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Impact of Non-Tariff Measures on the Margins of Trade: Evaluation of Additional Compliance Requirement Indicators[§]

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Abstract: *Countries export less to destination countries with greater regulatory burdens. We use finely disaggregated product-level bilateral trade value and quantity data for 98 countries, together with a new data set of detailed information on technical regulations, to answer the following question: if a country is facing a greater regulatory burden in a particular destination market, is that country more likely to export a narrower set of goods (the extensive margin) and to export lower quantities of each good at a higher price (the intensive margin)? We find that, behind the overall trade-diminishing effect, regulatory burdens adversely affect the extensive margin of trade. With respect to the intensive margin, regulatory burdens negatively affect the quantity margin but positively affect the price margin. Since the negative effect on the quantity margin is relatively larger in magnitude than the positive effect on the price margin, we obtain the negative net impact on the intensive margin.*

Keywords: technical regulations, regulatory compliance costs, extensive and intensive margins of trade

JEL Classification: F13, F14

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1. Introduction

Since the late 2000s, the issue of non-tariff measures (NTMs) in international trade has been gaining more importance, both amongst academics and in policy discussions. Trade liberalisation through tariff reductions has played an important part in shaping the current global economy. The East Asian Miracle and the rise of the Association of Southeast Asian Nations (ASEAN) demonstrate the positive linkage between active participation in international trade and economic and industrial growth. Nevertheless, the expected growth rate of global trade is slowing, and as a result some are concerned that NTMs have been (or can be) misused. If so, producers and consumers may suffer from higher production costs and prices because of the existence of NTMs and their regulatory requirements. Despite the sound purpose of NTMs to correct market failures, most past research shows that NTMs have a negative impact on international trade flows.

In addition, while the main purpose of NTMs is to protect domestic consumers in several different aspects (e.g. health, safety, and environmental protection), in some cases these NTMs can be utilised as 'hidden' protectionism. A study by Grundke and Moser (2019) examined the impact of port refusals (mainly citing failures to comply with food safety standards) in the United States (US) market on subsequent bilateral trade relationships. They find that past port refusals led to reductions in the trade of affected goods from violating countries, and this disproportionately affected developing countries. They also find that the impact was stronger during a time of crisis (e.g. the 2008 subprime mortgage crisis), suggesting that NTMs may be used as a tool of 'hidden' protectionism.

Thus, NTMs seem to have a negative effect on international trade, especially for developing countries and smaller firms. In fact, for many sectors, the impact of NTMs is larger than that of tariffs. This is especially true if tariff rates and NTMs are substitutes for each other.[1] That is, lower tariff rates do not necessary mean that market access is more liberalised. Given the relatively small economic size of ASEAN countries and the ongoing process of industrialisation, continuing reliance on external markets (including intra-ASEAN trade) and nurturing vibrant exporting

[1] For instance, Herghelegiu (2018) found that the likelihood of adopting NTMs is higher in the European Union (EU) and Japan if initial tariff levels were higher.

sectors will be a key economic consideration for these countries to achieve high growth rates in the future to avoid and/or escape from the middle-income trap.

Most previous studies examining the trade and economic effects of certain types of NTMs in importing countries do not take into account how these regulations differ from those of the exporting countries. In principle, exporters should meet all domestic regulations in their country of origin. In most cases, countries tend to implement similar types and sets of regulations for products. Therefore, it is reasonable to assume that some regulations will overlap in a pair of countries. As a result, the real impact of NTMs in importing countries should be the additional requirements (i.e. regulations not imposed in the exporting country) with which exporters must comply. Our study focuses on this additionality as the main explanatory variable to analyse the trade impact of NTMs, looking into bilateral extensive and intensive margins of trade, in line with Hummels and Klenow (2005).

This study focuses on trade relationships with positive trade flows. We first examine whether the additional regulatory requirements diminish trade values, before considering their different effects on the margins of trade. That is, we are interested in analysing which margin of trade accounts for the trade-diminishing effect of regulatory burdens. Within the destination market of a particular industry, is a country that faces more regulatory burdens likely to export a narrower set of goods and to export lower quantities at higher prices? This study builds on the literature looking at the margins of trade using finely disaggregated product-level trade data (e.g. Hummels and Klenow, 2005; Debaere and Mostashari, 2010; Kehoe and Ruhl, 2013). Specifically, our methodology follows Hummels and Klenow (2005), who decompose the differences in export flows to a particular market amongst origin countries into the intensive margin (price as well as quantity components) and extensive margin (product variety).

Following the Hummels and Klenow (2005) methodology, Bao and Chen (2013) examined the trade effect of the total number of notifications of technical barriers to trade (TBTs) to the World Trade Organization (WTO) by importing countries, looking into the margins of bilateral trade flows aggregated over sectors. Bao and Chen (2013) found that TBTs enhance trade primarily by expanding a range of goods traded rather than by increasing the trade values of each good.

Similarly, Shepherd (2015) studies the impact of EU product standards on the extensive margin of trade in the textile, clothing, and footwear sectors. Shepherd (2015) found that the international harmonisation of standards is associated with increased product variety, particularly for exports from developing economies. While our research focus is closely related to that of Bao and Chen (2013) and Shepherd (2015), this study contributes to the literature by quantifying regulatory burdens and analysing their effects on different margins of trade at the sectoral level.

Specifically, we construct the additional compliance requirement indicator (ACRI) to quantify the extra regulatory burdens that an exporter firm may face when serving a foreign country's market.[2] The construction of the ACRI requires detailed information on technical regulations in many countries. This study uses a new database created by the United Nations Conference on Trade and Development (UNCTAD) in collaboration with many other entities. This database contains a description of each mandatory regulation, which is enforced by national legislation, along with the measure type coded according to the UNCTAD's NTM classification (affected products are specified at the Harmonized Commodity Description and Coding System [HS] six-digit level), and the country codes for the imposing and affected countries.[3] Utilising this detailed information, we can construct the ACRI and estimate the impact of technical requirements on the margins of trade more precisely. Furthermore, unlike Bao and Chen (2013) and Shepherd (2015), we differentiate the price and quantity components of the intensive margin and highlight contrasting effects of the ACRI on prices and quantities traded.

We find that regulatory burdens diminish trade values, using the data for bilateral trade and associated margins calculated at the HS two-digit sector level for 98 x 97 country pairs as well as the constructed ACRI at the sector level. To comply with additional regulations in the destination market, exporter firms incur fixed costs to establish capacity and subsequently variable production costs (Ganslandt and Markusen, 2001; Chen, Wilson, and Otsuki, 2008; Bao and Chen, 2013). Such fixed costs of adapting products to foreign destination markets are thought to be associated with a narrow set of exported goods on the extensive margin. Meanwhile,

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[2] We follow the methodology of Nabeshima and Obashi (2020).

[3] Depending on their nature, the regulations can apply to all countries or to a specific country or region.

higher marginal costs push up the unit price of exported goods, decreasing quantities traded on the intensive margin. Consistent with these predictions, we find that regulatory burdens influence the extensive and intensive margins of trade differently, behind the overall trade-diminishing effect: within a particular sector of the destination market country, a country facing more regulatory burdens exports a narrower set of goods on the extensive margin and exports lower quantities of each good at higher prices on the intensive margin.

Beyond this literature on the margins of trade, our study is also related to the following two strands of literature analysing the trade effect of NTMs:[4] the first strand computes the tariff equivalents of NTMs by looking at either the quantity traded or the prices of imported products. The quantity-based approach estimates the ad valorem tariff equivalents of NTMs by comparing estimated and actual trade values, and determining at what tariff levels the actual trade value would be observed based on international trade data (e.g. Kee, Nicita, and Olarreaga, 2009). The price-based approach utilises extensive data on domestic prices, information on transportation costs, and international prices, and considers any price gap to be attributable to the impact of NTMs (e.g. Cadot and Gourdon, 2016; Cadot and Ing, 2015). In both approaches, the issue of NTMs is implied but not addressed specifically. The traditional approach of using tariff equivalents indicates only that there might be some trade restrictiveness on the whole concerning imports of a given product, but does not reveal where that restrictiveness might arise.[5] In essence, the tariff equivalent approach leaves the NTM component as a black box. However, it was necessary to rely on this approach given the lack of a systematic NTM database.

The second strand of the literature analyses the trade effect of NTMs at the firm level, paying more attention to firm heterogeneity. For instance, Fontagné et al. (2015) used the WTO database for specific trade concerns (STCs) reported by exporters, which are matched to French firms' export data. The authors find that

[4] There is also a large literature including NTMs (or a subset of them) in a gravity framework.

[5] In addition, the quantity-based approach is based on the assumption that the model (often a gravity-type model) is specified correctly. Any misspecification could turn up as the ad valorem equivalent (AVE). For the price-based approach, the question remains as to how much market structures in each country differ. Higher domestic prices could be the result of a more concentrated market structure, which may or may not be the result of NTMs.

concerns regarding sanitary and phytosanitary (SPS) measures in the destination market adversely affect firms' export participation as well as the extensive and intensive margins of exports, and the negative effects are dampening for larger firms. They also detect a positive effect of SPS-related concerns on the unit value of exports because of possible incentives for firms to increase the price of exported goods. However, studies like that by Fontagné et al. (2015) require firm-level export data, which are not available for many countries.

In the absence of firm-level data, the methodology developed by Helpman, Melitz, and Rubinstein (2008) can be used to examine firms' export participation decisions.[6] This methodology is based on a two-step procedure: estimation of the probability of exporting, and estimation of the trade volume taking into account selection bias and firm heterogeneity. Following Helpman, Melitz, and Rubinstein (2008); Shepotylo (2016) and Bao (2014) examined the trade effect of NTMs. Given the limitations of the single-year snapshot of detailed NTM information to construct the ACRI, we refrain from examining trade probability. Instead, we focus on trade relationships with positive trade flows, examine whether the additional regulatory requirements diminish trade values, and look into their different effects on the margins of trade.

The remainder of this chapter is organised as follows: section 2 describes the NTM data and trade value and quantity data, section 3 sets out methodologies to construct the ACRI and measure bilateral extensive and intensive margins of trade, section 4 uses the ACRI to estimate its effects on bilateral margins of trade, and section 5 concludes.

2. Data Description

This section describes the two main data sets used in the following analysis. First, we use detailed NTM information to quantify the additional technical requirements imposed by importing countries. We also use the NTM data to construct a coverage ratio of hard measures that is controlled for in the estimating

[6] Alternatively, Disdier and Marette (2010), Xiong and Beghin (2014), and Crivelli and Groeschl (2016) applied a Heckman selection model, controlling for sample selection bias but not for firm heterogeneity bias.

equation. Second, to analyse the effects of the additional technical requirements on the bilateral margins of trade, we use the finely disaggregated product-level data of bilateral trade values and quantities.

2.1. Data for Non-Tariff Measures

We use the NTMs Trade Analysis Information System researcher file for use in Stata (version 12), which is publicly available on the UNCTAD webpage. This new NTM database provides a snapshot of the NTMs affecting imports and exports by 85 countries and regions at the time of data collection. Although the year of data collection varies across countries from 2012 to 2017, the data collection year for three-quarters of countries is 2015 or 2016. In the current study, we aim to examine the implementation pattern of regulations effective in 2015 and 2016. To do so, using the NTM data collected in 2015 and later years, we narrow our focus to recorded measures whose starting years are before 2017 and ending years are after 2016.[7]

The database systematically records the mandatory measures implemented against merchandise products imported from abroad in a non-tariff form, as prescribed in national legal documents. For each measure, we have information on the implementing (importing or destination) country, the type of measure, the affected product, and the affected (exporting or origin) country or region.

As for measure types, recorded measures are categorised based on their purpose into chapter A (SPS measures); B (TBTs); C (pre-shipment inspection and other formalities); E (non-automatic licensing, quotas, prohibitions, and quantity control measures other than SPS or TBT reasons); F (price control measures including additional taxes and charges); G (finance measures); H (measures affecting competition); or I (trade-related investment measures), following the UNCTAD-Multi-Agency Support Team Classification of Non-Tariff Measures 2012 (known as the M3 version, or third revision of the Multi-Agency Support

[7] The information on start and end dates contained in the UNCTAD's NTM database is subject to inconsistencies across the reporting countries (Disdier, Gaigné, and Herghelegiu, 2018), which might depend on different national legislative systems. Given such inconsistency, we are hesitant to construct a panel of NTM data. Instead, we look at the measures recorded as effective during the 2-year period to better capture the whole set of effective regulations during the time under study.

Team NTM classification) (UNCTAD, 2015).[8] Each of the eight chapters is divided into groupings with a depth of up to three levels or three-digit numerical codes in a hierarchical tree structure.

The corresponding HS codes of the affected products are reported based on national tariff lines at the most disaggregated level, following either the H3 or H4 version of the HS classification. We convert all product information to the 5,224 six-digit codes of the H2 (HS2002) version to match them consistently with bilateral trade data at the six-digit level.[9]

By focusing on the effective measures in 2015–2016 as described above, we drop 17 of the 85 implementing (reporting) countries. We manually included India and the US amongst the 17 dropped countries by referring to the latest data available from the detailed query of the UNCTAD Trade Analysis Information System website (not yet incorporated into the researcher file in the Stata format). We also include the Republic of Korea (henceforth Korea) by using the detailed query, although it is not included in the latest researcher file. In addition, although the European Union (EU) is included in the UNCTAD NTM database as a single statistical unit (reporter), we consider the 28 individual EU member countries separately in our analysis of bilateral regulatory burdens and their effects on bilateral trade.[10] Ultimately, we reorganise the NTM data set on a bilateral basis, by looking at the affected country information for each of the implementing countries and considering the EU countries separately. Our data set includes 98 x 97 country pairs (85 – 17 + 2 + 1 – 1 + 28 = 98).[11]

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[8] Although the M3 classification includes 16 chapters, the scope of the worldwide data collection under the UNCTAD initiative was limited to chapters A–I and P so far. Of these, chapter P is reserved for export-related measures, and is outside the scope of our study. We also exclude chapter D (contingent trade protective measures) from our data analysis because of incomplete data.

[9] We employ the H2 version of the HS classification because the Philippines reports its trade statistics based on the H2 version during the period under study. The conversion tables from the newer to the older HS version are obtained from the webpage of the Trade Statistics Branch of the United Nations Statistics Division: https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp.

[10] As the United Kingdom was still a part of the EU during our sample period, we retained it as a member of the EU for this analysis.

[11] See Appendix A for the list of 98 sample countries.

2.2. Data for Trade Values and Quantities

We obtain bilateral trade data at the HS six-digit product level of the H2 version for 2015 and 2016 from the United Nations Commodity Trade Statistics Database (UN Comtrade). We basically use import statistics, but complement the missing import values and quantities with so-called mirror data, that is, the corresponding figures reported by the trading partner country in its export statistics.[12] When the missing import values are replaced by the mirror data, we adjust for the cost of insurance and freight by multiplying a conventional cost insurance and freight/free on board ratio of 1.1. We also ignore product-level bilateral trade values of less than $1.00, which appear to be unrealistic and negligible.[13]

To compute the price margin as a part of the intensive margin of trade, we first must calculate the unit values using the trade quantity as well as value data. In the product-level bilateral trade data set constructed as described above, one-tenth of observations are with quantity of zero or missing. We exclude those observations from our data set. In addition, to ensure data reliability, we refine the data set by dropping the following three types of observations, which together account for a small percentage of the whole: first, there are observations with the quantity token (the quantity classification used by UN Comtrade) of 1, which indicates that the reported quantity figures have no unit information.[14] Second, there are unrealistic observations with quantity figures of less than 1 based on one of the following three units: the quantity token of 5 representing 'number of items'; 6 representing 'number of pairs'; or 10 representing 'number of packages'. Third, there are some data inconsistencies in the sense that a reporter country uses different units of quantity for a particular product amongst different partner countries.

To match the trade value and quantity data with the NTM data, we take the average of trade values and quantities from 2015 to 2016 as long as the data are available (after being complemented by the mirror data) in both years; otherwise, we ignore the missing figures and adopt the figures reported in either year. In doing so, we smooth out yearly fluctuations and minimise the number of missing observations.

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[12] See Appendix B for the availability of import statistics for the sample countries.
[13] Employing different threshold values did not change the estimation results qualitatively.
[14] For the details of the quantity classification, see the web page of the World Bank. https://wits.worldbank.org/wits/wits/witshelp/Content/Codes/Quantity_Tokens.htm.

3. Methodology

In this section, we begin by arguing that technical measures do not necessarily restrict trade. What is trade-restrictive is not the mere presence of technical regulations in export destination countries, but the additional compliance requirements faced by exporters upon entering destination markets. Section 3.2 constructs the ACRI to approximate such additionality, section 3.3 demonstrates how to measure the bilateral extensive and intensive margins of trade to analyse the trade effects of the additional compliance requirements, and section 3.4 derives a set of equations to be estimated, followed by descriptive statistics in section 3.5.

3.1. Trade-Diminishing Effect of Technical Measures

To quantify the extra regulatory burdens faced by exporter firms when serving a foreign market, we look at mandatory technical measures such as SPS measures and TBTs recorded in the UNCTAD NTM database.[15] According to the definitions in the M3 classification, we consider NTMs under chapters A, B, or C to be technical measures. However, we exclude A11 (temporary geographic prohibitions for SPS reasons), A12 (geographical restrictions on eligibility), and B11 (prohibitions for TBT reasons), because imports are, by definition, explicitly prohibited upon the implementation of these measures, unlike other technical measures of interest to us.[16]

The presence of technical measures is not necessarily trade-restrictive, unlike other non-technical NTMs (as barriers).[17] Technical measures would be barriers to trade if countries enforced different regulations, but they would enhance trade if countries imposed technical requirements in an internationally harmonised manner

[15] The terms 'standards' and 'technical regulations' differ with respect to compliance norms: standards are market driven and are in principle voluntary, whereas technical regulations are officially enforced by governments and are mandatory. 'Technical measures' is a generic term used to refer to technical regulations, standards, and their conformity assessment procedures. As our focus is on mandatory technical measures, the terms 'technical regulations' and 'technical measures' are used interchangeably.

[16] Although the manually collected NTM data for India, Korea, and the US are recorded based on the newer M4 classification, there are no differences in the technical measure codes under study.

[17] NTMs coded under chapters E, F, G, H, or I differ from technical measures in terms of their impact on international trade. Chapter E is quantity-control measures and F is price-control measures; these are the 'hard' group of measures implemented at the border, which by definition have a discriminatory intent and are always expected to decrease trade. Chapters G, H, and I contain behind-the-border measures restricting payments for imports (Chapter G), market competition (Chapter H), and investments (Chapter I), which might adversely affect trade.

or streamlined conformity assessment procedures through mutual recognition agreements (MRAs). What is trade-restrictive is not the mere presence of technical measures in the export destination but substantially effective regulations in the destination country relative to the origin country. For example, if regulation A is enforced in the home country while regulations A and B are enforced in the foreign country, only regulation B requires additional compliance by firms to start exporting to the foreign country in addition to serving the domestic market, because firms operating domestically in the home country already comply with regulation A.

Thus, to identify the trade-diminishing effect of technical measures, we need to approximate the additional compliance requirements of effectual regulations in the export destination. Following Nabeshima and Obashi (2020), we construct the ACRI based on the proximity measure called cosine similarity, as described in detail below.[18]

3.2. Additional Compliance Requirement Indicator

We first construct a vector representing a regulatory pattern of technical measures regarding product i implemented domestically in origin country o as

$$F_{oi}^{D} = \left(F_{oi1}^{D}, \ \ldots, F_{oik}^{D}, \ \ldots, F_{oiK}^{D}\right) \quad (1),$$

where F_{oik}^{D} is the number of technical measures in force within a measure type grouping k. This domestic regulatory pattern vector (F_{oi}^{D}) is approximated by a set of technical measures implemented in origin country o against imports from all countries (with no discrimination amongst trading partners), which are also expected to be applicable to domestic production and sales.

We consider 18 groupings (i.e. $K = 18$) of technical measure types, as listed in Appendix A. We make groups at the one-digit numerical level for technical measures classified under chapters A and B. Meanwhile, we divide measures classified under chapter C into two groups based on their purpose: one group consists of measures affecting both domestic and imported products, such as (pre-shipment) inspection requirements coded as C1. The other group consists of those

[18] Cosine similarity is often used to compare the content of documents, such as the frequency of a particular keyword. In economics, the patent literature (e.g. Jaffe, 1986; Branstetter, 2006) uses cosine similarity to measure the proximity of one firm to another in terms of patenting patterns.

affecting imports only, namely, C2 (direct consignment requirement), C3 (requirement to pass through a specified port of customs), and C4 (import-monitoring and -surveillance requirements, and other automatic licensing measures).[19]

To count the number of technical measures by type grouping, we consider the unbalanced tree-like structure of the NTM classification. For technical measures classified under chapters A and B, although there are several three-digit numerical codes under A85 and B85, we check the incidence at the two-digit numerical level and count the number of measures by group. The measure of chapter C, on the other hand, is recorded with a one-digit numerical code, and we count its number by group.[20] Each element of the vector (F_{oik}^{D}) therefore takes an integer value between 0 and the maximum possible number shown in Appendix C.[21]

The count of technical measures may be affected by the potential number of regulations enforced in combination, depending on different legislative systems across countries. Nevertheless, the cumulative burden of multiple forms and types of similar regulations, even if imposed to achieve equivalent policy objectives, can be burdensome for exporter firms. Thus, we count the number of technical measures by type groupings rather than using binary variables to represent the regulatory pattern. In addition, when calculating cosine similarity to gauge the proximity between a pair of regulatory pattern vectors, the relative frequency of technical measures of each grouping (i.e. a proportion of the overall number of observations for the country) matters more than nominal frequency.

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[19] Technical measures of chapters A and B, except for import prohibitions for SPS and TBT reasons (i.e. A11, A12, and B11), are thought to affect both domestic and imported products.

[20] A technical measure is coded at a higher level even though more disaggregated codes exist, if a relevant legal document does not provide enough information to assign the measure to a disaggregated level. Such cases are rare exceptions and account for 3% of the technical measures recorded in our data set. Another such case is when the ‘not elsewhere specified’ (n.e.s.) code is used if a requirement is precisely defined in a legal document but does not match any existing code. For the sake of simplicity, we merge higher-level codes into the corresponding n.e.s. codes. See UNCTAD (2014) for more details on when higher-level and n.e.s. codes can be used to construct the original database.

[21] To consider the relatedness of measure codes, we could alternatively use the Mahalanobis distance with the ‘revealed’ relatedness matrix amongst the vector elements, as in Bloom, Schankerman, and Van Reenen (2013).

We construct another vector representing a regulatory pattern in destination country d against imports of a certain product i from origin country o as

$$F_{odi}^{F} = (F_{odi1}^{F}, \dots, F_{odik}^{F}, \dots, F_{odiK}^{F}) \quad (2),$$

where F_{odik}^{F} is the number of technical measures in force within a type grouping k.

Using a pair of domestic and foreign regulatory pattern vectors (F_{oi}^{D} and F_{odi}^{F}), we next approximate the additional compliance requirements of effectual regulations on product i, implemented in destination country d, relative to the domestic regulatory regime in origin country o. We assume that, the greater the degree of effectual regulations, the greater the additional compliance requirements will be. To quantify the degree of effectual regulations, we apply cosine similarity to measure the (dis-)proximity of the domestic regulation vector to the other vector for a set of domestic and foreign regulations faced by firms exporting to the foreign country. The former domestic regulation vector is F_{oi}^{D} as explained above. The latter vector is constructed by aggregating each pair of elements of the domestic and foreign vectors as follows:

$$F_{odi} = (F_{oi1}^{D} + F_{odi1}^{F}, \dots, F_{oik}^{D} + F_{odik}^{F}, \dots, F_{oiK}^{D} + F_{odiK}^{F}) \quad (3),$$

where we assume that firms exporting to a foreign country always serve the domestic market as well and are thereby required to comply with both domestic and foreign regulations.

The cosine similarity of F_{oi}^{D} to F_{odi} is calculated as

$$\mathrm{Cos}(\theta)_{odi} = \frac{F_{oi}^{D} \cdot F_{odi}{}'}{\|F_{oi}^{D}\| \|F_{odi}\|} = \frac{\sum_{k=1}^{K} F_{oik}^{D} F_{odik}}{\sqrt{\sum_{k=1}^{K} (F_{oik}^{D})^2} \sqrt{\sum_{k=1}^{K} (F_{odik})^2}} \quad (4),$$

where $\mathrm{Cos}(\theta)_{odi}$ is represented using an inner product of the two regulatory pattern vectors and their magnitudes. θ is the measure of an angle between the vectors and takes a value between 0 degrees (identical) and 90 degrees (orthogonal), because both vectors are composed only of elements with positive integer values. The lower the cosine similarity, the more the combined vector (F_{odi}) is de-correlated with the domestic regulation vector (F_{oi}^{D}), that is, the greater the degree of effectual regulations in the destination country d.

Finally, using the cosine similarity, we define the ACRI for the destination country d with respect to origin country o for product i as

$$\text{ACRI}_{odi} = 1 - \text{Cos}(\theta)_{odi} \quad (5),$$

which takes a higher value (between 0 and 1) when the degree of effectual regulations in destination country d, or their additional compliance requirements, is calculated to be greater. The ACRI is bilateral direction-specific: the ACRI calculated for the imports from country A to country B can differ from that of imports from country B to country A.

By construction, equation (5) always holds that $\text{Cos}(\theta)_{odi} \in (0,1]$ as long as the destination and origin countries both implement some regulation against product i, and so does $\text{ACRI}_{odi} \in [0,1)$. As a special case, when the domestic and foreign regulation vectors are identical, it will be that $\text{Cos}(\theta)_{odi} = 1$ and $\text{ACRI}_{odi} = 0$, meaning that there is no additional compliance requirement. When no regulation is implemented against product i in destination country d while some domestic regulation is enforced in origin country o, it will be that $\text{Cos}(\theta)_{odi} = 1$ and $\text{ACRI}_{odi} = 0$. When there is no domestic regulation against product i in origin country o, we cannot calculate $\text{Cos}(\theta)_{odi}$; instead, we set $\text{ACRI}_{odi} = 1$ if some regulation is implemented against the same product in the destination, and $\text{ACRI}_{odi} = 0$ if otherwise.

Lastly, we construct the sector-level ACRI by taking a weighted average of ACRI_{odi} across products $i \in I_{od}^{s}$ within sector s using the worldwide trade share as a weight, as follows:

$$\text{ACRI}_{od}^{s} = \sum_{i \in I_{od}^{s}} \frac{V_i}{V^s} \text{ACRI}_{odi} \quad (6),$$

where V_i is the world total trade value of product i, and V^s is the world total trade value of products in sector s.

The ACRI originally proposed by Nabeshima and Obashi (2020) is related to but different from the summary indicators that aim to evaluate the dissimilarity or relative stringency of a series of technical requirements based on quantitative information regarding the maximum residue levels of pesticides and other toxic chemicals (e.g. Drogué and DeMaria, 2012; Winchester et al., 2012). The ACRI is intended to quantify the overall degree of regulatory burdens implied by the qualitative information on the list of technical measures described in various legal documents.

Cadot et al. (2015) and Cadot and Ing (2015) also evaluated regulatory differences between countries based on the product-level qualitative information of technical measures, as an alternative to the conventional count variable and frequency index. The regulatory distance measure proposed by Cadot et al. (2015) and Cadot and Ing (2015) is intended to capture differences in the overall regulatory regime between a certain pair of countries, and is calculated to be symmetric by nature for the pair of countries. In contrast, our ACRI is bilateral direction-specific.

3.3. Decomposition of Bilateral Trade Values to Extensive and Intensive Margins

To measure the extensive and intensive margins of trade, we follow the decomposition methodology originally proposed by Feenstra (1994) and further developed by Hummels and Klenow (2005), Broda and Weinstein (2006), and Feenstra and Kee (2008). Although we could simply count the number of products exported within a certain group or sector as a measure of the extensive margin, we adapt Feenstra's (1994) approach because it is theoretically grounded and considers different economic weights of different products.

Specifically, we define the bilateral extensive and intensive margins in line with Hummels and Klenow (2005), but consider the margins by sectors. Let I_{od}^{s} denote the set of (observable) product categories (at the HS six-digit level in our empirical implementation) in which origin country o has a positive value of exports to destination country d within sector s (at the HS two-digit level). When country o's shipments to country d are a subset of reference country k's shipments to country d, the extensive margin is defined as

$$\mathrm{EM}_{od}^{s} = \frac{\sum_{i \in I_{od}^{s}} p_{kdi} q_{kdi}}{\sum_{i \in I_{kd}^{s}} p_{kdi} q_{kdi}} \quad (7),$$

where p denotes the export price and q, the quantity. EM_{od}^{s} equals country k's exports of I_{od}^{s} to country d relative to country k's exports of I_{kd}^{s} to country d. The corresponding intensive margin is given by

$$\mathrm{IM}_{od}^{s} = \frac{\sum_{i \in I_{od}^{s}} p_{odi} q_{odi}}{\sum_{i \in I_{od}^{s}} p_{kdi} q_{kdi}} \quad (8),$$

which compares nominal shipments by countries o and k in a common set of products.

In what follows, for each destination market d, we choose k to be all exporters around the world (i.e. the rest of the world other than the destination market d). Let $I_d^s \equiv \cup_{o \neq d} I_{od}^s$ be the total set of products imported by country d in sector s across origin countries, and let $V_{di} \equiv \sum_{o \neq d} p_{odi} q_{odi}$ be the world total export value of product i to destination market d. Equations (7) and (8) can be rewritten as

$$\mathrm{EM}_{od}^s = \frac{\sum_{i \in I_{od}^s} V_{di}}{\sum_{i \in I_d^s} V_{di}}; \text{ and } \mathrm{IM}_{od}^s = \frac{\sum_{i \in I_{od}^s} p_{odi} q_{odi}}{\sum_{i \in I_{od}^s} V_{di}} \quad (9),$$

The extensive margin can be thought of as a weighted count of country o's products exported to destination market d relative to the world average. The intensive margin is country o's nominal exports to destination market d relative to the worldwide exports to destination market d for those products in which country o actually exports to destination market d. It follows from equation (9) that the proportion of country o's nominal exports in worldwide exports to destination market d equals the product of the two margins:

$$\frac{\sum_{i \in I_{od}^s} p_{odi} q_{odi}}{\sum_{i \in I_d^s} V_{di}} = \mathrm{EM}_{od}^s \mathrm{IM}_{od}^s \quad (10).$$

The intensive margin is then decomposed into the price index and an implicit quantity index, as follows:

$$\mathrm{IM}_{od}^s = P_{od}^s Q_{od}^s \quad (11).$$

For the price index, we employ a variant of Feenstra's (1994) exact price index for the intensive margin. With worldwide exports to destination market d as a comparison, the price index is given by

$$P_{od}^s = \prod_{i \in I_{od}^s} \left(\frac{p_{odi}}{\overline{p}_{di}} \right)^{w_{odi}^s} \quad (12),$$

where $\overline{p}_{di} \equiv \frac{V_{di}}{\sum_{o \neq d} q_{odi}}$. The weight w_{odi}^s is the logarithmic mean of the share of product i in country o's exports to destination market d within sector s (which is denoted by s_{odi}^s) and the share of product i in worldwide exports of I_{od}^s to destination market d within sector s (which is denoted by $\overline{s}_{di}^s$). Specifically,

$$w_{odi}^s = \frac{\frac{s_{odi} - \overline{s}_{di}}{\ln s_{odi} - \ln \overline{s}_{di}}}{\sum_{i \in I_{od}^s} \frac{s_{odi} - \overline{s}_{di}}{\ln s_{odi} - \ln \overline{s}_{di}}} \quad (13),$$

with

$$s_{odi}^{s} \equiv \frac{p_{odi}q_{odi}}{\sum_{i \in I_{od}^{s}} p_{odi}q_{odi}}; \text{ and } \overline{s}_{di}^{s} \equiv \frac{V_{di}}{\sum_{i \in I_{od}^{s}} V_{di}}.$$

Once the price index P_{od}^{s} is computed by equation (12), the quantity index Q_{od}^{s} can be implicitly obtained from equations (9) and (11).

3.4. Estimating Equations

Defining $\sum_{i \in I_{od}^{s}} p_{odi}\, q_{odi} \equiv v_{od}^{s}$ and $\sum_{i \in I_{d}^{s}} V_{di} \equiv V_{d}^{s}$, it follows from equations (10) and (11) that

$$\frac{v_{od}^{s}}{V_{d}^{s}} = \mathrm{EM}_{od}^{s} P_{od}^{s} Q_{od}^{s} \qquad (14).$$

By taking the logarithms of both sides of the above equation, we have

$$\ln v_{od}^{s} = \ln V_{d}^{s} + \ln \mathrm{EM}_{od}^{s} + \ln P_{od}^{s} + \ln Q_{od}^{s} \qquad (15),$$

where the logged bilateral export value is additively separable in each of the logged, extensive, price, and quantity margins at the sector level.

We regress the logged bilateral export value ($\ln v_{od}^{s}$), as well as the decomposed respective margins, against the ACRI under study (ACRI_{od}^{s}) at the sector level. To do so, we employ a standard gravity equation, following Anderson and van Wincoop (2003), of a cross-sectional form, by including the origin-sector and destination-sector fixed effects to control for so-called multilateral resistance terms. Our baseline estimating equation is

$$\ln v_{od}^{s} = \alpha + \beta \ln t_{od}^{s} + I_{o}^{s} + I_{d}^{s} + \varepsilon_{od}^{s} \qquad (16),$$

where I_{o}^{s} denotes origin-sector individual effects and I_{d}^{s} denotes destination-sector individual effects. In practice, before aggregating product-level bilateral trade data into sectoral figures, we exclude origin-destination-product-specific observations subject to import prohibitions for SPS or TBT reasons (i.e. A11, A12, or B11 imposed by the destination country) or for other reasons (E3).

We take into consideration the ACRI as a part of sector-specific bilateral trade costs (t_{od}^{s}). Specifically, we assume that trade costs take the following form:

$$t_{od}^{s} = (\mathrm{dist}_{od})^{\gamma_1} \times \exp(\gamma_2 \mathrm{contig}_{od} + \gamma_3 \mathrm{lang}_{od} + \gamma_4 \mathrm{colony}_{od} + \gamma_5 \mathrm{deep}_{od})$$
$$\times (1 + \mathrm{tariff}_{od}^{s})^{\gamma_6} \times \exp(\gamma_7 \mathrm{HM}_{od}^{s} + \gamma_8 \mathrm{ACRI}_{od}^{s}) \qquad (17),$$

where dist_{od} is (population-weighted) bilateral distance between the two countries (in kilometers) and contig_{od}, lang_{od}, and colony_{od} are dummy variables indicating whether the two countries have a common border (contig_{od}), common official or primary language (lang_{od}), and (post-1945) colonial relationship (colony_{od}). These four variables are included as a proxy for country pair-wise cross-border transportation and telecommunication costs, as in Silva and Tenreyro (2006).[22]

In addition, we control for country pair-wise policy cooperation in SPS measures and TBTs, using the data set of Hofmann, Osnago, and Ruta (2017) on the content of preferential trade agreements (PTAs). The data set includes information on whether 279 PTAs notified to the WTO and signed in 2015 or earlier contain provisions regarding SPS measures (e.g. the affirmation of rights and obligations under the WTO Agreement on SPS; harmonisation of SPS measures) and TBTs (e.g. the affirmation of rights and obligations under the WTO Agreement on TBTs, provision of information, harmonisation of regulations, and MRAs). Given this information, we construct an indicator variable (deep_{od}) for the deep trade agreement including SPS- or TBT-related provisions between a pair of countries.

To capture the trade policies of the destination country against the origin country at the sector level, tariff_{od}^{s}, HM_{od}^{s}, and ACRI_{od}^{s} under study are included as proxies for bilateral, direction-specific trade costs. First, tariff_{od}^{s} is a trade-weighted average of ad valorem equivalent (AVE) bilateral tariffs across products within a particular sector.[23] We use the worldwide trade share as a weight as in the construction of ACRI_{od}^{s}. Second, HM_{od}^{s} is a coverage ratio of the hard measures classified under chapters E or F. Following UNCTAD (2018: 92), we calculate the sector-level coverage ratio using the worldwide trade share as a weight.

Given equation (15), we can run the same regression as in equation (16) for the extensive, price, and quantity margins and to examine different effects of the ACRI on different margins. To be more precise, we will estimate the following set

[22] Obtained from the Centre d'Études Prospectives et d'Informations Internationales (CEPII) Gravity database. http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8.

[23] Bilateral tariff data at the HS six-digit level are obtained from the World Bank's World Integrated Trade Solution (https://wits.worldbank.org/). If the tariff data are missing in the years under study, we replace them with the mean value between the years before and after the period under study. We employ the effective tariff rates in the sense that we use the MFN tariff rate unless there is a preferential tariff lower than the MFN rate.

of equations using ordinary least squares:[24]

$$\ln v_{od}^{s} = \alpha + \cdots + \delta_6 ln(1 + \text{tariff}_{od}^{s}) + \delta_7 \text{HM}_{od}^{s} + \delta_8 \text{ACRI}_{od}^{s} + I_o^s + I_d^s + \varepsilon_{od}^{s} \quad (18)$$

,

associated with

$$\ln \text{EM}_{od}^{s} = \alpha^{\text{EM}} + \cdots + \delta_6^{\text{EM}} ln(1 + \text{tariff}_{od}^{s}) + \delta_7^{\text{EM}} \text{HM}_{od}^{s} + \delta_8^{\text{EM}} \text{ACRI}_{od}^{s} + I_o^s + I_d^s + \varepsilon_{od}^{s,\text{EM}};$$

$$\ln P_{od}^{s} = \alpha^{P} + \cdots + \delta_6^{P} ln(1 + \text{tariff}_{od}^{s}) + \delta_7^{P} \text{HM}_{od}^{s} + \delta_8^{P} \text{ACRI}_{od}^{s} + I_o^s + I_d^s + \varepsilon_{od}^{s,P};$$

and

$$\ln Q_{od}^{s} = \alpha^{Q} + \cdots + \delta_6^{Q} ln(1 + \text{tariff}_{od}^{s}) + \delta_7^{Q} \text{HM}_{od}^{s} + \delta_8^{Q} \text{ACRI}_{od}^{s} + I_o^s + I_d^s + \varepsilon_{od}^{s,Q},$$

where, given the linearity of ordinary least squares, the estimated coefficients always satisfy[25]

$$\delta_j \equiv \delta_j^{\text{EM}} + \delta_j^{P} + \delta_j^{Q}, \forall j = 1, \dots, 8.$$

By employing the ACRI, we aim to capture the compliance cost-raising effect of technical regulations. To meet regulatory requirements in the destination market, exporter firms incur fixed costs to establish capacity and subsequently variable production costs (Ganslandt and Markusen, 2001; Chen, Wilson, and Otsuki, 2008; Bao and Chen, 2013). Such fixed costs of adapting products to foreign destination markets are thought to be associated with a narrow set of exported goods on the extensive margin, as smaller or less productive firms cannot afford the fixed costs. Meanwhile, higher marginal costs due to foreign regulatory burdens push up the unit price of exported goods, decreasing quantities of each traded good on the intensive margin. Therefore, we expect to get the ACRI coefficients estimated with the following signs: $\delta_8^{\text{EM}} < 0$, $\delta_8^{P} > 0$, and $\delta_8^{Q} < 0$.

Next, we focus on analysing export flows from developing nations to advanced economies. It is a common perception that technical regulations are more stringent in advanced economies than in developing nations. Thus, the same degree of effectual regulations (i.e. the same value of the calculated ACRI) implies a greater cost burden of compliance for exporter firms based in developing nations

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[24] We use δ for $\beta \times \gamma$ to ease the notation.

[25] Notice that variations in $\ln V_d^s$ are perfectly accounted for by I_d^s.

that serve markets in advanced economies, compared to firms in advanced economies exporting to developing nations.

To better highlight the compliance cost-raising effect of technical regulations, we examine export flows from developing nations to advanced economies. To do so, we group 98 sample countries into advanced economies and developing nations, based on the World Bank Country and Lending Group classification, which divides countries into low-income (L), lower-middle-income (LM), upper-middle-income (UM), and high-income (H) groups, as shown in Appendix A.[26] We aggregate the first three groups into a single group of less-developed nations while considering high-income countries as advanced economies. We are mainly interested in examining export flows from developing nations to advanced economies' markets. For comparison purposes, we also show the corresponding figures and estimation results for export flows from advanced economies to developing nations' markets, trade flows amongst developing nations, and trade flows amongst advanced economies.

3.5. Preliminary Data Observations

Descriptive statistics for all the variables used in our analysis are summarised in Table 4.1. The top table shows the statistics for the whole sample, while the bottom table shows the subsample on which we mainly focus: export flows from developing nations to advanced economies.

[26] For details of the country classifications, see https://datahelpdesk.worldbank.org/knowledgebase/articles/906519.

Table 4.1: Summary Statistics

Whole Sample

	Number of observations	Mean	Standard deviation	Minimum	Median	Maximum
Trade value ($'000)	418,265	21,609	363,163	0.001	102	1.43E+08
Extensive margin	418,265	0.440	0.349	1.04E-08	0.377	1
Intensive margin	418,265	0.041	0.114	3.94E-10	0.004	1
Price index	418,265	170.371	102,584	4.82E-06	1.402	6.63E+07
Quantity index	418,265	0.039	0.115	7.55E-12	0.002	0.9999999
Distance	418,265	6,769	4,854	115	6,235	19,650
Contiguity dummy	418,265	0.046	0.209	0	0	1
Common-language dummy	418,265	0.136	0.343	0	0	1
Colonial-tie dummy	418,265	0.016	0.124	0	0	1
Deep PTA dummy	418,265	0.390	0.488	0	0	1
Tariff	418,265	7.187	10.900	0	4.714	318.207
Hard measure	418,265	0.143	0.313	0	0	1
ACRI	418,265	0.204	0.314	0	0.042	1

Exports from Developing Nations to Advanced Economies

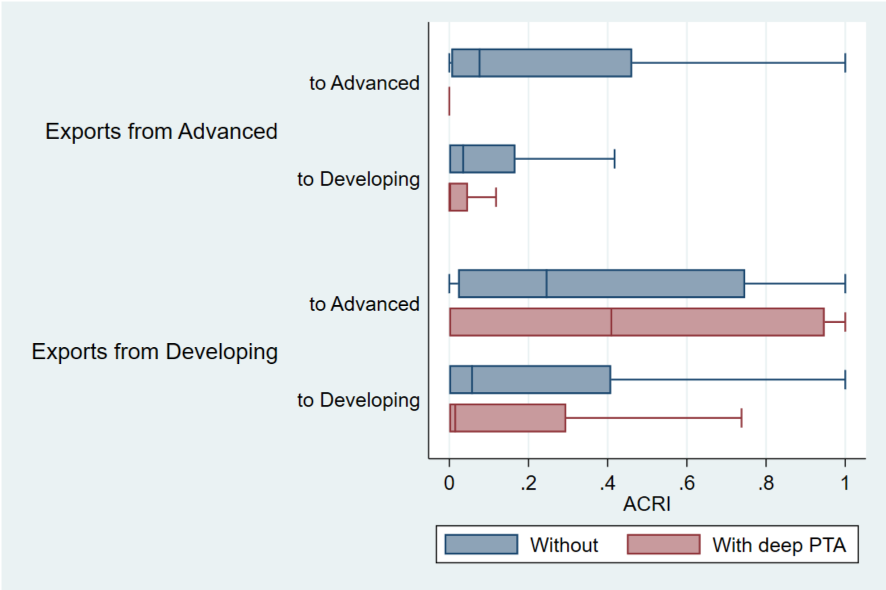
	Number of observations	Mean	Standard deviation	Minimum	Median	Maximum
Trade value ($'000)	88,913	19,385	567,437	0.001	47	1.43E+08
Extensive margin	88,913	0.366	0.322	1.04E-08	0.271	1
Intensive margin	88,913	0.029	0.095	1.48E-09	0.001	1
Price index	88,913	8.572	293	4.82E-06	1.241	49,219
Quantity index	88,913	0.031	0.103	8.47E-12	0.001	0.9999999
Distance	88,913	7,534	4,473	115	7,854	19,650
Contiguity dummy	88,913	0.017	0.131	0	0	1
Common-language dummy	88,913	0.121	0.327	0	0	1
Colonial-tie dummy	88,913	0.016	0.126	0	0	1
Deep PTA dummy	88,913	0.305	0.461	0	0	1
Tariff	88,913	5.222	11.143	0	3.384	318.207
Hard measure	88,913	0.153	0.324	0	0	1
ACRI	88,913	0.367	0.375	0	0.198	1

ACRI = additional compliance requirement indicator, PTA = preferential trade agreement.
Source: Authors' calculation.

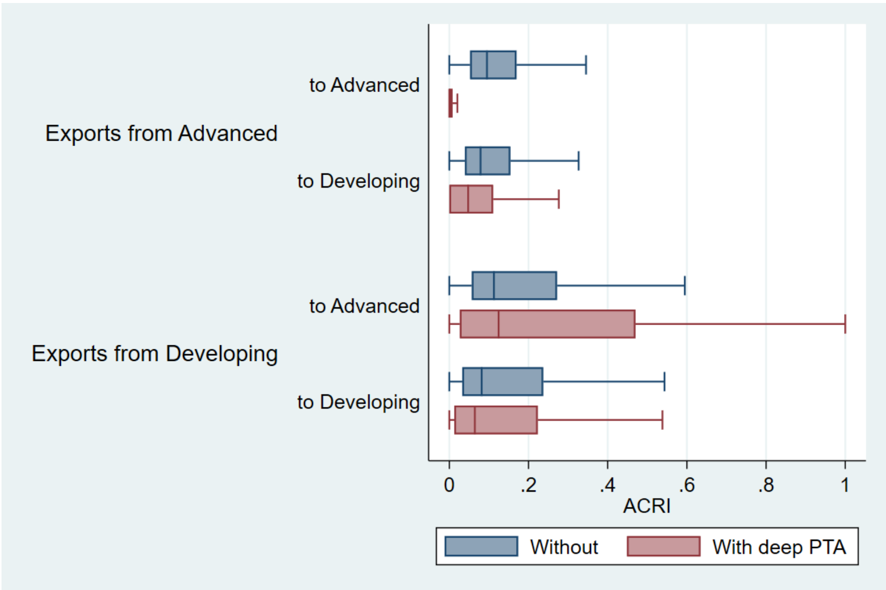
Box plots in Figure 4.1 show the central tendency of the ACRI for origin and destination country pairs with and without the deep trade agreements (including SPS- or TBT-related provisions) separately for four types of trade flows by country group. The box plots are depicted based on the data for exports of manufacturing and agricultural goods, ignoring outliers beyond either whisker of each box plot. For both manufacturing and agricultural exports, the red box representing the interquartile range of the ACRI for country pairs with deep trade agreements tends to be located on the left, compared to the corresponding blue box for those without deep trade agreements. That is, the degree of effectual technical regulations quantified by the ACRI tends to be smaller for country pairs engaged in policy cooperation in SPS measures and TBTs.

Figure 4.1: Additional Compliance Requirement Indicator for Country Pairs with and without the Deep Preferential Trade Agreement, including Provisions Related to Sanitary and Phytosanitary Measures or Technical Barriers to Trade

Manufacturing Sectors



Agricultural Sectors



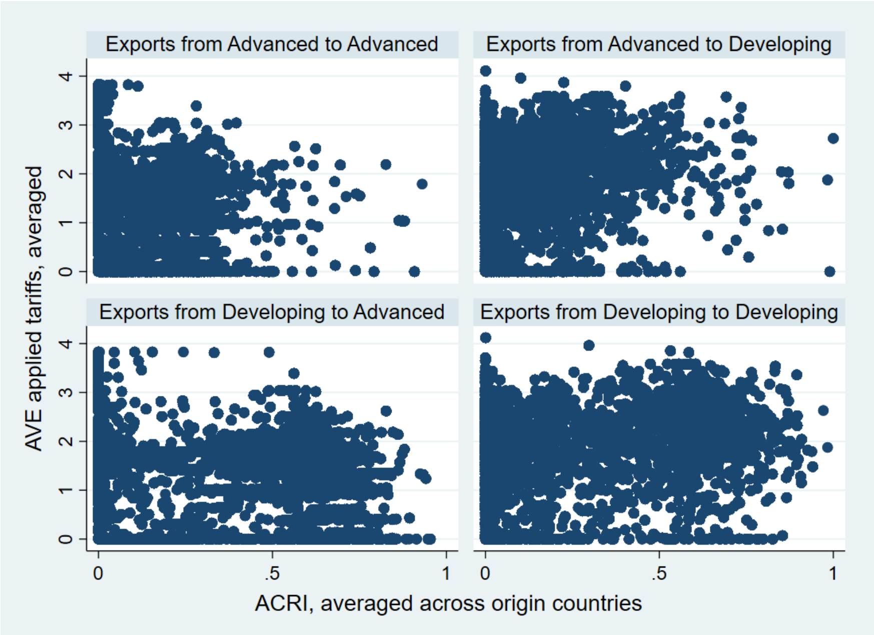
ACRI = additional compliance requirement indicator, Advanced = advanced economies, Developing = developing nations, PTA = preferential trade agreement.
Note: Outliers (beyond either whisker of each box plot) are omitted.
Source: Authors' calculation.

However, an exception lies on the subsample of our focus, the export flows from developing nations to advanced economies. The red box shows a relatively wide distribution toward both ends for manufacturing as well as agricultural exports, indicating that the ACRI is relatively high, even for country pairs with policy cooperation regarding technical regulations, to a non-negligible extent. The existence of SPS- or TBT-related provisions in trade agreements does not necessarily mean that the regulatory regime of a member country is similar to that of others. Rather, they mostly take the form of the provision of regulatory information and MRAs, as well as the affirmation of rights and obligations under the relevant WTO agreement, which are not interrelated with the international regulatory differences quantified by the ACRI.

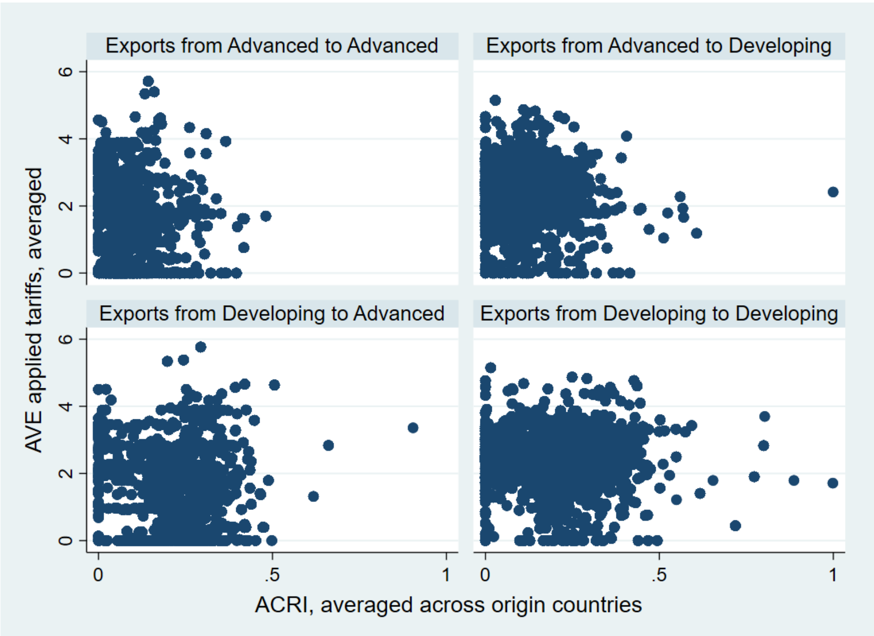
Figures 4.2 and 4.3 show correlation plots between the ACRI and the other two import-restrictive measures implemented in the destination country against the origin country at the sector level: the trade-weighted average of AVE tariffs (Figure 4.2) and the coverage ratio of hard measures (Figure 4.3). To depict the correlation plots, we take the average of each variable (originally defined at the origin-destination-sector level) across the origin countries. No clear positive, complementary relationship is seen between the ACRI and tariffs (Figure 4.2); nor is a clear negative, substitute relationship seen between the ACRI and hard measures (Figure 4.3).

Figure 4.2: Sector-Level Relationships between Additional Compliance Requirement Indicators and Tariffs

Manufacturing Sectors



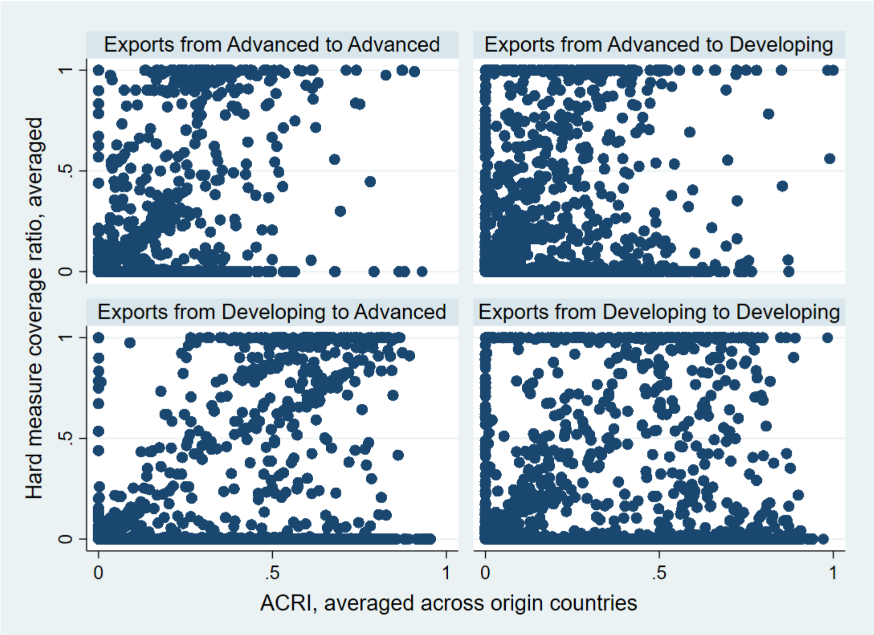
Agricultural Sectors



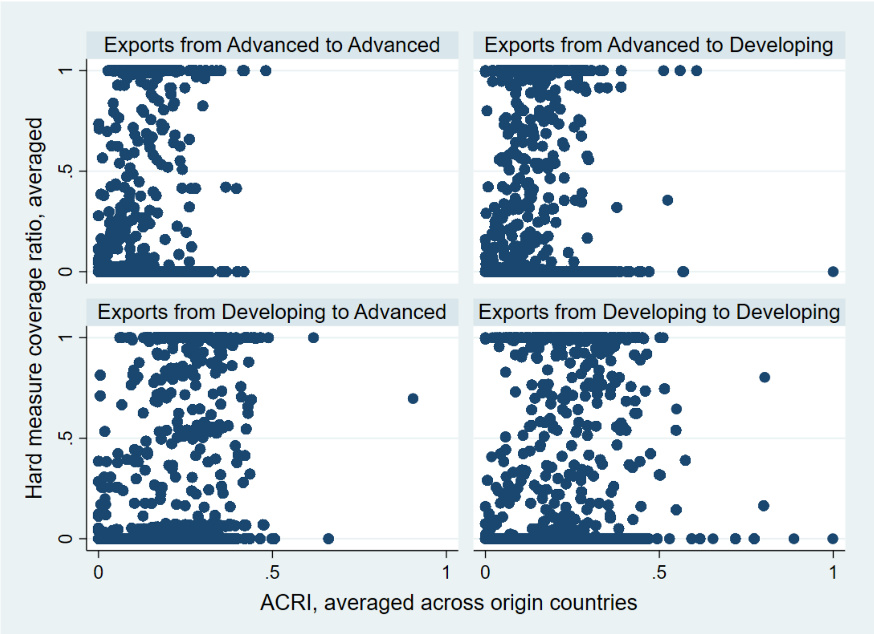
ACRI = additional compliance requirement indicator, Advanced = advanced economies, AVE = ad valorem equivalent, Developing = developing nations.
Notes: Although the policy variables of interest are defined at the origin-destination-sector level, as explained in the main text, we take an average of each variable across the origin countries to depict the plots in a concise manner. The tariff variable on the vertical axis is the natural logarithmic value.
Source: Authors' calculation.

Figure 4.3: Sector-Level Relationships between Additional Compliance Requirement Indicators and Hard Measures

Manufacturing Sectors



Agricultural Sectors



ACRI = additional compliance requirement indicator, Advanced = advanced economies, Developing = developing nations.
Note: Although the policy variables of interest are defined at the origin-destination-sector level, as explained in the main text, we take an average of each variable across the origin countries to depict the plots in a concise manner.
Source: Authors' calculation.

4. Estimation Results

For export flows from developing nations to advanced economies, our baseline estimation results for a set of equations (18) using data for all merchandise trade are summarised in Table 4.2. Column (1) of the table shows the estimates of the equation with sector-level bilateral trade values (in natural logs) as the dependent variable. Column (2) shows the decomposed estimates for the extensive margins (in natural logs) of the sector-level bilateral trade, and column (3) shows the estimates for the intensive margins. For each covariate as well as the ACRI, the sum of the estimated coefficients shown in columns (2) and (3) is equal to the coefficient in column (1), by construction. The intensive margin is further decomposed into price and quantity components: the sum of the estimated coefficients shown in columns (4) and (5) is equal to the coefficient in column (3).

Table 4.2: Baseline Results: All Merchandise Exports from Developing to Advanced

	(1) ln(Trade value)	(2) ln(EM)	(3) ln(IM)	(4) ln(P)	(5) ln(Q)
ln(distance)	-1.422***	-0.509***	-0.913***	0.171***	-1.083***
	(0.044)	(0.021)	(0.033)	(0.012)	(0.039)
Contiguity dummy	0.969***	0.236*	0.732***	-0.150**	0.882***
	(0.256)	(0.124)	(0.160)	(0.067)	(0.200)
Common-language dummy	0.588***	0.230***	0.358***	-0.008	0.366***
	(0.081)	(0.033)	(0.062)	(0.022)	(0.073)
Colonial-tie dummy	0.598***	0.134	0.463**	-0.125**	0.589***
	(0.228)	(0.090)	(0.187)	(0.061)	(0.211)
Deep PTA dummy	0.106	0.077**	0.029	-0.036**	0.066
	(0.067)	(0.030)	(0.052)	(0.018)	(0.059)
ln(1+Tariff)	-0.518**	-0.161	-0.358*	0.087	-0.445**
	(0.209)	(0.120)	(0.189)	(0.098)	(0.213)
Hard measure	-2.167***	-0.798***	-1.369***	0.357***	-1.726***
	(0.350)	(0.133)	(0.280)	(0.128)	(0.349)
ACRI	-1.024***	-0.231***	-0.793***	0.147***	-0.940***
	(0.101)	(0.050)	(0.086)	(0.035)	(0.097)
Origin-sector dummies Destination-sector dummies	YES	YES	YES	YES	YES
Number of observations	88,913	88,913	88,913	88,913	88,913
Adjusted R-squared	0.680	0.534	0.609	0.248	0.594

ACRI = additional compliance requirement indicator, PTA = preferential trade agreement.
Notes: Dependent variables, as well as the additional compliance requirement indicator under study, are defined at the origin-destination-sector level. We omit from the table coefficients for the constant term, origin-sector-specific effects, and destination-sector-specific effects. Robust standard errors clustered by origin and destination country pairs are in parentheses. Asterisks denote statistical significance: *** p< 0.01, ** p< 0.05, * p< 0.1. We group 98 sample countries into 48 advanced economies and 50 developing economies, based on the World Bank's country classification by income group, as explained in the main text. The estimates shown in this table are obtained using data for exports of all merchandise goods from 50 developing nations to 48 advanced economies.
Source: Authors' calculation.

In column (1) of Table 4.2, all of the coefficients are estimated as expected with statistical significance; the only exception is the dummy variable indicating the existence of a deep trade agreement (including SPS- or TBT-related provisions) between a pair of countries, whose coefficient is estimated to be positive as expected but statistically insignificant. The estimated coefficient for the ACRI indicates that sector-level bilateral trade values shrink by 10.2% if the sector-level ACRI was 0.1 point higher with other things unchanged. The estimated trade-diminishing effect of the ACRI is comparable to the effects of import-restrictive measures implemented in the destination country: trade values shrink by 5.2% if the trade-weighted average of AVE tariffs was 10% higher. Trade values also shrink by 21.7% if the coverage ratio of hard measures (i.e. price controls or quantity-restrictive measures) was 0.1 point higher.

Columns (2) and (3) of Table 4.2 indicate that the directions of the effects of the ACRI and covariates on both the extensive and intensive margins are the same as those on trade values. Comparing columns (2) and (3) shows that the magnitude of the estimated coefficient is uniformly larger on the intensive margin than on the extensive margin, except for the deep PTA dummy. Note that the level of aggregation at which we measure the extensive margin would affect the estimates, as discussed in Hummels and Klenow (2005). If product variety differences exist at more disaggregated levels (e.g. the eight-digit or 10-digit levels), we can only capture some of the variety differences in the extensive margin by using the six-digit level 'product' data within the four-digit 'sector' (the rest of the variety differences would instead be included in the intensive margin). Since it is possible to underestimate the effects on the extensive margin, we interpret the current estimation results of the extensive margin as the lower bound.[27]

With respect to the intensive margin, columns (4) and (5) of Table 4.2 show contrasting patterns in the signs of estimated coefficients between the price and quantity margins. In particular, a higher ACRI is associated with smaller quantities of each exported good to a large degree on the quantity margin, and with higher

[27] We calculate the extensive and intensive margins as defined in equation (9) using trade values only, without referring to trade quantities. Even when expanding the sample by including those without (reliable) quantity data, estimation results for trade values, extensive margin, and intensive margin do not differ substantially.

prices of exported goods. This is consistent with our prediction that higher marginal costs resulting from regulatory compliance requirements push up exported prices and decrease quantities. More precisely, the estimates for the ACRI indicate that if it was 0.1 point higher with other things unchanged, quantities of each traded good shrink by 9.4% while the prices increase by 1.5%.

Similarly, the deep PTA dummy, which captures international policy cooperation in SPS measures and TBTs (including the provision of regulatory information and MRAs), can be seen as (at least partially) capturing the effect that exporter firms can save the costs of collecting information on technical requirements in destination markets.[28] The estimated coefficient for the deep PTA dummy on the price margin indicates that export prices decline by 3.6% if a pair of countries has an SPS- or TBT-related trade agreement provision, enabling exporter firms to save the costs of collecting regulatory information in destination markets. A similar positive effect of the deep PTA dummy is found on the extensive margin as well. The information cost-saving effect could enable SPS- or TBT-related deep trade agreements to mitigate the trade impact of the ACRI, at least to some extent.

Continuing to focus on export flows from developing nations to advanced economies, Table 4.3 summarises the estimates for the manufacturing and agricultural sectors separately. There are some noticeable differences by sector: first, the overall trade-diminishing effect of the ACRI is twice as large in magnitude for the agricultural sector as it is for the manufacturing sector. The decomposed effects through the extensive and quantity margins also show relatively large adverse effects of the ACRI for the agricultural sector. Agricultural exporters of developing nations appear to face a greater cost burden to comply with additional regulatory requirements in advanced economies' markets, compared to manufacturing exporters.

[28] The information cost-saving effect of technical regulations has been pointed out in the related literature (Portugal-Perez, Reyes, and Wilson, 2010; Bao and Chen, 2013). Although the ACRI may partially reflect the information cost-saving effect in addition to the compliance cost-raising effect under study, the existence of SPS- or TBT-related provisions of deep trade agreements is a more direct indicator of the information cost-saving effect.

Table 4.3: Manufacturing and Agricultural Exports from Developing Nations to Advanced Economies

Manufacturing sectors

	(1) ln(Trade value)	(2) ln(EM)	(3) ln(IM)	(4) ln(P)	(5) ln(Q)
Deep PTA dummy	-0.029	0.011	-0.039	-0.004	-0.035
	(0.071)	(0.032)	(0.055)	(0.021)	(0.063)
ln(1+Tariff)	-0.550**	-0.220*	-0.330	0.136	-0.466*
	(0.262)	(0.125)	(0.250)	(0.126)	(0.279)
Hard measure	-2.564***	-0.921***	-1.644***	0.388**	-2.031***
	(0.410)	(0.167)	(0.323)	(0.191)	(0.431)
ACRI	-0.914***	-0.212***	-0.703***	0.155***	-0.857***
	(0.103)	(0.051)	(0.088)	(0.037)	(0.100)
Origin-sector dummies Destination-sector dummies	YES	YES	YES	YES	YES
Number of observations	61,522	61,522	61,522	61,522	61,522
Adjusted R-squared	0.712	0.558	0.635	0.235	0.624

Agricultural sectors

	(1) ln(Trade value)	(2) ln(EM)	(3) ln(IM)	(4) ln(P)	(5) ln(Q)
Deep PTA dummy	0.589***	0.268***	0.321***	-0.111***	0.432***
	(0.095)	(0.040)	(0.081)	(0.023)	(0.089)
ln(1+Tariff)	-0.479	-0.039	-0.440	0.014	-0.453
	(0.389)	(0.260)	(0.326)	(0.139)	(0.368)
Hard measure	-1.468***	-0.615***	-0.853*	0.360***	-1.213**
	(0.561)	(0.226)	(0.462)	(0.118)	(0.500)
ACRI	-1.924***	-0.391***	-1.533***	0.081	-1.614***
	(0.318)	(0.146)	(0.283)	(0.109)	(0.325)
Origin-sector dummies Destination-sector dummies	YES	YES	YES	YES	YES
Number of observations	19,470	19,470	19,470	19,470	19,470
Adjusted R-squared	0.572	0.489	0.522	0.266	0.505

ACRI = additional compliance requirement indicator, PTA = preferential trade agreement.
Notes: Dependent variables as well as the ACRI under study are defined at the origin-destination-sector level. We omit from the table coefficients for the constant term, origin-sector-specific effects, destination-sector-specific effects, and country pair-wise variables (except the deep PTA dummy). Robust standard errors clustered by origin and destination country pairs are in parentheses. Asterisks denote statistical significance: *** p< 0.01, ** p< 0.05, * p< 0.1. We group 98 sample countries into 48 advanced economies and 50 developing economies, based on the World Bank's country classification by income group, as explained in the main text. The estimates shown in the top and bottom table are obtained, respectively, using data for exports of manufacturing goods (HS28–HS92) and agricultural goods (HS1–HS24) from 50 developing nations to 48 advanced economies.
Source: Authors' calculation.

Second, the positive impact of the ACRI on the price margin is statistically significant in manufacturing and all merchandise exports, but not in agricultural exports. This indicates that agricultural exporters do not differentiate in terms of export prices across destination countries with respect to regulatory burdens imposed by those countries, suggesting that the 'law of one price' holds true.

Third, the coefficients for the deep PTA dummy are estimated to be statistically significant in all of the agricultural export equations, in stark contrast to manufacturing exports. The adverse effects of the ACRI appear to be mitigated by international policy cooperation on SPS measures and TBTs regarding agricultural goods, unlike in the case of manufacturing goods.

Fourth, tariffs lose statistical significance in all agricultural export equations, unlike the ACRI and hard measures. This is consistent with a general perception that non-tariff barriers rather than tariffs are substantial obstacles faced by agricultural exporters in developing nations when serving advanced economies' markets.

Next, Table 4.4 compares the estimated effects of the ACRI on the respective margins of all merchandise exports from developing nations to advanced economies with those for three other types of trade flow by origin and destination country groups. First, the estimated effect of the ACRI on the trade value of exports from developing nations to advanced economies is almost the same in magnitude as that for exports from advanced economies to developing nations. This similarity indicates that a unit increase in the calculated ACRI (or the same degree of additionally effectual regulations) leads to a similar percentage decline on average in the export values of the two trade flows.

Table 4.4: Trade Effects of the Additional Compliance Requirement Indicator: Comparison of Trade Flows by Country Group

	(1) ln(Trade value)	(2) ln(EM)	(3) ln(IM)	(4) ln(P)	(5) ln(Q)	Number of observations
Developing to Advanced						
	-1.024***	-0.231***	-0.793***	0.147***	-0.940***	88,913
	(0.101)	(0.050)	(0.086)	(0.035)	(0.097)	
Advanced to Developing						
	-1.028***	-0.315***	-0.713***	0.122***	-0.835***	111,562
	(0.131)	(0.057)	(0.100)	(0.043)	(0.120)	
Advanced to Advanced						
	-0.703***	-0.138***	-0.565***	0.278***	-0.843***	142,342
	(0.116)	(0.048)	(0.089)	(0.036)	(0.102)	
Developing to Developing						
	-0.519***	-0.141**	-0.378***	0.053	-0.431***	75,448
	(0.123)	(0.056)	(0.095)	(0.036)	(0.107)	

Notes: Dependent variables, as well as the additional compliance requirement indicator under study, are defined at the origin-destination-sector level. We omit from the table coefficients for the constant term, origin-sector-specific effects, destination-sector-specific effects, and other covariates than the additional compliance requirement indicator. Robust standard errors clustered by origin and destination country pair are in parentheses. Asterisks denote statistical significance: *** p< 0.01, ** p< 0.05, * p< 0.1. We group 98 sample countries into 48 advanced economies and 50 developing economies, based on the World Bank's country classification by income group, as explained in the main text. The estimates shown in this table are obtained using data for exports of all merchandise goods.
Source: Authors' calculation.

However, regulatory burdens would prohibit bilateral trade, resulting in zero trade values even at the sector level, especially in the case of developing nations' exports. Since we focus on examining trade relationships with positive trade values to decompose the trade effects of the ACRI into different margins in the current study, the estimates for developing nations' exports might be underestimated.[29] Indeed, the estimated coefficients of trade flows amongst developing nations are relatively small in magnitude compared to the other three trade flows.

Estimates on the quantity margin show that the same degree of additionally effectual regulations reduces quantities exported from developing nations to advanced economies the most. This result is consistent with the common belief that technical regulations are more stringent in advanced economies than in developing nations. Relatedly, the estimate on the quantity margin of trade flows amongst

[29] Examining the effects of the ACRI on the probability of exports is beyond the scope of the current chapter, and future studies are awaited.

advanced economies is the second largest in magnitude, while estimates of exports destined for developing nations tend to be smaller.

More importantly, we highlight differences in the pattern of decomposed effects of the ACRI on respective margins by trade flow. Decomposing trade flows into extensive and intensive margins and analysing how regulatory burdens affect different margins have important welfare implications. While a narrower range of exported goods would imply lower producer surplus in the exporting country, a higher unit price might adversely affect consumer surplus in the importing country. Smaller quantities of exported goods would deteriorate both producer surplus in the exporting country and consumer surplus in the importing country.

In the case of exports from developing nations to advanced economies, the overall trade-diminishing effect of the ACRI is attributed mainly to the quantity margin. In the case of exports from advanced economies to developing nations, on the other hand, the extensive margin is relatively important. It appears that advanced economies' exporters tend to be forced away from developing nations' markets with more regulatory burdens. Technical regulations implemented in developing nations, although thought to be less stringent, may deteriorate producer surplus in advanced exporting economies.

In contrast, in the case of trade flows amongst advanced economies, foreign regulatory burdens push up the price of exported goods to a relatively large extent, indicating that advanced economies' exporters tend to differentiate in terms of export prices amongst destination advanced economies with respect to their regulatory burdens. In this case, technical regulations may adversely affect consumer surplus as a result of higher prices of imported goods, even when regulations are enforced to protect consumers.

5. Conclusion

This chapter studied the trade impact of NTMs, focusing on how regulatory burdens imposed by importing countries influence the extensive and intensive margins of bilateral trade. To quantify the extra regulatory burdens that an exporter firm may face when serving a foreign country's market, we constructed the ACRI indicator, using the new UNCTAD NTM data set of detailed information on technical regulations. To measure bilateral margins of trade, we used finely disaggregated, product-level bilateral trade value and quantity data for 98 countries. We first showed that regulatory burdens diminish trade values. Behind the overall trade-diminishing effect of technical regulations, we also looked at the different effects on the margins of trade. Our major finding is that a country facing more regulatory burdens within a particular sector in the destination market country exports a narrower set of goods and exports lower quantities of each good at higher prices.

Since NTMs are in place (in most cases) to deal with legitimate concerns regarding citizens' health and safety, and environmental protections, the elimination of NTMs is neither desirable nor possible. Instead, policy should focus on how to deal with differences amongst NTMs, either through bilateral dialogues regarding the harmonisation or mutual recognition of regulations in each country, or strengthening the regulatory compliance capabilities of the economy and individual domestic firms.

First, policy should focus on improving the comparability of regulations. Since they are based on scientific knowledge and local conditions, harmonisation may be sometimes prove difficult, impossible, or in some cases, inappropriate. However, countries can discuss and collaborate with each other to facilitate mutual recognition of regulations amongst countries. This is especially important for developing countries, which tend to face much more difficulty in exporting when domestic and foreign regulations differ. This kind of discussion can take place in conjunction with various regional forums and regional integration efforts, such as ASEAN, the Regional Comprehensive Economic Partnership, or the Comprehensive and Progressive Agreement for Trans-Pacific Partnership.

The second area where policy is needed is improvements in the regulatory compliance capabilities of firms and society. To meet the regulatory requirements in importing countries, firms must understand them and take necessary action (e.g. modify their products and/or production processes). This means that aspiring exporting firms must develop and possess sufficient managerial and technological capabilities to comply with regulations in importing countries. In addition to the capabilities required by firms, society must also be equipped with testing and other quality assurance entities to help firms comply with regulations. In developing countries, such entities are in short supply or sometimes non-existent. Investment in these facilities should form part of industrial development policies. Once again, regional collaboration may be a way to economise on the investment and share the facilities amongst a group of countries.

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Appendix 4A: 98 Sample Countries

Country Name	ISO3	Group	Country Name	ISO3	Group	Country Name	ISO3	Group
United Arab Emirates	ARE	H	United Kingdom	GBR	H	Malaysia	MYS	UM
Argentina	ARG	UM	Greece	GRC	H	Nicaragua	NIC	LM
Antigua and Barbuda	ATG	H	Grenada	GRD	UM	Netherlands	NLD	H
Australia	AUS	H	Guatemala	GTM	LM	New Zealand	NZL	H
Austria	AUT	H	Guyana	GUY	UM	Oman	OMN	H
Belgium	BEL	H	Hong Kong	HKG	H	Pakistan	PAK	LM
Bulgaria	BGR	UM	Honduras	HND	LM	Panama	PAN	UM
Bahrain	BHR	H	Croatia	HRV	H	Peru	PER	UM
Bahamas	BHS	H	Hungary	HUN	H	Philippines	PHL	LM
Bolivia	BOL	LM	Indonesia	IDN	LM	Papua New Guinea	PNG	LM
Brazil	BRA	UM	India	IND	LM	Poland	POL	H
Barbados	BRB	H	Ireland	IRL	H	Portugal	PRT	H
Brunei Darussalam	BRN	H	Israel	ISR	H	Paraguay	PRY	UM
Canada	CAN	H	Italy	ITA	H	Qatar	QAT	H
Switzerland	CHE	H	Jamaica	JAM	UM	Romania	ROU	UM
Chile	CHL	H	Jordan	JOR	UM	Russian Federation	RUS	UM
China	CHN	UM	Japan	JPN	H	Saudi Arabia	SAU	H
Cameroon	CMR	LM	Kazakhstan	KAZ	UM	Singapore	SGP	H
Colombia	COL	UM	Kyrgyz Republic	KGZ	LM	El Salvador	SLV	LM
Costa Rica	CRI	UM	Cambodia	KHM	LM	Suriname	SUR	UM
Cuba	CUB	UM	Korea, Republic of	KOR	H	Slovakia	SVK	H
Cyprus	CYP	H	Kuwait	KWT	H	Slovenia	SVN	H
Czech Republic	CZE	H	Lao People's Democratic Republic	LAO	LM	Sweden	SWE	H
Germany	DEU	H	Lebanon	LBN	UM	Thailand	THA	UM
Dominica	DMA	UM	Sri Lanka	LKA	LM	Tajikistan	TJK	LM
Denmark	DNK	H	Lithuania	LTU	H	Trinidad and Tobago	TTO	H
Algeria	DZA	UM	Luxembourg	LUX	H	Tunisia	TUN	LM
Ecuador	ECU	UM	Latvia	LVA	LM	Turkey	TUR	UM
Spain	ESP	H	Morocco	MAR	LM	Uruguay	URY	H
Estonia	EST	H	Mexico	MEX	UM	United States	USA	H
Ethiopia	ETH	L	Malta	MLT	H	Venezuela, Bolivarian Republic of	VEN	UM
Finland	FIN	H	Myanmar	MMR	LM	Viet Nam	VNM	LM
France	FRA	H	Mauritania	MRT	LM			

Notes: The 'ISO3' column shows the International Organization for Standardization (ISO) 3166-1 alpha-3 country codes. The 'Group' column shows the World Bank Country and Lending Groups: low income (L), lower middle income (LM), upper middle income (UM), and high income (H).
Source: World Bank Country and Lending Groups.

Appendix 4B: Availability of Import Statistics for 98 Sample Countries in 2015–2016

ISO3	2015	2016	ISO3	2015	2016	ISO3	2015	2016
ARE	v	v	GBR	v	v	MYS	v	v
ARG	v	v	GRC	v	v	NIC	v	v
ATG	v	v	GRD	.	.	NLD	v	v
AUS	v	v	GTM	v	v	NZL	v	v
AUT	v	v	GUY	v	v	OMN	v	v
BEL	v	v	HKG	v	v	PAK	v	v
BGR	v	v	HND	v	v	PAN	v	v
BHR	v	v	HRV	v	v	PER	v	v
BHS	v	.	HUN	v	v	PHL	v	v
BOL	v	.	IDN	v	v	PNG	.	.
BRA	v	v	IND	v	v	POL	v	v
BRB	v	v	IRL	v	v	PRT	v	v
BRN	v	v	ISR	v	v	PRY	v	v
CAN	v	v	ITA	v	v	QAT	v	v
CHE	v	v	JAM	v	v	ROM	v	v
CHL	v	v	JOR	v	v	RUS	v	v
CHN	v	v	JPN	v	v	SAU	v	v
CMR	v	v	KAZ	v	v	SGP	v	v
COL	v	v	KGZ	v	v	SLV	v	v
CRI	v	v	KHM	v	v	SUR	v	v
CUB	.	.	KOR	v	v	SVK	v	v
CYP	v	v	KWT	v	v	SVN	v	v
CZE	v	v	LAO	v	v	SWE	v	v
DEU	v	v	LBN	v	v	THA	v	v
DMA	.	.	LKA	v	v	TJK	.	.
DNK	v	v	LTU	v	v	TTO	v	.
DZA	v	v	LUX	v	v	TUN	v	v
ECU	v	v	LVA	v	v	TUR	v	v
ESP	v	v	MAR	v	v	URY	v	v
EST	v	v	MEX	v	v	USA	v	v
ETH	v	v	MLT	v	v	VEN	.	.
FIN	v	v	MMR	v	v	VNM	v	v
FRA	v	v	MRT	.	v			

Notes: The 'ISO3' column shows the ISO 3166-1 alpha-3 country codes published by the International Organization for Standardization (ISO). 'v' indicates that import statistics reported by a country of concern are available for a given year. '.' means that the import statistics are not available; the mirror export data are instead used if applicable.
Source: United Nations International Trade Statistics Database.

Appendix 4C: Groupings of Technical Measures Considered in Constructing the Regulatory Pattern Vector

Group of technical measures	Maximum possible number of measures within group
A13, A14, A15, A19	4
A20, A21, A22	3
A30, A31, A32, A33	4
A41, A42, A49	3
A51, A52, A53, A59	4
A61, A62, A63, A64, A69	5
A81, A82, A83, A84, A85, A86, A89	7
A9	1
B14, B15, B19	3
B20, B21, B22	3
B30, B31, B32, B33	4
B41, B42, B49	3
B6	1
B7	1
B81, B82, B83, B84, B85, B89	6
B9	1
C1, C9	2
C2, C3, C4	3

Note: We count the number of technical measure codes at the two-digit level for groupings of chapters A and B and at the one-digit level for the chapter C grouping.
Source: Authors' calculation.

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