Regulatory Convergence within Technical Barriers to Trade

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Abstract

This paper analyses how regulatory convergence in different categories of technical barriers to trade (TBTs) imposed on imports of goods in information and communications technology (ICT) globally affected the values, volumes, and unit values of imported goods during the period 1996-2019. Keywords cited in TBTs that are notified to the World Trade Organization (WTO) give an indication of the regulatory objectives behind the imposition of TBTs. MAST also classifies TBTs based on their applicability, procedural and administrative uses, factors which will also be taken into consideration in the analysis. However, objectives of TBTs may provide better insights to policymakers. TBTs are non-discriminatory measures that are imposed unilaterally on all trading partners and on domestic producers. It is not feasible to analyse unilateral TBTs in a gravity setting, as they are excluded by the introduction of country-product-time fixed effects that control for multilateral resistances. However, regulatory convergence in TBT categories is a bilateral time-varying variable that is analysed in a gravity model in this paper. The empirical results suggest that regulatory convergence between trading partners in some TBT categories stimulates import values and volumes. However, the impact is very heterogeneous across TBT objectives and classes and across ICT product categories.

Keywords: Information and communications technology, regulatory convergence, technical barrier to trade, World Trade Organization, Pseudo Poisson Maximum Likelihood

JEL classification: F13, F14

CONTENTS

TABLES AND FIGURES

1. Introduction

Over the past two decades, non-tariff measures (NTMs) have become the most frequently used instruments of trade policy. Since the establishment of the General Agreement on Tariffs and Trade (GATT) in 1947, and the World Trade Organization (WTO) in 1995, countries have made efforts to facilitate smooth trade in goods by lowering tariffs and other non-tariff barriers (NTBs). While trade was being liberalised, markets also had to be regulated by governments, if the market itself failed to adjust for negative externalities. This has been particularly the case whereby low-quality goods or hazardous products and production may harm humans, animals, plant life or the environment, or endanger the health and safety of consumers, or give rise to national security concerns. To regulate the markets, policymakers need to regulate imported goods. This has been achieved through regulatory NTMs such as technical barriers to trade (TBTs). TBTs are imposed to protect consumers by prohibiting hazardous substances that pose a danger to their safety, such as chemicals that are used in many non-edible manufactured goods (e.g. in lithium batteries), or that cause concern in other areas (such as those mentioned above) or that create market inefficiencies (such as labelling and packaging), specification mismatches, national security concerns, etc. When an exporting firm needs to comply with a new regulation introduced by a TBT, its trade cost may increase, which leads to a higher imported price or lower trade volumes and values. However, if a TBT imposes a regulation that is similar to one that an exporting firm is already complying with at home, then it is far easier and less costly for the firm to comply with the TBT imposed by the destination market. This may lead to a surge in the volumes and values of imports. However, regulatory convergence and its implications are not widely studied in the literature. Therefore, this paper analyses the impact of regulatory convergence within TBTs on import values, volumes, and unit prices of goods in the information and communications technology (ICT) sector during the period 1996-2019. This is done using a gravity model of global bilateral trade at the six-digit level of the Harmonised System (HS), employing the objectives cited as keywords in notifications to the WTO of unilateral TBTs, while controlling for other bilateral quantitative NTBs, such as antidumping (ADP), countervailing (CV) duties, quantitative restrictions (QR) and traditional tariffs. Furthermore, regulatory similarity based on the two-digit procedural and administrative classes in TBTs that are classified by the United Nations Conference on Trade and Development (UNCTAD) Multi-Agency Support Team (MAST) nomenclature will be also used in the analysis.

Under WTO agreements, member states may impose TBTs on their imports as long as the measures are not discriminatory and are genuinely imposed to regulate all goods in a market. This has led to a proliferation of TBTs over the past two decades and to competition over regional and global standards. However, when the measures become discriminatory and hamper trade unnecessarily with the motive of protectionism, specific trade concerns (STCs) are raised regarding those TBTs, and this can sometimes lead to the WTO having to settle trade disputes. When standards and regulations are very similar in two trading countries, the firms in either of the countries can easily comply with the regulations in the other, and thus their trade is not impeded. By contrast, when the regulatory frameworks of two countries diverge markedly, compliance with the regulations imposed by the TBTs is costly and exports to the other market may decrease. For instance, thanks to harmonisation and the mutual recognition of standards and regulations in the single market of the European Union (EU), trade can flow smoothly

between member states of the EU without the need for regulatory inspections at the borders. This is in spite of the fact that member states sometimes unilaterally impose their own NTMs. But these affect only extra-EU imports from third countries: mutual recognition means that such unilateral NTMs do not affect intra-EU trade.

Many studies in the literature have investigated the impact of regulatory NTMs on trade values (Disdier et al., 2008; Bao and Qiu, 2010, 2012; Winchester et al., 2012; Ronen, 2017A, 2017B; Blyde, 2022), trade volumes (Kee et al., 2009; Beghin et al., 2015; Ghodsi et al., 2017; Bratt, 2017; Niu et al., 2018), trade prices (Cadot and Gourdon, 2016) and quality. Recent studies in the literature have found a positive impact of regulatory NTMs on trade, as they improve the quality of traded goods (Wilson and Otsuki, 2004; Trienekens and Zuurbier, 2008; Ing and Cadot, 2017; Disdier et al., 2020; Fałkowski et al., 2019; Curzi et al., 2020; Fiankor et al., 2021; Yue, 2021; Ghodsi and Stehrer, 2022; Ha and Zhang 2022). Thus, NTMs aimed at raising global standards and improving the quality of goods may also increase demand and trade in goods, if they manage to improve the quality of traded goods and the utility of consumers (Hummels and Klenow, 2005; Khandelwal, 2010; Feenstra and Romalis, 2014). The impact of regulatory NTMs on trade is very heterogeneous across countries, sectors, and years. In fact, ad-valorem equivalents of NTMs estimated by several papers in the literature are good evidence of such heterogeneity (Kee et al., 2009; Beghin et al., 2015; Ghodsi et al., 2017; Bratt, 2017; Niu et al., 2018; Ghodsi and Adarov, 2021). Moreover, various trading partners may be differently affected by NTMs. For instance, Essaji (2008) finds that trade costs increase for exporters in less advanced economies due to trade regulations in the US. Bao and Qiu (2012) find a positive impact of TBTs on intensive margins and a negative impact on extensive margins of trade. Some papers find a negative impact of NTMs on trade flows, such as Disdier et al. (2008), Li and Beghin (2012), Yousefi and Liu (2013).

However, very few studies in the literature have paid attention to regulatory convergence or similarities. Economic integration can be achieved with deep and comprehensive trade agreements that aim not only to reduce tariffs (as traditional customs unions do), but also to provide regulatory convergence, with harmonisation and mutual recognition of regulations, standards, and conformity assessments between countries. Harmonisation and mutual recognition become easier if there is a close similarity in the trade policy measures imposed by countries (Cadot et al., 2015). This can reduce both the variable and the fixed costs of compliance. Recent studies have attempted to show that trade between two countries increases, or the cost of trade between the two decreases, as regulatory distance narrows (Piermartini and Budetta, 2009; Cadot et al., 2015; Cadot and Ing, 2015; Knebel and Peters, 2019; Nabeshima and Obashi, 2021; Inui et al., 2021). However, these studies do not demonstrate convergence in terms of which types of NTMs affect trade, in which direction and with what magnitude. Moreover, these studies use the NTM data provided by the UNCTAD Trade Analysis and Information System (TRAINS). But the UNCTAD NTM database does not cover all countries, and for many years its coverage is patchy. Another source of information on NTMs is the database compiled by the WTO that covers official notifications to the WTO by member countries.

The data in the WTO Integrated Trade Intelligence Portal (I-TIP) include notifications of NTMs introduced by some countries even before the establishment of the WTO in 1995. Many countries' NTMs were notified to the WTO only after 1995, while some regulations went into force much earlier. Therefore, the date of entry into force is used in the analysis. The information is updated regularly to increase transparency in the imposition of trade policy measures by WTO members. No study in the literature has investigated regulatory convergence using WTO notifications, because the data do not

offer a classification of the measures based on the UNCTAD MAST nomenclature. However, the WTO I-TIP compiles all types of NTMs, with detailed information on the objectives of the measures, as cited in the keywords of the notification. TBTs are imposed unilaterally on the imports of all trading partners. This makes it difficult to analyse TBTs in a gravity model, controlling for multilateral resistances by including country-product-year fixed effects following the recent literature (Yotov et al., 2016). Therefore, to enable a gravity analysis of TBTs, this paper measures a bilateral similarity variable that is constructed using information on the shared objectives of TBTs imposed by trading partners.

However, one should also note that many WTO members' notification discipline is not always uniformly good. An increase in notifications by one member does not systematically imply an increase in regulations, but often simply an increase in reporting discipline. And these increases are asymmetric across countries. The problem of asymmetric coverage quality may appear in any other sources of trade statistics. For instance, Gaulier and Zignago (2010) make adjustments on detailed trade statistics at the six-digit level of HS to improve the symmetric coverage of trade values reported by countries. They provide BACI data which will be also used in this analysis. Furthermore, not all TBTs must be notified to the WTO. When new regulations are based on international standards, they do not have to be notified to the WTO. Since using international standards is an extreme form of convergence, this could be a significant data limitation. As there are notifications of draft legislation as well as notifications of final legislation, both are included in the analysis to indicate gradual enforcement. Furthermore, the date of regulations' entry into force is used as the starting point. Some economists consider that the NTM data provided by the UNCTAD TRAINS are better in comparison with WTO notifications, which is argued to be more comparable across countries since an independent comprehensiveness and quality check is conducted. It does not, however, allow for a time series or panel data analysis as it has many missing points across numerous countries and some limitations as discussed below and presented in Figure A5 in the online appendix[1]. Therefore, UNCTAD TRAINS data will be mainly used in a robustness analysis. Most importantly, the analysis of the similarity in MAST classes could inform policymakers about the applicability, administrative, and procedural aspects of TBTs. Also, the analysis of the similarity of TBT objectives could provide better guidance in targeting certain goals via the imposition of TBTs, which could be more helpful for policymakers.

Various TBT objectives may affect products in different ways, depending on their functionality. For instance, a TBT that aims to protect consumer safety or provide additional labelling and packaging information may affect consumer goods more than capital or intermediate goods. Or intermediate products that are used in other stages of production may need to conform to certain specifications. Thus, regulatory convergence in TBTs that aim at such detailed standards may affect trade in those intermediate goods. This shows the importance of analysing the trade implications of TBTs at the level of their detailed objectives. By contrast, a regulation that is effectively imposed on all types of imported goods may target characteristics that are only featured by some goods, and consequently may not necessarily affect other types. For instance, some TBT notifications have 'nutritional information' or 'organic agriculture' as keywords. Even though they may actually cite various other categories of products, in effect they are targeting food and edible products, rather than goods in other sectors. Convergence in TBT objectives that seek to facilitate trade between countries by addressing issues such as conformity assessments, compliance or harmonisation may affect trade in all types of goods. Such trade-enhancing TBTs may reduce trade costs while stimulating trade volumes, which may result in

[1] The online appendix can be found under this link: https://wiiw.ac.at/supplementary-appendix-regulatory-convergence-within-technical-barriers-to-trade-dlp-6631.pdf.

there being no significant impact on traded values. In other words, when it comes to the regulations and standards embedded within TBTs, their impact on the value of goods, volumes and price may be very heterogeneous, depending on the goods' functionality and the objectives of the regulatory TBT. Thus, to distinguish the ways in which various TBT objectives may affect different sets of goods depending on their functionality, this paper analyses different categories of ICT goods, as they have unique characteristics. Most importantly, with the lockdowns during the COVID-19 pandemic in many countries, businesses managed to run through home-office and teleworking supported by digitalisation. From 2019 to 2021 imports of ICT goods in the computer and peripheral equipment category increased by 13.5%, from USD 553 billion in 2019 to USD 628 billion in 2021, while imports of all goods in ICT increased by only 2.6%. This highlights the importance of ICT goods in the computer and peripheral equipment category that enabled workers to work from home.

Therefore, this paper analyses the impact that regulatory convergence within TBTs had on the import of ICT goods during the period 1996-2019 in a gravity framework. More precisely, the keywords mentioned in the regulations notified to the WTO will be used to measure the regulatory convergence in each type of TBT imposed by trading partners. Trade value, volume, and unit value (price) will be analysed to provide greater insight into the impact of the regulatory convergence of TBTs on import values, volumes and prices. Zero trade flows will be included in the estimation of trade values and volumes, and – following the literature (Santos Silva and Tenreyro, 2006; Yotov et al., 2016) – the Pseudo Poisson Maximum Likelihood (PPML) model is used to achieve robust results. Following Cadot et al. (2018) Ordinary Least Squares (OLS) will be used to estimated unit values. The impact of regulatory convergence will also be differentiated by the five major categories of ICT goods, in order to present the heterogeneity of the impact across the categories. The heterogeneity of impact across country pair groups will also be analysed. Developing versus developed countries form four groups of country pairs in the robustness analysis. Furthermore, as noted above, a robustness check using the regulatory similarity of two-digit TBT classes of MAST nomenclature will also be analysed as a robustness check. Due to the data limitation of NTMs obtained from UNCTAD TRAINS, the data sample in this robustness check is limited to the period 2012-2018. To have comparable results on the regulatory similarity of objectives of WTO notifications, another robustness check is run for the period 2012-2018 using these data. Furthermore, due to the harmonisation and mutual recognition of regulations and standards in the EU's single market, the benchmark specifications exclude intra-EU trade flows, while the estimations including them are provided as robustness checks.

The organisation of the paper is as follows. The next section describes the data used in the analysis and provides some stylised facts. Section 3 describes the methodology applied in the analysis. Section 4 provides the results of the analysis, while section 5 offers concluding remarks.

2. Data and stylised facts

The data on bilateral import values and import volumes were downloaded from two sources of UN COMTRADE provided by World Integrated Trade Solution (WITS) and BACI (Gaulier and Zignago, 2010) compiled by the French institute for research in international economics (CEPII) at the six-digit level of the HS 1996 version.[2] The databases on trade cover the period 1996-2021.

Data on bilateral tariffs are also downloaded from WITS. These data come from two sources: UNCTAD – with its Global Database on Non-Tariff Measures (TRAINS) (for tariffs and NTMs); and the WTO – with its Integrated Database (WTO-IDB) and the WTO Consolidated Tariff Schedules Database (WTO-CTS). Preferential tariffs take priority in the construction of tariff data for countries that have preferential trade agreements. If preferential tariffs are not available, the rates effectively applied are used. When neither is available, most-favoured nation (MFN) tariffs are included in the tariff data. The ad valorem equivalent tariffs are collected in the data when tariff quota rates are actually used. Tariffs on intra-EU trade are set to 0, whereas TBTs are not. The data on tariffs cover the period 1996-2020. The econometric analysis is however limited to the period 1996-2019 to exclude the pandemic years starting from 2020.

TBTs are generally set to 0 (like tariffs) on intra-EU trade. However, the similarity index needs to be equal to 1 for TBTs imposed at the EU level, which means that the TBTs on intra-EU trade cannot be set to 0 for the sake of the calculation of the convergence index. This does not mean that TBTs affect intra-EU trade flows. The data on TBTs are downloaded from two sources as mentioned above. The WTO's I-TIP data include official notifications to the WTO committees concerning NTMs imposed by WTO members. UNCTAD TRAINS is the second source of NTM data. As documented in Ghodsi et al. (2017), many notifications lack the HS codes for the products targeted by the NTMs. These HS codes are imputed using other information available in the notification. As noted above, ADP, CV and QR are other NTMs imposed bilaterally that are also included in the analysis. The data on these NTMs are also collected from WTO I-TIP, which is augmented by data from the Temporary Trade Barriers Database (TTBD) compiled by Bown (2005). The simple averages of ADP duties, CV duties, QRs, TBT notifications, and UNCTAD TBTs imposed on ICT goods during the period of analysis are presented in Figures A1-A5, respectively, in the online appendix.

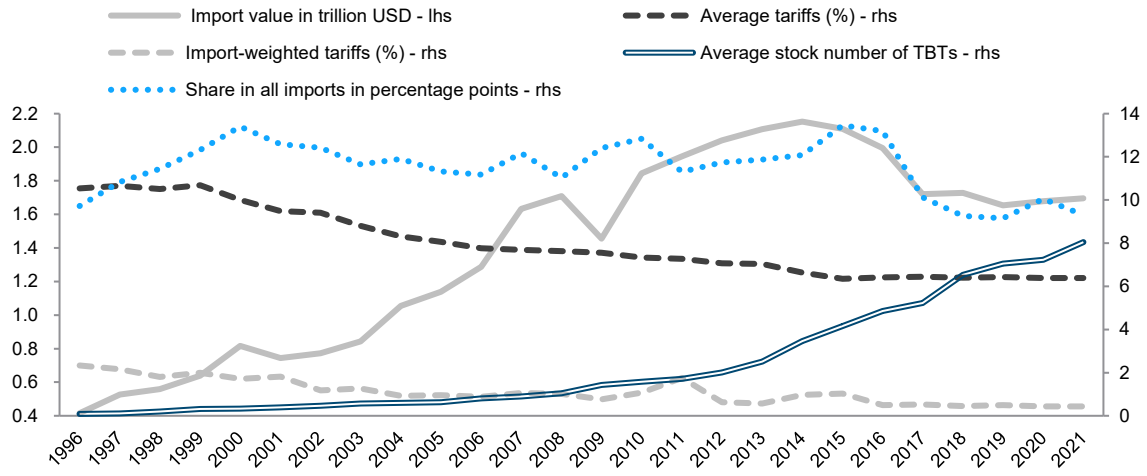
2.1. SIGNIFICANT ROLE OF ICT GOODS AS TRADE IN ICT GOODS INCREASES OVER YEARS

Figure 1 shows the development of aggregate trade, average tariffs, and average stock of TBT notifications on ICT goods during the period 1996-2021. The data on tariffs in 2020 is used for 2021 as it is not available through the sources mentioned above. As Figure 1 shows, the total import of ICT goods peaked in 2014 at USD 2.2 trillion. The import values slightly increased during the COVID-19 pandemic period 2020-2021 as noted above. The share of ICT imports in total global trade increased from 9.15% in 2019 to 10.05% in 2020 despite a reduction in total global trade due to border closures and the

[2] The data that support the findings of this study are available from the corresponding author upon reasonable request.

disruption of global value chains. This highlights the significant role played by the ICT sector at the beginning of the pandemic when many jobs shifted to home-office, increasing the demand for digital goods. In fact, globalisation and digitalisation are intertwined. On the one hand, the globalisation process over recent decades has stimulated trade in the manufacturing ICT sector (i.e. also known as part of the digital sector). On the other hand, the digitalisation created by the ICT sector has reduced trade costs, thus stimulating trade and the globalisation process (Ahmad et al., 2011; Mattes et al., 2012; Yushkova, 2014; Nath and Liu, 2017; Xing, 2018; Ozcan, 2018). Moreover, while tariffs imposed on ICT goods have been reduced substantially over the past two decades, TBTs imposed on these goods have proliferated.

Figure 1 / Development of trade, tariffs and TBTs on ICT goods – 1996-2021



Source: WITS, COMTRADE, UNCTAD, WTO I-TIP, author's elaboration.

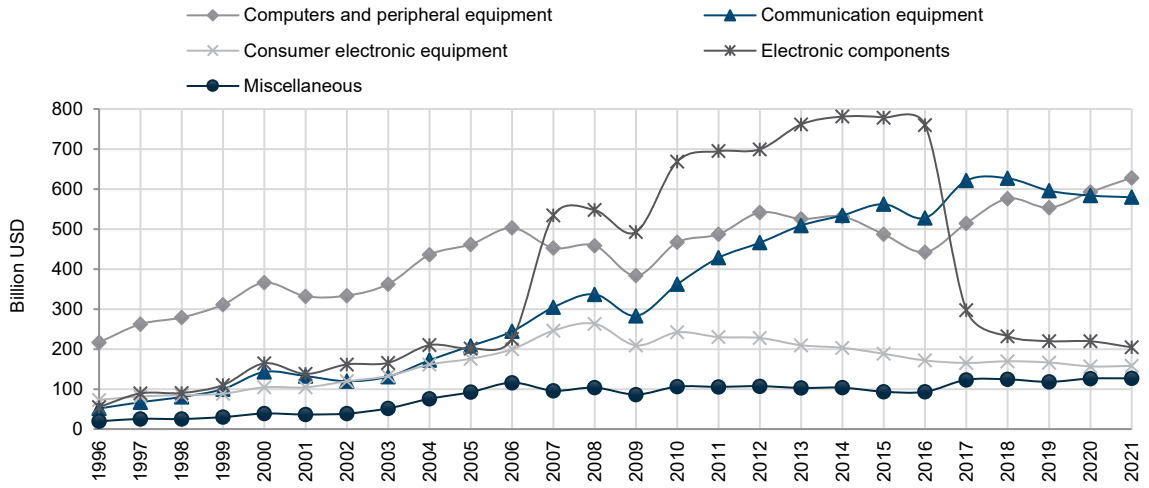
The statistics department of UNCTAD considers 93 goods at the six-digit level of the HS 2012 version as ICT goods.[3] Each of these goods may have a different functionality and use that can be clearly distinguished from other goods. Therefore, UNCTAD classifies the ICT goods into the following five categories: Computers and peripheral equipment (ICT01), Communication equipment (ICT02), Consumer electronic equipment (ICT03), Electronic components (ICT04) and Miscellaneous (ICT05). These goods correspond to 77 product codes in the HS 1996 version, for which data exist for a longer time span (since 1996). These goods and the related categories defined by UNCTAD are presented in Table A1 in the online appendix.

As Figure 2 shows, from the start of the dot-com boom in 1995 until 2007, computers and peripheral equipment were the largest category of trade in ICT goods. This was the era in which the major US tech companies were growing and other parts of the economy were investing heavily in computerisation and digital assets in the form of computers and peripheral equipment. The values of imports of ICT goods in this category and in the miscellaneous category are the only ones that experienced growth during the COVID-19 pandemic from 2019 to 2021. However, the import values of ICT goods in other categories decreased during the same period due to the global slowdown and border closures. After 2007, electronic components became the major category of trade in ICT goods, with a value that peaked at USD 800 billion

[3] The classification of ICT goods by UNCTADstat can be found here: https://unctadstat.unctad.org/en/Classifications/DimHS2012Products_Ict_Hierarchy.pdf

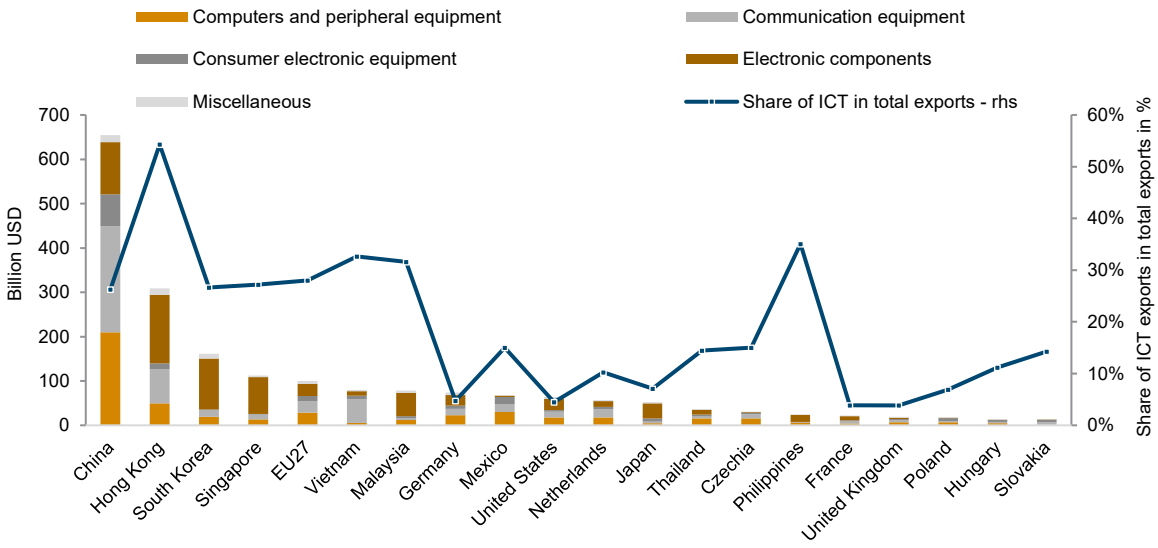
in 2014 – 5% of the global import value of all goods. This was mainly because these complex goods had become very important intermediate inputs to production in many other industries. Semiconductors and electronic chips are nowadays used in various products – from simple light bulbs to more complex products such as electronic devices and ICT goods, machinery, and automobiles. As Figure 3 illustrates, the major exporters of these important inputs to production are Asian countries, including China, Hong Kong, South Korea and Singapore. Border closures and disruptions to trade in the wake of the COVID-19 pandemic resulted in a shortage of semiconductors. The import values of electronic components dropped to USD 204 billion in 2021, less than its level in 2004. This disrupted production across many industries worldwide. It also indicates the importance of trade in these complex goods.

Figure 2 / Worldwide imports of ICT goods, USD billion, by product category, 1996-2019



Source: WITS, COMTRADE, author's elaboration.

Figure 3 / Top 20 exporters of ICT goods, USD billion, by product category; share of ICT exports in total exports, 2018

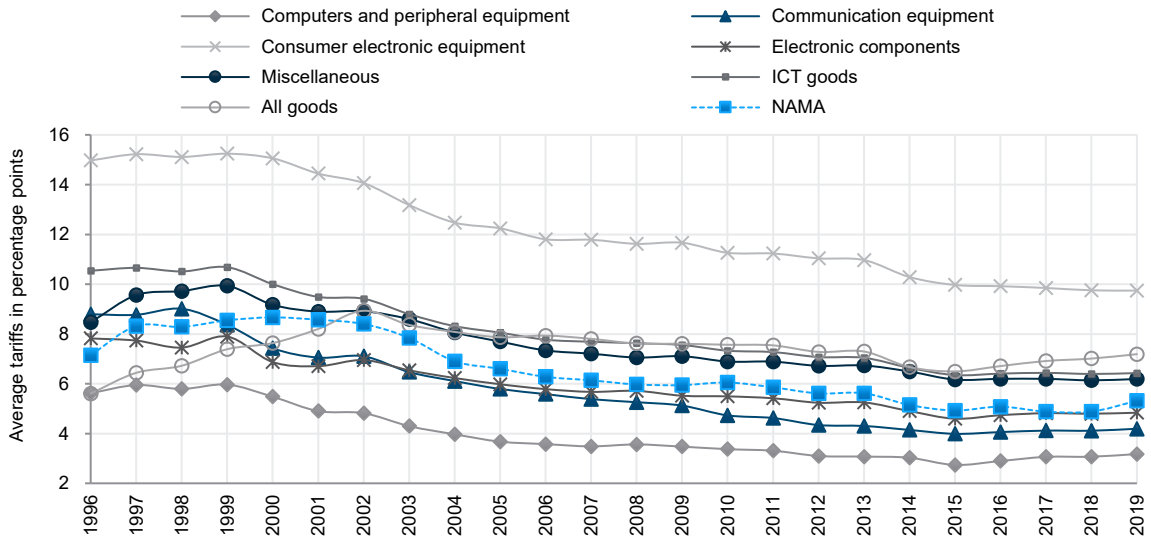


Sources: WITS; COMTRADE; UNCTAD; authors' elaboration.

2.2. LIBERALISATION OF TRADE IN ICT GOODS BY LOWERING TARIFFS

The liberalisation of trade in ICT goods has also been very important for policymakers, in terms of facilitating developments related to digitalisation. In fact, 14 members of the WTO concluded the Information Technology Agreement in December 1996, which envisages the elimination of tariffs on ICT goods. In December 2015 the signatories to this agreement – whose number had grown to 50 by that time – resolved to extend the agreement to more than 200 products. In September 2021, as they celebrated the 25th anniversary of the agreement, the participants consolidated their efforts by expanding membership to 53 countries, accounting for 97% of global trade in ICT goods. Figure 4 shows the simple average tariffs levied on ICT goods by product category and on all traded goods during the period 1996-2019. The simple average tariff levied on bilaterally traded ICT goods was larger than that levied on all goods at the beginning of the period. However, liberalisation efforts reduced the tariffs on ICT goods, so that by 2019 the simple average tariff stood at 6.45 – slightly below the 7.22 simple average tariff levied on all goods in 2019. It should be noted that the simple average tariff on Non-Agricultural Market Access (NAMA) is slightly smaller than tariffs on all goods, indicating greater protectionism for agricultural goods. As the right-hand side (rhs) axis of Figure 1 indicates, the import-weighted tariffs on ICT goods have been much lower than simple average tariffs. This indicates that import flows are directed at tariff lines with lower tariffs in this sector. Furthermore, as Figure 4 shows, trade in consumer electronics is protected by larger tariffs, whereas trade in intermediate inputs to production and ICT assets, like computers and peripheral equipment, communication equipment and electronic components, are less protected by tariffs. This is mainly because consumer electronics are produced, assembled and exported by numerous countries, whereas only very few countries specialise in the production and export of other ICT goods (see Figure 3).

Figure 4 / Development of tariffs levied on ICT goods, by product category, compared to all goods traded bilaterally during the period 2016-2019



Source: WITS, COMTRADE, UNCTAD, WTO-IDB, author's elaboration.

Figure A4 in the online appendix shows the development of simple average TBTs imposed on ICT goods in different categories. It is interesting to observe that in recent years, consumer electronic

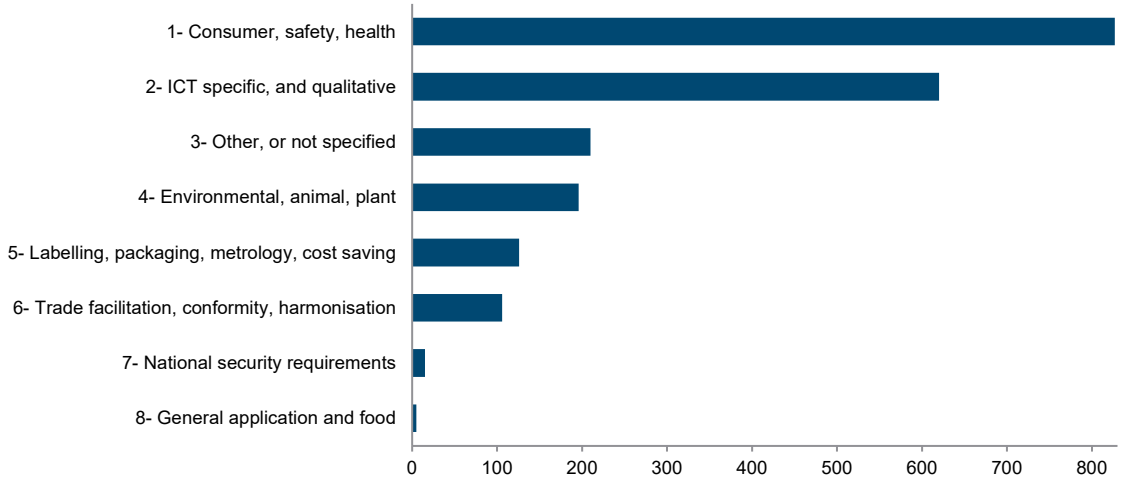
equipment is still one of the categories most targeted by TBTs, second only to the communication equipment category. And as ICT goods in computers and peripheral equipment face the lowest tariffs, they are also targeted by the least number of TBTs, ADPs (Figure A1), CV duties (Figure A2), and QRs (Figure A3). Thus, ICT goods in the form of computers and peripheral equipment, which played a key role in enabling teleworking during the recent pandemic, seem to be the least regulated goods in the global traded market.

2.3. TBTS AS AN IMPORTANT TRADE POLICY MEASURE FOR TRADE IN ICT GOODS

As tariffs have been reduced, TBTs have proliferated, as shown in Figure 1 and in Figure A4 in the online appendix. In 2021, goods in the communication equipment sector and then in the consumer electronic equipment sector were the most targeted sectors by TBTs, as shown in Figure A4. Goods in the computers and peripheral equipment sector were targeted by the least number of TBTs in 2021. Figure A5 in the online appendix presents the simple average of UNCTAD TBTs in force by ICT product category during the period 2016-2019. As observed, the average number of TBTs imposed on all ICT goods using WTO data is about 2.24 times larger than those using the UNCTAD TRAINS data in 2019. The TBTs from the two databases do not show a similar pattern of development over the years when comparing Figure A4 with Figure A5. In 2019, goods in the computers and peripheral equipment sector were targeted by the largest number of TBTs, followed by goods in communication equipment sector, that were targeted by the next largest number of TBTs. However, as the figure shows, there were two major drops in the number of UNCTAD TBTs in 2011 and 2016. The reason for this is that many TBTs in the UNCTAD TRAINS database expired in these two years, indicating that this data was not suitable for a gravity model using a panel database.

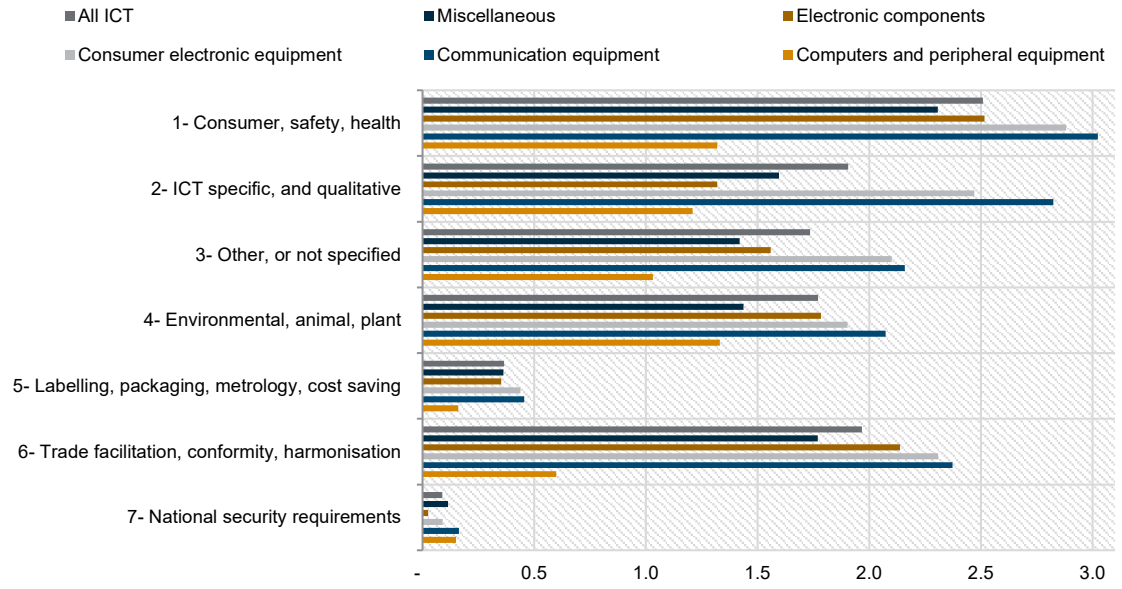
Nevertheless, TBTs are not necessarily protectionist measures: they may be imposed to regulate the market for legitimate reasons that are in line with all WTO agreements, and specifically with the WTO TBT agreement. According to the WTO I-TIP database, 1,456 notifications of TBTs imposed on ICT goods were received between 1996 and 2019. According to the descriptions of these notifications, NTMs were imposed in pursuit of 30 different regulatory objectives (suggested by their keywords). Figure 5 presents eight major classifications of the keywords cited. The most cited classification was related to consumer health and safety, which comprises the following keywords: Consumer information, Consumer protection, Crime protection, Human health, Prevention of deceptive practices and consumer protection, Protection of human health or safety, and Safety; these keywords are cited in 827 TBT notifications. The next most frequent classification was ‘ICT specific, and qualitative’, which includes the keywords Electromagnetic compatibility, Quality requirements and Telecommunication/Radiocommunication; these keywords are cited in 620 TBT notifications. The fourth most frequently cited keyword classification – ‘Environmental, animal, plant’ – has 196 TBT notifications, of which only very few are directly related to animal and plant life, with most being related to the negative environmental externalities generated by harmful ICT goods. The energy efficiency of electrical devices (important for global warming), substances that deplete the ozone layer or hazardous waste that is harmful to the environment, are common examples in this keyword class. As one can observe, TBTs with general applications (such as those covering the regulation of food) or with national security requirements, are those measures used the least frequently for trade in ICT goods.

Figure 5 / TBT notifications (based on keyword classification) in force in 2019 on ICT goods



Source: WTO I-TIP, author's elaboration.

Figure 6 / Average number of TBTs imposed on bilateral trade in ICT goods, by product category, based on keyword classification, 2019



Source: WITS, COMTRADE, UNCTAD, WTO-IDB, author's elaboration.

Each of these TBTs may target more than one product for cross-border regulation. Figure 6 illustrates the simple average of TBTs imposed on ICT products, according to the objectives cited in the keywords. Although keywords in the 'Trade facilitation, conformity, and harmonisation' classification were cited in 106 TBT notifications (which places that category sixth in Figure 5), these notifications target numerous products, and so in terms of the objectives of the TBTs, they are ranked second (with an average of 1.98 notifications per bilateral tariff line), behind objectives covering consumer health and safety (with an average of 2.5 notifications per bilateral tariff line). This indicates a significant heterogeneity within TBTs that is not studied in the literature. Furthermore, Figure A6 in the online appendix presents the average

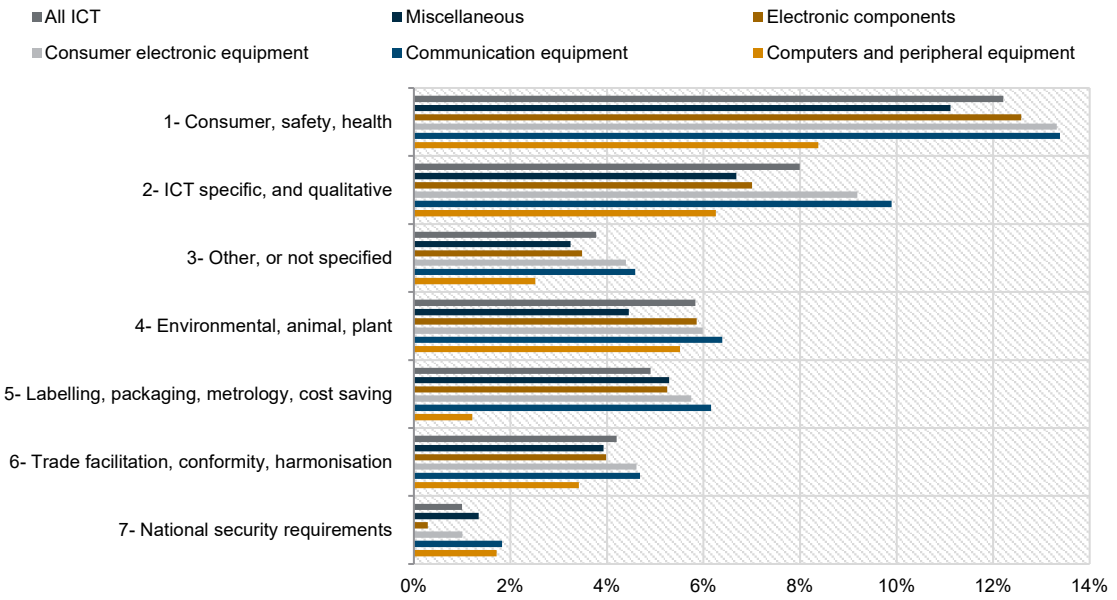
number of TBTs imposed on bilateral trade in ICT goods in 2019 by product category based on two-digit MAST classes. Conformity assessment related to technical barriers to trade (B8) is the most frequently used type of TBT. In fact, goods in computers and peripheral equipment are targeted by an average of 2.4 TBTs in class B8, while goods in communication equipment are targeted by an average of 1.8 such TBTs. However, the former goods are targeted by an average number of 0.6 TBTs in Trade facilitation, conformity, and harmonisation, while the latter are targeted by about 2.4 TBTs with these objectives. This indicates some degree of similarity in the number of TBTs between the two sources. While the MAST classification may hint at the applicability of the TBTs, the keywords cited in WTO notifications show their objectives, which could be more helpful for targeting policies.

2.4. REGULATORY CONVERGENCE IN TBTS ACROSS TRADING PARTNERS

Nonetheless, not every kind of TBT (based on its objective) is imposed by every country. If we consider ICT goods in 2019, Figure 7 presents the percentage of bilateral tariff lines on which both trading partners imposed TBTs with the same objectives (according to the keywords): consumer health and safety remains at the top of the rankings. In fact, for 13.5% and 13.4% of bilateral tariff lines covering 'communication equipment' and 'consumer electronic equipment' respectively, the objective of the TBT imposed by both trading partners is related to consumer health and safety. This shows that regulatory convergence also varies by product category and type of regulatory TBT.

Figure A7 in the online appendix shows the global regulatory convergence in the imposition of TBTs, by product category, based on two-digit MAST classes, as a percentage of global bilateral tariff lines in 2019. Again, the conformity assessment related to TBTs is the most used type of TBT imposed by many trading partners. In fact, for less than about 10% of all bilaterally traded goods in the communication equipment sector, both trading partners impose such TBTs.

Figure 7 / Global regulatory convergence in the imposition of TBTs, by product category, based on keyword class, as a percentage of global bilateral tariff lines in 2019



Source: WITS, COMTRADE, UNCTAD, WTO-IDB, author's elaboration.

Moreover, Figure A8 in the online appendix illustrates global regulatory convergence in the imposition of TBTs, by importing-exporting country groups, without intra-EU trade, based on the keyword class cited in TBT notifications, as a percentage of bilateral tariff lines in 2019. The group of developed countries include all EU member states plus OECD countries (except Columbia, Costa Rica, and Mexico). Other countries are considered developing countries. As observed, most regulatory convergence in all the cited objectives is between developed economies. In fact, about 55% of traded ICT goods between developed economies are targeted by TBTs with objectives on consumer, safety, health; about 51% with ICT-specific and qualitative objectives; and about 49% with environmental, animal, and plant objectives. Then, developing countries as importers and developed countries as exporters share 22% of traded ICT goods targeted by TBTs with the objectives of consumer, safety, health. Developed countries as importers and developing countries as exporters share about 18% of traded ICT goods targeted by TBTs with the objectives of consumer, safety, health. The least number of similarities in objectives is for trade flows between developing economies.

3. Methodology and data

As mentioned above, TBTs are imposed unilaterally on imports of goods from all exporting countries. Therefore, to measure the impact of TBTs on imported goods, one should choose a unilateral setting – an approach also used in earlier studies, such as Kee et al. (2009). However, to analyse the impact of TBTs on bilateral imports in a gravity model that includes country-product-year fixed effects that control for multilateral resistances, one needs to create a measure for TBTs that varies over time within each bilateral product. In fact, these high-dimensional fixed effects control for unilateral TBTs, which leads to an unbiased estimation of the similarity index. The similarity index is one such measure, and that is what we use. This index takes the value 1 when the two trading partners impose a TBT on a product at the six-digit level of the HS that has the same objective cited in its notification to the WTO, or the same two-digit procedural class as defined by MAST. This means that the two countries have regulatory convergence on that specific TBT. By contrast, when one of the two trading partners imposes a TBT with a certain objective (procedural class), but the other partner does not, there is a regulatory divergence between the two countries and the value of the index is equal to 0.

Furthermore, some countries have zero trade flows for certain imported products, which may cause sample selection bias in estimating the impact of regulatory convergence, especially if regulatory divergence increases the trade costs of a product so significantly that it completely rules out bilateral trade. Thus, to control for zero trade flows in the import data, PPML is used to run multidimensional fixed effects, following Santos Silva and Tenreyro (2006) (see also Head and Ries, 2008; Head and Mayer, 2014; Yotov et al., 2016; Larch et al., 2019), and further developed by Correia et al. (2019a; 2019b) for import values and import volumes. The equation for the estimation of bilateral trade values or volumes is as follows:

$$m_{ijht} = exp\big[\alpha_0 + \alpha_1 TBT_{ijht}^{SIM,c} + \alpha_2 PTA_{ijt} \times TBT_{ijht}^{SIM,c} + \alpha_3 PTA_{ijt} + \alpha_4 \operatorname{arc} T_{ijht} + \alpha_5 \operatorname{arc} ADP_{ijht} + \alpha_6 \operatorname{arc} CV_{ijht} + \alpha_7 \operatorname{arc} QR_{ijht} + \omega_{iht} + \omega_{jht} + \omega_{ijh}\big] + \varepsilon_{ijht} \quad (1)$$

Where m_{ijht} is either total import values m_{ijht}^{v} or import volumes m_{ijht}^{q} of product h exported from country i to country j in year t; $TBT_{ijht}^{SIM,c}$ is a dummy variable that indicates whether the two trading partners i and j impose a TBT that cites a keyword within the same classification c on product h in year t;[4] only six keyword classifications that are relevant to trade in ICT goods are used here – the keyword classifications 'Other, or not specified' and 'General application and food' are not included in the analysis. Furthermore, all eight two-digit procedural and administrative MAST classes are used instead of these TBT objectives (as cited in WTO notifications) using the UNCTAD TRAINS NTM data in a robustness check; $\operatorname{arc} T_{ijht}$ is the hyperbolic sine (arcsine) transformation (Bellemare and Wichman, 2020) of simple average tariffs (in percentage) levied by country j on imports of product h from country i in year t; the reason for using arcsine transformation is that tariffs (or other variables) include zero values; there are many products on which zero tariff rates are applied. Therefore, taking the natural log of those tariffs without the arcsine transformation would exclude the zero values as missing. Moreover, as Bellemare and Wichman (2020) shows, the arcsine transformation gives asymptotically equivalent

[4] It is important to note that a TBT that is in force in year t could have been imposed in an earlier year or in the same year, because no TBT in the WTO I-TIP data is reported as having been lifted.

marginal effects as the natural logarithm. ADP_{ijht} is the number of antidumping (ADP) duties[5] imposed by importing country j on the import of product h from exporting country i in year t; CV_{ijht} is the number of countervailing (CV) duties[6] imposed on the bilateral imports by the importer; QR_{ijht} is the number of bilateral quantitative restrictions (QRs)[7] imposed by the importer against the exporter; PTA_{ijt} is a count variable from 0 to 4 that shows whether the two trading partners have a preferential trade agreement (PTA) with a provision on TBTs if the value is not zero, and the value increases when the depth of the agreement increases with additional new agreements. This variable is borrowed from the World Bank Deep Preferential Trade Agreements database (Hofmann et al., 2017) and is updated for more recent years. As is shown in equation (1), this variable is also combined (multiplied) with the TBT variable to show whether country pairs that are parties to a PTA with the TBT provision are more likely to also have regulatory convergence in the specific areas considered for ICT goods; ω_{iht}, ω_{jht} and ω_{ijh} are, respectively, exporter-product-time, importer-product-time and importer-exporter-product fixed effects that control for multilateral resistances and for the potential endogeneity of trade policy measures (Baier and Bergstrand, 2007; Felbermayr, et al., 2020); and ε_{ijht} is the error term that is clustered by bilateral product to control for autocorrelation and heteroscedasticity. Controlling for country-product-year fixed effects also means that the unilateral TBTs are controlled for, and the similarity variable in TBT objectives or classes indicate mainly convergence in regulations.

The benchmark estimation of equation (1) is done on the sample of all 77 ICT goods in the HS 1996 version, which gives the average global impact of regulatory convergence in TBTs on the values and volumes of imports across all these ICT goods. Zero trade values could be important in analysing the impact of trade policy measures because a restrictive measure might prohibit trade fully, which requires the use of a suitable methodology such as PPML. However, for unit values and prices of traded goods, zero values do not have a meaningful reason to be included in the estimation. Therefore, following Cadot et al. (2018), the unit values of traded goods are estimated using normal OLS in the equation as follows:

$$\ln m^{p}_{ijht} = \beta_0 + \beta_1 TBT^{SIM,c}_{ijht} + \beta_2 PTA_{ijt} \times TBT^{SIM,c}_{ijht} + \beta_3 PTA_{ijt} + \beta_4 \operatorname{arc} T_{ijht} + \beta_5 \operatorname{arc} ADP_{ijht} + \beta_6 \operatorname{arc} CV_{ijht} + \beta_7 \operatorname{arc} QR_{ijht} + \omega_{iht} + \omega_{jht} + \omega_{ijh} + \epsilon_{ijht} \quad (2)$$

where $\ln m^{p}_{ijht}$ is the natural logarithm of unit value of product h imported to country j from country i in year t; ϵ_{ijht} is the error term, and the definitions of other variables remain as before.

As noted above and discussed in the literature, different products may be differently affected by different types of TBTs. Therefore, in order to observe the impact of regulatory convergence in TBT types across the five product categories defined by UNCTAD, estimations are also run separately for the imports of each of the five product categories. A list of these categories and the ICT goods classified by UNCTAD is provided in Table A1 in the online appendix. As robustness tests, estimations are run on a sample

[5] According to MAST classification 2019, antidumping 'duties are levied on the imports of a particular good originating from a specific trading partner to offset injurious dumping found to exist as a result of an investigation. Duty rates are generally enterprise-specific.'

[6] According to MAST classification 2019, countervailing 'duties are levied on imports of a particular product to offset the subsidies granted by the exporting country on the production or trade of that product, where an investigation has found that the subsidized imports are causing injury to the domestic industry making the like product.'

[7] According to the WTO, 'certain regulatory regimes, discretionary licensing schemes, price requirements, and restrictions on circumstances of importation have been considered quantitative restrictions by the WTO jurisprudence.' https://www.wto.org/english/tratop_e/markacc_e/qr_e.htm#:~:text=Certain%20regulatory%20regimes%2C%20discretionary%20licensing,restrictions%20by%20the%20WTO%20jurisprudence.

including intra-EU trade. Furthermore, additional robustness checks are run for specific country-pair groups that identify how the convergence effect varies and compares with the effect on average. These country-pair groups are developed-developed, developed-developing, developing-developing, and developing-developed, where the first term in each country-pair refers to the importing country group and the second term refers to the exporting country group. The results of these robustness checks are presented in the online appendix and briefly discussed in the next section.

4. Estimation results

4.1. ESTIMATIONS OF IMPORT VALUES OF ICT GOODS

Table 1 presents the PPML estimation results for the import values of ICT goods traded bilaterally during the period 1996-2019, which excludes intra-EU trade flows. As may be observed, in only three TBT categories – 'consumer, safety, health', 'ICT specific, and qualitative' and 'environmental, animal, plant' – does regulatory convergence have a positive impact on the import values of ICT goods that is statistically significant at 1%. The coefficient of TBTs in 'labelling, packaging, metrology, cost saving' is also positive and statistically significant at the 10% level. One can interpret the results as indicating that when, in a given year, the two countries impose a TBT that targets, say, environmental issues (such as the energy efficiency of ICT goods), then the bilateral import value should increase by about 13%.[8] The impact that regulatory convergence in 'consumer, safety, health' has on import values is the strongest impact reported in Table 1. One can observe that the interaction of the PTA variable with TBTs citing only 'consumer, safety, health' is significant at 5% with a negative coefficient that is about half of the main effect of convergence in that type of TBT. This means that such a TBT has a very strong positive net impact. However, for PTAs with the TBT provision going into force, the positive impact of TBT convergence on such an objective is reduced. This could be because similarities in TBTs could have gone beyond the PTA, which might have even converged prior to the PTA. The variable of PTA is statistically insignificant in all the models presented in Table 1. The impact of TBTs pursuing objectives on 'trade facilitation, conformity, and harmonisation' is however negative, and statistically significant at only the 10% level.

One can also observe a statistically significant negative impact of tariffs on bilateral import values: a 1% reduction in tariffs since 1996 has contributed to a 0.35% increase in the import value of ICT goods. CV duties are the next most effective NTMs in terms of their prohibitive impact on the import value of ICT goods. While these quantitative NTBs have targeted only very few tariff lines during the period in question, they managed to significantly reduce the import value of the goods they were targeting. As Figure A2 shows, the use of CV duties peaked at 0.0002 per tariff line in computers and peripheral equipment in 2007, and in electronic components they peaked at 0.0001 in 2016. However, a 1% reduction in the number of CV duties targeting a bilateral tariff line[9] contributed to an increase of about 0.77% in the value of its imports. ADPs and QRs also reduced import values, though they are not statistically significant in all models.

[8] i.e. $exp(0.12) - 1 = 0.1274969$

[9] It is important to note that the maximum number of CV duties applied on a tariff line is five. This is accumulated over the years between 2011 and 2015 by adding an additional CV duty by the US on the imports of product code '854140' (Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes) from China.

Table 1 / PPML estimation results for bilateral import values of ICT goods during the period 1996-2019

Dep. var. is m^{v}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.13***	0.11***	0.12***	0.076*	-0.089*	-0.20
	(0.026)	(0.032)	(0.032)	(0.041)	(0.048)	(0.25)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.060**	-0.013	-0.059	-0.0091	-0.018	0.32
	(0.030)	(0.035)	(0.038)	(0.044)	(0.044)	(0.24)
PTA_{ijt}	0.036	0.0094	0.017	-0.000051	0.0072	0.0035
	(0.027)	(0.027)	(0.025)	(0.025)	(0.024)	(0.024)
arc T_{ijht}	-0.35***	-0.35***	-0.36***	-0.35***	-0.36***	-0.36***
	(0.091)	(0.091)	(0.092)	(0.092)	(0.092)	(0.092)
arc ADP_{ijht}	-0.016	-0.011	-0.0071	-0.0094	-0.0083	-0.0091
	(0.047)	(0.047)	(0.048)	(0.047)	(0.047)	(0.047)
arc CV_{ijht}	-0.77***	-0.77***	-0.79***	-0.76***	-0.76***	-0.77***
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
arc QR_{ijht}	-0.66	-0.63	-0.64	-0.66	-0.67	-0.66
	(0.47)	(0.48)	(0.47)	(0.47)	(0.47)	(0.47)
Constant	13.4***	13.4***	13.4***	13.4***	13.4***	13.4***
	(0.25)	(0.26)	(0.26)	(0.25)	(0.25)	(0.25)
Observations	13081244	13081244	13081244	13081244	13081244	13081244
Pseudo R-squared	0.982	0.982	0.982	0.982	0.982	0.982
AIC	4.76284e+09	4.76509e+09	4.76401e+09	4.76597e+09	4.76588e+09	4.76655e+09
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

After limiting the sample of estimation to the period 2012-2018, only the coefficients of convergence in 'labelling, packaging, metrology, cost saving' and 'environmental, animal, plant' remain statistically significant and positive as presented in Table A2 of the online appendix. The rest of TBT variables become statistically insignificant. Even coefficients of a tariff become statistically insignificant. Coefficients of PTAs become slightly significant in some of the models but with a negative sign. The coefficients of PTAs combined with convergence in TBTs citing the objective 'consumer, safety, and health' and becomes negative and statistically significant at the 10% level, while it becomes positive when it is combined with TBTs citing the 'national security requirement' objective. QRs are excluded as they become collinear with the sets of fixed effects. Coefficients of ADP remain statistically insignificant. Coefficients of CV duties remain negative and statistically significant at the 1% level. Tables A27 through to A29 in the online appendix present the results of estimations for the first eight years of the period of analysis, in order to see how different the end years and beginning years are compared to each other. In other words, this shows whether or not the notification discipline has an impact on the results. In two of the objectives of TBTs we do not observe convergence in those early years and that is why their variables are excluded from the estimations. The results from the two other objectives (namely ICT specific, and qualitative, and Trade facilitation, conformity, harmonisation) are counterintuitive as the convergence in them hampers trade.

The results of estimations including convergence in two-digit TBT classes based on the MAST nomenclature during the period 2012-2018 are presented in Table A5 of the online appendix. Coefficients of convergence in only three types of TBTs are statistically significant at 1%. One of them is the effect of convergence in 'labelling, marking and packaging requirements' (B3), which is opposite of

the positive effect of TBT notifications citing convergence in 'labelling, packaging, metrology, cost saving' reported in Table A3. Convergence in product quality, safety or performance requirements (B7) also reduces the trade values of ICT goods. A negative impact of regulatory convergence on trade costs, measured as unit values, is similar to the results found in Knebel and Peters (2019) using UNCTAD's NTM data. While the effects of convergence in TBT notifications citing 'consumer, safety, health' and 'ICT specific, and qualitative' objectives reported for the same period in Table A3 were negative, their effects were statistically insignificant, while for the whole period of analysis reported in Table 1, their effects were positive and statistically significant at the 1% level. Convergence in TBTs in the two-digit class 'product identity requirements' (B6), however, stimulates traded values, which is statistically significant at the 1% level. Furthermore, one can observe that the interaction of PTAs with TBT variables gives statistically significant coefficients for three of the models. When a PTA with the TBT provision goes into force, convergence in TBTs in 'production or postproduction requirements' (B4), in 'product quality, safety or performance requirements' (B7), and in 'conformity assessment related to technical barriers to trade' (B8) increases import values. In fact, while the main effect of the convergence in TBT in these classes was either statistically insignificant or negative, convergence in these classes stimulates trade mainly through establishing PTAs.

By adding intra-EU trade flows to the estimation sample for the whole period, as shown in Table A8 of the online appendix, the results remain robust and consistent across almost all models. The positive effect of convergence in the objective 'labelling, packaging, metrology, cost saving' becomes statistically insignificant, and the negative impact of convergence on the objective 'trade facilitation, conformity, and harmonisation' becomes statistically significant at the 1% level. Furthermore, the interaction terms of PTAs and TBT variables now become positive and statistically significant at 1% in all models. This indicates the importance of the EU single market in the sample of estimation, with the deepest PTA facilitating harmonisation and mutual recognition of TBTs across member states. The coefficients of other variables remain like the results presented in Table 1. Moreover, the EU coefficient becomes statistically significant at the 5% level in only the first model, while it is positive in all models.

4.2. ESTIMATIONS OF IMPORT VOLUMES OF ICT GOODS

Table 2 presents the PPML estimation results for the import volumes of ICT goods traded bilaterally during the period 1996-2019. The results show that regulatory convergence in TBTs does not have a statistically significant impact on import volumes of ICT goods. This impact is also statistically insignificant, even with the introduction of PTAs. However, PTAs alone stimulate volumes of trade in ICT goods. In fact, when an additional treaty or agreement is signed to deepen a free trade agreement with the TBT provision between the two trading partners, the volumes of trade of ICT goods are stimulated by at least 6% according to the far right column. Furthermore, the elasticity of import volumes of these goods with respect to tariffs is close to unity. A one-percent increase in tariffs or the price of imports leads to about a one-percent reduction in volumes of trade in ICT goods, which is statistically significant at 1%. The elasticity of import volumes with respect to CV duties is now larger than unity. In fact, a one-percent increase in the number of CV duties targeting ICT goods would decrease their import volumes by about 1.13%, which is statistically significant at 1%.

Table 2 / PPML estimation results for bilateral import volumes of ICT goods during the period 1996-2019

Dep. var. is m^{q}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.016	0.027	0.053	-0.0055	-0.069	-0.22
	(0.031)	(0.034)	(0.033)	(0.059)	(0.065)	(0.22)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.017	-0.061	-0.086	-0.045	-0.013	0.046
	(0.040)	(0.050)	(0.061)	(0.071)	(0.088)	(0.22)
PTA_{ijt}	0.069**	0.088***	0.081**	0.070**	0.064*	0.060*
	(0.035)	(0.031)	(0.031)	(0.031)	(0.033)	(0.036)
arc T_{ijht}	-0.99***	-1.00***	-0.99***	-1.00***	-1.00***	-1.00***
	(0.22)	(0.22)	(0.22)	(0.22)	(0.22)	(0.22)
arc ADP_{ijht}	0.012	0.012	0.013	0.012	0.013	0.012
	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)
arc CV_{ijht}	-1.13***	-1.13***	-1.14***	-1.13***	-1.12***	-1.13***
	(0.23)	(0.23)	(0.23)	(0.24)	(0.23)	(0.23)
arc QR_{ijht}	-0.52	-0.52	-0.51	-0.52	-0.52	-0.52
	(0.51)	(0.51)	(0.51)	(0.51)	(0.51)	(0.51)
Constant	9.27***	9.27***	9.27***	9.28***	9.28***	9.28***
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
Observations	12692097	12692097	12692097	12692097	12692097	12692097
Pseudo R-squared	0.976	0.976	0.976	0.976	0.976	0.976
AIC	111447892.9	111441520.9	111434053.0	111445213.0	111443078.4	111447387.4
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

As Table A3 of the online appendix shows, limiting the period of analysis to 2012-2018would not change the results of estimation of import volumes with respect to convergence in TBTs. Only the impact of regulatory convergence in 'labelling, packaging, metrology, cost saving' becomes positive and statistically significant at the 10% level. When the two trading partners have a PTA with TBT provisions, convergence in TBTs with the objectives 'consumer, safety, and health' and 'environmental, animal, and plant' becomes positive and statistically significant at the 1% level for the period 2012-2018. The positive effect of TBT convergence for the objective 'trade facilitation, conformity, harmonisation' also becomes statistically significant at the 10% level when the two trading partners deepen their PTAs with TBT provisions. Tariffs during this period do not have any statistically significant impact on import volumes of trade in ICT goods; this could be due to their minimal change at their lowest level. ADPs imposed during this period restrict volumes of imports of ICT goods during 2012-2018. In fact, a one-percent increase in the number of ADPs reduced import volumes by about 40%, which is statistically significant at the 1% level. Furthermore, according to the results, a one-percent increase in CV duties could reduce import volumes by at least 3.65%.

Table A6 presents the PPML estimation results for bilateral import volumes of all ICT goods during 2012-2018 using UNCTAD NTMs data and the MAST classification. Only TBT convergence in 'product identity requirements' (B6) has a statistically significant impact on import volumes during this period, and convergence in all other classes has statistically insignificant coefficients. Furthermore, it is observed that the interaction term between PTA and convergence in B6 is excluded from the estimations, which suggests that convergence in this TBT class exists in country-pairs without PTAs.

Including intra-EU trade volumes in the estimation of the sample for the whole period yields results that are presented in Table A9 of the online appendix. Again, the interaction term between the PTAs and TBT convergence shows statistically significant and positive coefficients in almost all objectives, except for 'ICT specific, and qualitative' objectives that remain statistically insignificant. This indicates that intra-EU trade, the deepest PTA, is now added to the estimation sample that made the results more robust. TBT convergence between EU members through harmonisation and mutual recognition significantly stimulates trade volumes in ICT goods. However, the coefficient for the EU itself has a negative coefficient across all models, that is also statistically significant at the 1-10% level, which shows that the intra-EU volume of imports of ICT goods is less than the extra-EU volume of imports. As shown in Figure 3, the EU – as a single block – is the fourth largest exporter of ICT goods, which might explain why intra-EU imports could be significantly lower than extra-EU imports.

4.3. ESTIMATIONS OF IMPORT PRICES OF ICT GOODS

Table 3 presents the OLS estimation results for bilateral import prices of ICT goods during the period 2016-2019. Convergence in TBTs with the three objectives of 'consumer, safety, health', 'ICT specific, and qualitative', and 'national security requirements', are correlated with lower prices of imports in a statistically significant manner. However, convergence in TBTs with 'labelling, packaging, metrology, cost saving' objectives have increased prices. One could also interpret these coefficients as the ad-valorem equivalence of TBT convergence, like Cadot and Gourdon (2016). Therefore, while controlling for the imposition of unilateral TBTs with country-product-time fixed effects, the imposition of an additional TBT in 'labelling, packaging, metrology, cost saving' by the trading partner that leads to convergence is equivalent to a tariff with the magnitude of 2.22%. In contrast, a negative coefficient could be equivalent to a subsidy on a traded good rather than a tariff (or tax) in the form of an NTM. In the presence of PTAs with TBT provisions, convergence in TBTs has positive and statistically significant coefficients in three objectives of 'ICT specific, and qualitative', 'environmental, animal, plant', and 'national security requirements.' However, coefficients of bilateral PTAs with the TBT provision are statistically significant in some models. This suggests that those PTAs without convergence in 'consumer, safety, health' and 'national security requirement' objectives increase the prices of imports of ICT goods, in a statistically significant manner. Tariffs reduce import prices in a statistically significant manner. In fact, a one-percent increase in tariffs reduces the price of imported goods by about 13%. ADPs also reduce import prices with a marginal effect of about 8%. However, CV duties and QRs do not affect import prices in a statistically significant manner. One can also observe that the R-square of the OLS regressions for import prices is much smaller than the Pseudo-R-square of the PPML regressions on import values and volumes of ICT goods. This might suggest that additional unobservable factors that are not explained by the gravity model could affect prices.

Table A4 in the online appendix presents the OLS estimation results for bilateral import prices of all ICT goods during the period 2012-2018 using WTO notifications. Convergence in TBTs with 'ICT specific, and qualitative' reduces import prices in a statistically significant manner only during the recent period. However, deeper PTAs with the TBT provision increase the price of imported goods through convergence in these TBT objectives. Yet the net marginal effect of convergence of these TBT objectives on import prices remains negative and close to 2% in magnitude according to both coefficients. Furthermore, TBT convergence in 'consumer, safety, and health' had a negative coefficient when it interacted with PTAs, which is statistically significant at the 1% level. This suggests that convergence in TBTs in these TBT

objectives acts as a subsidy on trade and reduces prices when a PTA with the TBT provision deepens the bilateral relationship of the two trading partners during the recent period.

Table 3 / OLS estimation results for bilateral import prices of ICT goods during the period 1996-2019

Dep. var. is m^{p}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	-0.011**	-0.026***	-0.0035	0.022***	0.0026	-0.099**
	(0.0055)	(0.0062)	(0.0073)	(0.0083)	(0.0094)	(0.045)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.0074	0.038***	0.054***	0.010	0.017	0.076*
	(0.0063)	(0.0066)	(0.0097)	(0.0096)	(0.010)	(0.039)
PTA_{ijt}	0.010**	-0.0014	0.0024	0.0073	0.0066	0.0083*
	(0.0049)	(0.0048)	(0.0047)	(0.0046)	(0.0047)	(0.0046)
arc T_{ijht}	-0.13***	-0.12***	-0.12***	-0.13***	-0.13***	-0.13***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
arc ADP_{ijht}	-0.079***	-0.080***	-0.081***	-0.079***	-0.080***	-0.080***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
arc CV_{ijht}	0.039	0.046	0.051	0.043	0.041	0.040
	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)
arc QR_{ijht}	-0.020	-0.018	-0.014	-0.016	-0.016	-0.017
	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Constant	4.37***	4.37***	4.37***	4.37***	4.37***	4.37***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Observations	4638201	4638201	4638201	4638201	4638201	4638201
Pseudo R-squared	0.552	0.552	0.552	0.552	0.552	0.552
AIC	13868742.2	13868678.1	13868676.9	13868729.0	13868747.2	13868747.8
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table A7 in the online appendix presents the OLS estimation results for bilateral import prices of all ICT goods during the period 2012-2018 using UNCTAD NTMs data and the MAST two-digit classes. Convergence in almost all classes has a statistically insignificant impact on import prices. However, convergence in four classes acts as a subsidy on trade and reduces traded prices in a statistically significant manner when PTAs with the TBT provision deepen the bilateral relations. These four classes are B3, B4, B7, and B8.

Table A10 presents the OLS estimation results for bilateral import prices of all ICT goods during the period 2016-2019, including intra-EU trade. While the results of the impact of convergence in TBTs on import prices are heterogeneous across objectives, the effect of convergence in TBTs for deep PTAs with the TBT provision is negative and statistically significant across almost all models, except for 'national security requirements', which is not significant. Furthermore, the negative and statistically significant EU coefficients indicate that intra-EU imports of ICT goods are smaller than extra-EU imports. This indicates the importance of the single market in reducing the cost of imports.

4.4. IMPACT OF REGULATORY CONVERGENCE ON IMPORTS ACROSS PRODUCT CATEGORIES

4.4.1. Imports of computers and peripheral equipment

Tables 4, 5, and 6 present the results for the import values, volumes, and prices, respectively, of computers and peripheral equipment. Regulatory convergence in the field of 'consumer, safety, health' stimulated both import values and import volumes significantly, while it did not affect import prices in a statistically significant way. Regulatory convergence in the classification 'ICT specific, and qualitative' stimulated trade values and reduced the trade prices of these goods in a statistically significant manner. Convergence in 'environmental, animal, plant' had no impact on any of indicators of trade in these goods. Regulatory convergence in the classifications 'labelling, packaging, metrology, cost saving' and 'trade facilitation, conformity, harmonisation' reduced import values in a statistically significant manner while not affecting other indicators of trade in these goods. Only convergence in the objective 'national security requirements' has reduced volumes of imports of these goods in a statistically significant manner.

Table 4 / PPML estimation results for bilateral import values of computers and peripheral equipment during the period 1996-2019

Dep. var. is m^{v}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.20***	0.14***	0.084	-0.13*	-0.19**	-0.39
	(0.045)	(0.049)	(0.057)	(0.079)	(0.076)	(0.29)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	0.087	0.032	0.068	0.097	0.013	-0.39
	(0.064)	(0.069)	(0.060)	(0.083)	(0.098)	(0.25)
PTA_{ijt}	-0.033	-0.019	-0.034	-0.027	-0.018	-0.021
	(0.047)	(0.047)	(0.045)	(0.044)	(0.044)	(0.043)
arc T_{ijht}	-1.09	-1.12	-1.14	-1.09	-1.15	-1.14
	(0.92)	(0.92)	(0.92)	(0.91)	(0.91)	(0.91)
arc ADP_{ijht}	-0.024	-0.014	-0.0018	-0.0045	-0.0061	-0.0085
	(0.073)	(0.074)	(0.076)	(0.075)	(0.075)	(0.075)
arc CV_{ijht}	-0.78***	-0.79***	-0.77***	-0.79***	-0.79***	-0.79***
	(0.20)	(0.20)	(0.20)	(0.21)	(0.20)	(0.21)
arc QR_{ijht}	-0.063	-0.042	-0.059	-0.091	-0.097	-0.094
	(0.55)	(0.55)	(0.55)	(0.54)	(0.54)	(0.54)
Constant	13.2***	13.2***	13.3***	13.3***	13.3***	13.3***
	(0.23)	(0.24)	(0.23)	(0.23)	(0.23)	(0.23)
Observations	3084162	3084162	3084162	3084162	3084162	3084162
Pseudo R-squared	0.985	0.985	0.985	0.985	0.985	0.985
AIC	1.27750e+09	1.27973e+09	1.28060e+09	1.28085e+09	1.28089e+09	1.28094e+09
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 5 / PPML estimation results for bilateral import volumes of computers and peripheral equipment during the period 1996-2019

Dep. var. is m^{q}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.11*	-0.047	0.059	-0.049	-0.083	-0.63*
	(0.055)	(0.050)	(0.056)	(0.071)	(0.12)	(0.34)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	0.079	0.11	-0.039	-0.20**	-0.26*	-0.17
	(0.063)	(0.082)	(0.068)	(0.092)	(0.13)	(0.27)
PTA_{ijt}	0.0091	-0.0065	0.046	0.062	0.052	0.033
	(0.058)	(0.052)	(0.057)	(0.053)	(0.054)	(0.052)
arc T_{ijht}	-0.70	-0.70	-0.64	-0.69	-0.67	-0.65
	(1.22)	(1.24)	(1.24)	(1.23)	(1.24)	(1.24)
arc ADP_{ijht}	0.031	0.033	0.032	0.034	0.029	0.031
	(0.079)	(0.079)	(0.079)	(0.078)	(0.078)	(0.079)
arc CV_{ijht}	0.32**	0.34**	0.33**	0.34**	0.33**	0.33**
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
arc QR_{ijht}	-0.32	-0.34	-0.33	-0.36	-0.35	-0.34
	(0.61)	(0.61)	(0.61)	(0.61)	(0.61)	(0.61)
Constant	9.33***	9.39***	9.35***	9.38***	9.37***	9.37***
	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)
Observations	3047121	3047121	3047121	3047121	3047121	3047121
Pseudo R-squared	0.979	0.979	0.979	0.979	0.979	0.979
AIC	27686651.2	27695594.1	27701150.8	27682980.0	27683958.5	27696858.5
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 6 / OLS estimation results for bilateral import prices of computers and peripheral equipment during the period 1996-2019

Dep. var. is m^{p}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	-0.019	-0.021*	0.0078	0.034	-0.037	0.15
	(0.012)	(0.012)	(0.014)	(0.026)	(0.025)	(0.14)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.012	0.040**	0.057***	-0.018	-0.034	-0.19*
	(0.013)	(0.017)	(0.017)	(0.030)	(0.030)	(0.11)
PTA_{ijt}	-0.0089	-0.017*	-0.016*	-0.010	-0.0090	-0.011
	(0.0090)	(0.0090)	(0.0088)	(0.0087)	(0.0087)	(0.0086)
arc T_{ijht}	-0.55***	-0.54***	-0.54***	-0.54***	-0.55***	-0.55***
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
arc ADP_{ijht}	-0.082	-0.083	-0.085	-0.083	-0.083	-0.081
	(0.094)	(0.094)	(0.094)	(0.094)	(0.094)	(0.094)
arc CV_{ijht}	-0.036	-0.029	-0.021	-0.034	-0.034	-0.032
	(0.096)	(0.095)	(0.095)	(0.096)	(0.096)	(0.096)
arc QR_{ijht}	-0.30	-0.30	-0.29	-0.30	-0.30	-0.30
	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)
Constant	4.63***	4.63***	4.63***	4.63***	4.63***	4.63***
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
Observations	1186147	1186147	1186147	1186147	1186147	1186147
Pseudo R-squared	0.431	0.431	0.431	0.431	0.431	0.431
AIC	3526600.9	3526596.0	3526579.3	3526606.6	3526596.2	3526606.5
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

TBT convergence in the objectives ‘labelling, packaging, metrology, cost saving’ and ‘trade facilitation, conformity, harmonisation’ reduces import volumes when PTAs deepen bilateral relations in a statistically significant way. Furthermore, regulatory convergence in classifications ‘ICT specific, and qualitative’ and ‘environmental, animal, plant’ increases imported prices when PTAs with the TBT provision deepen bilateral relations. However, the imposition of TBTs with ‘national security objectives’ by both trading partners reduces the price of imported goods when both countries have PTAs with TBT provisions, while it does not affect import values or volumes of goods in this category.

Furthermore, PTAs alone do not affect values or volumes of imports of these goods in a statistically significant manner. However, they reduce the price of imports of ICT goods in a few models, which is weakly significant. Tariffs do not affect values or volumes of imports of computers and peripheral equipment in a significant manner, while they do reduce the price of imports. This could suggest that the demand for these consumer goods is inelastic with respect to changes in prices. CV duties reduce the value of imports of these ICT goods significantly but increase the volume of imports less significantly, while not affecting import prices.

4.4.2. Imports of communication equipment

Table 7 presents the results for the value of imports, Table 8 for the volume of imports, and Table 9 the price of imports of ICT goods in the communication equipment category. Regulatory convergence in the objective ‘ICT specific, and qualitative’ stimulates both the values and volumes of imports of these goods while significantly reducing their prices. Regulatory convergence in the classification ‘environmental, animal, plant’ stimulates the values and volumes of imports of these goods in a statistically significant way, while not affecting their prices. Convergence in TBTs with the objective ‘labelling, packaging, metrology, cost saving’ also stimulates the volumes of imports of these goods in a statistically significant manner, while it does not affect the other two trade indicators. Convergence in the objectives ‘consumer, safety, and health’ and ‘national security requirements’ also reduces the price of these goods’ imports in a statistically significant manner.

Convergence in TBTs in several objectives reduces import values when the two countries have PTAs with TBT provisions. Similarity in the imposition of TBTs with ‘national security requirements’, however, increases the values of imports of these goods when the PTA deepens bilateral relations between the two trading partners. A similar pattern could be observed for the volumes of imports of goods in communication equipment. However, the coefficient of convergence in ‘national security requirements’ becomes statistically insignificant. According to Table 9, regulatory convergence in classifications ‘national security requirements’, ‘environmental, animal, and planet’, and ‘ICT specific and qualitative’ increases the prices of these imported goods. On the other hand, convergence in the objective ‘consumer, safety, and health’ reduces the price of these imported goods.

Furthermore, tariffs significantly reduce the value of imports of communication equipment, while they do not affect their volumes or prices. ADP duties positively affect the values of imports of these goods, while they do not affect the volumes or prices of imports of these goods in a statistically significant manner. While ADP duties should impede trade, a stimulative impact by them might reflect the dumping cases that are targeted by these measures. In contrast, QRs reduce the values and volumes of imports of goods in communication equipment in a statistically significant manner.

Table 7 / PPML estimation results for bilateral import values of communication equipment during the period 1996-2019

Dep. var. is m^{v}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.059	0.22**	0.13*	0.097	0.039	-0.19
	(0.062)	(0.090)	(0.074)	(0.084)	(0.086)	(0.27)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.19***	-0.022	-0.19**	0.081	-0.18**	0.50*
	(0.070)	(0.069)	(0.084)	(0.10)	(0.078)	(0.30)
PTA_{ijt}	-0.0064	-0.11*	-0.056	-0.15**	-0.11*	-0.12**
	(0.072)	(0.064)	(0.062)	(0.059)	(0.058)	(0.057)
arc T_{ijht}	-1.70**	-1.78**	-1.76**	-1.92**	-1.86**	-1.87**
	(0.78)	(0.81)	(0.78)	(0.80)	(0.80)	(0.80)
arc ADP_{ijht}	1.22**	1.23**	1.24**	1.36***	1.30**	1.31**
	(0.50)	(0.51)	(0.50)	(0.52)	(0.52)	(0.52)
arc QR_{ijht}	-3.29***	-3.29***	-3.29***	-3.30***	-3.34***	-3.33***
	(0.60)	(0.61)	(0.61)	(0.61)	(0.61)	(0.61)
Constant	15.3***	15.2***	15.3***	15.4***	15.4***	15.4***
	(0.35)	(0.36)	(0.35)	(0.36)	(0.35)	(0.35)
Observations	1936353	1936353	1936353	1936353	1936353	1936353
Pseudo R-squared	0.978	0.978	0.978	0.978	0.978	0.978
AIC	1.35726e+09	1.35722e+09	1.35695e+09	1.35737e+09	1.35812e+09	1.35794e+09
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 8 / PPML estimation results for bilateral import volumes of communication equipment during the period 1996-2019

Dep. var. is m^{q}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.099*	0.15*	0.14**	0.16**	-0.019	-0.18
	(0.052)	(0.080)	(0.066)	(0.077)	(0.100)	(0.25)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.14**	-0.13**	-0.36***	-0.24**	-0.36***	0.41
	(0.061)	(0.060)	(0.094)	(0.10)	(0.11)	(0.28)
PTA_{ijt}	0.038	0.032	0.046	0.00068	-0.00049	-0.031
	(0.054)	(0.050)	(0.048)	(0.048)	(0.045)	(0.045)
arc T_{ijht}	-0.72	-0.75	-0.66	-0.76	-0.81	-0.80
	(0.52)	(0.52)	(0.52)	(0.53)	(0.53)	(0.53)
arc ADP_{ijht}	0.45	0.41	0.42	0.46	0.49*	0.49*
	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)
arc QR_{ijht}	-2.83**	-2.82**	-2.80**	-2.82**	-2.87**	-2.80**
	(1.34)	(1.34)	(1.33)	(1.34)	(1.34)	(1.34)
Constant	9.18***	9.14***	9.18***	9.21***	9.23***	9.21***
	(0.51)	(0.51)	(0.51)	(0.51)	(0.51)	(0.51)
Observations	1899429	1899429	1899429	1899429	1899429	1899429
Pseudo R-squared	0.967	0.967	0.967	0.967	0.967	0.967
AIC	12782053.7	12780911.0	12766222.3	12778297.0	12776149.5	12786249.0
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 9 / OLS estimation results for bilateral import prices of communication equipment during the period 1996-2019

Dep. var. is m^{p}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	-0.033**	-0.039***	-0.0078	-0.017	-0.031	-0.22***
	(0.013)	(0.014)	(0.018)	(0.018)	(0.021)	(0.067)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.031**	0.048***	0.086***	0.035	0.025	0.13*
	(0.015)	(0.014)	(0.026)	(0.021)	(0.023)	(0.069)
PTA_{ijt}	0.024**	-0.000032	0.0081	0.013	0.014	0.015
	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)
arc T_{ijht}	-0.13	-0.13	-0.12	-0.13	-0.13	-0.13
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
arc ADP_{ijht}	0.11	0.14	0.13	0.12	0.12	0.11
	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)
arc QR_{ijht}	0.29	0.30	0.30	0.30	0.29	0.29
	(0.87)	(0.87)	(0.87)	(0.87)	(0.87)	(0.87)
Constant	4.84***	4.84***	4.83***	4.83***	4.83***	4.83***
	(0.12)	(0.12)	(0.11)	(0.11)	(0.11)	(0.11)
Observations	722220	722220	722220	722220	722220	722220
Pseudo R-squared	0.432	0.432	0.432	0.432	0.432	0.432
AIC	2121283.6	2121282.7	2121279.8	2121303.7	2121304.8	2121290.1
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

4.4.3. Imports of consumer electronic equipment

Table 10 presents the results for the value of imports, Table 11 shows the results for the volume of imports, and Table 12 provides the results for the prices of imports of ICT goods in the consumer electronic equipment category. In none of the keyword classifications does regulatory convergence affect the import values or volumes of these goods in a statistically significant manner. However, regulatory similarity in the field 'Trade facilitation, conformity, harmonisation' increases the price of imports of these goods at the 5% level of significance. Furthermore, regulatory convergence in the objectives 'consumer, safety, health' and 'ICT specific and qualitative' reduces the price of imports of these goods in a statistically significant manner. This suggests that countries managed to reduce the price of these consumer goods with better harmonisation of regulations regarding these objectives related to consumers. However, convergence in the objectives 'ICT specific, and qualitative', 'environmental, animal, plant', and 'labelling, packaging, metrology, cost saving', increased the price values of these goods after signing PTAs with TBT provisions, in a statistically significant way.

One can also observe that PTAs with the TBT provision stimulated the value and volumes of imports of ICT goods in the consumer electronic equipment category. Tariffs have reduced the values, volumes, and prices of imports of these goods in a statistically significant manner, which shows an important impediment to the trade of consumer goods in ICT. As Figure 4 above shows, the simple average of tariffs levied on this category is the largest of all the ICT categories, though the figure declined by 35% during the period of analysis. This indicates that import values in this category rose by about 7.7% from the beginning of the period, thanks to falling tariffs. However, ADP duties stimulated the values and volumes and reduced the prices of imports of these goods in a statistically significant manner, which might be the consequence of dumping and lowering prices by producers and exporters.

Table 10 / PPML estimation results for bilateral import values of consumer electronic equipment during the period 1996-2019

Dep. var. is m^{v}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.022	-0.089*	0.018	0.050	-0.036	-0.27
	(0.037)	(0.049)	(0.048)	(0.062)	(0.062)	(0.18)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.097*	-0.018	0.021	-0.055	0.061	0.12
	(0.055)	(0.069)	(0.083)	(0.090)	(0.097)	(0.16)
PTA_{ijt}	0.14***	0.090**	0.074	0.094**	0.070	0.080
	(0.053)	(0.042)	(0.049)	(0.047)	(0.051)	(0.060)
arc T_{ijht}	-0.23***	-0.24***	-0.23***	-0.23***	-0.24***	-0.24***
	(0.068)	(0.068)	(0.068)	(0.068)	(0.068)	(0.068)
arc ADP_{ijht}	0.23***	0.22***	0.21***	0.22***	0.21***	0.22***
	(0.069)	(0.069)	(0.069)	(0.069)	(0.069)	(0.070)
arc QR_{ijht}	-0.95	-0.98	-0.95	-0.94	-0.95	-0.95
	(0.60)	(0.60)	(0.59)	(0.59)	(0.59)	(0.59)
Constant	12.2***	12.2***	12.2***	12.2***	12.2***	12.2***
	(0.18)	(0.19)	(0.18)	(0.18)	(0.18)	(0.18)
Observations	4501172	4501172	4501172	4501172	4501172	4501172
Pseudo R-squared	0.980	0.980	0.980	0.980	0.980	0.980
AIC	666696807.1	666769792.3	666902455.3	666832911.1	666873058.8	666901280.8
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 11 / PPML estimation results for bilateral import volumes of consumer electronic equipment during the period 1996-2019

Dep. var. is m^{q}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation
$TBT^{SIM,c}_{ijht}$	-0.042	-0.029	-0.082	-0.13	0.046
	(0.053)	(0.073)	(0.061)	(0.14)	(0.11)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.11	-0.076	-0.059	-0.014	0.13
	(0.080)	(0.093)	(0.13)	(0.14)	(0.13)
PTA_{ijt}	0.23***	0.21***	0.18***	0.18***	0.14**
	(0.073)	(0.062)	(0.064)	(0.062)	(0.070)
arc T_{ijht}	-0.53***	-0.55***	-0.54***	-0.55***	-0.54***
	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)
arc ADP_{ijht}	0.17**	0.15*	0.16*	0.15*	0.14*
	(0.079)	(0.081)	(0.082)	(0.081)	(0.082)
arc QR_{ijht}	1.33	1.31	1.31	1.31	1.33
	(0.84)	(0.84)	(0.84)	(0.84)	(0.84)
Constant	8.82***	8.83***	8.82***	8.83***	8.82***
	(0.17)	(0.18)	(0.17)	(0.17)	(0.17)
Observations	4425837	4425837	4425837	4425837	4425837
Pseudo R-squared	0.976	0.976	0.976	0.976	0.976
AIC	37744979.8	37752754.5	37750534.7	37743918.2	37747240.5
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 12 / OLS estimation results for bilateral import prices of consumer electronic equipment during the period 1996-2019

Dep. var. is m^{p}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	-0.017**	-0.033***	-0.014	0.0060	0.027**	-0.019
	(0.0086)	(0.0099)	(0.011)	(0.012)	(0.014)	(0.071)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	0.012	0.052***	0.068***	0.030**	0.012	0.034
	(0.0097)	(0.0097)	(0.015)	(0.014)	(0.015)	(0.060)
PTA_{ijt}	0.013	0.00096	0.0087	0.014*	0.015**	0.017**
	(0.0082)	(0.0080)	(0.0078)	(0.0077)	(0.0077)	(0.0076)
$\text{arc}\,T_{ijht}$	-0.10**	-0.098**	-0.096*	-0.10**	-0.11**	-0.11**
	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)
$\text{arc}\,ADP_{ijht}$	-0.068***	-0.070***	-0.071***	-0.068***	-0.066**	-0.067**
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
$\text{arc}\,QR_{ijht}$	1.46	1.45	1.46	1.46	1.46	1.46
	(1.03)	(1.03)	(1.03)	(1.03)	(1.03)	(1.03)
Constant	3.40***	3.40***	3.40***	3.39***	3.39***	3.39***
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Observations	1532640	1532640	1532640	1532640	1532640	1532640
Pseudo R-squared	0.552	0.552	0.552	0.552	0.552	0.552
AIC	4412155.0	4412102.1	4412119.9	4412149.0	4412148.2	4412163.0
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

4.4.4. Imports of electronic components

Tables 13, 14, and 15 present the results for the value, volume, and price of imports of ICT goods in the electronic components category, respectively. Prices of imports of these goods are not affected by regulatory convergence in any of the objectives in any models presented in Table 15. Regulatory convergence in 'environmental, animal, plant' and 'national security requirements' only stimulates the value of imports of these goods. Regulatory convergence in 'consumer, safety, and health' stimulates the value of these goods' imports, but significantly reduces their import volumes. Regulatory similarity in the 'ICT specific and qualitative' category stimulates the volume of imports of these goods, while their import value remains statistically unaffected.

The interaction term between the PTA and TBT variables has only one coefficient that is statistically significant across all models in these tables; this is related to the TBT objective 'labelling, packaging, metrology, cost saving' and is positive. Furthermore, tariffs, ADP duties, CV duties, and QRs reduce both the value and volume of imports of electronic components in a statistically significant manner, while they do not affect the prices of imports. Therefore, we can see that quantitative non-tariff barriers and tariffs are the most important impediments for these important high-tech products, considered the engine of the modern digital world.

Table 13 / PPML estimation results for bilateral import values of electronic components during the period 1996-2019

Dep. var. is m^{v}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.13**	0.015	0.15**	0.13	-0.13	1.32**
	(0.054)	(0.074)	(0.063)	(0.081)	(0.096)	(0.66)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.050	-0.032	-0.071	-0.076	0.039	-0.47
	(0.049)	(0.078)	(0.081)	(0.068)	(0.069)	(0.47)
PTA_{ijt}	0.076	0.060	0.064	0.054	0.049	0.050
	(0.049)	(0.048)	(0.044)	(0.045)	(0.044)	(0.043)
arc T_{ijht}	-3.89***	-3.91***	-3.83***	-3.84***	-3.85***	-3.89***
	(1.02)	(1.04)	(1.02)	(1.01)	(1.02)	(1.02)
arc ADP_{ijht}	-0.32**	-0.31**	-0.32**	-0.30**	-0.33**	-0.31**
	(0.15)	(0.15)	(0.15)	(0.14)	(0.14)	(0.15)
arc CV_{ijht}	-0.53***	-0.54***	-0.56***	-0.51***	-0.51***	-0.54***
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
arc QR_{ijht}	-3.17**	-3.12**	-3.10**	-3.11**	-3.14**	-3.13**
	(1.29)	(1.28)	(1.29)	(1.29)	(1.28)	(1.28)
Constant	15.9***	15.9***	15.9***	15.9***	15.9***	15.9***
	(1.08)	(1.06)	(1.07)	(1.07)	(1.06)	(1.06)
Observations	2631684	2631684	2631684	2631684	2631684	2631684
Pseudo R-squared	0.982	0.982	0.982	0.982	0.982	0.982
AIC	1.09041e+09	1.09147e+09	1.09006e+09	1.09076e+09	1.09096e+09	1.09149e+09
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 14 / PPML estimation results for bilateral import volumes of electronic components during the period 1996-2019

Dep. var. is m^{q}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	-0.17*	0.18*	0.15	-0.0011	-0.29*	-0.74
	(0.091)	(0.090)	(0.11)	(0.12)	(0.17)	(0.71)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	0.070	-0.16	0.16	0.22**	0.15	0.39
	(0.11)	(0.13)	(0.20)	(0.11)	(0.14)	(0.43)
PTA_{iht}	-0.033	0.033	-0.016	-0.052	-0.0098	0.00094
	(0.081)	(0.069)	(0.066)	(0.071)	(0.071)	(0.065)
arc T_{ijht}	-2.45***	-2.49***	-2.45***	-2.45***	-2.45***	-2.44***
	(0.83)	(0.83)	(0.83)	(0.83)	(0.83)	(0.83)
arc ADP_{ijht}	-0.26*	-0.27*	-0.25*	-0.26*	-0.28**	-0.27*
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
arc CV_{ijht}	-1.84***	-1.85***	-1.83***	-1.82***	-1.80***	-1.83***
	(0.27)	(0.27)	(0.27)	(0.26)	(0.26)	(0.27)
arc QR_{ijht}	-4.56***	-4.54***	-4.56***	-4.58***	-4.61***	-4.57***
	(1.43)	(1.43)	(1.42)	(1.43)	(1.43)	(1.43)
Constant	11.3***	11.2***	11.2***	11.2***	11.2***	11.2***
	(0.48)	(0.48)	(0.47)	(0.48)	(0.48)	(0.48)
Observations	2430630	2430630	2430630	2430630	2430630	2430630
Pseudo R-squared	0.975	0.975	0.975	0.975	0.975	0.975
AIC	22162336.5	22160950.6	22165949.4	22163336.2	22164950.2	22174879.4
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 15 / OLS estimation results for bilateral import prices of electronic components during the period 1996-2019

Dep. var. is m^{p}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.016	-0.020	-0.016	0.053**	0.021	0.065
	(0.014)	(0.017)	(0.020)	(0.021)	(0.024)	(0.32)
$PTA_{iht} \times TBT^{SIM,c}_{ijht}$	-0.012	0.0045	0.024	-0.013	0.0050	-0.068
	(0.016)	(0.019)	(0.027)	(0.023)	(0.029)	(0.21)
PTA_{ijt}	0.020	0.014	0.013	0.016	0.014	0.015
	(0.013)	(0.013)	(0.012)	(0.012)	(0.013)	(0.012)
arc T_{ijht}	0.069	0.072	0.075	0.079	0.075	0.073
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
arc ADP_{ijht}	-0.077	-0.076	-0.075	-0.072	-0.074	-0.076
	(0.067)	(0.067)	(0.067)	(0.067)	(0.067)	(0.067)
arc CV_{ijht}	0.10	0.11	0.11	0.11	0.10	0.10
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
Constant	5.00***	5.01***	5.01***	5.00***	5.00***	5.00***
	(0.0069)	(0.0070)	(0.0064)	(0.0064)	(0.0063)	(0.0063)
Observations	846017	846017	846017	846017	846017	846017
Pseudo R-squared	0.529	0.529	0.529	0.529	0.529	0.529
AIC	2637984.4	2637984.7	2637985.1	2637972.8	2637985.0	2637987.6
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

4.4.5. Imports of miscellaneous ICT goods

Tables 16, 17, and 18 present the results for the value, volume, and price of imports of goods in the miscellaneous ICT category, respectively. Regulatory convergence in 'labelling, packaging, metrology, cost saving' increases all indicators of imports of these goods. Regulatory convergence in 'environmental, animal, plant' stimulates both the value and volume of imports of these goods. Regulatory convergence in 'consumer, safety, health' raises the value of imports of such goods but does not affect their import volumes or import prices to any statistically significant degree. By contrast, regulatory convergence in 'ICT specific, and qualitative' contributes positively to import volumes in a statistically significant manner but does not affect import values.

Similarity in the TBT objectives 'consumer, safety, health' and 'labelling, packaging, metrology, cost saving' reduces import values of these goods in a statistically significant manner when the two trading partners integrate more with PTAs. Convergence of the objectives 'ICT specific, and qualitative' and 'environmental, animal, plant' reduces the volume of imports of these ICT goods to a statistically significant degree when the trading partners deepen their bilateral relations with PTAs. Imposing similar TBTs with the objectives 'trade facilitation, conformity, harmonisation' by both trading partners in PTAs increases the price of imports of these goods, while with the objectives 'labelling, packaging, metrology, cost saving' it reduces the price of imports of these goods.

Furthermore, tariffs reduce the volume of imports of goods in the miscellaneous ICT category in a statistically significant manner. While other trade policy measures have no impact on the values or volumes of imports of these goods, ADP duties reduce the price of imports of these goods in a statistically significant manner.

Table 16 / PPML estimation results for bilateral import values of miscellaneous ICT goods during the period 1996-2019

Dep. var. is m^{v}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.14*	0.054	0.20**	0.26***	-0.22	0.091
	(0.074)	(0.081)	(0.089)	(0.095)	(0.14)	(0.31)
$PTA_{iht} \times TBT^{SIM,c}_{ijht}$	-0.20***	-0.048	-0.16	-0.24***	-0.20	-0.19
	(0.072)	(0.074)	(0.11)	(0.095)	(0.14)	(0.18)
PTA_{ijt}	0.14*	0.057	0.063	0.070	0.057	0.022
	(0.076)	(0.066)	(0.074)	(0.064)	(0.065)	(0.065)
arc T_{ijht}	-0.75	-1.09	-1.03	-1.05	-1.49	-1.11
	(0.93)	(1.01)	(0.99)	(1.03)	(1.00)	(1.02)
arc ADP_{ijht}	-0.014	-0.017	-0.033	-0.029	0.031	-0.019
	(0.091)	(0.092)	(0.089)	(0.093)	(0.086)	(0.092)
arc QR_{ijht}	-0.28	-0.26	-0.26	-0.25	-0.26	-0.28
	(1.31)	(1.30)	(1.31)	(1.31)	(1.31)	(1.31)
Constant	12.1***	12.1***	12.1***	12.1***	12.1***	12.1***
	(0.58)	(0.58)	(0.58)	(0.58)	(0.58)	(0.58)
Observations	927873	927873	927873	927873	927873	927873
Pseudo R-squared	0.971	0.971	0.971	0.971	0.971	0.971
AIC	363102793.8	363901547.2	363259578.8	362936955.7	362673252.5	363943751.4
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 17 / PPML estimation results for bilateral import volumes of miscellaneous ICT goods during the period 1996-2019

Dep. var. is m^{q}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.099	0.18**	0.28***	0.26***	0.034	0.078
	(0.093)	(0.089)	(0.10)	(0.097)	(0.20)	(0.62)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.085	-0.59***	-0.50***	-0.13	-0.31	-0.086
	(0.094)	(0.11)	(0.16)	(0.14)	(0.27)	(0.36)
PTA_{ijt}	-0.039	0.32***	0.040	-0.079	-0.043	-0.085
	(0.081)	(0.078)	(0.074)	(0.073)	(0.075)	(0.074)
arc T_{ijht}	-4.73***	-4.84***	-4.92***	-4.84***	-4.97***	-4.78***
	(0.91)	(0.94)	(0.92)	(0.93)	(0.91)	(0.92)
arc ADP_{ijht}	0.16	0.18	0.18	0.13	0.19	0.15
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
arc QR_{ijht}	-0.68	-0.52	-0.60	-0.66	-0.64	-0.66
	(0.98)	(0.97)	(0.98)	(0.98)	(0.98)	(0.98)
Constant	9.10***	9.00***	9.07***	9.12***	9.13***	9.14***
	(0.25)	(0.25)	(0.24)	(0.24)	(0.24)	(0.24)
Observations	889080	889080	889080	889080	889080	889080
Pseudo R-squared	0.969	0.969	0.969	0.969	0.969	0.969
AIC	10747888.6	10690026.2	10704048.0	10738786.1	10741020.7	10751978.1
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

Table 18 / OLS estimation results for bilateral import prices of miscellaneous ICT goods during the period 1996-2019

Dep. var. is m^{p}_{ijht}, and c is:	Consumer, safety, health	ICT specific, and qualitative	Environmental, animal, plant	Labelling, packaging, metrology, cost saving	Trade facilitation, conformity, harmonisation	National security requirements
$TBT^{SIM,c}_{ijht}$	0.025	0.018	0.048	0.11***	-0.015	0.012
	(0.022)	(0.028)	(0.034)	(0.032)	(0.039)	(0.26)
$PTA_{ijt} \times TBT^{SIM,c}_{ijht}$	-0.044	-0.0025	-0.027	-0.074*	0.10**	0.12
	(0.028)	(0.028)	(0.046)	(0.039)	(0.045)	(0.17)
PTA_{ijt}	0.020	0.0074	0.0093	0.013	-0.0024	0.0075
	(0.020)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)
$\text{arc}\, T_{ijht}$	-0.0097	0.0096	0.013	0.0025	0.016	0.0061
	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)
$\text{arc}\, ADP_{ijht}$	-0.12**	-0.13**	-0.13**	-0.12**	-0.13**	-0.13**
	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)
$\text{arc}\, QR_{ijht}$	0.98	0.98	0.98	0.99	0.98	0.98
	(0.85)	(0.85)	(0.85)	(0.85)	(0.85)	(0.85)
Constant	4.26***	4.26***	4.26***	4.26***	4.27***	4.27***
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)
Observations	351177	351177	351177	351177	351177	351177
Pseudo R-squared	0.512	0.512	0.512	0.512	0.512	0.512
AIC	1140438.5	1140444.2	1140440.5	1140420.8	1140432.8	1140441.1
Imp-product-year FE ω_{jht}	Yes	Yes	Yes	Yes	Yes	Yes
Exp-product-year FE ω_{iht}	Yes	Yes	Yes	Yes	Yes	Yes
Imp-exp-product FE ω_{ijh}	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.

4.5. IMPACT OF REGULATORY CONVERGENCE ON IMPORTS BY COUNTRY-PAIR GROUPS

4.5.1. Developed economies as importing and exporting countries

Tables A11, A12, and A13 of the online appendix present the estimation results for import value, import volume, and import price for the group of developed-developed country pairs, respectively. Intra-EU trade is excluded from these estimations. Regulatory convergence in the objective 'ICT specific, and qualitative' stimulates both the values and volumes of imports between developed economies in a statistically significant manner. Similarity in the imposition of TBTs with the objective 'environmental, animal, plant' stimulates the value of imports and reduces the price of imports between advanced economies in a statistically significant way, while its impact on the volumes of imports of ICT goods is insignificant. Regulatory convergence in 'national security requirements' stimulates the value of imports of ICT goods between these countries, while it does not affect the volume or price of imports between them. Convergence in 'labelling, packaging, metrology, cost saving' reduces the volume of imports of ICT goods among these economies, which is statistically significant at 10%. Convergence in the objective 'trade facilitation, conformity, harmonisation' increases the volume of trade of these goods between developed economies.

The interaction of the TBT variable with the PTA yields negative coefficients that are statistically significant for the value of imports between developed economies, and for the volume of imports across most models in Table A12, except for the first two columns on the left. This interaction gives positive

coefficients that are statistically significant for the price of imports among developed economies in almost all TBT objectives except for 'ICT specific, and qualitative' and 'national security requirements'. Deep PTAs with the TBT provision between advanced economies stimulate the values of imports across almost all models, while they have no significant impact on the volume or price of imports of ICT goods. Other trade policy measures imposed between these economies have no significant impact on the import prices of ICT goods, while they significantly reduce import values. Both tariffs and ADP duties reduce the volume of imports of ICT goods between developed countries.

4.5.2. Developed economies as importing and developing economies as exporting countries

Tables A14, A15, and A16 in the online appendix provide the estimation results for import value, import volume, and import price for the group of developed-developing country pairs, respectively. Regulatory convergence of the objective 'ICT specific, and qualitative' stimulates both values and volumes of imports from developing economies to developed economies in a statistically significant manner. Similarity in the imposition of TBTs with the objective 'national security requirements' reduces both the value of imports and the volume of imports to advanced economies from developing economies in a statistically significant way. However, similarity in such regulations for countries having deep PTAs with the TBT provision stimulates both the value and volume of imports much more than the direct effect of convergence, which can offset that negative impact. Therefore, the integration of countries could lead to increased trade after imposing similar TBTs with objectives targeting national security requirements. Regulatory convergence in 'trade facilitation, conformity, harmonisation' increases the volume and price of imports of ICT goods from developing countries to developed economies, while it does not affect the value of imports between them. Convergence in the objective 'environmental, animal and plant' reduces the price of imports of ICT goods for advanced economies from developing economies, in a statistically significant manner. However, the establishment of deep PTAs with the TBT provision increases the price of imports through TBT similarity in this objective.

Deeper PTAs lead to larger volumes of imports of ICT goods flowing from developing to developed economies. Among other trade policy measures, only CV duties reduce the value of imports of ICT goods from developing to developed economies in a statistically significant manner. However, both tariffs and CV duties reduce the volume of imports among this group. Furthermore, tariffs and ADP duties reduce the price of imports of ICT goods from developing to developed economies, which is statistically significant at the 1% level.

4.5.3. Developing economies as importing and exporting countries

Tables A17, A18, and A19 in the online appendix provide the estimation results for import value, import volume, and import price for the group of developing-developing country pairs, respectively. Regulatory convergence in the objective 'national security requirement' stimulates both the values and volumes of imports between developing economies in a statistically significant manner. Regulatory convergence in 'consumer, safety, health' increases the values and prices of imports of ICT goods between developing countries, while it does not affect the volumes of imports between them. Convergence in the objective 'environmental, animal and plant' increases the value and price of imports while it reduces volumes of imports of ICT goods between developing economies. Regulatory convergence in the classification 'ICT

specific and qualitative' reduces the volumes of imports of ICT goods among these countries, while it does not affect the value or price of these imports in a statistically significant manner.

The interaction of the PTA and TBT variables shows that with deepening bilateral relations between developing economies, regulatory divergence in 'consumer, safety, health', 'ICT specific, and qualitative', and 'environmental, animal, plant' could further reduce the value of trade in ICT goods. However, signing a deep PTA does not affect imports of ICT goods among developing economies in a statistically significant way. Regulatory convergence in 'consumer, safety, health', 'environmental, animal, plant', and 'labelling, packaging, metrology, cost saving' could decrease the price of imports in ICT goods with the enforcement of deeper PTAs. In contrast, similarity in the imposition of TBTs with the objective 'trade facilitation, conformity, harmonisation' could increase the price of imports with the enforcement of deeper PTAs with a TBT provision. Most importantly, deeper PTAs could lead to lower prices of imports of ICT goods between developing economies. Finally, tariffs seem to be the most trade-impeding trade policy measures affecting imports of ICT goods between developing economies.

4.5.4. Developing economies as importing and developed economies as exporting countries

Tables A20, A21, and A22 in the online appendix provide the estimation results for the import values, volumes, and prices for the group of developing-developed country pairs, respectively. Regulatory convergence in the objective 'consumer, safety, health' raises the value of imports from developed economies to developing economies in a statistically significant manner, while it does not affect the volume of imports; moreover, it reduces the price of imports. Enforcing deeper PTAs with the TBT provision would further reduce the price of imports due to regulatory convergence in this class. Regulatory similarity in the objective 'environmental, animal, plant' reduces both the value and price of imports of ICT goods from developed to developing economies. Similarity in TBTs with the objective 'national security requirements' reduces only the value of imports for this group in a statistically significant manner. However, deepening the PTA with the TBT provision would increase the values and volumes of imports due to similarity in this objective so much that the net impact on values and volumes of imports would be strongly positive. Regulatory convergence in 'trade facilitation, conformity, harmonisation' reduces the volumes of imports in this group in a statistically significant manner. However, enforcing a deeper PTA with the TBT provision would reduce this negative impact on the volumes of imports by about 90%, and also reduces the price of imports in a statistically significant manner. Regulatory convergence in objectives 'ICT specific, and qualitative' and 'environmental, animal, plant' negatively affects the volume of imports of ICT goods in this group of country-pairs when they have deeper PTAs. Regulatory convergence in objectives 'ICT specific, and qualitative' and 'Labelling, packaging, metrology, cost saving' reduces the prices of imports of ICT goods from developed economies to developing economies in a statistically significant way, while it does not affect the values or volumes of imports.

However, PTAs increase the volumes and prices of imports of ICT goods from developed economies to developing economies in a statistically significant manner. This means that this negative impact of PTAs is for bilateral relations without regulatory convergence. Thus, tariffs are the most significant trade policy measures prohibiting imports of ICT goods from advanced economies to developing economies.

5. Summary and concluding remarks

In recent decades, efforts have been made by many countries around the world to liberalise trade. Countries have joined the WTO and have cut their tariffs substantially, to achieve smooth and frictionless trade. However, the use of non-tariff measures has been on the rise. Regulatory NTMs such as technical barriers to trade have proliferated. When a firm exports to a destination that then imposes a new regulatory TBT, that firm is bound to incur costs of compliance, if it is to continue to export to that market. But if the firm's home country imposes a similar regulation, as TBTs are unilateral and non-discriminatory in nature, the firm must already comply at home. Thus, when two trading partners impose similar regulations, trade between them should not suffer, and could actually benefit. However, regulations can be quite diverse, as can their functionality. This paper offers an analysis of the impact of regulatory convergence in bilateral global import values and volumes during the period 1996-2019. Since goods in the ICT sector have unique characteristics that differentiate them in terms of their functionality, the analysis focuses on global bilateral imports of ICT goods generally and of five separate categories within this grouping.

While tariffs and quantitative NTMs are imposed bilaterally, with preference given to countries with preferential trade agreements, TBTs are imposed unilaterally against all trading partners. Therefore, the analysis of TBTs in a gravity model is not feasible once country-product-year fixed effects are included to control for multilateral resistances (Head and Mayer, 2014; Yotov et al., 2016). By creating a variable of bilateral regulatory similarity or regulatory convergence, we analyse them in a gravity model where these fixed effects can also control for unilateral TBTs. Regulatory convergence is measured for several classifications of the keywords cited in the TBT notifications to the WTO. This is a first attempt to classify and analyse TBTs by their objectives, as stated by their notification keywords. The UNCTAD MAST classification of NTMs defines the applicability, administrative, and procedural classes of NTMs. However, an analysis of the objectives cited in NTM notifications would be of more interest to policymakers who are imposing NTMs to achieve certain goals, rather than aiming at their applicability. Therefore, the cited objectives in TBT notifications are the focus of the study. However, the paper also analyses how convergence in two-digit MAST classes affects trade of ICT goods in robustness checks.

The econometric results show heterogeneity in the impact of regulatory convergence across TBT classes, product categories, and country groups. Regulatory convergence in 'consumer, safety, health', 'ICT specific, and qualitative', 'environmental, animal, plant', and 'labelling, packaging, metrology, cost saving' all stimulate the value of imports of all ICT goods, while regulatory convergence in none of them affects the volume of imports of ICT goods. The reason for the latter is the heterogeneity across various ICT goods and the measurement of volume across these goods that leads to an insignificant impact on the whole sample of global ICT goods. Convergence in different objectives also leads to heterogeneous effects on the price of global ICT imports. Convergence in procedural MAST class 'product identity requirements' increases the value and volume of imports, while convergence in classes 'labelling, marking and packaging requirements' and 'product quality, safety or performance requirements' reduces the import values of ICT goods. Therefore, the findings suggest that convergence in most objectives cited in TBT notifications stimulate trade while this is not the case for convergence in procedural classes

as defined in MAST. The negative impact of convergence in UNCTAD's MAST classes is close to the results presented by Knebel and Peters (2019).

Tariffs and CV duties reduce both the value and volume of imports of all ICT goods in a statistically significant manner. Deepening preferential trade agreements (PTA) increases the volumes of imports, while not affecting import values. Tariffs and quantitative NTBs prove to be the most prohibitive factors for imports of ICT goods in the electronic components category – the engine of the modern global digitalised economy. This shows how the reduction in tariffs and quantitative NTBs has contributed to the liberalisation of – and the increase in – trade in ICT goods in recent decades. The conclusion is that trade liberalisation during the first decade of the millennium may have simultaneously promoted a reduction in tariff barriers and CV duties, while the selective and bilateral increase in TBTs has enhanced trade in ICT goods.

Therefore, one can argue that while tariffs and quantitative NTMs should be reduced or eliminated to facilitate smooth and frictionless trade in ICT goods, countries should take steps to impose regulatory measures that pursue similar global objectives. Protecting the health and safety of consumers, safeguarding the environment and mitigating climate change, improving the compatibility and quality of ICT devices, providing enough detailed information on the labelling and packaging of ICT goods, and facilitating trade by means of conformity assessment agreements and harmonisation and through the mutual recognition of regulations and standards – all these are global objectives that can stimulate trade, provided all countries implement them in a uniform manner. Furthermore, pursuing some objectives such as 'national security requirements' by both trading partners might reduce import values, which is particularly the case for trade flows between the developed and developing economies. Deepening bilateral relations after enforcing PTAs with TBT provisions could substantially offset such a negative impact and stimulate trade values. This suggests that there is always a possibility to stimulate trade via regulatory convergence in TBT objectives.

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