

Effects of Technical Barriers to Trade on Vietnam's Export Performance and Global Value Chain Participation

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Abstract This study investigates the effects of Technical Barriers to Trade (TBTs) on Vietnam's exports, with a focus on participation in Global Value Chains (GVCs). Utilizing panel data on product-level exports from 2007 to 2019 and employing a modified gravity model, we assess the impact of TBTs by considering its way to participate GVC. We find that TBTs are positively associated with Vietnam's export performance. Nonetheless, in sectors where Vietnam is deeply engaged in backward GVC participation, in low value-added activities such as assembly, TBTs incur additional compliance costs, which mitigate the positive effects on exports. Moreover, TBTs implemented by OECD member countries raise compliance costs for Vietnam due to stringent TBT requirements, thereby reducing Vietnam's exports regardless of the sectors in which Vietnam is highly involved in GVCs. However, TBTs from non-OECD countries in sectors where Vietnam participates in forward GVC stimulate import demand by providing positive signals regarding quality, which enhances Vietnam's exports.

Keywords: Technical Barriers to Trade, Global Value Chain, Vietnam's Export

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I. Introduction

Since Vietnam joined the World Trade Organization (WTO) in 2007, its exports have soared and diversified from primarily agricultural products to manufactured items. Thanks to a significant reduction in tariffs worldwide, trade liberalization in Vietnam has been achieved successfully and rapidly. However, other types of trade policies, besides tariffs, non-tariff measures (NTMs), have rapidly increased (Figure 1). Among NTMs, Technical Barriers to Trade (TBT) measures are classified as standard-like NTMs because they have the objective of protecting human health and ensuring safety. Theoretically, the relationship between TBTs and bilateral trade is ambiguous. On the one hand importers' TBTs may be negatively associated with exports from their trading partners by increasing trade costs. On the other hand, TBTs may be positively associated with

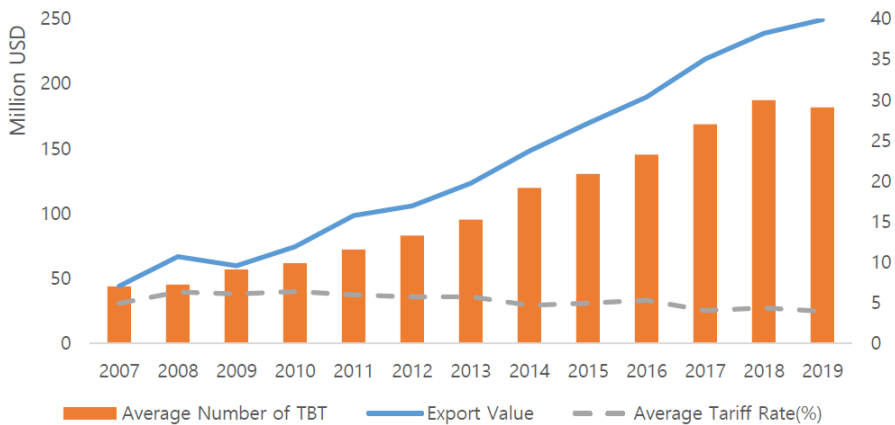
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exports by improving consumers' awareness in import countries. In other words, exporters subject to newly established TBTs in their targeting markets may have to raise production costs or prices due to additional compliance costs, reducing bilateral trade flows. Due to an increase in production costs, TBTs act like barriers to trade. On the other hand, once TBTs provide information and a positive signal to ensure higher quality or safety, consumers may increase their import demand. Such demand-enhancing effects are considered catalysts for trade. Empirically, numerous studies analyzing the impact of TBTs on bilateral trade have not shown consistent results regarding the direction and extent of the effects as findings depend on the industries, countries, and time periods studied.

Figure 1. Trends in TBT, tariffs, and Vietnam's export value



In this study, we analyze the effects of TBTs on Vietnam exports with consideration of its way to participate Global Value Chain (GVC). Vietnam has become one of countries that actively involved in GVC. Furthermore, recent literature points out Vietnam as the one of winners of the trade war because many export items of Vietnam are overlapped with the targeted items under the war. As a result, Vietnam increases its exports to the United States in the response to the US-China trade war (Fajgelbaum et al. 2020). As a result, Vietnam's participation in GVC is growing in significance; nevertheless, very few papers have examined Vietnam's GVC role among research examining the effects of TBT.

This paper contributes to the literature by being the first study to analyze the effects of TBT on Vietnam with consideration of its GVC participation. TBTs can have ripple effects throughout the supply chain. Given that Vietnam faces significant unilateral TBT from importers, it is crucial to analyze their impact on exports. Hollweg et al. (2017) point out that Vietnam is generally carrying out the lowest technology step of production in the GVC, where it has become an assembly platform, specializing in final production stages, including information and

communications technology (ICT) hardware, textiles, and apparel. Those inputs that Vietnam creates and sells to other countries tend to be low value-added. In other words, Vietnam involves backward GVC participation, such as processing inputs from more upstream countries, rather than participating in forward GVC activities that provide intermediate inputs to other countries. Moving up the GVC ladder is important in terms of creating higher value-added, but it requires raising economic complexity in productive knowledge and capabilities, which are associated with high-value-added GVC participation (IMF 2015). It is crucial to examine the effects of TBTs on Vietnam's exports industry-wide by considering how those sectors participate in GVCs, backward or forward.

We address these questions by using the augmented gravity model with Vietnam's export data from 2007 to 2019. Based on the estimated results, we find that the rigidity of TBTs is positively associated with Vietnam's trade in general; however, the TBTs in the sectors that are deeply involved in backward GVC reduce the overall positive impact. Specifically, in low-technology sectors with backward GVC participation, TBTs diminish the positive impact on Vietnam's exports. On the other hand, TBTs in high-technology sectors boost exports by stimulating import demand. We also find heterogeneous effects of TBTs across importers with different income levels. TBTs of OECD member countries in sectors where Vietnam is highly involved in backward GVC participation create relatively low value-added activities (e.g., assembly), generate additional production costs such as compliance costs, and reduce the positive effects of TBTs on Vietnam's exports. On the other hand, TBTs of non-OECD members raise Vietnam's exports because they provide positive signals to consumers in terms of product quality by complying with the requirements of TBTs; hence, exports would increase due to enhanced import demand.

The rest of this paper is organized as follows: Section 2 introduces the related literature analyzing the effects of TBTs and GVCs. Section 3 introduces the data and empirical models. Section 4 presents the results, and Section 5 concludes the paper.

II. Literature Review

Studies examining the effect of TBTs on exports have yielded inconsistent conclusions about the direction and magnitude of the effect. This is because non-tariff measures, such as standards and technical regulations, may increase trade costs, limiting bilateral trade flows while simultaneously increasing import demand by ensuring consumer safety and quality (Ganslandt and Markusen 2001). The influence of NTMs varies depending on the types of measures as well as the observed country, industry, or period (Li and Beghin 2012, Nardella and Boccaletti 2004). In particular, the impact of TBTs is especially diverse across imposing countries and

their trading partners (Bao and Qui 2012, Chen and Matoo 2008, Essaji 2008, Ghodsi et al. 2017a). Furthermore, TBTs have varying effects on export probability and export volume (Bao and Chen 2013, Fontagne and Orefice 2018).

Few papers empirically analyze the effects of NTMs on bilateral trade within the context of the global value chain. Yang and Otsuki (2020) analyzed the impact of non-tariff measures according to a company's position in the GVCs using Chinese company data. According to Yang and Otsuki (2020), the effects of NTMs are more positive for intermediate goods produced by multiple companies or countries. However, firms using intermediate products closer to raw materials experience reduced intensive and extensive margins due to cumulative NTMs. This is because downstream companies face lower additional compliance costs for complying with NTMs, whereas upstream companies face higher additional compliance costs. Lombini (2021) investigates the effect of trade restrictiveness of NTMs by constructing his own regulatory distance indicator, total bilateral dissimilarity in NTM patterns between exporters and their trade partners, on GVC-related trade in 59 countries from 2005 to 2015. He finds a significant negative impact of regulatory distance on overall, backward, and forward global value chain-related trade.

Regarding the effects of NTMs on Vietnam's exports, there are few studies. Luu et al. (2022) examine the effects of NTMs on Vietnam's export performance and find that TBTs have a positive effect on Vietnamese exports, especially intermediate goods. With respect to Vietnam's export-related NTMs, technical measures seem to be effective in increasing Vietnam's exports of final products to importing countries with a per capita income below US\$11,462. On the other hand, TBTs are found to have a negative impact on Vietnam's tea exports, based on the study by Thuong et al. (2021). Sanitary and phytosanitary (SPS) measures are also found to decrease Vietnam's rice exports, based on the estimation results from 2000 to 2015 using a gravity model, according to another study by Thuong (2018). According to Hien et al. (2022), SPS and TBTs imposed by the EU increase Vietnam's agricultural exports by 1.24% and 2.34%, respectively, using data from 2001 to 2020 in a gravity setting. Webb et al. (2020) examine the effects of NTMs on all ASEAN countries using computable general equilibrium (CGE) models and find that liberalized NTMs increase Vietnam's GDP by 1.28%, composed of increasing exports (0.31 percentage points) and attributed to import-augmenting technological shocks (0.87 percentage points). Nguyen and Hayakawa (2024) analyze the relationship between ASEAN Trade in Goods Agreement (ATIGA) tariffs and NTMs in Vietnam from 2012 to 2018. According to their study, a reduction in ATIGA tariffs is likely to introduce non-technical NTMs, such as price control measures, to compensate for the reduction in tariff rates. However, they do not find any statistically significant effects of ATIGA tariffs on technical NTMs such as TBTs.

III. Data and Empirical Strategy

A. Data

We observe exports of Vietnam from 2007¹⁾ to 2019 at Harmonized System (HS) 4-digit product code from the UN Comtrade. We include 168 trading partner countries, which have a trade value greater than 1,000 USD with Vietnam. Tariff data are obtained from the Trade Analysis Information System (TRAINS) database. We use the lowest tariff rates between effectively applied tariff rates (AHS) and most favored nation rates (MFN) at HS 4-digit product codes. Data for gravity variables such as distance, population, GDP, and RTA, are from the CEPII. Data for NTM is obtained from the wiiw NTM database (Ghodsi et al. 2017a, 2017b), which originally extracted NTM notifications from the WTO I-TIP and the World Bank TTBD (Temporary Trade Barriers Database). The data matches NTM notifications with imposing importers, affected exporters, targeted HS 4-digit product codes, and years of initiation and entry into force. We use Vietnam's trading partners' TBT notification, either unilateral or bilateral, from 2007 to 2019. The rigidity of TBTs is calculated using the frequency ratio and coverage ratio at HS 4-digit product codes, following Disdier and Fugazza (2020).

For the second stage of the estimation to analyze heterogeneous effects considering types of GVC participation, we obtain data from UIBE GVC indicators database (RIGVC UIBE 2016). The input-output tables for Asia's countries from 2007 to 2019 are provided by ADB-MRIO, upon which the GVC indicators are computed. As recommended by Wang et al. (2017a)²⁾, we employ two distinct indices: forward and backward linkage from GDP and final goods and services production decomposition. GVC indicators are presented according to the ADB-MRIO industrial classification for 62 countries and 35 sectors. For 35 sectors, we employ Vietnam's GVC indicators. In our research, we employ the GVC indicators of 16 industrial and agricultural industries (C1-C16). The UN Statistics Division's database of HS 4-digit code to ISIC 2-digit is utilized to match GVC indicators to export data and NTM data after the industry classification from ADB is converted to the 2-digit level of ISIC code.

B. Research model

The dependent variable in our model is Vietnam's exports at HS four-digit product level

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- 1) The observation period for GVC indicators calculated using ADB MRIO is restricted to the period starting from 2007, due to the availability of input-output data provided by ADB only for this timeframe. Furthermore, 2007 is the year that Vietnam joined the WTO, making it an appropriate year to start observation.
 - 2) Forward GVC participation refers to the proportion of domestic value added derived from activities within global value chains, encompassing intermediate exports and production sharing across countries, relative to total value added (i.e., GDP). Backward GVC participation is defined as the proportion of domestic and foreign value added in intermediate imports relative to the total production of final goods and services (Wang et al. 2017a).

over the period 2007-2019. Our model is based on a gravity model, which is widely utilized in studies on international trade and has demonstrated strong explanatory power in empirical analysis. All of Vietnam's trading partners' exports are included in the sample, which is tracked at the HS four-digit product level. Using an augmented gravity model, the export value of product k from Vietnam to partner j at time t is calculated as follows:

$$Export_{jkt} = \exp \left[\begin{array}{l} \beta_1 \ln GDP_{jt} + \beta_2 D.RTA_{jt} + \beta_3 \ln(Tariff + 1)_{jkt-s} \\ + \beta_4 D.TBT_{jkt-s} + \phi_{jk} + \phi_{kt} \end{array} \right] \epsilon_{jkt} \quad (1-1)$$

$$Export_{jkt} = \exp \left[\begin{array}{l} \beta_1 \ln GDP_{jt} + \beta_2 \ln Dist_j + \beta_3 D.Contig_j + \beta_4 D.Colony_j \\ + \beta_5 D.WTO_{jt} + \beta_6 D.RTA_{jt} + \beta_7 \ln(Tariff + 1)_{jkt-s} \\ + \beta_8 D.TBT_{jkt-s} + \phi_{kt} \end{array} \right] \epsilon_{jkt} \quad (1-2)$$

where $\ln GDP_{jt}$ and $\ln DIST_j$ represent the logged GDP of importer j at time t , and the distance between j and Vietnam, respectively. $D.Contig_j$ and $D.Colony_j$ are dummy variables set to one for importers that share a land border with Vietnam and had a colonial relationship. Additionally, $D.WTO_{jt}$ is a dummy variable equal to unity for importers with WTO membership. $D.RTA_{jt}$ is a dummy variable reflecting the existence of regional trade agreement between Vietnam and j at time t . The trade policy variables used in our analysis are tariff rates and TBTs. $\ln(Tariff_{jkt-s} + 1)$ is the logged tariff rates by importer j to product k from Vietnam at previous period, $t-s$ (where $s = 1, 2, 3$), plus one. TBT_{jkt-s} and refer to TBT indices applied to Vietnam's exports of HS 4-digit product categories by importer j at time $t-s$. The coverage ratio and frequency ratio of TBT are used to measure the intensity. Equation (1-1) follows an augmented structural gravity model, using importer-product (ϕ_{jk}) and product-year fixed effects (ϕ_{kt}), simultaneously, to control for unobserved country-specific features at the product level as well. Equation (1-2) follows a classical gravity model with industry-year fixed effects (ϕ_{kt}) to control unobserved macroeconomic variations across industries in a given year.³⁾ ϵ_{jkt} is the error term. To address concerns about the endogeneity of trade policy variables on exports, we employ lagged variables for tariffs and TBTs.⁴⁾ TBTs are used by importers to mitigate injury to domestic industries that receive a large volume of imports. In other words, inverse

3) One of the classical control variables in the gravity model, Vietnam's GDP, cannot be included in this model specification because it only accounts for year-specific features, and thus should be omitted due to perfect collinearity with the year fixed effects. Additionally, rather than using two-way fixed effects, we applied product and year fixed effects, separately, but the results remain the same. We report the results with two-way fixed effects because they explain more variability in the model.

4) According to Baier and Bergstrand (2007), using standard instrumental variable (IV) approaches to address endogeneity in cross-sectional settings has not been particularly effective, as existing IV studies have produced mixed results. They recommend using country-pair fixed effects to address the endogeneity of trade policy in gravity models. However, since our data consists of a single exporter, Vietnam, we cannot apply country-pair fixed effects. Instead, we use importer fixed effects.

causality may exist between trade policies and exports. To account for endogeneity, we utilize one-, two-, and three-year lagged tariffs and TBT variables. To reflect TBT's rigidity, we employ two separate indices. The coverage ratio and frequency ratio are used to determine the intensity of TBT. These are computed as follows (Disdier and Fugazza 2020).

$$FI_{jkt} = \frac{\sum_h NTM_{jht} D_{jht}}{\sum_h D_{jht}} \times 100 \quad (2)$$

$$CR_{jkt} = \frac{\sum_h TBT_{jht} X_{jht}}{\sum_h X_{jht}} \times 100 \quad (3)$$

where h indicates HS 6-digit level of product. TBT_{jht} is a dummy variable indicating the presence of TBT targeting product h by importer j from exporter i at time t . D_{jht} is a dummy variable that indicates if there is any bilateral trade flow of product h from country i to country j . X_{jht} is the import value of product h from Vietnam to importer j . The frequency Index (FI) indicates the percentage of products where TBT applies, whereas the coverage Ratio (CR) indicates the percentage of bilateral trade subject to TBT.

We use importer-product (ϕ_{jk}) to control for unobserved country-specific features at the product level, and industry-year fixed effects (ϕ_{kt}) to account for macroeconomic variations in a given year. ϵ_{jkt} is the error term. Equation (3) is estimated by Pseudo Poisson Maximum Likelihood (PPML). To avoid sample selection and heteroscedasticity bias, the Poisson Pseudo-Maximum Likelihood (PPML) method is used, as described by Silva and Tenreyro (2006). When the export value of product h from Vietnam to importer j is zero, then it may be excluded from the sample, resulting in a sample selection bias problem. Furthermore, PPML yields consistent estimates even when heteroscedasticity exists, which is a common problem in trade data when trade flow variation is determined by the scale of explanatory variables.

The second stage of estimation involves with the assumption that TBT will have varying effects on Vietnam exports across industries depending on their level of participation in GVCs. The hypothesis is that accumulated TBT will have a greater influence on bilateral trade in industries that are part of the global production process chain. To investigate the disparate impacts of TBT in industries with varying levels of participation in GVCs, we estimate the following equation:

$$Export_{jkt} = \exp \left[\beta_1 \ln GDP_{jt} + \beta_2 D.RTA_{jt} + \beta_3 \ln(Tariff + 1)_{jkt-s} + \beta_4 D.TBT_{jkt-s} + \beta_5 D.TBT_{jkt-s} \times D.GVC_{jct} + \phi_{jk} + \phi_{kt} \right] \epsilon_{jkt} \quad (4)$$

where c represents 16 different agricultural and manufacturing sectors, as defined by Asian Development Bank's Multiregional Input-Output Database (ADB-MRIO). All HS 4-digit level products are assigned to 16 sectors, and the interaction terms ($TBT_{jkt-s} \times GVC_{jct}$) demonstrate the heterogeneous effects of TBT in sectors based on their participation in GVCs. The GVC participation variable (GVC_{jkt}) is a dummy variable that indicates whether a sector actively participates in GVCs or not. Each GVC dummy variable is created using two different GVC participation indices: forward and backward participation. Each dummy variable is assigned a value of one for sectors with higher values than the median participation indices for a given year and exporter. For example, the forward GVC participation variable takes a value of one for a sector that has a higher value than the sectoral median value of forward GVC participation of a given year and country. To address endogeneity, lagged trade policy variables such as tariffs and TBT are used. Importer-product (ϕ_{jk}) and product-year fixed effects (ϕ_{kt}) are applied. ϵ_{jkt} is error term. Table 1 below presents the summary of descriptive statistics for all variables used in the estimation.

Table 1. Summary of Descriptive Statistics

Variable	Description	Mean	S.D.	Min	Max
Export _{jkt}	Vietnam's export value in thousand USD dollars	5.16	73.94	0.00	1367
ln GDP _{jt}	Log importer's GDP in thousand USD dollars	19.56	19.57	12.54	23.79
ln Dist _j	Log distance between importer and Vietnam	8.78	0.80	6.28	9.87
D.Contig _j	1 for importer that share a common land border	0.04	0.20	0	1
D.Colony _j	1 for importer that ever in colonial or dependency relationship	0.02	0.15	0	1
D.WTO _{jt}	1 for importer with WTO membership"	0.97	0.17	0	1
D.RTA _{jt}	1 for importer that have a common Regional Trade Agreement	0.24	0.43	0	1
ln (1+Tariff) _{jkt}	Effectively applied minimum tariff rate log (tariff rate +1)	0.05	0.07	0	2.40
D.TBT _{jkt}	Frequency Index or Coverage Ratio of TBT	0.53	0.49	0	1
B_GVC _{jct}	1 for industries of a given exporter whose value is higher than the median backward participation index at a given year	0.74	0.44	0	1
F_GVC _{jct}	1 for industries of a given exporter whose value is higher than the median forward participation index at a given year	0.51	0.50	0	1

IV. Empirical Results

The main research question of our paper is whether TBT measures promote Vietnam's exports. Table 2 presents the results of the fixed-effects panel regression analysis of equation (1-1) (Columns (1)-(2), (5)-(6), (9)-(10)) and equation (1-2) (Columns (3)-(4), (7)-(8), (11)-(12)). Columns (1) - (4) show the results with 1-year lagged trade policy variables. Columns (5) -

(8) present the results with 2-year lagged trade policy variables, and Columns (9) - (12) show the results with 3-year lagged trade policy variables. Columns (1), (3), (5), (7), (9), and (11) use the frequency index (FI), while other columns use the coverage ratio (CR) to measure the rigidity of NTMs.

The estimated coefficients of logged GDP of importers in all columns are positive and statistically significant, confirming the expectations from the classic gravity model that the economic size of the importer is positively associated with bilateral trade value. The estimated effect of distance is statistically significant and negative, confirming that distance hinders trade. WTO membership of importers also has positive and significant effects on Vietnam's exports. However, other control variables used to measure trade costs in the classic gravity model, such as contiguity and colonial relationships, are statistically significant but do not align with the theoretical expectation of positive effects from sharing a common border and colonial ties. This inconsistency may arise from the failure to properly account for heterogeneity across importers without incorporating fixed effects.⁵⁾ The estimated coefficients of tariffs are negative and statistically significant in the case of one- and two-year lags, as expected based on theory (Column (1),(2),(5),(6)). For TBTs, the variable of interest in this study, the estimated coefficient was found to be positive and statistically significant only when the frequency index was used, as shown in Columns (1), (5), and (9). This indicates that TBTs boost Vietnam's exports, suggesting that stringent TBTs stimulate import demand by sending positive signals about product quality to consumers, thereby enhancing Vietnam's exports.

Table 3 presents the results of equation (4). Panels A and B illustrate the effects of TBTs alongside backward and forward GVC participation, respectively. Columns (1) and (2) display the results with 1-year lagged trade policy variables. Columns (3) and (4) provide the results with 2-year lagged trade policy variables, while Columns (5) and (6) show the results with 3-year lagged trade policy variables. Columns (1), (3), and (5) use the frequency ratio, whereas Columns (2), (4), and (6) use the coverage ratio to measure the rigidity of NTMs. As seen in Table 2, control variables such as GDP, co-membership in the same RTA, and tariffs are statistically significant. Vietnam's exports increase as the partner country's GDP rises, tariff rates fall, and when both countries are members of the same RTA. The role of GVCs in Vietnamese exports is also evident: backward GVC linkages boost exports, whereas forward GVC linkages reduce exports. This suggests that Vietnam has comparative advantages in sectors where it is deeply involved in backward GVC participation rather than forward GVC participation.

Based on Columns (1), (3), and (5) of Panel A, the FIs of TBT measures have a positive and statistically significant impact on Vietnam's exports. This indicates that the one-year, two-year, and three-year lagged TBT measures are positively associated with exports. However,

5) This concern is further supported by the estimated coefficients for RTAs and tariffs, which fail to align with theoretical expectations.

the interaction terms with backward participation are negative and statistically significant in all cases, except for Column (5). This suggests that the positive effects of TBTs from the previous year, two years ago, and three years ago diminish in sectors that are more likely to participate in backward GVC. In Panel B, the estimated coefficients for TBTs are positive and statistically significant when sectors are less involved in forward participation, as shown in Columns (1), (3), and (5). However, the interaction terms are statistically insignificant, indicating that there are no statistically significant heterogeneous effects of TBTs in sectors more likely to participate in forward GVC.

Table 2. *Effects of TBT on Vietnam's Exports*

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)		(11)		(12)		
	One-year lagged (t-1, s=1)				Two-year lagged (t-2, s=2)				Three-year lagged (t-3, s=3)																
	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	
ln GDP _{jt}	0.959*** (0.232)	0.968*** (0.232)	0.950*** (0.0698)	0.949*** (0.0684)	0.954*** (0.233)	0.969*** (0.234)	0.964*** (0.0696)	0.963*** (0.0679)	0.900*** (0.240)	0.915*** (0.242)	0.964*** (0.0709)	0.963*** (0.0692)													
ln Dist _j			-0.824*** (0.116)	-0.827*** (0.118)			-0.864*** (0.111)	-0.867*** (0.114)			-0.892*** (0.111)	-0.895*** (0.114)													
D.Contig _j			-0.610*** (0.195)	-0.611*** (0.196)			-0.661*** (0.200)	-0.662*** (0.201)			-0.629*** (0.216)	-0.630*** (0.217)													
D.Colony _j			-0.391*** (0.0846)	-0.389*** (0.0837)			-0.394*** (0.0796)	-0.393*** (0.0793)			-0.395*** (0.0874)	-0.393*** (0.0876)													
D.WTO _{jt}			0.596*** (0.169)	0.579*** (0.163)			0.575*** (0.164)	0.563*** (0.155)			0.572*** (0.135)	0.566*** (0.120)													
D.RTA _{jt}	0.0845 (0.107)	0.0974 (0.111)	-0.509*** (0.181)	-0.514*** (0.182)	0.0365 (0.111)	0.06 (0.114)	-0.577*** (0.166)	-0.580*** (0.166)	0.0352 (0.0696)	0.0628 (0.0666)	-0.594*** (0.161)	-0.596*** (0.160)													
ln (1+Tariff) _{ikt}	-1.178*** (0.440)	-1.172** (0.457)	-0.321 (0.890)	-0.331 (0.889)	-1.317** (0.567)	-1.317** (0.567)	-0.299 (0.892)	-0.304 (0.888)	-0.881 (0.720)	-0.882 (0.699)	-0.310 (0.938)	-0.311 (0.934)													
D.TBT _{ikt}	0.208* (0.111)	0.084 (0.171)	0.0472 (0.160)	0.0808 (0.153)	0.168** (0.0847)	-0.0226 (0.182)	0.0763 (0.157)	0.0979 (0.143)	0.134*** (0.0457)	-0.062 (0.161)	0.0948 (0.153)	0.107 (0.131)													
Constant	-8.816* (5.026)	-8.934* (5.013)	-2.339 (1.498)	-2.273 (1.452)	-8.640* (5.102)	-8.859* (5.099)	-2.141 (1.392)	-2.092 (1.337)	-7.405 (5.245)	-7.629 (5.261)	-1.849 (1.370)	-1.814 (1.320)													
Importer-product FE	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N													
product-year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y													
Observations	347487	347487	361607	361607	243364	243364	250655	250655	212103	212103	218971	218971													
Pseudo R-squared	0.973	0.973	0.792	0.792	0.976	0.976	0.800	0.800	0.978	0.977	0.801	0.801													

Notes. Dependent variable is export value. FI is frequency index and CR is coverage ratio. Importer, product, and year clustered standard errors are in parentheses: ***p<0.01, ** p<0.05, *p<0

Table 3. Heterogeneous Effects of TBT Along with GVC Participation on Vietnam's Exports

PANEL A	Backward GVC Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
	One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)	
	FI	CR	FI	CR	FI	CR
ln GDP _{jt}	0.954*** (0.228)	0.961*** (0.227)	0.948*** (0.229)	0.959*** (0.231)	0.901*** (0.240)	0.908*** (0.239)
D.RTA _{jt}	0.0847 (0.107)	0.0979 (0.111)	0.0398 (0.124)	0.0650 (0.109)	0.0362 (0.0718)	0.0641 (0.0573)
ln (1+Tariff) _{jkt}	-1.179** (0.511)	-1.172** (0.516)	-1.318** (0.621)	-1.318** (0.648)	-0.874 (0.762)	-0.891 (0.781)
B_GVC _{jct}	0.240** (0.118)	0.263** (0.122)	0.161 (0.119)	0.207* (0.123)	0.0399 (0.102)	0.190* (0.113)
D.TBT _{jkt}	0.330** (0.130)	0.228 (0.174)	0.246*** (0.0627)	0.0969 (0.154)	0.185** (0.0864)	0.0417 (0.118)
B_GVC _{jct} # D.TBT _{jkt}	-0.176** (0.0870)	-0.203** (0.0938)	-0.114* (0.0640)	-0.167** (0.0705)	-0.0921 (0.151)	-0.140* (0.0825)
Constant	-8.864* (4.961)	-8.985* (4.936)	-8.611* (5.004)	-8.800* (5.042)	-7.438 (5.261)	-7.621 (5.203)
Observations	342310	342310	240096	240096	209350	209350
Pseudo R-squared	0.973	0.973	0.976	0.976	0.977	0.977
PANEL B	Forward GVC Participation					
	(1)	(2)	(3)	(4)	(5)	(6)
	One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)	
	FI	CR	FI	CR	FI	CR
ln GDP _{jt}	0.958*** (0.232)	0.967*** (0.232)	0.954*** (0.233)	0.970*** (0.234)	0.901*** (0.240)	0.916*** (0.242)
D.RTA _{jt}	0.0837 (0.102)	0.0939 (0.106)	0.0345 (0.107)	0.0527 (0.108)	0.0362 (0.0718)	0.0623 (0.0669)
ln (1+Tariff) _{jkt}	-0.0421 (0.0861)	0.0298 (0.106)	0.0463 (0.106)	0.174 (0.127)	0.0399 (0.102)	0.174 (0.120)
F_GVC _{jct}	-1.177** (0.572)	-1.166** (0.580)	-1.311** (0.669)	-1.304* (0.671)	-0.874 (0.762)	-0.870 (0.724)
D.TBT _{jkt}	0.218* (0.122)	0.153 (0.149)	0.218* (0.114)	0.134 (0.151)	0.185** (0.0864)	0.107 (0.123)
F_GVC _{jct} # D.TBT _{jkt}	-0.0167 (0.124)	-0.113 (0.147)	-0.0858 (0.156)	-0.255 (0.184)	-0.0921 (0.151)	-0.278* (0.168)
Constant	-8.761* (5.039)	-8.941* (5.037)	-8.661* (5.110)	-8.988* (5.125)	-7.438 (5.261)	-7.768 (5.307)
Observations	342310	342310	240096	240096	209350	209350
Pseudo R-squared	0.973	0.973	0.976	0.976	0.977	0.978

Notes. Panel A and B show the results with forward and backward GVC participation, respectively. All estimations include importer-product and product-year fixed effects. Dependent variable is export value. FI is frequency index and CR is coverage ratio. Importer, product, and year clustered standard errors are in parentheses: ***p<0.01, ** p<0.05, *p<0.1.

In other words, the results in Columns (1), (3), and (5) of both Panel A and Panel B indicate that TBTs in sectors not heavily involved in backward or forward GVC participation are

positively associated with Vietnam's exports. Conversely, in sectors where Vietnam is deeply involved in backward GVC participation, which often involves relatively low value-added activities like assembly, TBTs generate additional production costs, such as compliance costs, thereby reducing the positive effects of TBTs on Vietnam's exports. In sectors where Vietnam is deeply involved in forward GVC activities, TBTs do not have statistically significant heterogeneous effects on Vietnam's exports.

A. Heterogeneity across technical level of industry

It is crucial to understand the differential impact of TBTs across various industries, as Vietnam's GVC participation varies significantly along with technological intensity. Therefore, we estimate the heterogeneous effects of TBTs based on different levels of technology and R&D intensity by dividing observations into three groups: (1) Agriculture and Mining (2) Low- and Medium- technology industries (3) High-technology industries. Details are provided in Table A.1 in the online Appendix.⁶⁾ The model specifications for the Agriculture and Mining industries were difficult to estimate due to the limited number of observations; thus, the results are presented in Table A.2 in the online Appendix. Our primary focus is on the manufacturing sector, as the majority of TBTs have a greater impact on manufacturing industries.

Tables 4 and 5 present the heterogeneous effects of TBTs based on the technology levels of manufacturing industries. Columns (1)-(6) display the results for low- and medium-technology industries, while columns (7)-(12) focus on the high-technology industries. Specifically, Table 4 shows the effects of TBTs on the manufacturing industries more likely to participate in backward GVC, whereas Table 5 shows the effects of TBTs on industries more inclined to engage in forward GVC.

The impact of TBTs on low- and medium-technology industries is consistent with the overall effect of TBTs on all industries, as shown in Table 3. While TBTs boost Vietnam's exports overall, sectors more inclined to engage in backward GVC experience a decline in exports (Column (1) and Column (6)). In contrast, TBTs in the high-technology industries reduce Vietnam's exports, although these negative effects diminish in the high-technology industries more likely to participate in backward GVC (Column (10) and Column (12)).

In other words, in low- and medium-technology sectors, where Vietnam is heavily engaged in backward GVC participation, which typically involves low value-added activities like assembly, TBTs increase production costs, such as compliance expenses, thereby diminishing the positive impact of TBTs on Vietnam's exports. However, in high-technology sectors, where Vietnam also has significant backward GVC participation, the higher value-added nature of these activities allows TBTs to stimulate import demand by signaling improved product quality to consumers,

6) The classification of high-tech manufacturing industries is sourced from Eurostat.

ultimately boosting Vietnam's exports. In the case of forward GVC participation, we do not find any statistically significant effects of TBTs.

B. Heterogeneity across importers income level

Furthermore, we analyze the heterogeneous impacts of TBTs in conjunction with GVC participation by considering the relative income levels between Vietnam and its trading partners. We expect that income gaps, resulting from disparities in advanced technologies or labor skills between trading partners, may influence the effects of TBTs differently. To explore this, we categorize our samples into two groups based on OECD membership.⁷⁾

Table 4. *Heterogeneous Effects of TBT Along with Backward GVC Participation by Level of Technology*

	Medium- and Low- Technology Intensity						High-Technology Intensity																			
	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)		(11)		(12)			
	One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)		One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)		One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)		One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)			
	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR		
ln GDP _{jt}	0.909*** (0.231)	0.911*** (0.230)	0.879*** (0.249)	0.880*** (0.249)	0.789*** (0.251)	0.789*** (0.251)	1.067*** (0.325)	1.059*** (0.319)	1.064*** (0.337)	1.041*** (0.323)	1.077*** (0.338)	1.060*** (0.318)														
D.RTA _{jt}	0.192** (0.0903)	0.196** (0.0906)	0.150** (0.0711)	0.153** (0.0709)	0.133*** (0.0515)	0.133*** (0.0511)	0.0603 (0.0541)	0.0772 (0.0522)	0.0708 (0.0827)	0.0903 (0.0618)	0.0647 (0.0567)	0.0968** (0.0456)														
B_GVC _{jet}	0.0615 (0.128)	0.0620 (0.130)	-0.0489 (0.0849)	-0.0469 (0.0912)	0.00119 (0.0912)	0.00930 (0.0913)	-0.583* (0.302)	-0.502** (0.239)	-0.580** (0.244)	-0.614** (0.212)	*	-0.872** (0.338)	-0.797** (0.268)													
ln (1+Tariff) _{ikt}	-1.232** (0.484)	-1.229** (0.486)	-1.366** (0.673)	-1.366** (0.672)	-0.920 (0.879)	-0.920 (0.877)	-0.522 (0.671)	-0.491 (0.632)	-1.266 (0.965)	-1.307 (0.956)	-1.091 (1.176)	-1.163 (1.169)														
D.TBT _{ikt}	0.206** (0.0918)	0.180* (0.0968)	0.215** (0.102)	0.202* (0.105)	0.201* (0.106)	0.204* (0.104)	-0.150 (0.227)	-0.428 (0.370)	-0.308 (0.190)	-0.781** (0.363)	-0.437 (0.274)	-0.948** (0.408)														
B_GVC _{jet} #	-0.106* (0.0636)	-0.105 (0.0648)	-0.0970 (0.0635)	-0.0954 (0.0652)	-0.0917 (0.0564)	-0.0967* (0.0556)	0.299** (0.131)	0.150 (0.106)	0.346*** (0.106)	0.171*** (0.0390)	0.579*** (0.218)	0.448** (0.179)														
Constant	-8.479* (5.108)	-8.514* (5.107)	-7.744 (5.500)	-7.767 (5.508)	-5.767 (5.563)	-5.785 (5.573)	-9.719 (6.658)	-9.472 (6.544)	-9.542 (7.040)	-8.820 (6.687)	-9.481 (7.043)	-8.996 (6.606)														
Observations	228954	228954	164789	164789	144473	144473	103646	103646	68938	68938	59463	59463														
Pseudo R-squared	0.979	0.979	0.981	0.981	0.983	0.983	0.967	0.967	0.970	0.970	0.972	0.972														

Notes. All estimations include importer-product and product-year fixed effects. Dependent variable is export value. FI is frequency index and CR is coverage ratio. Importer, product, and year clustered standard errors are in parentheses: ***p<0.01, ** p<0.05, *p<0.1.

7) We also estimate the model by categorizing observations based on GDP per capita. Specifically, using the median GDP per capita of all importing countries for each year, we classified countries with a higher GDP per capita as the "North" and the others as the "South." However, classifying observations based on OECD membership proves to be more suitable for estimating the model, as it yields higher statistical significance and a higher R-squared. To demonstrate the robustness of the estimation, we present the results for the North and South in Tables A.3 and A.4 in the online Appendix.

Table 5. *Heterogeneous Effects of TBT Along with Forward GVC Participation by Level of Technology*

	Medium- and Low- Technology Intensity						High-Technology Intensity																		
	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)		(11)		(12)		
	One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)		One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)		One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)		One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)		
	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	FI	CR	
ln GDP _{jt}	0.913*** (0.233)	0.915*** (0.233)	0.882*** (0.251)	0.883*** (0.251)	0.790*** (0.252)	0.790*** (0.253)	1.066*** (0.325)	1.058*** (0.319)	1.062*** (0.336)	1.040*** (0.322)	1.075*** (0.338)	1.058*** (0.317)													
DRTA _{jt}	0.188** (0.0855)	0.192** (0.0858)	0.144** (0.0673)	0.147** (0.0674)	0.136*** (0.0523)	0.135*** (0.0521)	0.0614 (0.0587)	0.0784 (0.0575)	0.0717 (0.0825)	0.0915 (0.0654)	0.0644 (0.0605)	0.0971** (0.0486)													
F_GVC _{jt}	-0.0981 (0.0974)	-0.0877 (0.0949)	-0.0253 (0.0830)	-0.0289 (0.0822)	-0.0585 (0.0730)	-0.0815 (0.0730)	0.0405 (0.111)	0.0647 (0.124)	0.0482 (0.120)	0.0557 (0.118)	0.00165 (0.119)	0.0274 (0.124)													
ln (1+Tariff) _{jt}	-1.228** (0.524)	-1.225** (0.532)	-1.350** (0.675)	-1.353** (0.677)	-0.904 (0.878)	-0.910 (0.879)	-0.523 (0.668)	-0.494 (0.651)	-1.262 (0.966)	-1.298 (0.948)	-1.088 (1.174)	-1.151 (1.170)													
D.TBT _{jt}	0.159 (0.132)	0.138 (0.137)	0.194 (0.137)	0.177 (0.140)	0.180 (0.115)	0.165 (0.116)	0.276 (0.205)	-0.103 (0.330)	0.116 (0.218)	-0.463 (0.334)	0.201 (0.198)	-0.348 (0.280)													
F_GVC _{jt} #	-0.0699 (0.139)	-0.0808 (0.133)	-0.130 (0.134)	-0.114 (0.129)	-0.130 (0.0922)	-0.0842 (0.0920)	-0.140* (0.0745)	-0.192* (0.108)	-0.0842 (0.0950)	-0.158 (0.0991)	-0.0633 (0.101)	-0.161 (0.102)													
D.TBT _{jt}																									
Constant	-8.496* (5.143)	-8.529* (5.142)	-7.837 (5.550)	-7.851 (5.565)	-5.781 (5.584)	-5.779 (5.614)	-10.32 (6.917)	-10.01 (6.743)	-10.14 (7.232)	-9.466 (6.841)	-10.33 (7.252)	-9.786 (6.727)													
Observations	228954	228954	164789	164789	144473	144473	103646	103646	68938	68938	59463	59463													
Pseudo R-squared	0.979	0.979	0.981	0.981	0.983	0.983	0.967	0.967	0.970	0.970	0.972	0.972													

Notes. All estimations include importer-product and product-year fixed effects. Dependent variable is export value. FI is frequency index and CR is coverage ratio. Importer, product, and year clustered standard errors are in parentheses: ***p<0.01, ** p<0.05, *p<0.1.

We assume that Vietnam's trading partners belonging to the OECD are more likely to possess higher technology and skilled labor compared to Vietnam. Consequently, OECD member countries are more inclined to participate in forward GVC activities (such as exporting high-technology intermediate inputs), whereas non-OECD member countries are more likely to engage in backward GVC activities (such as assembling imported intermediate inputs).

Table 6 presents the estimation results with separate samples. First, we examine the effects of TBTs in sectors where Vietnam is deeply involved in backward GVC activities. Panel A and B depict the effects of TBTs alongside backward GVC participation on Vietnam's exports to OECD and non-OECD member countries, respectively. Columns (1) to (2) display the results with 1-year lagged trade policy variables. Columns (3) to (4) present the results with 2-year lagged trade policy variables, and Columns (5) to (6) show the results with 3-year lagged trade policy variables. Columns (1), (3), and (5) utilize the FIs, while Columns (2), (4), and (6) utilize the CRs to measure the rigidity of NTMs. Consistent with previous estimations, the coefficients of partner countries' GDP are positive and statistically significant. The coefficients of tariffs are negative but only statistically significant in cases involving non-OECD members. The estimated coefficients related to co-membership in an RTA are not statistically significant. In summary, we find that Vietnam's exports tend to increase with the GDP of trading partners and decrease as tariff rates imposed by partners rise.

Table 6. *Heterogeneous Effects of TBT Along with Backward GVC Participation Depending on Trading Partner's OECD Membership*

PANEL A	OECD					
	(1)	(2)	(3)	(4)	(5)	(6)
	One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)	
	FI	CR	FI	CR	FI	CR
ln GDP _{jt}	0.962** (0.431)	0.968** (0.429)	1.014** (0.429)	1.030** (0.419)	0.989** (0.452)	1.013** (0.450)
D.RTA _{jt}	0.135 (0.117)	0.156 (0.117)	0.119 (0.143)	0.154 (0.116)	0.108 (0.108)	0.138 (0.110)
ln (1+Tariff) _{jkt}	-0.798 (0.946)	-0.812 (0.955)	-0.800 (0.828)	-0.848 (0.896)	-0.561 (0.976)	-0.617 (0.990)
B_GVC _{jct}	0.175 (0.107)	0.201* (0.113)	0.0606 (0.103)	0.0944 (0.102)	0.0121 (0.114)	0.0514 (0.105)
D.TBT _{jkt}	0.355** (0.143)	0.238 (0.215)	0.176** (0.0757)	-0.00671 (0.219)	0.139 (0.119)	-0.0621 (0.199)
B_GVC _{jct} # D.TBT _{jkt}	-0.226*** (0.0726)	-0.249*** (0.0772)	-0.120 (0.0789)	-0.160** (0.0632)	-0.0623 (0.108)	-0.113 (0.0950)
Constant	-9.309 (9.485)	-9.372 (9.413)	-10.26 (9.461)	-10.51 (9.235)	-9.663 (9.974)	-10.06 (9.888)
Observations	174242	174242	133796	133796	119504	119504
Pseudo R-squared	0.980	0.980	0.981	0.981	0.982	0.982
PANEL B	Non-OECD					
	(1)	(2)	(3)	(4)	(5)	(6)
	One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)	
	FI	CR	FI	CR	FI	CR
ln GDP _{jt}	1.028*** (0.251)	1.023*** (0.256)	0.822*** (0.237)	0.805*** (0.271)	0.837*** (0.265)	0.824*** (0.270)
D.RTA _{jt}	-0.0489 (0.135)	-0.0386 (0.131)	-0.178 (0.156)	-0.164 (0.153)	-0.0789 (0.134)	-0.0603 (0.126)
ln (1+Tariff) _{jkt}	-1.958** (0.925)	-1.928** (0.914)	-2.550*** (0.938)	-2.525*** (0.926)	-1.813** (0.771)	-1.794** (0.780)
B_GVC _{jct}	0.451** (0.223)	0.446** (0.212)	0.339* (0.189)	0.372* (0.209)	0.423** (0.196)	0.450** (0.196)
D.TBT _{jkt}	0.342** (0.161)	0.225 (0.176)	0.359** (0.183)	0.247 (0.186)	0.388 (0.237)	0.314 (0.240)
B_GVC _{jct} # D.TBT _{jkt}	-0.0726 (0.116)	-0.111 (0.120)	-0.0469 (0.121)	-0.101 (0.122)	-0.0854 (0.178)	-0.147 (0.176)
Constant	-9.890* (5.287)	-9.721* (5.406)	-5.336 (5.019)	-4.935 (5.777)	-5.702 (5.691)	-5.394 (5.798)
Observations	165924	165924	104193	104193	87908	87908
Pseudo R-squared	0.971	0.971	0.976	0.976	0.978	0.978

Notes. Panel A and B show the results with OECD and non-OECD trade partners, respectively. All estimations include importer-product and product-year fixed effects. Dependent variable is export value. FI is frequency index and CR is coverage ratio. Importer, product, and year clustered standard errors are in parentheses: ***p<0.01, **p<0.05, *p<0.1.

According to the results in Panel A, the coefficients of TBTs are positive and statistically significant in Columns (1) and (3), while their interaction terms with backward GVC participation are also statistically significant but negative in Columns (1), (2), and (4). TBTs from OECD member countries in sectors where Vietnam is relatively active in backward GVC activities diminish the positive effects of TBTs in other sectors. This effect may stem from the fact that TBTs in developed countries increase production costs for Vietnamese exporters to comply with requirements in backward GVC activities, such as assembly. Conversely, the interaction terms with TBTs from non-OECD countries are not statistically significant, indicating no heterogeneous effects based on backward GVC participation in Vietnam's exports to non-OECD members. Therefore, TBTs from developing countries do not impose additional compliance costs on Vietnam's exports. In summary, the results in Columns (1) and (3) of both Panel A and Panel B indicate that TBTs in sectors not involved in backward GVC participation are positively associated with Vietnam's exports to both OECD and non-OECD member countries. However, TBTs from OECD member countries in sectors where Vietnam is deeply engaged in backward GVC activities, such as assembly with relatively low value-added activities, incur additional production costs like compliance costs, thereby reducing the positive effects of TBTs on Vietnam's exports. In sectors deeply involved in backward GVC activities, TBTs from non-OECD member countries do not significantly impact Vietnam's exports.

Table 7 presents the estimated results of TBTs along with Forward GVC participation. Panel A and B illustrate the effects of TBT along with forward GVC participation on Vietnam's exports to OECD and non-OECD member countries, respectively. Columns (1) to (2) show the results with 1-year lagged trade policy variables. Columns (3) to (4) present the results with 2-year lagged trade policy variables, and Columns (5) to (6) show the results with 3-year lagged trade policy variables. Columns (1), (3), and (5) use FIs, whereas Columns (2), (4), and (6) use CRs to measure the rigidity of NTMs. Consistent with previous estimations, the coefficients of partner countries' GDP are positive and statistically significant. The coefficients of tariffs are negative but only statistically significant in cases involving non-OECD members. The estimated coefficients of co-membership in the same RTA are not statistically significant. In summary, we can draw a conclusion that Vietnam's exports tend to increase with the GDP of trading partners and decrease as tariff rates imposed by partners' increase.

Table 7. Heterogeneous Effects of TBT Along with Forward GVC Participation Depending on Trading Partner's OECD Membership

	OECD					
	(1)	(2)	(3)	(4)	(5)	(6)
	One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)	
	FI	CR	FI	CR	FI	CR
ln GDP _{jt}	0.979** (0.442)	0.984** (0.439)	1.042** (0.429)	1.052** (0.415)	1.021** (0.451)	1.028** (0.439)
D.RTA _{jt}	0.131 (0.113)	0.147 (0.107)	0.105 (0.140)	0.129 (0.109)	0.0972 (0.0937)	0.116 (0.0879)
ln (1+Tariff) _{jkt}	-0.812 (0.959)	-0.828 (0.975)	-0.782 (0.846)	-0.839 (0.915)	-0.542 (0.968)	-0.598 (1.042)
F_GVC _{jct}	0.130 (0.136)	0.240* (0.126)	0.283* (0.163)	0.467*** (0.122)	0.299* (0.169)	0.504*** (0.109)
D.TBT _{jkt}	0.311 (0.190)	0.246 (0.215)	0.300* (0.160)	0.218 (0.201)	0.294*** (0.109)	0.224 (0.150)
F_GVC _{jct} # D.TBT _{jkt}	-0.270* (0.156)	-0.402*** (0.150)	-0.475** (0.190)	-0.695*** (0.158)	-0.486** (0.216)	-0.736*** (0.154)
Constant	-9.622 (9.778)	-9.731 (9.716)	-10.99 (9.513)	-11.20 (9.220)	-10.50 (10.01)	-10.66 (9.738)
Observations	174242	174242	133796	133796	119504	119504
Pseudo R-squared	0.980	0.980	0.981	0.981	0.982	0.983
PANEL B	Non-OECD					
	(1)	(2)	(3)	(4)	(5)	(6)
	One-year lagged (t-1, s=1)		Two-year lagged (t-2, s=2)		Three-year lagged (t-3, s=3)	
	FI	CR	FI	CR	FI	CR
ln GDP _{jt}	1.028*** (0.256)	1.024*** (0.264)	0.823*** (0.239)	0.805*** (0.277)	0.833*** (0.262)	0.811*** (0.272)
D.RTA _{jt}	-0.0587 (0.136)	-0.0453 (0.130)	-0.192 (0.155)	-0.172 (0.148)	-0.103 (0.129)	-0.0762 (0.117)
ln (1+Tariff) _{jkt}	-1.960** (0.886)	-1.927** (0.875)	-2.575*** (0.911)	-2.537*** (0.892)	-1.838*** (0.711)	-1.817** (0.711)
F_GVC _{jct}	-0.135 (0.152)	-0.0716 (0.145)	-0.00723 (0.0949)	0.0546 (0.102)	-0.0618 (0.150)	-0.0259 (0.145)
D.TBT _{jkt}	0.140 (0.118)	0.0682 (0.132)	0.113 (0.139)	0.0545 (0.146)	0.0609 (0.118)	0.0165 (0.124)
F_GVC _{jct} #D.TBT _{jkt}	0.234* (0.126)	0.128 (0.134)	0.325** (0.155)	0.193 (0.161)	0.417** (0.171)	0.302* (0.163)
Constant	-9.444* (5.312)	-9.347* (5.478)	-5.093 (5.037)	-4.697 (5.843)	-5.233 (5.503)	-4.749 (5.713)
Observations	165924	165924	104193	104193	87908	87908
Pseudo R-squared	0.971	0.971	0.976	0.976	0.978	0.978

Notes. Panel A and B show the results with OECD and non-OECD trade partners, respectively. All estimations include importer-product and product-year fixed effects. Dependent variable is export value. FI is frequency index and CR is coverage ratio. Importer, product, and year clustered standard errors are in parentheses: ***p<0.01, **p<0.05, *p<0.1.

Based on the statistically significant and positively estimated coefficients of TBT (Columns (3) and (5)) and negatively estimated coefficients of interaction terms (Columns (1)-(6)) in Panel A, TBTs from OECD member countries in sectors where Vietnam is highly involved in forward participation diminish the positive effects of TBTs in other sectors. On the other hand, TBTs from non-OECD member countries in sectors where Vietnam is highly engaged in forward participation do show positive and statistically significant effects. TBTs from developing countries in sectors where Vietnam is deeply involved in forward GVC participation increase Vietnam's exports to non-OECD members. In other words, TBTs from OECD members in sectors where Vietnam is heavily engaged in forward GVC participation require Vietnamese exporters to increase production costs to comply with OECD TBT requirements. However, TBTs from non-members increase Vietnam's exports because they provide positive signals to consumers regarding product quality, thereby enhancing import demand and increasing exports.

So far, we have identified a statistically significant impact of TBTs from OECD member countries, with the effects varying across sectors where Vietnam is deeply involved in GVC participation. In sectors where Vietnam is heavily engaged in backward GVC activities, such as low value-added assembly work, TBTs from OECD countries may impose additional production costs, including compliance expenses, which diminish their positive impact on Vietnam's exports. Conversely, in sectors where Vietnam is more involved in forward GVC participation, TBTs from non-OECD countries tend to boost Vietnam's exports by sending positive signals about product quality to consumers, thereby increasing import demand and driving up exports.

V. Conclusion

We investigate how TBTs impact Vietnam's exports, considering its participation in GVC. Vietnam's exports have increased and diversified since joining WTO in 2007. Recent literature highlights Vietnam's resilience during the US-China trade war, primarily through increased production and exports of targeted products. Vietnam has also emerged as an active participant in GVCs. Therefore, it is crucial to understand how TBTs, among standard-like NTMs, influence its exports — whether as obstacles or catalysts.

Based on our estimations using Vietnam's export data from 2007 to 2019, TBTs generally are positively associated with Vietnam's exports. However, in sectors deeply engaged in backward GVC participation, such as low value-added activities like assembly, TBTs impose additional production costs such as compliance costs, thereby mitigating their positive impact on Vietnam's exports. We further analyze the heterogeneous effects of TBTs based on industry technology levels and the income of importers. In low- and medium-technology sectors where Vietnam

is heavily engaged in backward GVC participation, TBTs diminish the positive impact on Vietnam's exports. In contrast, in high-technology sectors, where Vietnam also has significant backward GVC participation, TBTs boost Vietnam's exports by signaling improved product quality to consumers. Moreover, TBTs enforced by OECD member countries increase Vietnam's production costs as they comply with stringent requirements, reducing exports in sectors involved in both backward and forward GVC activities. Conversely, TBTs from non-OECD members stimulate import demand by signaling higher product quality to consumers, thereby boosting Vietnam's exports.

Recent literature on GVC emphasizes the importance of moving up the value-added ladder. Therefore, investing in research and development (R&D) and enhancing human capital are crucial for elevating Vietnam's technical capabilities and productive knowledge to achieve this goal.

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