Adoption of Technical Barriers to Trade and the Quality of Exports: Empirical Analysis on the Machinery Sector

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***Abstract*—Non-tariff Measures (NTMs) ensure the safety of consumer health and the environment. However, regardless of the sound purpose of NTMs, past literature often addressed the negative impact of NTMs on international trade. This research narrows down NTMs to Technical Barriers to Trade (TBT) in the machinery sector to show whether the additional imposition of TBT contributes to or hampers the quality of imported goods. We employ newly published NTMs data from UNCTAD-TRAINS by constructing an Additional Compliance Requirement Indicator. The results indicate that additional TBT negatively affects the quality of imported goods in the machinery sector with statistical significance. The imposition of completely different TBT regulations lowers the quality of imported machinery goods by $38. Additional TBT may ensure minimum quality, but firms will engage in fewer innovative activities in the long term, leading to the eventual deterioration of quality. Therefore, with the considerable impact of TBT on consumer safety, each government needs to engage in TBT harmonization to prevent unnecessary trade costs.**

***Index Terms*—Non-tariff measures, poisson pseudo maximum likelihood, product quality, technical barriers to trade.**

I. Introduction

Non-tariff measures (NTMs) ensure the safety of the environment and consumer health of imposing countries. Unlike Non-tariff Barriers (NTBs), the purpose of NTMs serves as a legitimate tool to enhance the quality of imported goods and facilitate international trade. According to [1], “NTMs are not inherently good or bad – they add to trade costs, but can be important instruments in achieving SDGs, and can even promote trade.” Reference [2] stated that NTMs alleviate market imperfections, which frequent discussions on the trade-reducing effect of NTMs are exaggerated. Nonetheless, trade literature often focuses on the trade-distorting effect of NTMs. Reference [1] also addressed that, “At the same time, a key characteristic of NTMs is that they generate costs for producers and traders who adhere to them. Such costs may raise prices, thus inhibiting international trade.” Series of literature also showed a negative impact of NTMs on international trade [3]–[5].

However, a handful of studies dealt with the quality of products imported. NTMs are often treated as fixed costs. Reference [6] assumed technical regulations as fixed costs using the monopolistic competition. As exporters need to comply with standards and regulations before entering the foreign market, standards and regulations serve as thresholds. Satisfying additional fixed costs imposed by the importing countries may force less productive foreign firms to exit the market and serve only their domestic market [7]. Consequently, the quality of imported goods will increase to meet additional NTMs imposed by the importing countries.

Nevertheless, the past literature on the relationship between NTMs and the quality of products often shows ambiguous results. Reference [8] showed mixed results of the impact of NTMs on the quality of traded goods. They examined the 2008 to 2013 period of food processing firms in Ukraine to show that Sanitary and Phytosanitary Measures (SPS) positively affect exports of upstream industries and negatively affect the certification process on the product quality. Regardless of the sound purposes of NTMs, NTMs are often treated as trade costs and barriers that hamper the quality of imported goods.

This literature focuses on the Technical Barriers to Trade (TBT) portion of NTMs. TBT is part of NTMs, along with SPS. SPS often covers agricultural products and offer safeguard to prevent human diseases and protect animal life. On the other hand, TBT focus on the technical regulation related to production methodologies of goods and conformity assessment, including packaging and sampling. They mostly affect manufacturing goods, specifically, machinery goods. To evaluate the impact of TBT on the quality of traded goods, we empirically test whether the influence of TBT is limited to the machinery sector or exists throughout the whole sector. We interchangeably use technical regulations and TBT in this paper.

Contributions of this paper to the international trade literature is twofold: First, do additional TBT imposed by importing countries hamper the quality of imported goods? By following [9], we construct the Additional Compliance Requirement Indicator (hereafter, ACRI) to examine the additional technical regulations that exporting firms or countries need to follow before entering the regulation-imposing market. Unlike most of the past literature, we extract TBT data from the United Nations Conference on Trade and Development (UNCTAD) – Trade Analysis Information System (TRAIS); a recently published database by UNCTAD and the Economic Research Institute for ASEAN and East Asia (ERIA). Then, we use conventional unit value as the quality of imported goods to empirically test the impact of ACRI on the quality of goods. Second, we conduct regression by sectors to compare whether additional TBT requirements show different impacts in the machinery sector. As TBT are not only highly related to manufacturing or machinery goods but also do not show many observations on agricultural goods, we focus on the total sector, manufacturing sector, and machinery sector in our analysis

The rest of the contents is as follows. We examine the past

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works of literature that are in line with our research in Section II. In Section III, we explain the data sources and empirical methodology. Section IV explains the empirical results. We employ the Poisson pseudo maximum likelihood (PPML) to adjust for anticipated heteroskedasticity in the panel data dealing with international trade flow. The results indicate that although additional TBT negatively affect the quality of imported goods for all sectors, the machinery sector only shows a statistically significant result. As machinery goods are relatively easier to diversify than other sectors, technical regulations such as TBT could be a threshold for exporting countries to comply with before entering the foreign market. Fewer incentives to participate in the innovation process, which require adjustment costs, will eventually deteriorate the quality of the products in the long run. Also, additional costs incurred by innovation will discourage firms from engaging in exports, resulting in a trade-distorting effect. Therefore, TBT critically influence the quality of machinery goods. Section V concludes the paper with policy implications.

II. Literature Review

The majority of past empirical papers show the distorting impact of NTMs on international trade. Reference [6] adopted SPS and TBT notifications of the agricultural sector from UNCTAD. They negatively influenced the exports of developing nations to the members of the Organization for Economic Cooperation and Development (OECD). The gravity equation, however, showed insignificant results among the intra-trade of OECD members. Reference [10] addressed the direct adverse effect of NTMs on low-income economies. Reference [11] utilized the Computable General Equilibrium (CGE) model to show that the harmonization or elimination of NTMs would result in welfare gains of both the exporters and importers. Series of literature also stressed the weak capacities of firms in developing countries to comply with technical regulations of the foreign market [6], [12], [13]

Strands of literature focused on the impact of TBT on international trade. Reference [14] showed both trade restriction and the promotion effect of TBT by constructing coverage ratio and frequency index using the Chinese database from the Ministry of Commerce and Custom General Administration of China. TBT imposed by China showed the trade-restricting effect on the agricultural sector. On the other hand, they showed the trade-promoting effect on the manufacturing sector. Reference [15] and [16] also showed the ambiguous impact of TBT on international trade. Reference [17] examined the fact that TBT increase the volume of incumbent goods via an extensive margin of international trade, especially those imposed by developing countries. However, TBT reduce the probability of trade relationships, especially with those raised by developed countries.

A handful of past literature focused on the impact of technical regulations on the quality of traded goods. Reference [18] used French firm data to show that domestic low-quality firms exit the market as quality standards increase, indicating that overall quality is positively related to technical regulations. Reference [19] stressed the diverse effect of TBT on the imports of the European Union (EU). They examined the market protection of the EU from the 1996 to 2014 period to show that TBTs negatively affect the quantity of trade imported to the EU market. On the other hand, both TBT and SPS positively affected the quality of imports where the quality implies unit value. However, the majority of the past literature constructs the absolute number of reported NTMs, coverage ratio, or frequency index as technical regulations. As they only capture the technical regulations imposed by the importers, the magnitude of compliance for exporters may be biased. Some technical regulations possessed by both exporting and importing countries may not be cumbersome for the exporters to comply with before entering the foreign market. Hence, we suggest the novel methodology of constructing ACRI, that can capture the additional burden of exporters to comply before entering the foreign market, to examine the precise impact of TBT on the quality of imported goods. We further contribute to the literature by narrowing down our sample to machinery goods where the majority of TBT regulations affect machinery goods. As machinery goods are relatively easier to diversify compared to other sector goods, we focus on whether the machinery sector shows different results compared to other sectors.

III. Data and Methodology

A. Figures and Tables

We extract TBT data from UNCTAD-TRAINS. The database recently released the NTMs data with 92 importing countries covering the period from 2010 to 2018. It is unbalanced panel data at the importing country-exporting country-product-year-MAST classification level (M4). MAST refers to Multi-Agency Support Team explained through [20]. Product-level here refers to HS six-digit products. The data represents technical regulations at the time of data collection imposed by the importing countries. Among the MAST group classification chapters of NTMs, we extract chapter B, which refers to TBT. Table 1 refers to the classification of NTMs.

TABLE I: Classification of NTMs

Imports Measure	A	Sanitary and Phytosanitary Measures
	B	Technical Barriers to Trade
	C	Pre-shipment Inspection and other Formalities
	D	Contingent Trade-protective Measures
	E	Restrictions other than SPS and TBT
	F	Price-control Measures
	G	Financial Measures
	H	Measures Affecting Competition
	I	Trade-related Investment Measures
	J	Distribution Restrictions
	K	Restrictions on Post-sales Services
	L	Subsidies and other Forms of Support
	M	Government Procurement Restrictions
	N	Intellectual Property
	O	Rules of Origin
Exports Measure	P	Export-related Measures

Source: See [21] for more details.

We construct variables for NTMs using the three-digit MAST classification level from chapter B. Table II shows the three-digit technical regulations for chapter B. The database standardized the database with M4 MAST classification.

TABLE II: THREE-DIGIT CLASSIFICATION OF CHAPTER B

Two-digit Classification (Measure-type Grouping)	Three-digit classification
B1	B140, B150, B190
B2	B210, B220
B3	B310, B320, B330
B4	B410, B420, B490
B6	B600
B7	B700
B8	B810, B820, B830, B840, B851, B852, B853, B859, B890
B9	B900

Source: For information on each three-digit classification, see [21]. The information is further adjusted by the author.

The data also possess mixed combinations of HS nomenclatures: H2002 (H2), H2007 (H3), H2012 (H4), and H2017 (H5). To comply with trade data, we convert the data using H3 nomenclature using the concordance table from United Nations Trade Statistics (UNSTATS).

We further adjust the data using the start date reported by UNCTAD-TRAINS. If an importing country reports an observation in 2017 and the start date as 2015, we assume the measure reported is documented from 2015 to 2017 for the importing country-exporting country-product-year. As most importing countries before 2015 only cover one period, we use data from the 2015 to 2018 period by adjusting the start date. As a result, our sample includes 59 importing countries-58 counterparts exporting countries-product level from 2015 to 2018. Table III illustrates the International Organization for Standardization three-digit (ISO3) codes for the total sample countries for this research. As the intra-EU does not report any TBT, we include the EU as an aggregate group using EUN.

TABLE III: ISO3 FOR THE SAMPLE

ISO3	ARG, ATG, AUS, BGD, BLR, BOL, BRA, BRN, BWA, CAN, CHL, CHN, COL, CRI, CUB, DZA, ECU, EUN, GTM, HKG, HND, IDN, IND, ISR, JOR, JPN, KAZ, KGZ, KHM, KOR, LAO, LBN, LKA, MAR, MEX, MMR, MUS, MYS, NIC, NZL, PAK, PAN, PER, PHL, PNG, PRY, QAT, RUS, SAU, SGP, SLV, THA, TJK, TUN, TUR, URY, USA, VNM, ZWE

Source: Author's calculation.
Note: See United Nations Country Code for detailed information on each ISO3 code. https://unstats.un.org/unsd/tradekb/knowledgebase/country-code

We then construct a unit value from the international trade flow from the United Nations International Trade Statistical Database (UN COMTRADE) using the import statistics. We complement missing import statistics with mirror export statistics when the entire sector (HS two-digit code) is missing import statistics. As suggested by [22], we multiply 1.1 with the mirror export statistics when replacing, to meet the c.i.f./f.o.b. ratio where cost, insurance and freight are represented as c.i.f., and free on board is represented as f.o.b. The unit of trade data is the constant 2015 US dollar. We divide the trade value by the quantity, which represents the price of goods evaluated with one unit of quantity; higher quality goods will be more expensive.

Control variables of this research are Free Trade Agreements (FTA), distance, and Gross Domestic Product (GDP) per capita of both importing countries and exporting countries. FTA is retrieved from the WTO's Regional Trade Agreements (RTA) database. It is a dummy variable with a value one when the importing and exporting countries have any preferential trade agreement (PTA) relationship. It captures whether tariff reductions from FTA enhanced the quality of imported goods or not. Distance is from Research and Expertise on the World Economy (CEPII). We use the physical distance from the capital cities and take a natural logarithm to normalize the distribution. We suppose Brussels as the capital city of the EU, as it incorporates significant institutions of the EU, such as the European Parliament, the European Commission, and the Council of the European Union. We extract GDP per capita of importing and exporting countries from World Development Indicators (WDI) and further use natural logarithm to normalize the value. In line with the trade data, unit of the GDP per capita is also the constant 2015 US dollar.

B. Methodology

We first begin by constructing the ACRI suggested by [9]. Instead of constructing the observable number of NTMs reported by the NTMs database, they focused on the additional technical regulation that exporting countries need to comply with when entering the foreign market. We define the regulatory vector of TBT implemented by exporting countries i on product p at time t against the world as

$$R^E_{ipt} = \left(R^E_{ipt1},\ R^E_{ipt2}, \dots, R^E_{iptk}, \dots, R^E_{iptK}\right), \qquad (1)$$

where R^E_{iptk} reflects the number of three-digit TBT measures in measure type grouping k. As shown in Appendix B, the largest possible number of R^E_{iptk} is nine in B8. E refers to exporting countries. The inherent assumption is that exporting countries need to meet the domestic TBT regulations that are imposed against the world on each product before penetrating the foreign market. We suppose 59 total sample countries as the world and constructed vector R^E_{ipt}.

Vector for bilateral technical regulations imposed by the importing countries j that are mandatory for exporting countries i to comply on product p at time t is

$$R^I_{ijpt} = \left(R^I_{ijpt1}, R^I_{ijpt2}, \dots, R^I_{ijptk}, \dots, R^I_{ijptK}\right), \qquad (2)$$

where R^I_{ijptk} reflects the number of three-digit TBT measures in k. Along with R^E_{iptk}, the largest number of possible R^I_{ijptk} is nine. I refers to importing countries. We then sum (1) and (2) to construct the aggregate measure of technical regulations as

$$R_{ijpt} = \left(R^E_{ipt1} + R^I_{ipt1}, R^E_{ipt2} + R^I_{ipt2}, \dots, R^E_{iptk} + R^I_{ijptk}, \dots, R^E_{iptK} + R^I_{iptK}\right). \qquad (3)$$

Vector R_{ijpt} is the sum of vector R^E_{ipt} and R^I_{ijpt} which indicates the aggregate measure of TBT measures that exporting countries need to follow. As R^E_{ipt} and R^I_{ijpt} coincide with specific three-digit TBT measures, we apply cosine similarity between R^E_{ipt} and R_{ijpt} to determine the dissimilarity that exporting countries need to follow before entering the foreign market which is shown as

$$\mathrm{Cos}(\theta)_{ijpt} = \frac{R^E_{ipt} \cdot R_{ijpt}{}'}{\|R^E_{ipt}\| \|R_{ijpt}\|} = \frac{\sum_{k=1}^{K} R^E_{ipt} R_{ijpt}}{\sqrt{\sum_{k=1}^{K}\left(R^E_{ipt}\right)^2}\sqrt{\sum_{k=1}^{K}\left(R_{ijpt}\right)^2}}. \qquad (4)$$

Equation (4) shows a cosine similarity result between R^E_{ipt}

and R_{ijpt} . θ implies whether vectors are identical or orthogonal, where zero degrees indicate an identical relationship, and 90 degrees indicate an orthogonal relationship. As the two vectors R_{ipt}^{E} and R_{ijpt} show less relationship, $\mathrm{Cos}(\theta)_{ijpt}$ result in a lower value. Finally, we construct ACRI as

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

The larger the value of $\mathrm{ACRI}_{ijpt,}$ the more exporting countries need to comply with more additional TBT regulations before entering the foreign market. ACRI always have value if exporting countries and importing countries impose at least one TBT measure ($\mathrm{ACRI}_{ijpt} \in [0,1)$). We replace $\mathrm{ACRI}_{ijpt} = 0$ when importing countries do not impose any TBT, implying that exporting countries do not need to comply with the additional requirements of TBTs. On the other hand, when exporting countries need to follow at least one or more TBT measure and exporting countries do not require domestic TBT measures to follow, we replace $\mathrm{ACRI}_{ijpt} = 0$, as we cannot calculate cosine similarity.

Equation (6) indicates the empirical framework of this paper. $Quality_{ijpt}$ refers to the quality of traded goods from exporting country i to importing country j on product p at time t. We constructed unit value to represent $Quality_{ijpt}$.

$$Quality_{ijpt} = f\left(ACRI_{ijpt} \cdot Distance_{ij} \cdot FTA_{ijt} \cdot V_{ijpt} \cdot \delta_{ijp} \cdot u_{ijpt}\right) \quad (6)$$

The quality of traded goods is a function of vectors such as technical regulations ($ACRI_{ijpt}$), distance ($Distance_{ij}$), FTA (FTA_{ijt}), other control variables (V_{ijpt}) and error terms (δ_{ijp} and u_{ijpt}), where δ_{ijp} refers to time-invariant error term and u_{ijpt} as time-variant error term, respectively. We re-write (6) as a form of gravity equation as

$$\begin{aligned} Quality_{ijpt} = a_0 + a_1 ACRI_{ijpt} + a_2 lnDistance_{ij} \\ + a_3 FTA_{ijt} + a_4 lnGDPPC_{jt} \\ + a_4 lnGDPPC_{it} + \delta_{ijp} + u_{ijpt}), \end{aligned} \quad (7)$$

where we decompose V_{ijpt} as $lnGDPPC_{jt}$ (natural log of importing countries' GDP per capita) and $lnGDPPC_{it}$ (natural log of exporting countries' GDP per capita). We take a natural logarithm to normalize the distribution of distance and GDP per capita of importing and exporting countries. We conduct (7) using the PPML estimation with the total sample, manufacturing sector sample, and machinery sector sample. As [23] suggests, the PPML estimator is effective in controlling for heteroskedasticity. As our data is panel data composed of cross-section and time-series, employing Ordinary Least Squares (OLS) may violate the necessary assumptions for an unbiased estimator. Therefore, we adopt PPML to account for the panel characteristics of our data. Tables IV to IX report summary statistics and the correlation matrix of each sample. We extract observations from HS 2-digit code from 28 to 92 as the manufacture sector and 84 to 92 to define the machinery sector. The matrices show no significant outliers, and the correlation tables also show less correlations between variables.

TABLE IV: SUMMARY STATISTICS (TOTAL SAMPLE)

VARIABLES	N	Mean	SD	Min	Max
Quality	4,854,065	2.51e+08	4.29e+11	1.03e-12	9.11e+14
ACRI	4,854,065	0.261	0.410	0	1
FTA	4,854,065	0.551	0.497	0	1
Distance	4,854,065	7580.706	5212.814	111.093	19812.04
GDPPC (i)	4,854,065	9.98e+07	1.09e+11	4.02e-22	2.13e+14
GDPPC (j)	4,854,065	88060.42	254420.7	693.185	1188732

Source: Author's calculation.
Note: N refers to the number of observations. SD refers to standard deviation. Min and Max refer to the minimum and maximum value, respectively. All variables are of raw value. GDPPC refers to GDP per capita.

TABLE V: CORRELATION MATRIX (TOTAL SAMPLE)

	Quality	ACRI	FTA	Distance	GDPPC (i)	GDPPC (j)
Quality	1					
ACRI	-0.000	1				
FTA	0.001	-0.029*	1			
Distance	-0.000	0.0122*	-0.322*	1		
GDPPC (i)	0.022*	-0.001	0.001	0.001	1	
GDPPC (j)	-0.000	0.277*	-0.131*	0.016*	0.000	1

Source: Author's calculation.
Note: N refers to the number of observations. SD refers to standard deviation. Min and Max refer to minimum and maximum value, respectively. All variables are raw value. GDPPC refers to GDP per capita. * p<0.01.

TABLE VI: SUMMARY STATISTICS (MANUFACTURING SECTOR)

VARIABLES	N	Mean	SD	Min	Max
Quality	4,127,479	2.87e+08	4.65e+11	1.03e-12	9.11e+14
ACRI	4,127,479	0.260	0.414	0	1
FTA	4,127,479	0.549	0.498	0	1
Distance	4,127,479	7661.421	5241.385	111.0933	19812.04
GDPPC (i)	4,127,479	1.17e+08	1.18e+11	4.02e-22	2.13e+14
GDPPC (j)	4,127,479	85862.65	251466.4	693.1848	1188732

Source: Author's calculation.
Note: N refers to the number of observations. SD refers to standard deviation. Min and Max refer to the minimum and maximum value, respectively. All variables are of raw value. GDPPC refers to GDP per capita.

TABLE VII: CORRELATION MATRIX (MANUFACTURING SECTOR)

	Quality	ACRI	FTA	Distance	GDPPC (*i*)	GDPPC (*j*)
Quality	1					
ACRI	-0.000	1				
FTA	0.001	-0.032*	1			
Distance	0.000	0.013*	-0.313*	1		
GDPPC (*i*)	0.022*	-0.001	0.001	0.001	1	
GDPPC (*j*)	-0.000	0.291*	-0.131*	0.011*	0.000	1

Source: Author's calculation.

Note: N refers to the number of observations. SD refers to standard deviation. Min and Max refer to the minimum and maximum value, respectively. All variables are of raw value. GDPPC refers to GDP per capita. * p<0.01.

TABLE VIII: SUMMARY STATISTICS (MACHINERY SECTOR)

VARIABLES	N	Mean	SD	Min	Max
Quality	1,224,713	9.63e+08	8.53e+11	1.56e-08	9.11e+14
ACRI	1,224,713	0.262	0.412	0	1
FTA	1,224,713	0.543	0.498	0	1
Distance	1,224,713	8142.364	5330.776	111.093	19812.04
GDPPC (*i*)	1,224,713	3.95e+08	2.17e+11	2.08e-14	2.13e+14
GDPPC (*j*)	1,224,713	79297.94	239928.3	693.1848	1188732

Source: Author's calculation.

Note: N refers to the number of observations. SD refers to standard deviation. Min and Max refer to the minimum and maximum value, respectively. All variables are of raw value. GDPPC refers to GDP per capita.

TABLE IX: CORRELATION MATRIX (MACHINERY SECTOR)

	Quality	ACRI	FTA	Distance	GDPPC (*i*)	GDPPC (*j*)
Quality	1					
ACRI	-0.001	1				
FTA	0.001	-0.015*	1			
Distance	-0.001	-0.002	-0.268*	1		
GDPPC (*i*)	0.022*	-0.001	0.001	0.002	1	
GDPPC (*j*)	-0.000	0.298*	-0.112*	-0.010	0.000	1

Source: Author's calculation.

Note: N refers to the number of observations. SD refers to standard deviation. Min and Max refer to the minimum and maximum value, respectively. All variables are of raw value. GDPPC refers to GDP per capita. * p<0.01.

IV. RESULTS

Table X shows the PPML regression results using (7). We include year dummies to control for the year fixed effect.

TABLE X: PPML RESULTS

VARIABLES	(Total) PPML	(Manufacture) PPML	(Machinery) PPML
ACRI	-1.268	-20.085	-38.867***
	(2.074)	(17.213)	(19.016)
FTA	4.952***	4.748***	4.878***
	(0.786)	(0.833)	(0.849)
Log of Distance	-0.774***	-1.035***	-1.301***
	(0.300)	(0.329)	(0.405)
Log of GDPPC (*i*)	0 .853***	-0.905***	0.926***
	(0.248)	(0.279)	(0.284)
Log of GDPPC (*j*)	-0.496***	-0.496**	-0.495***
	(0.179)	(0.194)	(0.195)
Constant	9.253***	10.759**	12.281***
	(6.675)	(5.377)	(5.118)
Year FE	YES	YES	YES
Observations	4,854,065	4,127,479	1,224,713
R-squared	0.567	0.700	0.726
Pseudo log-likelihood	-2.663e+15	-2.292e+15	-2.144e+15

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

As shown in Table X, ACRI shows negative coefficients toward all samples. However, ACRI is only statistically significant in the machinery sector. If the technical regulation between the exporting country and importing country is completely different, exporters need to comply with new TBT regulations before entering the importing market (ACRI=1). In this case, the unit price of machinery goods, which represents the quality in this research, decreases by $39. In contrast to the sound purposes of TBT, additional TBT for the exporting countries disturb the quality of imported goods. As [7] discussed, low productive firms will exit the foreign market as fixed costs increase. They will serve only the domestic market to make profits. If low productive firms exit the foreign market, the quality of imported goods may increase in the short term. However, in the medium term and long term, the quality of imported goods will deteriorate. First, the additional imposition of TBT by importing countries ensures the minimum quality of imported goods. As machinery goods are relatively easy to diversify (an extensive margin of international trade), firms with minimum quality will enter more. Technical regulations will eventually become a threshold to enter the foreign market for exporting firms, and less innovation will occur both for the small firms and large firms. as they do not have incentives to pay extra costs. Second, innovation to fulfill additional TBT requirements incurs adjustment costs [24]. Additional costs will discourage firms from formulating trading relationships and lead to a trade-distorting effect regardless of the firms' size. as high productive firms may also seek other low-cost counterparts.

Additionally, we verify that the FTA relationship increases the quality of imported goods by $5. Eliminating tariffs not only induce low-quality goods but also high-quality goods that are more vulnerable to tariffs. The results show that high-quality goods suffer more from bilateral or multilateral tariffs, and the FTA relationship contributes to the import of high-quality goods. As traditional international trade literature often suggests, longer distance negatively affects not only international trade flow but also the quality of imported goods.

V. Conclusion

This research conducts empirical analysis on the impact of TBT on the quality of imported goods with the total sample, manufacturing sector sample, and machinery sector sample. The results indicate that additional TBT negatively affect the quality of imported goods in the machinery sector with statistical significance. Although the additional imposition of TBT ensures minimum quality, it will deteriorate in the long term, as firms have fewer incentives to participate in the innovation process. Even those firms engaging in the new innovation to meet additional technical regulations may also seek different partners with smaller costs (trade-distorting effect).

Although we employed a new method suggested by [9] to calculate an additional technical regulations requirement by the exporters to capture the impact of TBT in the machinery sector, there are few shortcomings. First, the magnitude of TBT is still ambiguous. With the current database, NTMs only show the existence of technical regulations. Some regulations may have a more considerable impact than others, which is challenging to capture from currently documented regulations. Second, future works need to consider constructing an improved quality variable. As the current research only focuses on the price side of quality using the unit value, future research needs to capture the supply side of quality.

Nonetheless, TBT contribute to consumer safety. Additional regulations can prevent hazardous materials from entering the domestic market. As an unexpected effect of TBT is to hamper international trade and negatively affect the quality of traded goods, harmonization of TBT within international society is essential to avoid unnecessary trade costs. Each government needs to be aware of the trade-distorting effect of TBT and contribute to the harmonization of the technical regulations rather than the mere eradication.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

The author conducted the research, analyzed the data and wrote the paper. The author had approved the final version.

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