importer*Product*Year fixed effect, Exporter*Product*Year fixed effect, and Importer*Exporter*Product fixed effect. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

Source: Authors.

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