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# Impact of Technical Barriers to Trade on the Trade in Goods in the Information and Communications Technology Sector:

## Differentiating by Aim of the Regulatory Measure

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# Impact of Technical Barriers to Trade on the Trade in Goods in the Information and Communications Technology Sector:

## Differentiating by Aim of the Regulatory Measure

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# Abstract

In this modern digital world, goods from the information and communications technology (ICT) sector are the engine of the global economy. While tariffs levied on ICT goods have been eliminated or significantly reduced since the conclusion in December 1996 of the Information Technology Agreement of the World Trade Organization (WTO), non-tariff measure (NTMs) have come to be used more frequently with regard to imports of these goods. Technical barriers to trade (TBTs), as the most important trade policy measure imposed on imports of ICT goods, form the focus of this study. This paper analyses how different types of TBTs imposed on imports of ICT goods globally affected the values and volumes of imported goods at the six-digit level of the Harmonised System (HS) during the period 1996-2018. Keywords cited in the TBTs notified to the WTO give an indication of the aims behind the imposition of TBTs. Therefore, this study digs deeper into the impact of 30 types of TBT, using the keywords cited. The methodology used in this paper controls for zero trade flows using the Pseudo Poisson Maximum Likelihood (PPML) technique; and it controls for endogeneity bias using the exogenous instrumental variable approach. Furthermore, the paper provides more detailed analysis of the impact of TBTs across five ICT product categories that are defined by the United Nations Conference on Trade and Development (UNCTAD). The results indicate that TBTs have a generally strong positive impact on the value of imports of ICT goods. While many keywords cited in TBTs notified to the WTO affect the values and volumes of imports in a positive way, certain other TBTs function as trade barriers that reduce their values and volumes.



Keywords: Information and communications technology, non-tariff measures, technical barrier to trade, World Trade Organization, Pseudo Poisson Maximum Likelihood

JEL classification: F13, F14, L15

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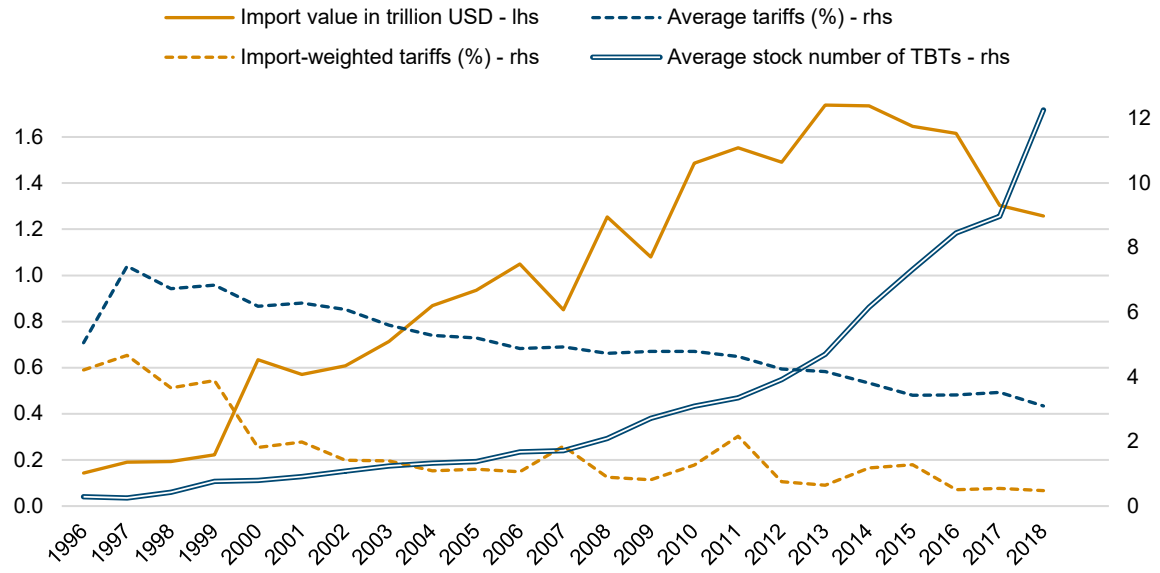
# 1. Introduction

Globalisation and digitalisation are intertwined. On the one hand, the globalisation process in recent decades has stimulated trade in the information and communications technology (ICT) sector (known as 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). According to World Bank data,[1] ICT goods imports made up about 12.9% of total goods imports in 2019. As Figure 1 shows, the total import of ICT goods peaked in 2013 at USD 1.74 trillion. That indicates the importance of the trade in digital goods in the global economy. While tariffs imposed on ICT goods have been substantially reduced over the past two decades, non-tariff measures (NTMs) covering product regulations and standards imposed on goods have proliferated. Technical barriers to trade (TBTs) are among the most common NTMs imposed on ICT goods. Therefore, this paper analyses the impact of TBTs on imports of ICT goods over the period 1996-2018.

**Figure 1 / Development of trade, tariffs and TBTs on ICT goods – 1996-2018**




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

With the establishment of the World Trade Organization (WTO) in 1995, tariffs and traditional barriers to trade have been substantially reduced. In December 1996, members of the WTO concluded the Information Technology Agreement, which envisaged the elimination of tariffs on ICT goods. In December 2015, 50 members of this agreement resolved to extend the agreement to more than 200 products. As the right-hand side (rhs) axis of Figure 1 indicates, the simple average tariffs (in percentage) imposed on ICT goods have been gradually decreasing since 1997, while the import-

[1] https://data.worldbank.org/indicator/TM.VAL.ICTG.ZS.UN

weighted tariffs have been much lower than the simple average tariffs. This indicates that import flows are directed at tariff lines with lower tariffs in this sector. However, the use of NTMs has been on the rise. In fact, the average number of technical barriers to trade imposed on the import of ICT goods increased by 43 times, from about 0.3 at the start of the period to 12.3 in 2018.

This highlights the importance of the regulatory NTMs on the trade pattern of ICT goods, which is the focus of this study. Many studies in the literature have shown the heterogeneity of regulatory NTMs and their diverse implications for the trade in goods (Kee et al., 2009; Beghin et al., 2015; Ghodsi et al., 2016; Bratt, 2017; and Niu et al., 2018). TBTs imposed by a large, growing economy, such as China, may stimulate imports to facilitate the organisation of supply chains and imports of intermediate materials that are used in other stages of production domestically (Ghodsi, 2020). By contrast, certain other regulatory NTMs, such as sanitary and phytosanitary (SPS) measures imposed on the import of consumer goods may significantly hamper trade (Disdier et al., 2008). ICT goods are used as capital, intermediate inputs and consumer goods. Therefore, the implications of NTMs for trade in ICT goods may be very far-reaching. In other words, the impact of regulations and standards embedded within TBTs on the use of goods, demand and price may be very heterogeneous.

The statistics department of the United Nations Conference on Trade and Development (UNCTAD) considers 93 goods at the six-digit level of the Harmonised System (HS) 2012 version, placing them in five broad categories.[2] Each of these goods may have a different functionality and use that can be clearly distinguished from other goods. Therefore, UNCTAD classifies these goods into five categories:

› ICT01 - Computers and peripheral equipment

› ICT02 - Communication equipment

› ICT03 - Consumer electronic equipment

› ICT04 - Electronic components

› ICT05 - Miscellaneous

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 Appendix.

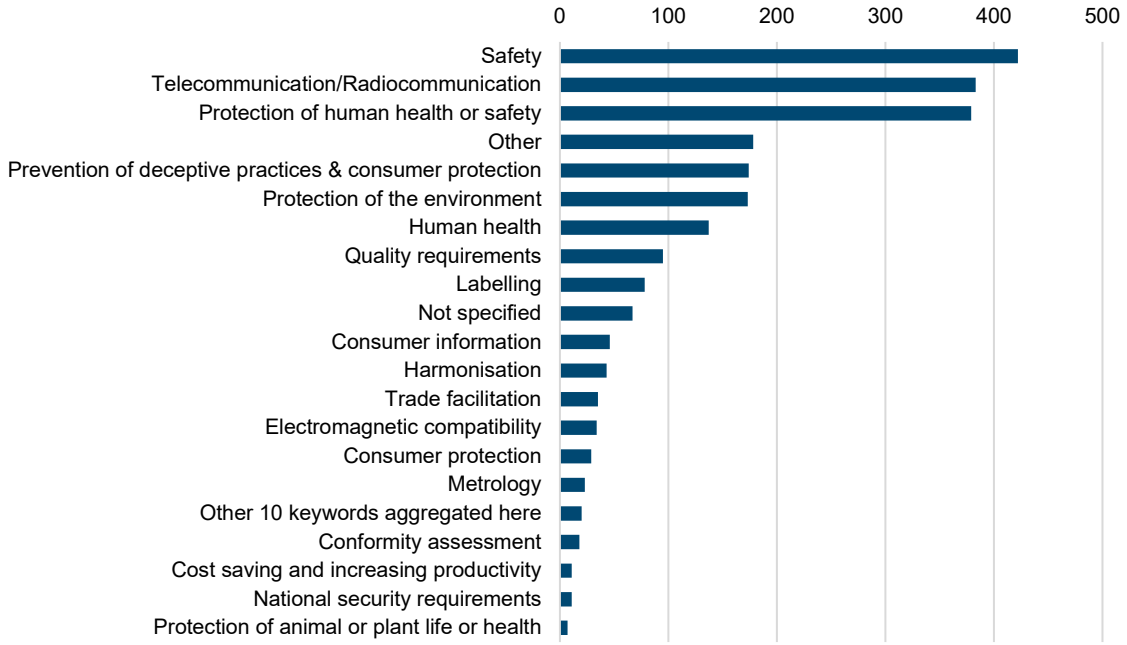
TBTs are imposed to regulate the market for legitimate reasons that are in line with all WTO agreements, and specifically with the TBT agreement of the WTO. According to the WTO's Integrated Trade Intelligence Portal (I-TIP) data, 1,351 TBT notifications were imposed on these 77 goods between 1996 and 2018. According to the descriptions of these notifications, the NTMs were imposed in pursuit of 30 different regulatory objectives (suggested by their keywords). Figure 2 presents the number of TBT notifications in force in 2018 for each of the 30 objectives, on the basis of the keywords cited. Some 95% of the notifications provided at least one keyword; for the remaining 5% of the TBTs imposed on ICT goods, no keyword was specified ('not specified' ranks tenth among all the keywords cited in TBT notifications to the WTO – see Figure 2). About 46% of the TBTs imposed on ICT goods had only one keyword (including those with 'not specified'); thus 54% of TBTs provided at least two keywords (and up to eight).

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

The most common keyword used in the description of a TBT imposed on ICT goods and notified to the WTO was ‘safety’, with 422 notifications. The second most important category, with 383 TBTs imposed on ICT goods, had the keyword ‘telecommunication/radiocommunication’ (which is uncommon for other types of goods). ‘Protection of human health or safety’ was the third most common keyword, mentioned in 379 TBT notifications. ‘Prevention of deceptive practices & consumer protection’, ‘protection of the environment’, ‘human health’ and ‘quality requirements’ are the next most commonly cited keywords, in 174, 173, 137 and 95 TBT notifications, respectively.

Each of these TBTs may target more than one product for regulation across a border. For instance, many TBTs are imposed on all products classified under chapter 85 of HS, which covers all ‘electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles’, which also includes non-ICT goods. Therefore, these TBTs may be very effective in controlling imports across the whole sector, if complying with them becomes too costly. Compliance costs may increase simply because of the bureaucracy or ‘red tape’: extra staff may be required to handle it. However, the costs may decline thanks to digitalisation and the automation of many customs offices. To reduce costs, some countries may regulate the market using ‘harmonisation’, ‘trade facilitation’ and ‘conformity assessment’ TBTs, with the relevant keywords cited in, respectively, 43, 35 and 18 TBT notifications that target ICT goods. When the cost of compliance across the border increases due to the burden of the numerous regulations, these become an example of red tape hindering trade.

**Figure 2 / TBT notifications (based on keywords) in force in 2018 on ICT goods**




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

Therefore, this paper analyses the impact of regulatory TBTs on the import of ICT goods during the period 1996-2018. More precisely, the keywords mentioned in the regulations notified to the WTO will be used to provide greater insight into what types of TBT have what kind of impact on imports of ICT goods.

For instance, while ‘safety’ was the most frequently cited keyword in TBTs imposed on ICT goods, the results show that these TBTs did not have any significant impact on the value or the volume of imports across many econometric specifications. However, TBTs that pursued ‘conformity assessment’ played a stimulative and facilitating role in terms of the value of imports of ICT goods globally. These effects will be differentiated on the basis of the categories determined by UNCTAD statistics in July 2019. Both the value of trade and its volume will be analysed to provide greater insight into the impact of TBTs on import prices, values and volume. Since TBTs are regulations that are imposed unilaterally on all exporters, unilateral import values of 77 HS six-digit ICT goods during the period 1996-2018 are used. However, because of mutual recognition and harmonisation of standards, regulations and NTMs across the single market of the European Union (EU), unilateral imports are calculated in such a way that intra-EU trade and intra-EU trade policy measures are excluded from the analysis. The organisation of the rest of the paper is as follows. The next section describes the methodology and the data used in the analysis. Section 3 provides the results of the analysis. And section 4 offers a conclusion.

# 2. 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 can choose a unilateral setting, which is also used in earlier studies, such as Kee et al. (2009). However, there are zero trade flows for some imported products to certain countries, which may cause sample selection bias in the estimation of the impact of NTMs, especially if the NTM imposed on a product prohibits trade completely. To control for zero trade flows in the import data, the Pseudo Poisson Maximum Likelihood (PPML) is used that is implemented in Stata by Santos Silva and Tenreyro (2006) (see also Head and Ries, 2008; Head and Mayer, 2014; Yotov et al., 2016; Larch et al., 2019), further developed by Correia et al. (2019a,b) to run multidimensional fixed effects. The equation for the estimation of unilateral trade is as follows:

$$m_{iht} = exp^{[\alpha_0+\alpha_1 \operatorname{arc} T_{iht}+\alpha_2 TBT_{iht}+\omega_{it}+\omega_{ih}]} + \varepsilon_{iht} \quad (1)$$

where $m_{iht}$ is total import values $m^v_{iht}$ (or import volumes $m^q_{iht}$) of product $h$ to country $i$ in year $t$; $\operatorname{arc} T_{iht}$ is the hyperbolic sine transformation (Bellemare and Wichman, 2020) of simple average tariffs (in per cent) levied by country $i$ on imports of product $h$ in year $t$; $TBT_{iht}$ is the stock number of TBTs imposed by country $i$ on the imports of products $h$ and in force in year $t$, which also includes TBTs imposed in earlier years that are not withdrawn;[3] $\omega_{it}$ is the country-time dummy that controls for any time-variant country characteristics, such as the size of the economy or the level of development, factors of production, membership of the WTO or the EU or any other preferential trade agreements, etc.; $\omega_{ih}$ is the country-product fixed effect that controls for any time-invariant characteristics of a country-product dyad, such as those persistent on the supply side or the demand side of a product in a country; and $\varepsilon_{iht}$ is the error term. As noted above, intra-EU values are excluded from the analysis. Therefore, when country $i$ is a member of the EU, its imports from other EU members are not included in the dependent variable, and its tariffs and TBTs that are usually set to zero are also excluded from the calculation of explanatory variables.

It is widely discussed in the literature that, due to reverse causality of TBTs and the dependent variable, there is a potential endogeneity bias in the estimation of TBTs, as TBTs may be correlated with the error term $E(TBT_{iht}\ \varepsilon_{iht}) \neq 0$. Such an endogeneity bias is controlled for using the instrumental variable approach in the literature (Kee et al., 2009; Beghin et al., 2015; Bratt, 2017; Niu et al., 2018; Ghodsi, 2020). Moreover, other sources of endogeneity bias could be measurement error and the omitted variable bias. While the latter is controlled for using the appropriate fixed effects in equation (1), the former could also be controlled for using the instrumental approach. Following the seminal work of Kee et al. (2009), past growth in imports $\Delta m_{iht-1} = \operatorname{arc} m_{iht-1} - \operatorname{arc} m_{iht-2}$, and total exports $\operatorname{arc} x_{iht}$ of product $h$ from country $i$ in year $t$ are two exogenous variables that may affect the imposition of TBTs, but do not correlate with the dependent variable in year $t$. Moreover, Kee et al. (2009) also use the GDP-weighted average TBT of the five geographically closest countries to importing country $i$ as the third exogenous instrument for TBT, to control for the measurement error in the calculation of TBT. However, the five closest countries may be quite arbitrary: in a globalised world, distant countries may

[3] It is important to note that no TBT in the WTO I-TIP data is reported as having been withdrawn.

impose new TBTs, following other distant trading partners, to harmonise their standards and regulation settings. For instance, China is very distant from the EU and the US, but their global value chains have been intensively intertwined in the past two decades. This means that regulations and standards in Chinese manufacturing sectors may have converged with those in other countries, so that foreign intermediate inputs can be imported and used in Chinese value chains (Ghodsi, 2020). Therefore, as the third exogenous instrument, the average stock number of TBTs imposed by countries other than the importing country $i$ under estimation $TBT^{W}_{i'ht}$ is used, which is weighted by the per capita GDP of countries. The reason for choosing per capita GDP, rather than GDP, is that the level of development may be a better indicator of a qualitative and regulatory framework for the implementation of TBTs than simply the size of the economy.[4] Therefore, the first stage of the instrumental variable approach is as follows:

$$TBT_{iht} = exp^{\left[\beta_0+\beta_1 \operatorname{arc} T_{iht}+\beta_2 \Delta m_{iht-1}+\beta_3 \operatorname{arc} x_{iht}+\beta_4 TBT^{W}_{i'ht}+\omega_{it}+\omega_{ih}\right]} + \mu_{iht} \quad (2)$$

After estimating equation (2) and after retrieving the fitted value of $\widehat{TBT}_{iht}$, this variable is included in the second-stage estimation, as follows:

$$m_{iht} = exp^{[\gamma_0+\gamma_1 \operatorname{arc} T_{iht}+\gamma_2 \widehat{TBT}_{iht}+\omega_{it}+\omega_{ih}]} + \vartheta_{iht} \quad (3)$$

where the fitted value of TBT is not correlated with the error term $E\left(\widehat{TBT}_{iht}\, \vartheta_{iht}\right) = 0$. It is important to note that because multiple fixed effects are used in the second stage, it is not possible to use a bootstrapping estimation. However, the error term is clustered by importer-product $ih$ to control for the heteroskedasticity and autocorrelation in the error term.

The benchmark estimation of equation (3) is done on the sample of all 77 ICT goods in the HS 1996 version, which gives the average global impact of TBTs on the values and volumes of imports across all these ICT goods. However, as noted above and discussed in the literature, different products may be differently affected by TBTs. Therefore, to observe the impact of TBTs across the five product categories defined by UNCTAD, the fitted TBT in equation (3) is interacted with five product category dummies to obtain five point estimates and confidence intervals for a TBT's impact on the imports of the five product categories. A list of these categories and the ICT goods classified is provided in Table A1 in the Appendix. One can estimate the impact of TBTs on different product categories using separate samples of estimations. However, estimating all the products in the same sample would yield results that are more robust. The main reason for that is that all the available information on all products is used in one single estimation; that not only provides a greater degree of freedom for the calculation of statistics, but also uses more information for the estimation of parameters. Moreover, this methodology gives standard deviation and point estimates of each coefficient of TBT for each product category conditional on the coefficients of TBT for other product categories in the same estimation.

Furthermore, the TBT variable used in the benchmark specification includes all types of TBT notified to the WTO that target ICT goods. Thirty separate variables are generated to take account of the 30 different keywords cited in the TBTs imposed on these goods. These 30 variables are estimated in separate regressions to infer their impact on trade flows in ICT goods and their product categories.

[4] The GDP weights instead of per capita GDP weights are also used in separate specifications, the results of which are available on request.

## 2.1. DATA

The data on bilateral import values and import volumes are downloaded from UN COMTRADE and are provided by the World Integrated Trade Solution (WITS) at the six-digit level of the HS 1996 version. These bilateral trade data are then aggregated to the unilateral level. As noted, intra-EU trade data are excluded from this aggregation.

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, effectively applied rates 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. Then, using simple averages and including zero bilateral trade flows at the six-digit HS level, bilateral tariffs are aggregated to a unilateral tariff for each product by importing country. Intra-EU trade is again excluded from this aggregation.

The data on TBTs are downloaded from the WTO's I-TIP data, which include official notifications to the WTO committees concerning NTMs imposed by WTO members. As is documented in Ghodsi et al. (2017), many notifications lack the HS codes of the products targeted by the NTMs. These HS codes are imputed using other information available in the notification. Since only WTO members notify their NTMs, and since the data include only the TBTs imposed by WTO members, the estimation sample is restricted to countries that were members of the WTO during the period in question. China joined the WTO in 2001, and so its imports of ICT goods are included in the analysis for the whole period 1996-2018. However, Iran has never been a member of the WTO, and thus it is excluded from the sample of analysis as an importing country.

# 3. Estimation results

Table 1 presents the second-stage instrumental variable estimation results using PPML for imports of all ICT goods during the period 1996-2018. Estimation results using the stock number of TBTs in levels are presented in the left-hand panel (the two left-hand columns) of Table 1. The number of TBTs imposed by an importing country that was a member of the WTO in 2018 has a statistically positive effect on the value of its imports of ICT goods $m^v_{iht}$ at the 5% level of significance. The coefficient suggests that an additional TBT imposed each year on ICT goods increases the value of imports by 2.2%. However, the elasticity of import values with respect to the number of TBTs is statistically insignificant; this result is presented in the right-hand panel of Table 1, which uses hyperbolic sine transformation of the number of TBTs and is defined as $\operatorname{arc}\widehat{TBT}_{iht}$. The results using an instrumental variable (IV) approach and the fitted values of TBTs in the second stage are very similar to those obtained from the estimations using the actual values of TBTs in the models presented in Table A2 in the Appendix. The difference between the two results suggests that the bias that is corrected by the exogenous instruments yields results that underestimate the impact of endogenous TBTs.

**Table 1 / Second-stage instrumental variable estimation results using PPML on imports of ICT goods during 1996-2018**

| | TBT in levels | | TBT using arcsine transformation | |
|---|---|---|---|---|
| **Dependent variable:** | $m^v_{iht}$ | $m^q_{iht}$ | $m^v_{iht}$ | $m^q_{iht}$ |
| $\operatorname{arc} T_{iht}$ | 0.21 | 8.32 | 0.22 | 8.27 |
| | (0.17) | (6.38) | (0.17) | (6.34) |
| $\widehat{TBT}_{iht}$ or $\operatorname{arc}\widehat{TBT}_{iht}$ | 0.022** | 0.032 | 0.20 | 0.14 |
| | (0.011) | (0.034) | (0.18) | (0.35) |
| **Constant** | 22.1*** | 23.5*** | 21.9*** | 23.4*** |
| | (0.11) | (0.28) | (0.37) | (0.84) |
| **Observations** | 181971 | 177246 | 181971 | 177246 |
| **Pseudo R-squared** | 0.957 | 0.964 | 0.956 | 0.964 |
| **Akaike information criterion (AIC)** | 7.23635e+12 | 1.58665e+12 | 7.33042e+12 | 1.58866e+12 |
| **Importer-year FE $\omega_{it}$** | Yes | Yes | Yes | Yes |
| **Importer-product FE $\omega_{ih}$** | Yes | Yes | Yes | Yes |

Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.
These estimations are run on equation (3).

PPML first-stage estimation results on TBTs are presented in Table A3. From the three exogeneous instruments used, only the average global number of TBTs weighted by the per capita GDP of each country that imposes them is statistically significant. Past growth in import values (volumes) $\Delta m^v_{iht-1}$ ($\Delta m^q_{iht-1}$) or export values (volumes) $\operatorname{arc} x^v_{iht}$ ($\operatorname{arc} x^q_{iht}$) are not correlated with the endogenous $TBT_{iht}$, and only the TBTs that are imposed globally are significantly related to the number of TBTs that a country imposes on each ICT good. This result comes despite the inclusion of country-product fixed effects that control for any regulatory measure and characteristics that are persistent in each country that demands or supplies one of these ICT goods. As can be observed from the results of the first-stage IV regressions (Table A3), the number of observations decreased to 63,509 (from 181,971 in the non-IV

regression presented in Table A2). The reason is that dropped observations are either singletons or are separated by a fixed effect, as Correia (2015) also explains. This means that those dropped observations for TBTs will be controlled for by the fixed effects if they are included in the estimations as explanatory variables. However, the inclusion of these fixed effects gave statistically insignificant coefficients for other exogenous instruments in the first stage. Therefore, when the fitted value of a TBT is used in the second stage, the actual values of TBTs could replace the missing observations from the fitted values of the first-stage estimation, simply because those actual values of TBTs are controlled for by the fixed effects in the second-stage estimation.

Another interesting result appears to be the insignificant impact of tariffs on the value or volume of imports in any specification. As explained above, tariffs were reduced to a low level (or zero) by many WTO members after the Information Technology Agreement was concluded in December 1996. The simple average global tariffs levied on these products declined from 7.4% in 1997 to 2.1% in 2018. In December 2015, 50 members of the WTO that were committed to the Information Technology Agreement implemented a reduction in tariffs to zero on the import of further ICT goods.

Even more interestingly, the results of the first-stage estimation (Table A2) illustrate that a 1% reduction in tariffs is correlated in a statistically significant way with a 0.032% increase in the number of TBTs imposed, which serves to indicate the substitutability of TBTs for tariffs. The reason is that, while tariffs fell by 58% from 1997 to 2018, the number of TBTs grew by 48 times over the same period. Meanwhile, the impact is estimated to be 0.032%, controlling for fixed effects and other variables in the estimation. The substitutability of NTMs for other types of trade policy measures – such as traditional tariffs or other NTMs – has been widely studied in the literature (Rosendorff, 1996; Yu, 2000; Moore and Zanardi, 2011; Aisbett and Pearson, 2012; Orefice, 2017).

## 3.1. ESTIMATION RESULTS BY PRODUCT CATEGORY

Figures A1 to A4 in the Appendix illustrate the point estimates and confidence intervals of TBT coefficients that are interacted with the five product categories, using the models presented in Table 1. Full estimation tables of these results are available on request. As may be observed, in none of the product categories is the volume of imports affected by TBTs in a statistically significant way. With a few exceptions, a similar picture may be observed for the impact of TBTs on the value of imports. The value of the import of products in the second category (‘communication equipment’) is increased in a statistically significant way by the TBT imposed. In fact, from Figure A1 it is possible to see that an additional TBT imposed on the products in that category can stimulate the value of imports by a point estimate of 0.03 which is statistically significant at the 1% level. From Figure A2, one can observe that a 1% increase in the number of TBTs imposed on the import of goods in this product category can increase import values by 0.3%, which is statistically significant at the 10% level. Since the point estimate for the import volume of products in this category is also positive in Figure A4 (0.42), despite its statistical insignificance at the 10% level, one can conclude that TBTs imposed on the imports of this product category increase the volume of imports more than their value. This means that prices decline because of TBTs, resulting in a greater volume and value of imports.

## 3.2. IMPACT OF TBTS ON IMPORTS BY THE KEYWORD CITED

Figure A5 in the Appendix illustrates the point estimates and confidence intervals of the PPML second-stage instrumental variable on import values of ICT goods during the period 1996-2018 by the keywords cited in TBTs, using the hyperbolic transformation of the number of TBTs. The hyperbolic sine transformation is used because it is asymptotically a log-log estimation that gives comparable elasticity results across different models (Bellemare and Wichman, 2020). As may be observed from the keywords, only a very few types of TBT stimulate import values to a statistically significant degree. A 1% increase in TBTs that cite the keywords 'conformity assessment', for instance, stimulates the value of imports by 1.03%, which is statistically significant at the 10% level. However, by taking a look at Figure A6 in the Appendix, which illustrates the point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes of ICT goods during the period 1996-2018 by keywords cited in the TBTs using the hyperbolic transformation of TBTs, one can observe that TBTs with the keyword 'conformity assessment' have a positive coefficient that is slightly smaller in magnitude than the coefficient in Figure A5 and that is also statistically less significant. This result suggests that those TBTs that pursue 'conformity assessment' may have a significant impact on the price of imports, which results in a larger value of the imports of these goods. TBTs that cite the keywords 'electromagnetic compatibility' and 'other' have a similar characteristic to those that cite 'conformity assessment'. While these TBTs increase the value of imports in a statistically significant way, they increase the volume of imports to a statistically insignificant degree. TBTs that pursue 'electromagnetic compatibility' may lead to an additional cost for the imported goods, in the drive to make them more compatible with the domestic standards settings implemented for all electronic devices. This additional cost may bring about higher quality, making the product more compatible, but it also results in a higher value of imports (and export revenue for the exporting firm).

TBTs with the keyword 'crime protection' also have a statistically significant impact on import values: though the impact is smaller than the impact on the volume of imports, it is statistically more significant. This means that TBTs that pursue 'crime protection' and that are imposed on ICT goods may reduce the price of imported goods, resulting in greater demand for imports and also higher import values.

TBTs with the keyword 'food standards' (mentioned in just five TBTs) reduce the value of ICT goods imports, though this is statistically significant only at the 10% level. However, the impact of these TBTs on the volume of imports of ICT goods is negative but statistically insignificant. Therefore, it could be argued that while the volume of imports is not affected in a statistically significant way by these 'food standards', the prices of the imported goods may have been reduced by them. TBTs with the keyword 'protection of animal or plant life or health' have similar results and are susceptible to a similar interpretation as 'food standards': they increase the value of imports in a statistically significant way and reduce the volume of imports to a statistically insignificant degree. TBTs with the keyword 'nutrition information' have a negative effect on the import values of ICT goods that is statistically significant at the 10% level. However, these TBTs do not have any impact on the volume of imports, and their results do not appear in Figure A6. The reason is that these TBTs target products that become collinear with fixed effects in the estimation of import volumes.

A 1% increase in the number of TBTs citing the keyword 'harmonisation' stimulates the value of imports of ICT goods by 0.49%, which is statistically significant at 5%. However, these TBTs do not affect the volume of imports to any statistically significant degree. This suggests that when a government tries to

harmonise the regulations and standards governing these products with those of other countries, the adjustment may be costly, resulting in higher import prices and consequently higher import values. TBTs citing the keyword 'national security requirements' have similar results and a similar interpretation.

The only types of TBT that increase the volume of imports of ICT goods to a statistically significant extent are the 95 that cite the keyword 'quality requirements' and the 67 with no keywords specified in their notifications ('not specified'). It is interesting that those TBTs that cite 'quality requirements' do not affect the value of imports in a statistically significant way, but they do increase the volume of imports at a 5% level of significance. In fact, a 1% increase in the number of TBTs imposed that target quality requirements may increase the volume of imports of ICT goods by 1.54%. The main reason behind such a shift in demand is the greater demand for better quality, which is also analysed in earlier studies (Khandelwal, 2010; Hallak and Schott, 2011; Feenstra and Romalis, 2014; Ghodsi and Stehrer, 2021; Ghodsi, 2021).

## 3.3. IMPACT OF TBTS ON IMPORT VALUES BY THE CITED KEYWORD ACROSS PRODUCT CATEGORIES

Figures A7 to A11 in the Appendix present the point estimates and confidence intervals of the PPML second-stage instrumental variable estimations on import values in the five product categories, using the hyperbolic sine transformation of TBTs. Figure A7 shows the results for the product category 'computers and peripheral equipment'. Only one keyword cited in the TBTs stimulates the value of imports of products in this category: 'protection of animal or plant life or health'. In fact, a 1% increase in the number of TBTs citing this keyword stimulates import values by 0.57%, which is statistically significant at the 5% level. Many other keywords that have statistically significant coefficients reduce the value of imports of these goods. 'Consumer information', 'food standards', 'labelling', 'nutrition information', 'organic agriculture', 'packaging', 'quality requirements', 'safety' and 'telecommunication/radiocommunication' are the keywords mentioned in TBTs that reduce the value of imports of goods in this category.

Figures A12 to A16 in the Appendix illustrate the point estimates and confidence intervals of the PPML second-stage instrumental variable estimations on import volumes of ICT goods in the five product categories, using the hyperbolic sine transformation of TBTs. Looking at the results obtained for the first product category of 'computers and peripheral equipment', one can observe that many TBT keywords stimulate the volume of imports of these goods in a statistically significant way. These are TBTs with keywords 'cost saving and increasing productivity', 'crime protection', 'electromagnetic compatibility', 'other', 'pesticides', 'plant health', 'telecommunication/radiocommunication' and other TBTs whose keywords were 'not specified'. However, there is only one keyword cited that has a statistically significant and negative impact on the volume of imports of these goods: 'genetically modified organisms'. These results indicate the heterogeneous impact of different types of TBT: many of them have a negative impact on the value of imports, while some of them have a positive impact on the import volumes of these goods. This could be due to a lower price of the imports caused by TBTs: that would result in higher import volumes, but lower import values.

The results for the impact of TBTs by keyword on the value of the import of goods in the category of 'communication equipment' are presented in Figure A8, and the corresponding results for import volume are presented in Figure A13. In all, 21 keywords cited in TBTs have a statistically significant stimulation

effect on the value of imports in this category. None of the keywords has any statistically significant and negative effect on import values. This is not surprising, and is in line with the positive and statistically significant effect of all types of TBT presented in Figures A1 and A2. Figure A13 indicates that 12 keywords cited in TBTs have a statistically significant and positive effect on the volume of imports of these goods. However, there are only two keywords with a statistically significant and negative effect in this graph: 'labelling' and 'consumer information'. These two keywords have a statistically significant and positive impact on the value of imports of these goods, which suggests that these two types of TBT have resulted in a higher cost and price of the imported goods. The higher cost and price of goods after compliance with these two types of TBT is much greater than the reduction in the volume of imports, leading to a lower volume of imports, but a higher value.

The point estimates and confidence intervals on the impact of TBTs by keyword on the import value of goods in the category 'consumer electronic equipment' are presented in Figure A9, while the corresponding results for import volumes are illustrated in Figure A14. The import values of these goods are statistically increased by only two keywords cited in TBTs: 'conformity assessment' and 'crime protection'. 'Labelling', 'organic agriculture' and 'quality requirements' are the keywords cited in TBTs that lead to a statistically significant decrease in the value of imports of these goods. TBTs citing 'labelling' as a keyword also reduce the volume of imports at the 10% level of significance. 'National security requirements', 'pesticides', 'plant health', 'protection of animal or plant life or health' and other TBTs that did not specify keywords ('not specified') lead to a statistically significant improvement in import volumes. Since these goods are consumer goods, it is not surprising that these objectives of the TBTs should have increased consumer demand.

'Electronic components' is the next import product category, and the estimation results for point estimates and confidence intervals of the keywords of TBTs affecting import values are presented in Figure A10, while the corresponding results for import volumes are presented in Figure A15. Semiconductors and technologically advanced electronic chipsets form part of this category. More recently, the COVID-19 pandemic and the border closures have disrupted the global value chains of these high-tech products and have led to semiconductor shortages; these have affected many sectors, such as the automobile industry, which uses these goods as intermediate inputs. Nine keywords cited in the TBTs imposed on these goods lead to a statistically significant increase in the import values of these goods. There is no keyword cited in the TBTs that has a statistically significant negative effect on the value of imports of these vital goods. However, 'cost saving and increasing productivity', 'harmonisation' and 'organic agriculture' are keywords cited in TBTs that lead to a statistically significant reduction in the volume of imports of these goods. 'Crime protection' and keywords that are not specified ('not specified') in other TBTs have a positive and statistically significant effect on the volume of imports of these goods.

'Miscellaneous' is the fifth category of ICT goods, and its estimation results, with point estimates and confidence intervals of TBTs by keyword, are presented in Figure A11 for the value of imports, and in Figure A16 for the volume of imports. 'Conformity assessment' is the only keyword cited in TBTs that results in a statistically significant increase in the value of imports of these goods. In fact, TBTs citing the keyword 'conformity assessment' stimulate the value of imports of all ICT goods across all product categories. 'Quality requirements' and 'other' are the keywords cited in TBTs that lead to a statistically significant reduction in the value of imports. TBTs citing 'crime protection' increase the volume of imports in this category in a statistically significant way, while those citing 'packaging' and 'telecommunication/radiocommunication' reduce the volume of imports of these goods.

# 4. Concluding remarks

In the modern digitalised world, ICT goods are the engine of the global economy. According to the data provided by UNCTAD to the World Bank, trade in ICT goods was about 12.9% of total imports of goods in 2019, which indicates their importance in the global economy. While tariffs levied on ICT goods have been eliminated or significantly reduced since the conclusion of the WTO's Information Technology Agreement in December 1996, NTMs have become more relevant and important for trade in these goods. As the most important trade policy measure imposed on imports of ICT goods, TBTs form the focus of this study. This paper analyses how the different types of TBT imposed on imports of ICT goods globally affected the value and volume of imports of these goods at the six-digit level of the Harmonised System during the period 1996-2018. Keywords cited in the TBTs that are notified to the WTO indicate the aims behind the imposition of the TBTs. Therefore, as a major contribution to the literature, this study delves deeper into the impact of 30 types of TBT, using the keywords cited in them. The methodology used in the paper controls for zero trade flows by using the PPML technique and for endogeneity bias by using the exogenous instrumental variable approach. Moreover, the paper provides more detailed analysis of the impact of TBTs across five ICT product categories that were defined by UNCTAD in July 2019.

The results indicate that TBTs have a generally strong positive impact on the value of imports of ICT goods. Moreover, this positive impact is stronger and statistically more significant for the 'communication equipment' category of ICT goods. Furthermore, TBTs that cite the keywords 'conformity assessment', 'crime protection', 'electromagnetic compatibility', 'harmonisation', 'national security requirements', 'other', 'protection of animal or plant life or health' lead to a statistically significant stimulation of the value of imports of ICT goods. While TBTs that cite 'nutrition information' significantly reduce the value of imports, other TBTs do not have any statistically significant impact on the import values of ICT goods. Most importantly, TBTs that cite 'quality requirements' stimulate the volume of imports of ICT goods in a statistically significant way. The imposition of this important TBT – one that improves the quality of traded goods – could be an important way of stimulating trade volume, while the imposition of other TBTs mentioned above can increase export revenues.

Overall, the results presented here could give policy makers a better insight into how to adjust trade in ICT goods by implementing smart policies to regulate the market, when the market cannot automatically adjust and reduce the negative externalities. For instance, TBTs that cite 'conformity assessment' stimulate the value of imports of all ICT goods in all five product categories. TBTs in pursuit of 'harmonisation' or 'plant health' may also improve trade values across many categories. However, some other TBTs – such as those that pursue 'labelling' or 'packaging' – may result in a statistically significant reduction in the volume of imports, as the costs associated with compliance increase at the plant level where the ICT good is produced or packed, but do not necessarily induce positive externalities to stimulate demand or export revenues.

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# Appendix

## Table A1 / List of ICT products and their related categories in the HS 1996 version

| Category | Category description | Product code HS rev. 1996 | Product description |
|---|---|---|---|
| ICT01 | Computers and peripheral equipment | 847050 | Cash registers |
| | | 847130 | Portable digital automatic data processing machines, weighing not more than 10 kg, consisting of at least a central processing unit, a keyboard and a display |
| | | 847141 | Other digital automatic data processing machines: Comprising in the same housing at least a central processing unit and an input and output unit, whether or not combined |
| | | 847149 | Other digital automatic data processing machines: Other, presented in the form of systems |
| | | 847150 | Digital processing units other than those of sub-headings 8471.41 and 8471.49, whether or not containing in the same housing one or two of the following types of unit: storage units, input units, output units |
| | | 847160 | Input or output units, whether or not containing storage units in the same housing |
| | | 847170 | Storage units |
| | | 847180 | Other units of automatic data processing machines |
| | | 847190 | Other |
| | | 847290 | Other |
| | | 847330 | Parts and accessories of the machines of heading No. 84.71 |
| | | 847350 | Parts and accessories equally suitable for use with machines of two or more of the headings Nos. 84.69 to 84.72 |
| ICT02 | Communication equipment | 851711 | Telephone sets; videophones: Line telephone sets with cordless handsets |
| | | 851719 | Telephone sets; videophones: Other |
| | | 851750 | Other apparatus, for carrier-current line systems or for digital line systems |
| | | 851780 | Other apparatus |
| | | 851790 | Parts |
| | | 852510 | Transmission apparatus |
| | | 852520 | Transmission apparatus incorporating reception apparatus |
| | | 853110 | Burglar or fire alarms and similar apparatus |
| ICT03 | Consumer electronic equipment | 851810 | Microphones and stands therefor |
| | | 851821 | Loudspeakers, whether or not mounted in their enclosures: Single loudspeakers, mounted in their enclosures |
| | | 851822 | Loudspeakers, whether or not mounted in their enclosures: Multiple loudspeakers, mounted in the same enclosure |
| | | 851829 | Loudspeakers, whether or not mounted in their enclosures: Other |
| | | 851830 | Headphones, earphones and combined microphone/speaker sets |
| | | 851840 | Audio-frequency electric amplifiers |
| | | 851850 | Electric sound amplifier sets |
| | | 851890 | Parts |
| | | 851939 | Turntables (record-decks): Other |
| | | 851999 | Other sound reproducing apparatus: Other |
| | | 852020 | Telephone answering machines |
| | | 852110 | Magnetic tape-type |
| | | 852190 | Other |
| | | 852210 | Pick-up cartridges |
| | | 852290 | Other |
| | | 852540 | Still image video cameras and other video camera recorders |
| | | 852712 | Radio-broadcast receivers capable of operating without an external source of power, including apparatus capable of receiving also radio-telephony or radio-telegraphy: Pocket-size radio cassette-players |
| | | 852713 | Radio-broadcast receivers capable of operating without an external source of power, including apparatus capable of receiving also radio-telephony or radio-telegraphy: Other apparatus combined with sound recording or |

contd.

## Table A1 / Contd.

| Category | Category description | Product code HS rev. 1996 | Product description |
|---|---|---|---|
| ICT03 | Consumer electronic equipment | 852719 | Radio-broadcast receivers capable of operating without an external source of power, including apparatus capable of receiving also radio-telephony or radio-telegraphy: Other |
| | | 852721 | Radio-broadcast receivers not capable of operating without an external source of power, of a kind used in motor vehicles, including apparatus capable of receiving also radio-telp...:Combined with sound recording or reproducing apparatus |
| | | 852729 | Radio-broadcast receivers not capable of operating without an external source of power, of a kind used in motor vehicles, including apparatus capable of receiving also radio-telephony or radio-telegraphy: Other |
| | | 852731 | Other radio-broadcast receivers, including apparatus capable of receiving also radio-telephony or radio-telegraphy: Combined with sound recording or reproducing apparatus |
| | | 852732 | Other radio-broadcast receivers, including apparatus capable of receiving also radio-telephony or radio-telegraphy: Not combined with sound recording or reproducing apparatus but combined with a clock |
| | | 852739 | Other radio-broadcast receivers, including apparatus capable of receiving also radio-telephony or radio-telegraphy: Other |
| | | 852812 | Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus: Colour |
| | | 852813 | Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus: Black and white or other monochrome |
| | | 852821 | Video monitors: Colour |
| | | 852830 | Video projectors |
| | | 950410 | Video games of a kind used with a television receiver |
| ICT04 | Electronic components | 852330 | Cards incorporating a magnetic stripe |
| | | 853400 | Printed circuits |
| | | 854011 | Cathode-ray television picture tubes, including video monitor cathode-ray tubes: Colour |
| | | 854012 | Cathode-ray television picture tubes, including video monitor cathode-ray tubes: Black and white or other monochrome |
| | | 854020 | Television camera tubes; image converters and intensifiers; other photo-cathode tubes |
| | | 854040 | Data/graphic display tubes, colour, with a phosphor dot screen pitch smaller than 0.4 mm |
| | | 854060 | Other cathode-ray tubes |
| | | 854071 | Microwave tubes (for example, magnetrons, klystrons, travelling wave tubes, carcinotrons), excluding grid-controlled tubes: Magnetrons |
| | | 854079 | Microwave tubes (for example, magnetrons, klystrons, travelling wave tubes, carcinotrons), excluding grid-controlled tubes: Other |
| | | 854081 | Other valves and tubes: Receiver or amplifier valves and tubes |
| | | 854089 | Other valves and tubes: Other |
| | | 854091 | Parts: Of cathode-ray tubes |
| | | 854099 | Parts: Other |
| | | 854110 | Diodes, other than photosensitive or light emitting diodes |
| | | 854121 | Transistors, other than photosensitive transistors: With a dissipation rate of less than 1 W |
| | | 854129 | Transistors, other than photosensitive transistors: Other |
| | | 854130 | Thyristors, diacs and triacs, other than photosensitive devices |
| | | 854140 | Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes |
| | | 854150 | Other semiconductor devices |
| | | 854160 | Mounted piezo-electric crystals |
| | | 854190 | Parts |
| | | 854212 | Monolithic digital integrated circuits: Cards incorporating an electronic integrated circuit (smart cards) |
| | | 854230 | Other monolithic integrated circuits |
| | | 854290 | Parts |
| ICT05 | Miscellaneous | 852390 | Other |
| | | 852910 | Aerials and aerial reflectors of all kinds; parts suitable for use therewith |
| | | 852990 | Other |
| | | 901320 | Lasers, other than laser diodes |

Source: The classification of ICT goods by UNCTADstat in HS 2012 version; Product nomenclature in HS 1996 version provided by WITS; Concordance from HS 2012 version to HS 1996 version provided by WITS; author's elaboration.

## Table A2 / PPML estimation results on imports of ICT goods during 1996-2018

| | TBT in levels | | TBT using arcsine transformation | |
|---|---|---|---|---|
| **Dependent variable:** | $m^v_{iht}$ | $m^q_{iht}$ | $m^v_{iht}$ | $m^q_{iht}$ |
| **arc** $T_{iht}$ | 0.21 | 8.34 | 0.22 | 8.42 |
| | (0.17) | (6.38) | (0.17) | (6.36) |
| $\widehat{TBT}_{iht}$ **or arc** $\widehat{TBT}_{iht}$ | 0.018** | 0.046 | 0.18 | 0.43 |
| | (0.0089) | (0.044) | (0.11) | (0.45) |
| **Constant** | 22.2*** | 23.4*** | 22.0*** | 22.7*** |
| | (0.083) | (0.35) | (0.22) | (1.08) |
| **Observations** | 181971 | 177246 | 181971 | 177246 |
| **Pseudo R-squared** | 0.957 | 0.964 | 0.957 | 0.964 |
| **AIC** | 7.24961e+12 | 1.58358e+12 | 7.31676e+12 | 1.58444e+12 |
| **Importer-year FE** $\omega_{it}$ | Yes | Yes | Yes | Yes |
| **Importer-product FE** $\omega_{ih}$ | Yes | Yes | Yes | Yes |

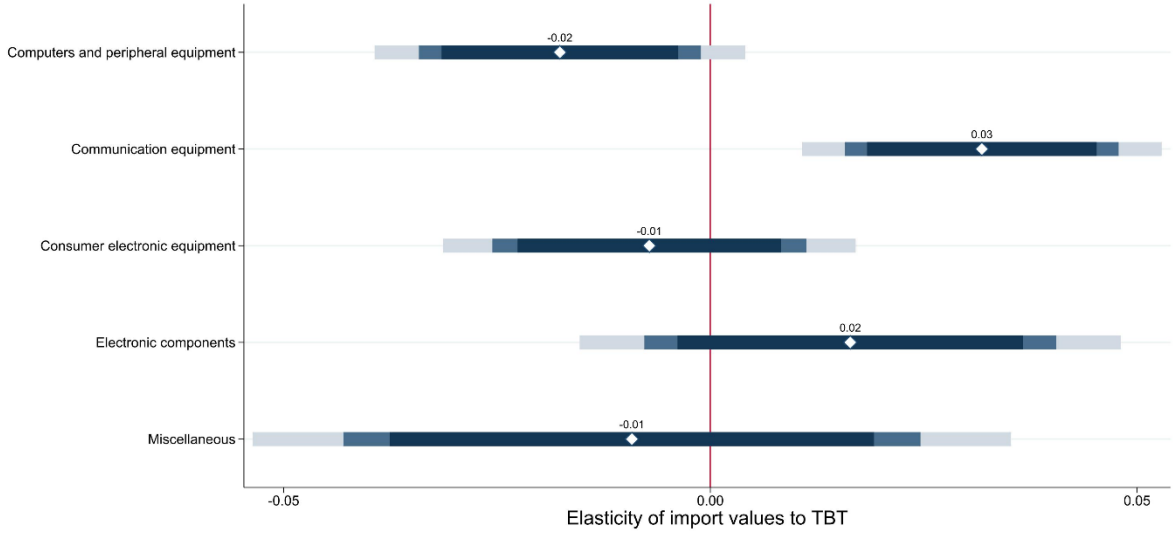
Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.
These estimations are run on equation (1)

## Table A3 / PPML estimation results on imports of ICT goods during 1996-2018

| | TBT in levels | | TBT using arcsine transformation | |
|---|---|---|---|---|
| **Dependent variable:** | $m^v_{iht}$ | $m^q_{iht}$ | $m^v_{iht}$ | $m^q_{iht}$ |
| **arc** $T_{iht}$ | 0.032** | 0.032** | 0.031** | 0.031** |
| | (0.016) | (0.016) | (0.015) | (0.015) |
| $\Delta m^v_{iht-1}$ **or** $\Delta m^q_{iht-1}$ | 0.00013 | -0.00018 | 0.00016 | -0.00016 |
| | (0.00029) | (0.00018) | (0.00029) | (0.00018) |
| **arc** $x^v_{iht}$ **or arc** $x^q_{iht}$ | -0.000018 | 0.00048 | 0.00013 | 0.00068 |
| | (0.00069) | (0.00071) | (0.00070) | (0.00071) |
| $TBT^w_{i'ht}$ **or arc** $TBT^w_{i'ht}$ | 0.019*** | 0.019*** | 0.14*** | 0.13*** |
| | (0.0046) | (0.0046) | (0.037) | (0.037) |
| **Constant** | 2.24*** | 2.23*** | 2.06*** | 2.06*** |
| | (0.018) | (0.016) | (0.062) | (0.062) |
| **Observations** | 63509 | 63509 | 63509 | 63509 |
| **Pseudo R-squared** | 0.711 | 0.711 | 0.711 | 0.711 |
| **AIC** | 180498.8 | 180498.4 | 180490.7 | 180490.1 |
| **Importer-year FE** $\omega_{it}$ | Yes | Yes | Yes | Yes |
| **Importer-product FE** $\omega_{ih}$ | Yes | Yes | Yes | Yes |

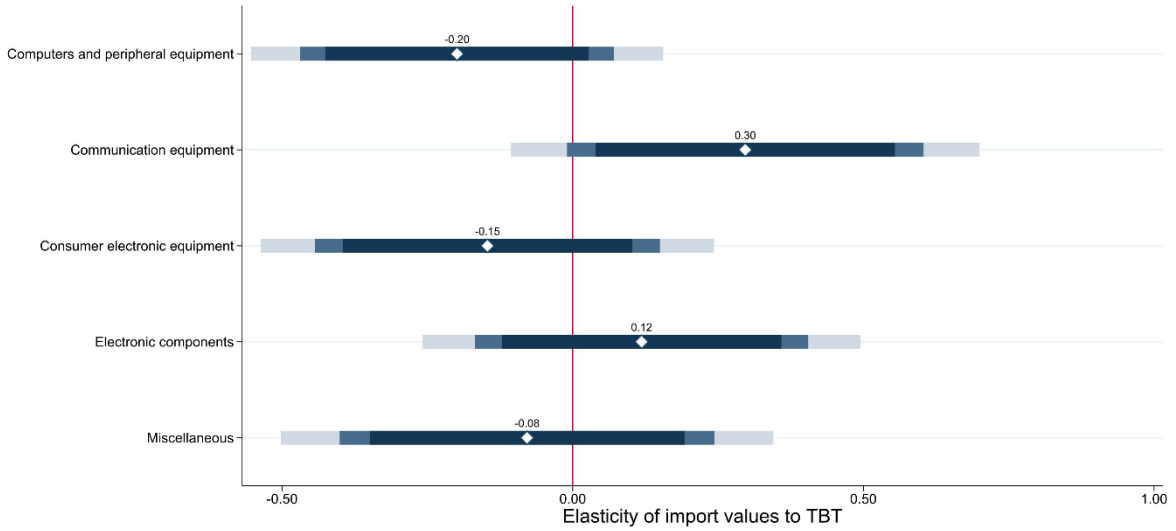
Robust standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01.
These estimations are run on equation (1)

**Figure A1 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import values of ICT goods by category during the period 1996-2018, using TBTs in levels**



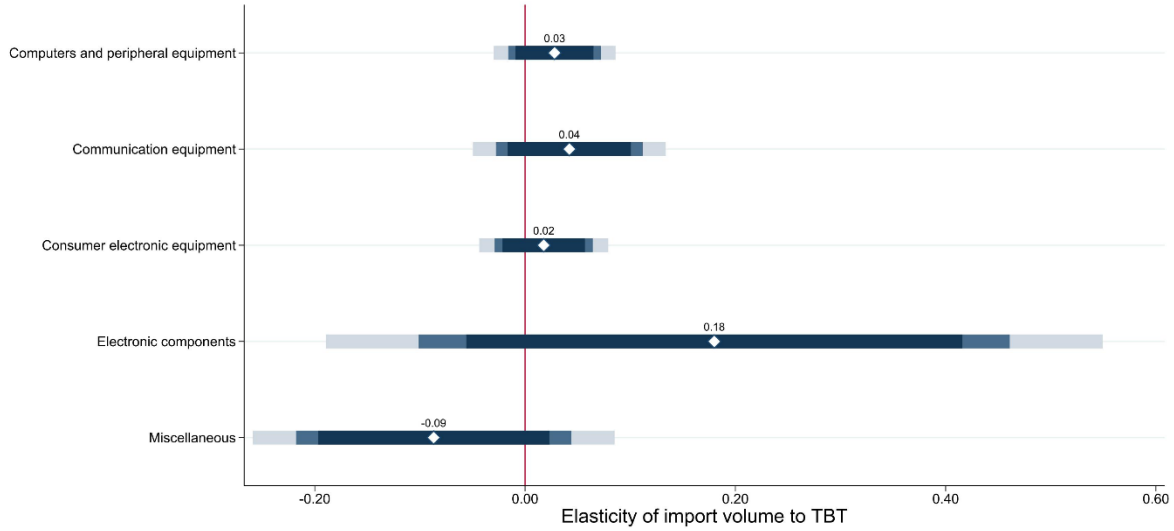

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A2 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import values of ICT goods by category during the period 1996-2018, using TBTs in arcsine transformation**



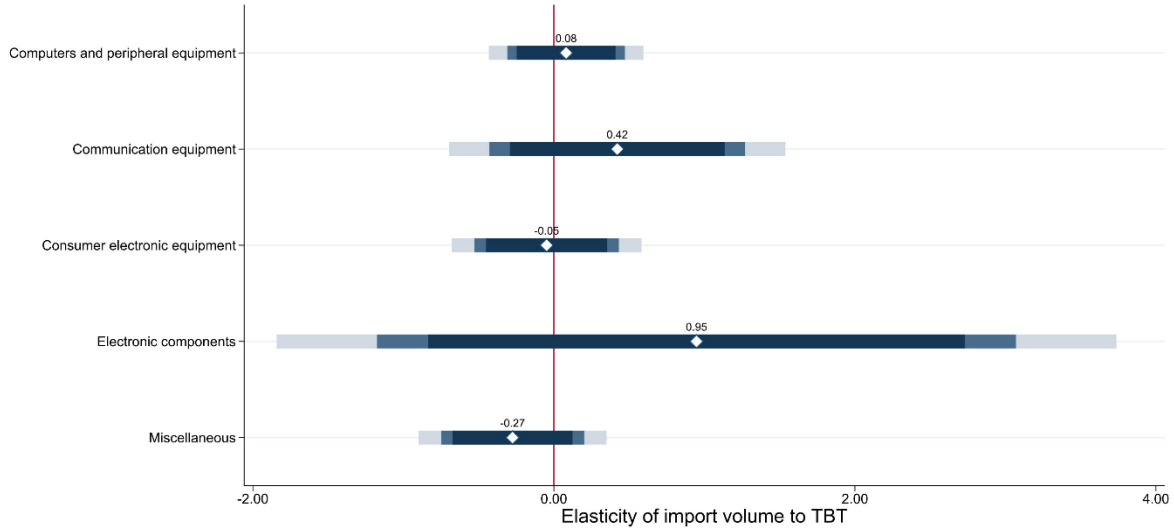

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A3 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes of ICT goods by category during the period 1996-2018, using TBTs in levels**



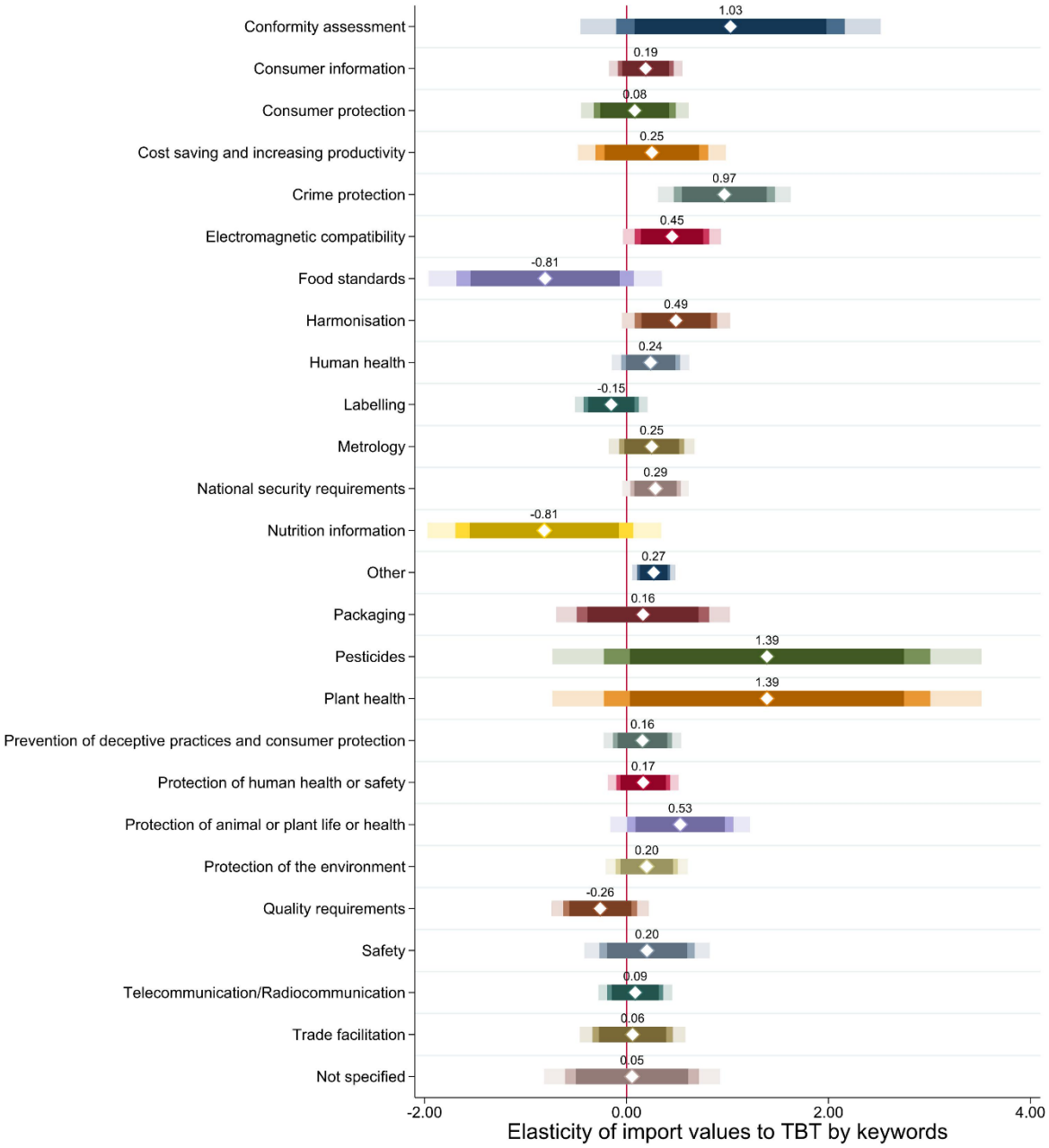

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A4 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes of ICT goods by category during the period 1996-2018, using TBTs in arcsine transformation**



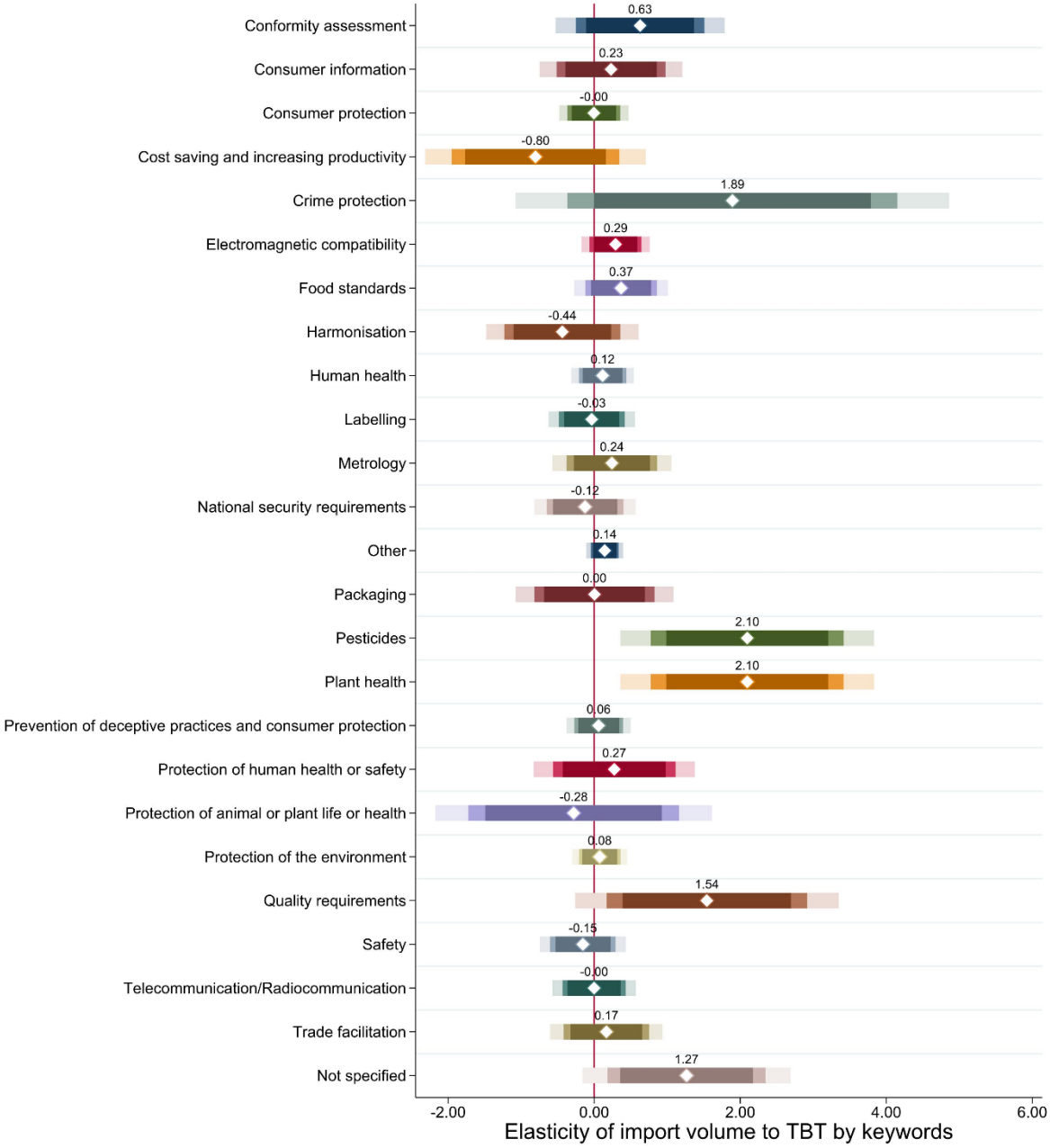

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A5 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import values of ICT goods during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



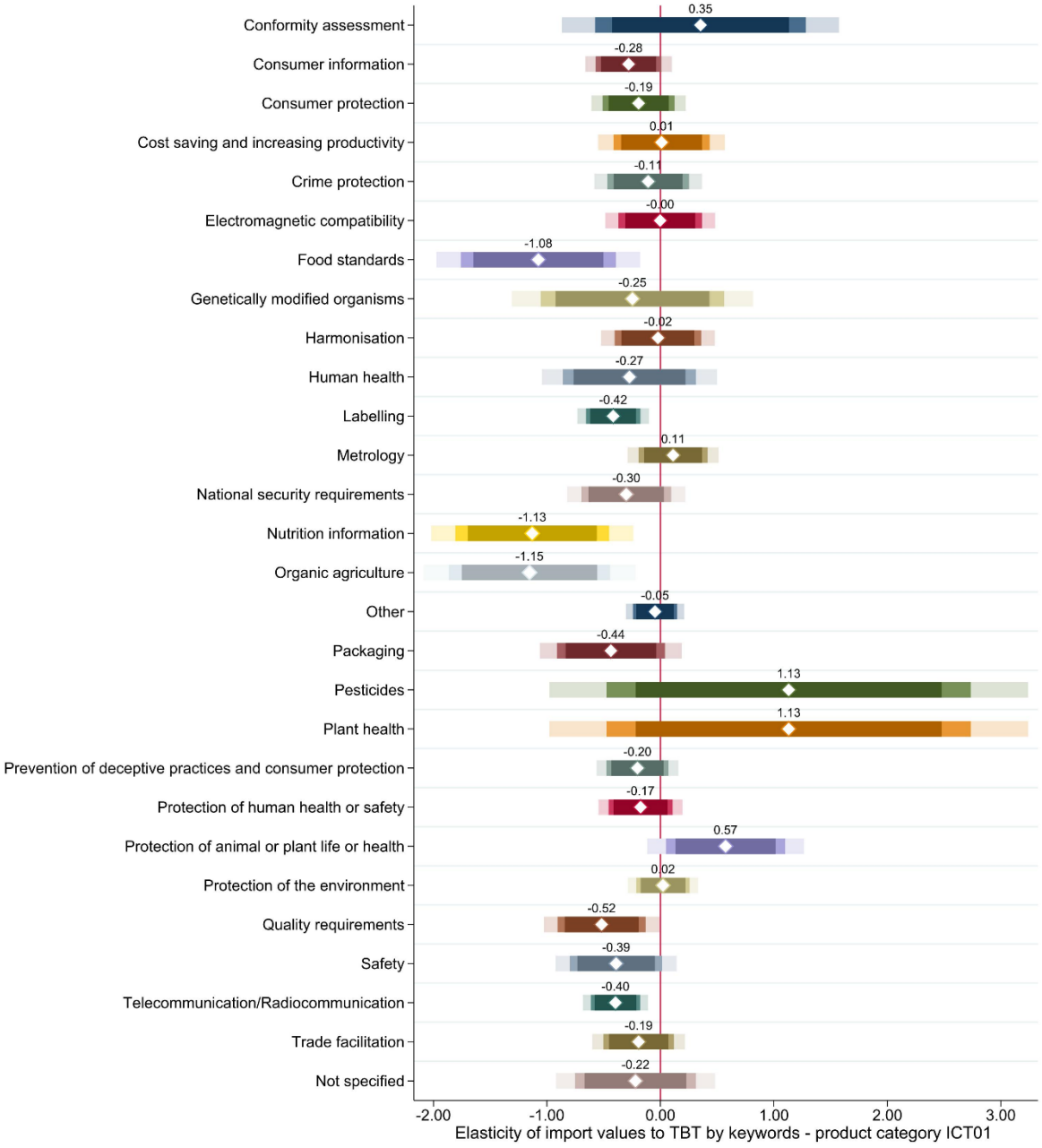

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A6 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes of ICT goods during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



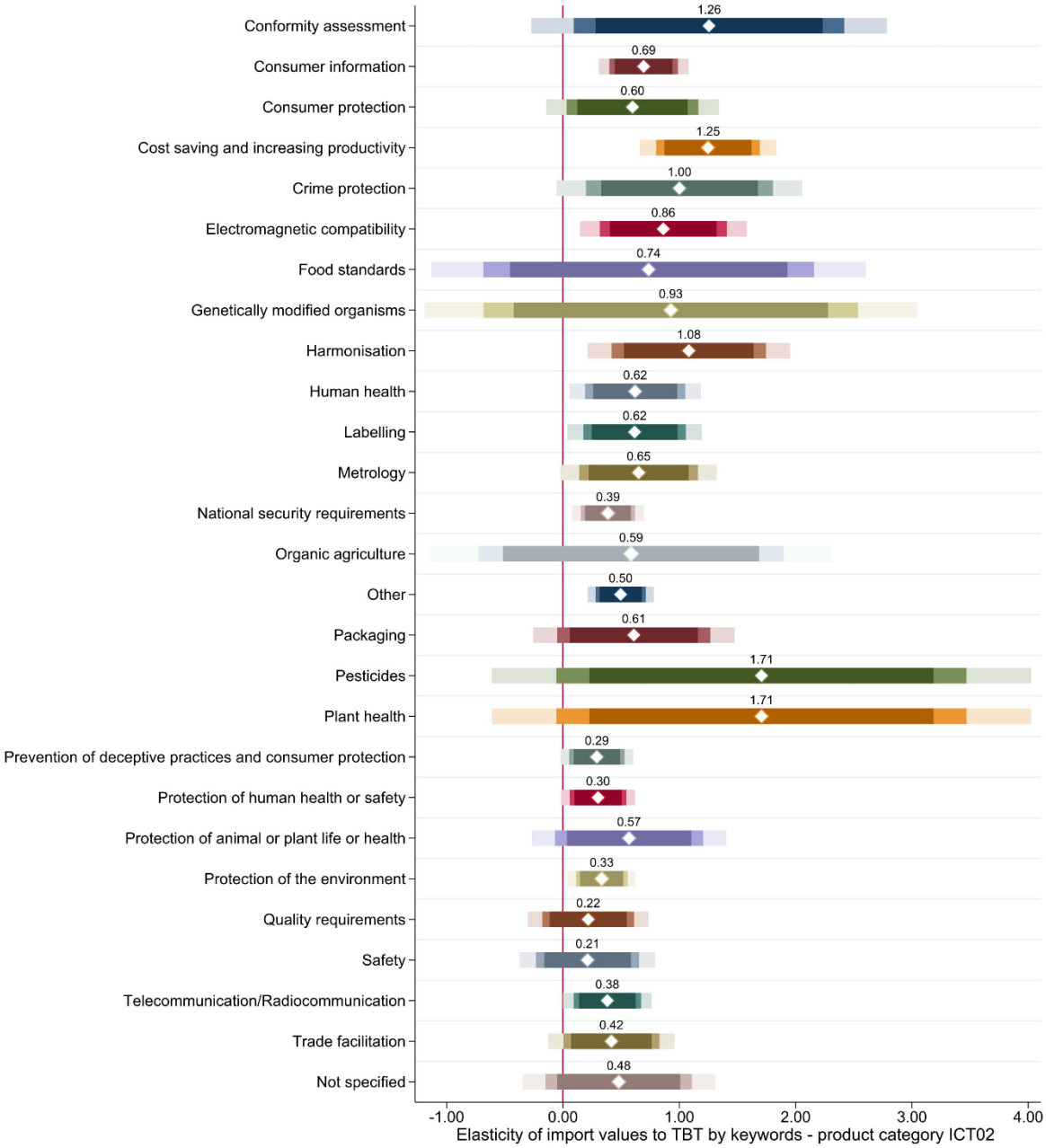

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A7 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import values in 'computers and peripheral equipment' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



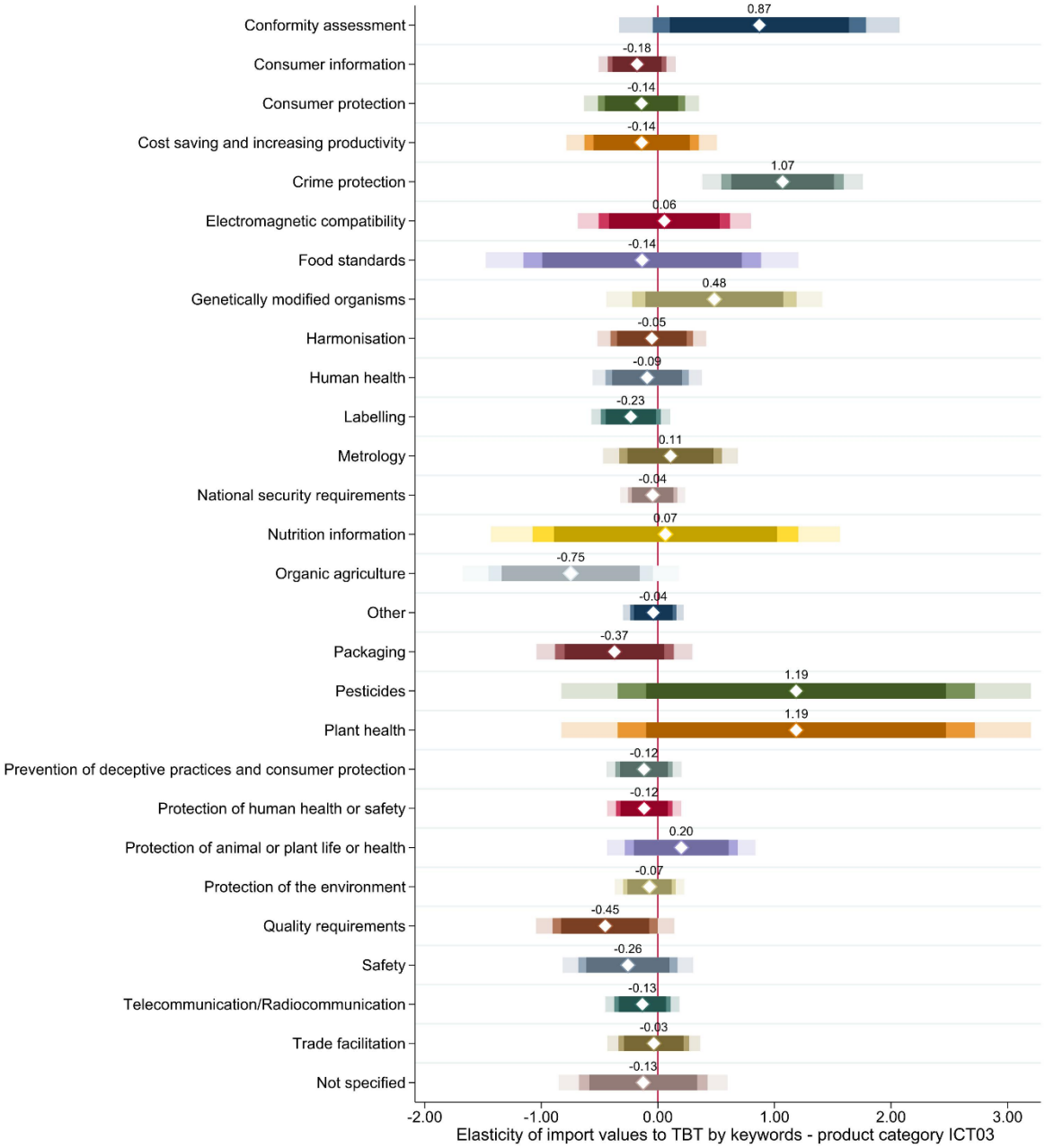

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A8 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import values in 'communication equipment' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



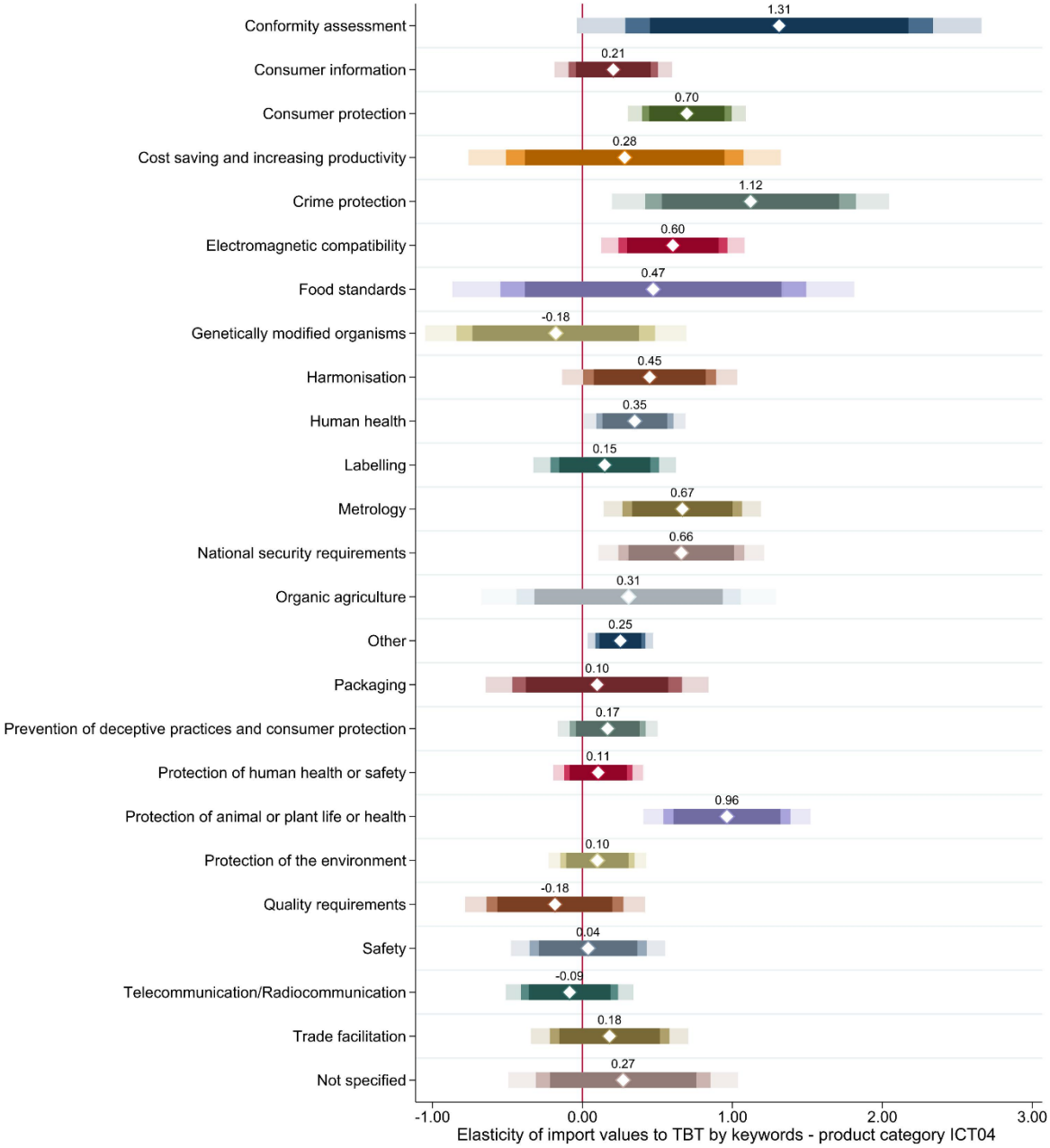

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A9 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import values in 'consumer electronic equipment' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



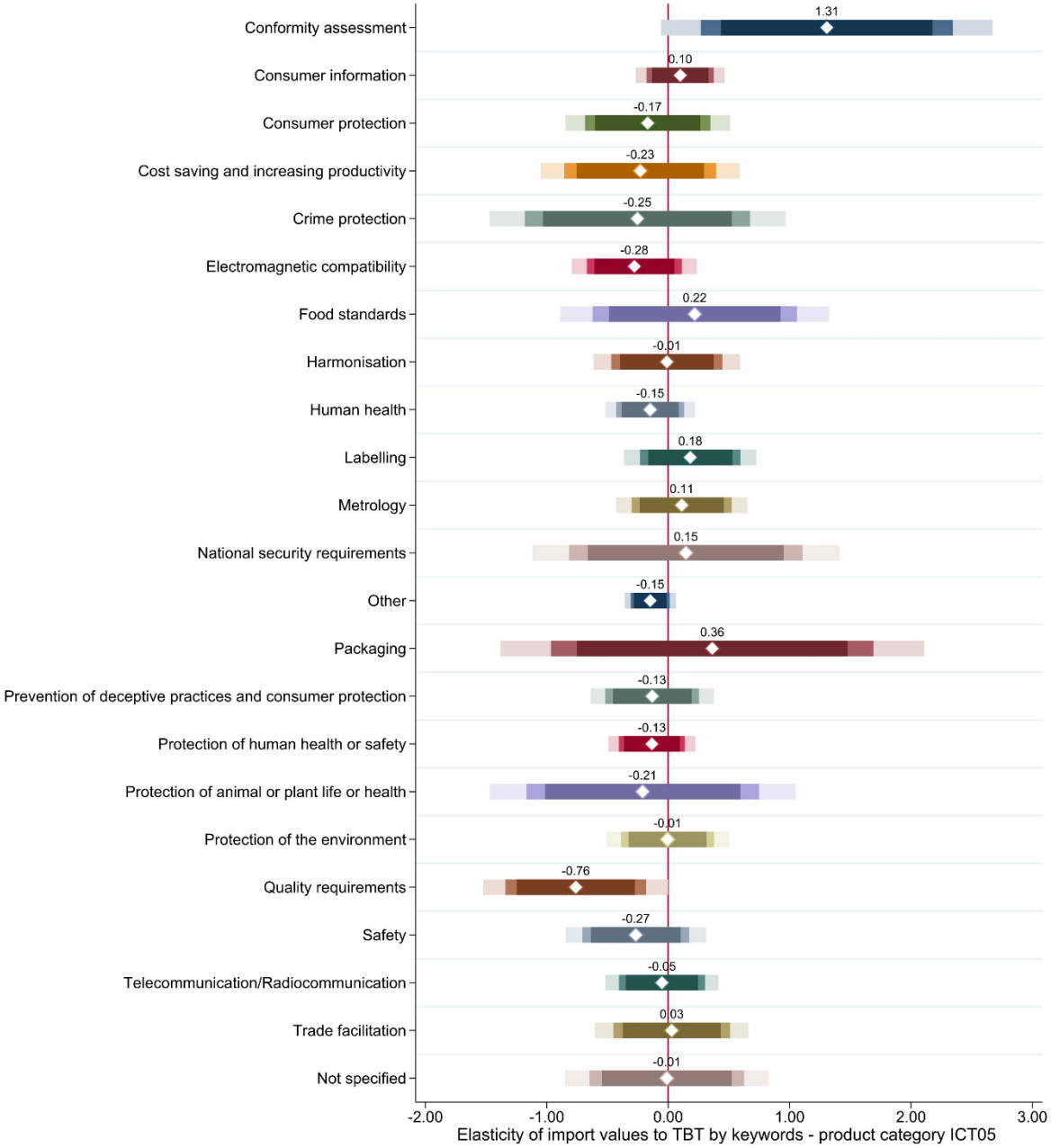

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A10 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import values in 'electronic components' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



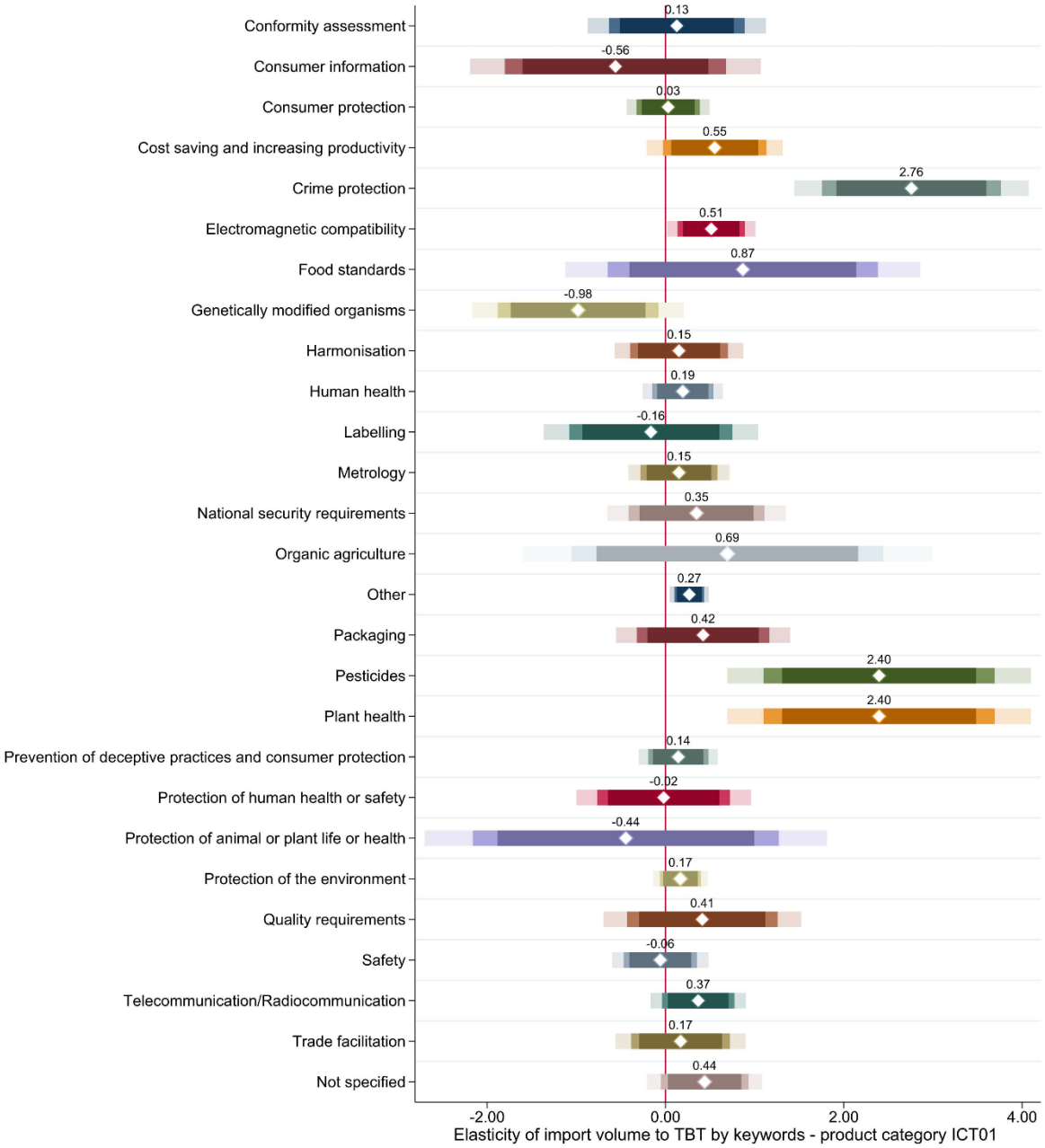

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A11 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import values in 'miscellaneous' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



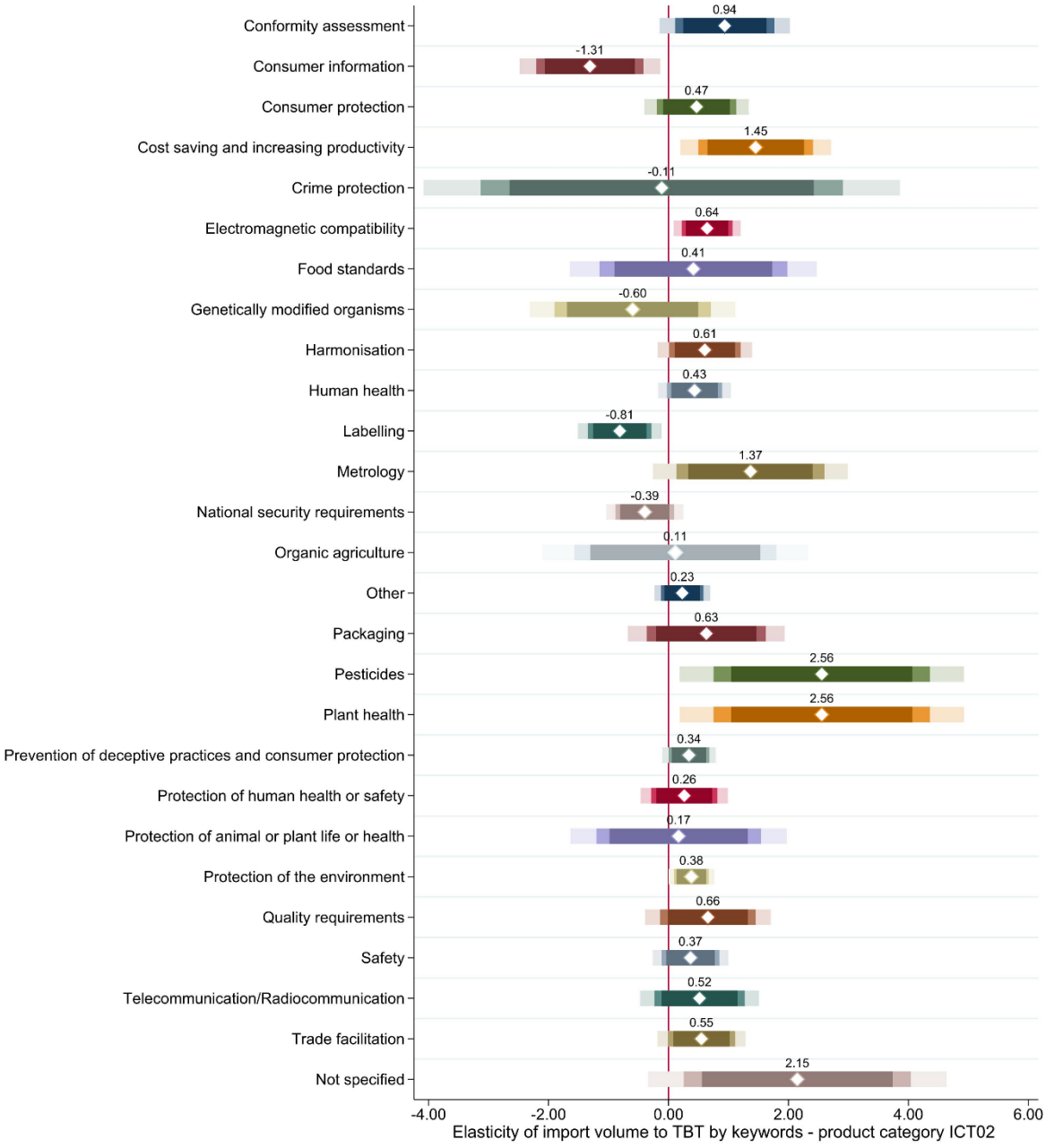

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A12 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes in 'computers and peripheral equipment' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



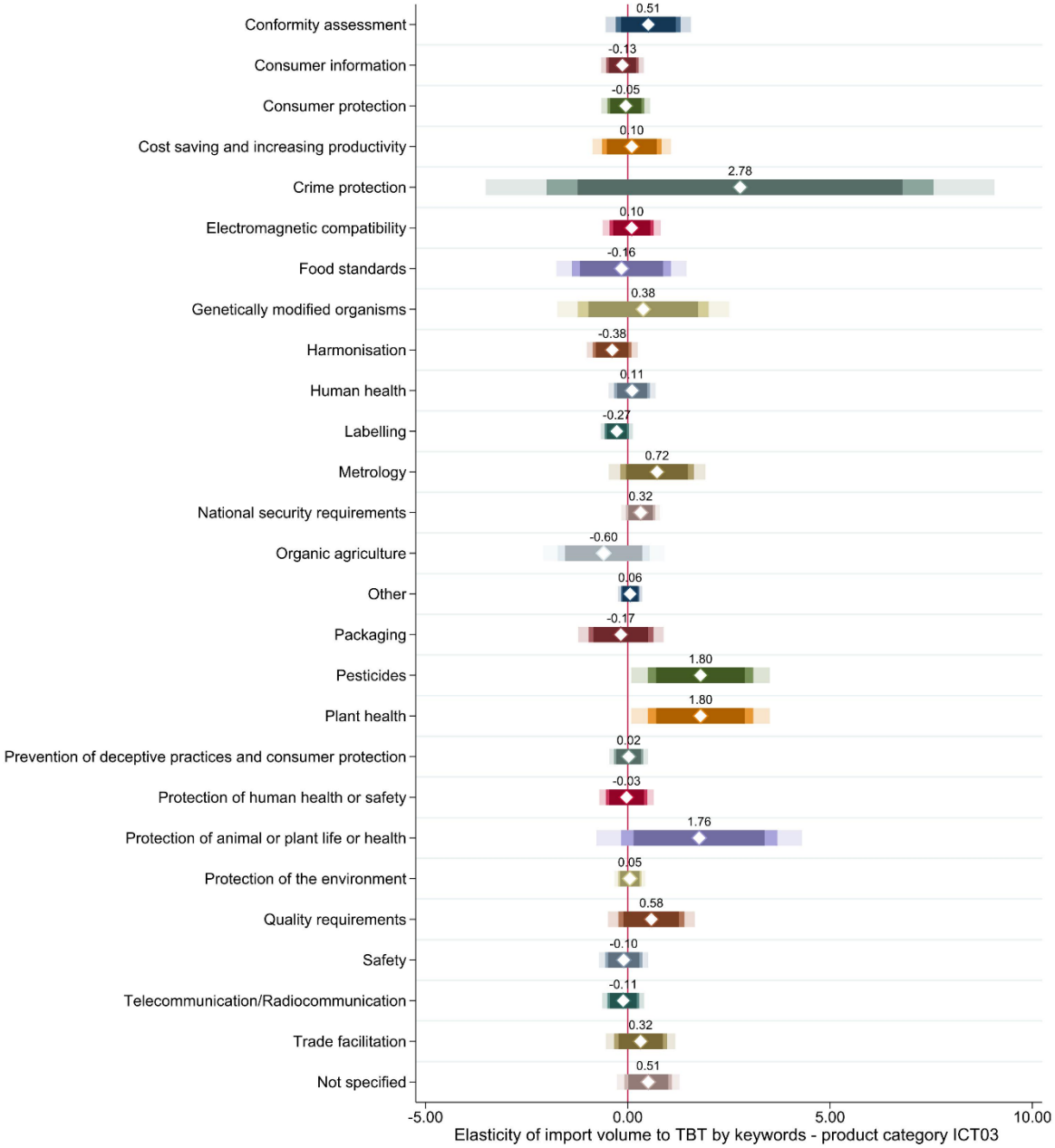

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A13 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes in 'communication equipment' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



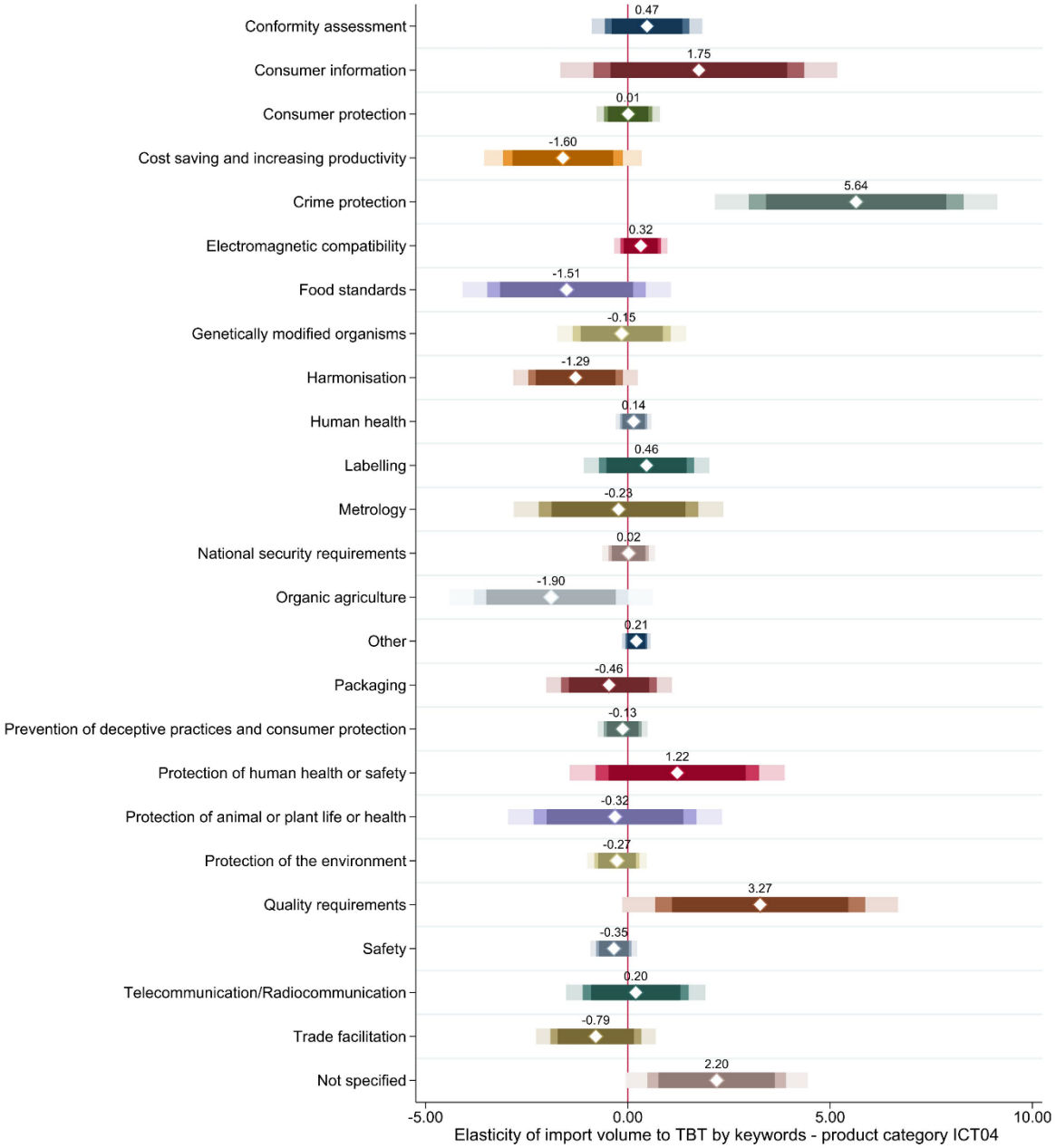

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A14 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes in 'consumer electronic equipment' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**



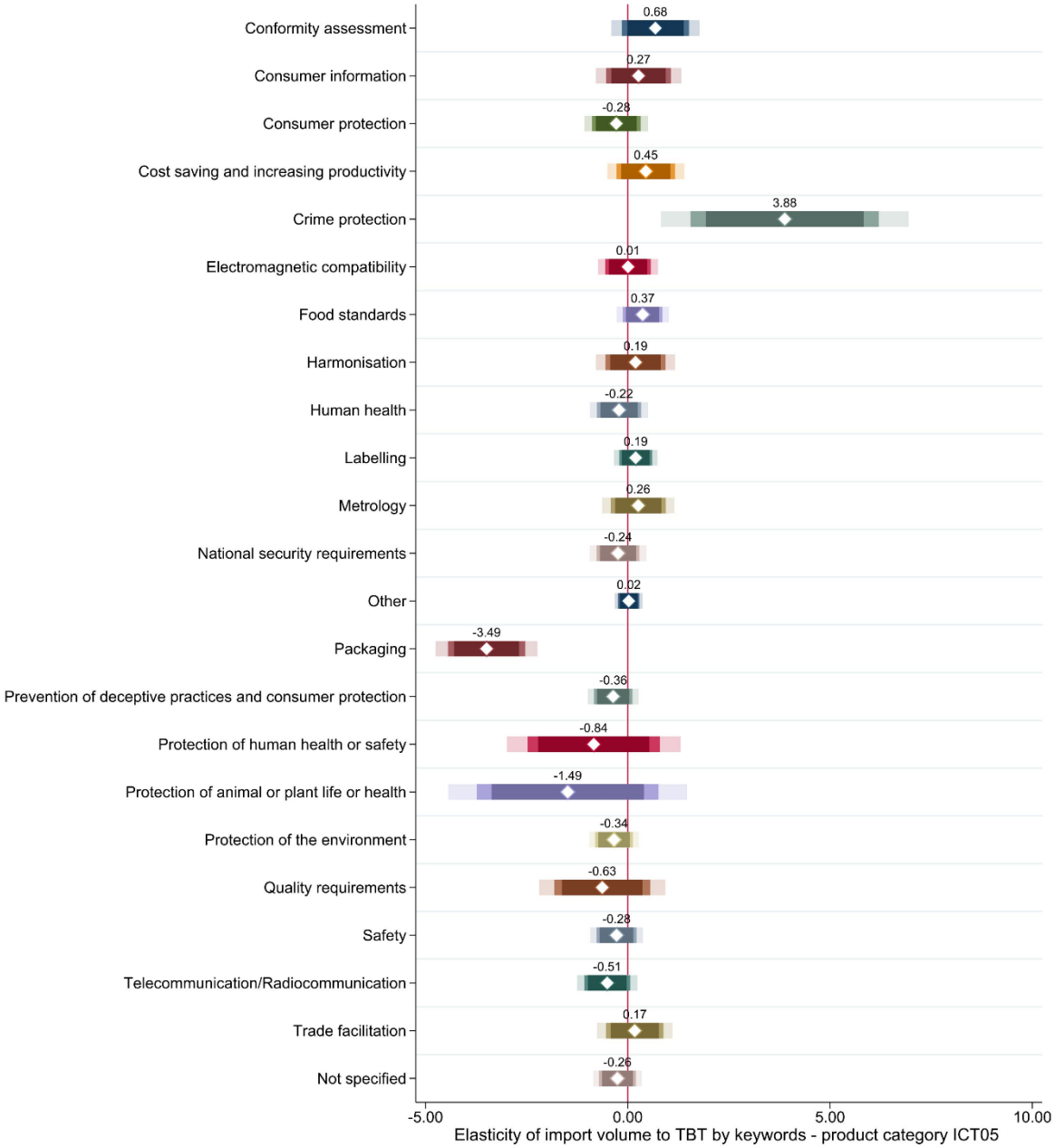

Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A15 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes in 'electronic components' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**




Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

**Figure A16 / Point estimates and confidence intervals of the PPML second-stage instrumental variable on import volumes in 'miscellaneous' during the period 1996-2018 by keywords of TBTs, using hyperbolic TBTs**




Darkest colour p<0.1, middle dark colour p<0.05, lightest colour p<0.01.

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