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The extensive and intensive effects of Vietnam's technical measures on agricultural imports

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ABSTRACT

Technical measures, particularly Sanitary and Phytosanitary measures (SPS) and Technical barriers to trade (TBT) can affect to firms' market entry and the volume of trade. Yet, technical measures is ambiguous and complicated, especially for developing countries. Therefore, the study analyses the extensive and intensive effects of SPS and TBT measures imposed by Vietnam on agricultural imports across products and partners. The empirical analysis employs gravity model with Heckman two-stage estimation at the disaggregated level from 2007 to 2019. The findings show that SPS and TBT have positive effects at the extensive margin while having heterogeneous effects at the intensive margin. Across different products, technical measures imposed on agricultural processed products are significant positive to firms' participation but are insignificant to the scale of trade. Imposing SPS measures on animal products facilitates market entry, while decreasing the intensive margin. In plant products, SPS measures play the market barriers to protect the advantage of exporting products, but firms can expand the import volume after adapting to TBT regulations. The estimation also shows that SPS and TBT increase the probability of imports from developed countries while having insignificant effects on developing countries.

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SUBJECTS

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1. Introduction

With the proliferation of trade liberalization, many countries have benefited from diminishing tariffs and other traditional non-tariff barriers. Nonetheless, it is also critical that the government transform the tariff-centric trade policy into a technical measures-centric policy. The traditional approach often regulates participants in the market with underlying trade protectionism intention, while the new approach has been heavily embedded with the social and environmental interest via technical non-tariff measures (NTMs). According to the UNCTAD's NTM classification (2019), non-tariff measures are categorized as technical measures (mainly technical barriers to trade – TBT and sanitary and phytosanitary measures – SPS) and non-technical measures. The number of mandatory requirements and voluntary standards that monitor the safety threshold for human, plant, and animal health, or environmental sustainability, are examples of technical non-tariff measures. Market access requires foreign enterprises to fulfil the importing country's mandatory regulations and standards.

Previous research on technical measures at the disaggregated level (Bao & Qiu, 2010; Chen et al., 2008; Crivelli et al., 2016; Disdier et al., 2008; Maskus et al., 2013) have mentioned the mixed effects both the extensive margin (the probability of market access) and intensive margin (volume of trade). On the one hand, technical measures raise exporters' trade costs in variable costs and fixed costs. The variable costs are caused by the clearance and customs checks for each consignment, whereas the fixed costs stem from the transformation of procedures or production process to adapt with the partners' mandatory requirements and standards. The rise in trade cost influences firms' decisions to enter or exit the market. On the demand side, technical measures ensure the safety of goods, which leads to the

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increased consumer trust on the products. It contributes to increase demand or create trade-promoting effects. By using firm-level data, some recent studies by Chen & Bao (2023) emphasize the strong influences of technical barriers to trade on the extensive and intensive margins by incorporating the characteristics of firms such as size, productivity and ownership. Technical measures as policy instruments represent countries' characteristics, then their effects vary from countries to countries. Some empirical studies investigate one country or economy to give the specific insights as a lesson for the others such as: in China (Bao, 2014; Ghodsi, 2020), in Korea (Wood et al., 2017), in Egypt (Hoda et al., 2016), in France (Fontagné et al., 2015; Fontagné & Orefice, 2018).

From the perspective of low-middle income country, Vietnam has been described as one of the countries with comparative advantages in agricultural exports, but agricultural supply chain is strongly depend on the intermediate inputs from foreign market. Vietnam has obtained trade surplus over the years, but the average growth rate of agricultural imports in two periods of 2008–2012 and 2012–2017 was double the rate of export (about 22,02% and 17,94% of the growth rate of agricultural import in the mentioned periods, compared with 10,88% and 7,62% of the growth rate of exporting in agricultural goods). Furthermore, most imported agricultural products are served for manufacturing or supporting industries in Vietnam. For example, Vietnam has mainly imported corn, soybean and cassava for animal feed industry and livestock industry or imported 70% of milk products for milk industry. With the prevalence of technical measures, Vietnam has struggled to overcome the stringent measures of importing countries (usually developed countries) to promote export but lack awareness of building a comprehensive and cohesive non-tariff policy. Consequently, it is necessary to express high concerns about technical non-tariff measures in Vietnam, especially agricultural market and lessons for other low-income countries.

Consequently, the paper aims to examine the extensive and intensive margin effects of technical non-tariff measures imposed by Vietnam across various agricultural imports, including live animal and animal origin products, live plant and plant origin products, and agricultural processed products. The empirical study contributes to the literature in the following ways: First, the study reinforces the theoretical framework of non-tariff measures impacts on trade in an case study of the emerging developing country as Vietnam. The dramatic growth in agriculture imports put pressure on government trade policy and required the policy transformation from tariff imposition to a regime regulated by requirements and standards. It is critical to understand the technical barriers to agricultural imports' market access and the effects on the agricultural market expansion. Second, at the disaggregated level, the study emphasizes the diversification of agricultural product categories, which absorbs the heterogenous effects of technical non-tariff measures. Finally, the positive effects of technical measures on Vietnam's agricultural market participation suggest that government should increasingly pursue these measures for social and environmental reasons and the economic harm may not be severe.

The paper includes 4 parts: the first part presents a literature review on the effect of technical measures such as SPS and TBT on agricultural products; the second part provides an overview of agricultural imports in Vietnam; the third part describes the dataset and methodology; and the fourth part points out estimation results, and discussion about the effects on agricultural imports, and some suggestions.

2. Background

2.1. Situation on Vietnam's agricultural trade

The situation in Vietnam's agricultural trade highlights some noteworthy points. Trade deficit represents two main categories including animal-origin products and agricultural processed products (-2.39 and -3.4 billion USD in 2022, respectively) (Figure 1). It shows that domestic agricultural intermediate supply capacity has not kept up with the expansion of the agricultural supply chain. Table 1 shows that top agricultural imports are primarily raw materials for livestock and agricultural process industries, such as animal feed, fresh cashew nuts, maize, fertilizers, wheat and milk and dairy products. Trade policy instruments imposed on imports may be neglected by the significant pressure from the demand side. Whether technical measures imposed by Vietnam's government have impacted market access and volume of agricultural imports is ambiguous. Hence, the paper examines the impacts of technical measures

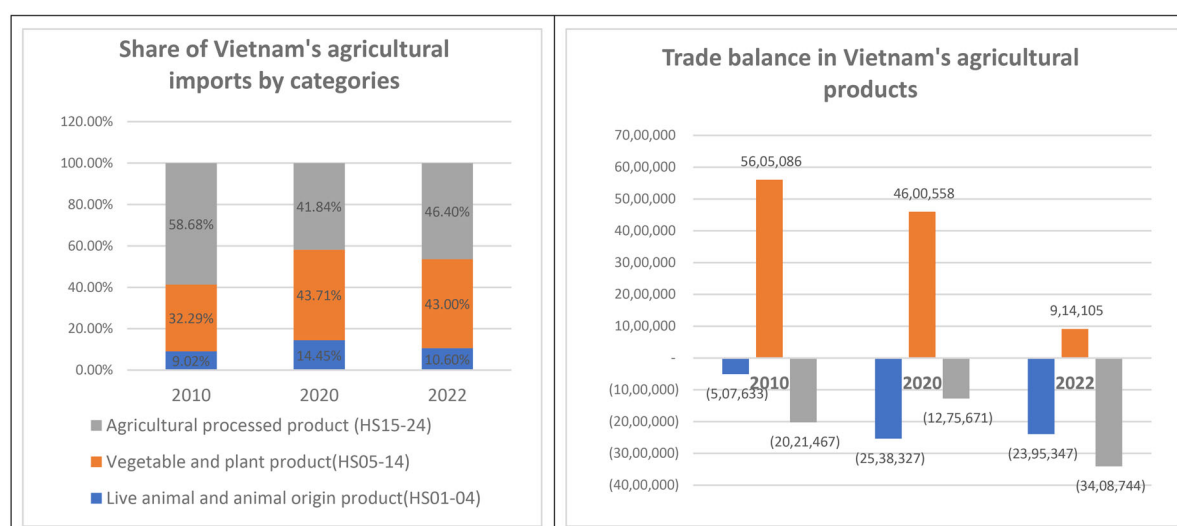


Figure 1. Situation on Vietnam's agricultural trade by categories (unit: thousand USD).

Notes: The agricultural products was defined by WTO, including the products listed from Chapter 1 to 24 but excluding chapter 3 - Fish and crustaceans, molluscs and other aquatic invertebrates.

Source: Author's own calculations based on ITC's database extracted on 6th December, 2023 from <https://www.trademap.org>.

Table 1. Vietnam's main agricultural imports by products Unit: Million USD.

Agricultural products	2016	2019	2022
Animal feeding	3.448,90	3.841,20	5.599,10
Cashew nut	1.658,00	1.808,00	2.678,50
Maize	1.672,60	2.388,30	3.327,80
Fertilizers	1.125,80	951,3	1.617,70
Wheat	1.005,00	755	1.515,10
Milk and dairy products	880,5	1.016,30	1.252,70

Source: Vietnam General Statistics Office (2022), extracted from: <https://www.gso.gov.vn/en/px-web/?pxid=E0818&theme=Trade%2C%20Price%20and%20Tourist>.

imposed on agricultural imports on extensive and intensive margins. The results may have some policy implications for monitoring the agricultural trade balance, notably to ensure that agricultural imports for consumption and production for export serve dual functions.

2.2. The development of Vietnam's technical measures on agricultural products

Under the 16 FTAs signed until 2022, Vietnam has obliged to implement tariff reduction duty in most product lines. It means that Vietnam has built consistently a set of regulations and requirements harmonized with WTO agreements of SPS and TBT. Table 2 indicates the landscape of Vietnam's agricultural technical measures. SPS measures have covered up to 95% more agricultural product lines than TBT measures. Concerns about contamination, abuse of fertilizers, or handling of unsafe food and other agricultural products are considerable.

Trade policy transformation process has reflected some key points. First, the specialization testing has been carried out by multiple ministries. In agricultural products, specialization testing is related to 3 Ministries (Ministry of Agricultural and Rural Development, Ministry of Industry and Trade, and Ministry of Health). This may lead to overlapping jurisdictions across government ministries and may raise lack of transparency, uniformity, and consistency in government policies. Besides, testing and inspection procedure can incur some expenses and be time-consuming for firms. From the understanding of how Vietnam's technical measures are applied to agricultural products, the study focuses on the dual effects of technical measures on the probability of foreign firms participating in the agricultural market and if participating how technical measures impact on trade expansion. Therefore, the study contributes to the empirical literature on the extensive and intensive effects of technical measures imposed by Vietnam as one of leading agricultural exporters. However, there are some differences as below. First, the effects of

Table 2. The application of technical measures (SPS and TBT) on the different groups of agricultural products in Vietnam.

The ratio	Animal and animal-origin products		Plant and plant-origin products		Processed agricultural products	
	SPS	TBT	SPS	TBT	SPS	TBT
Frequency Ratio	78,94%	75,91%	99,98%	97,36%	91,66%	95,93%
Coverage Ratio	94,62%	85,77%	99,07%	86,02%	99,03%	97,09%
The number of products be imposed by technical measures	246	223	319	277	204	200

Source: WITS – UNCTAD database, extracted on 20th February, 2020 from <https://trains.unctad.org/>.

technical measures can be explained based on the microeconomics foundation where policy instruments affect the firms' decisions. Second, the study shows the heterogeneous effects of technical measures on agricultural imports from extensive to intensive margins, from different product categories (animal products, plant products and agricultural processed products), from developing and developed partners. The findings show the impacts of technical measures both from supply side and demand side, which agricultural imports serve for domestic consumption and production chain across sectors.

3. Theoretical literature review

The theoretical framework of research is based on trade models with heterogeneous firms (Chaney, 2008; Melitz & Ottaviano, 2008). In particular, the theory assumes the firm differences in the same industry and each firm produces unique exporting products to fixed costs. However, these firms cover the additional costs from tariff, non-tariff barriers or other trade barriers which are specific from each market. Therefore, these barriers on imports can create two effects at the extensive margin and intensive margin. Helpman et al. (2008) develop a gravity model with heterogeneous firms. The authors extend Heckman's estimation method to take into account the bias associated with the heterogeneity.

Furthermore, Disdier & Marette (2010) develop the theory related to non-tariff measures impacts. The theoretical framework give six assumptions as follows: i) the commodity market is homogeneous or relatively homogeneous; ii) domestic consumers may or may not be aware of harmful issues from products; iii) importing products and domestic products are homogeneous and perfect substitutes; iv) the shift in the demand curve is independent of the implementation of non-tariff measures; v) the role or stringency of non-tariff measures by type is the same; vi) does not take into account sunk costs arising in trade or commercial fraud. The theory indicates the impact of non-tariff measures create a shift in the supply and demand curves in the market. On the one hand, the shift in the supply curve is due to the fact that foreign firms need to incur costs to meet mandatory regulations in non-tariff policy to enter the new market, with simultaneously costs arising in the process of quarantine or inspection for each shipment to increase the trade volume. On the other hand, the impact of shifting demand is observed from the perspective of consumers. An increase in consumer trust is possible in the quality and safety of products, after solving the problem of information asymmetry in the market. However, it is difficult to quantify the impact of non-tariff measures from the demand side. Most previous empirical studies examine the impact of non-tariff measures from the supply side. In the study, agricultural imports are described as domestic demand for final consumption and supply chain then the impact of technical measures (SPS and TBT particularly) represent the effects from supply side (foreign exporting firms) and demand side (from domestic consumption and production).

From the theoretical framework, the empirical study examines the two-stage effects of non-tariff measures with fixed costs incurring from market access (or first stage to measure the probability of market entry) and the variable costs raising from market expansion (or second stage to quantify the effects on trade volume). The empirical study constructs two main parameters into the equation. First, trade cost factors representing tariff, technical measures (SPS and TBT) and regional trade agreements. The factors related to tariff and technical measures are expected to have negative effects on market access (extensive margin) and positive effects on market expansion (intensive margin). Regional trade agreements represent trade liberalization in the process of economic transformation in developing countries

(particularly in the case of Vietnam). The second factors capture the differences in country pairs such as distances, income level, other invariant control variables (Anderson & van Wincoop, 2003).

4. Empirical literature review and hypothesis development

With the proliferation of empirical studies related to non-tariff measures, most studies indicate that technical measures have heterogeneous trade effects at the aggregate level. Technical barriers to trade (TBT) create both trade-restricting and trade-promoting effects (Bao & Qiu, 2010). From the demand side, the trade-enhancing effects reflect market failures solved by information asymmetry or imperfect competition. Imported products that meet technical regulations and standards may build consumer's confidence related to quality, safety and health-related issues, then it boosts trade flow (Bao & Qiu, 2010; Crivelli & Groeschl, 2016). There is also evidence of trade-impeding effects by raising the cost of compliance from the perspective of producers, particularly felt by middle and low-income exporting countries (Anders & Caswell, 2009; Chen et al., 2008; Disdier et al., 2008).

Regarding extensive and intensive margin, previous studies show non-tariff measures, particular TBT and SPS may restrict firm's market entry probability but promote volume. By classifying NTMs by public and trade goals, the study of Hu et al. (2021) shows that China's trade policy NTMs restrict the intermediate firm's market entry probability and trade volume, but public policy NTMs bring trade-promoting effect in the manufacturing sector due to reduced information costs. By using firm-level dataset, some recent studies (Fontagné et al., 2015; Fontagné & Orefice, 2018; Kamal & Zaki, 2018) show that TBT may decrease the probability of firm's exports and export flow. However, the positive effect of TBT may appear at the intensive margin of large firms, but the negative effect remains at the intensive margins of small firms (Chen & Bao, 2023). Regarding SPS measures, Fontagné et al. (2015) found the negative effects of SPS measures on export participation and export volume. The study of Hoda et al. (2016) also support the negative impact of SPS measures on the probability of exporting but the insignificant effect on the intensive margin of export.

From the perspective of the sectoral level, many studies show that the impact of technical measures is completely different for commodity groups. In particular, agriculture is always a sensitive industry and is more affected by the imposition of non-tariff measures than other manufacturing products. Trade costs for agricultural products are higher than for manufactured goods due to customs clearance requirements at the border, specialized inspection measures, strict phytosanitary measures, and the nature of perishable agricultural products. Thus, technical regulations and standards tend to create trade-restricting effect on agricultural sector, but trade-enhancing effects on manufacturing (Chen et al., 2008; Disdier et al., 2008; Ghodsi, 2020; Li & Beghin, 2012). Agricultural products respond slowly with the process of trade facilitation and liberalization. The nature of agricultural products are perishability (time and temperature), strict product and process standards (technical regulations), logistics (warehousing) and infrastructure, difficulty in financing and the higher transaction costs than manufactured goods (Mai & Ngoc, 2018). Regarding to agricultural sector, studies on the impact of technical measures often approach from the perspective of developed countries as imposing countries on agricultural developing exporters. The remarkable studies of Chen et al. (2008) and Maskus et al. (2013) analysed the disaggregated effects of technical regulations and standards on developing country exporters across sectors. Few of studies from the perspective of imposing countries as developing countries consider the effects of technical measures at extensive and intensive margins. Developing countries frequently prioritize export-promoting policy, while lacking a sophisticated and cohesive regulatory system to monitor imports. Thus, the paper investigates the extensive and intensive margin effects of technical non-tariff measures designed by developing countries across 3 different categories of agricultural import, including live animal and animal origin products, live plant and plant origin products, and agricultural processed products.

5. Research design

5.1. Research data

With these 20 Vietnam's major exporters and 13 years at HS4-digits level products from HS01-24 (excluding HS03, based on the WTO's agricultural definitions), the study collects a panel of 47320 observations.

The panel data are controlled by year fixed effects. In the gravity model, the agricultural import value was obtained from General Statistics Office of Vietnam from 2007 to 2019. GDP of exporters (*Ingdpe*) and GDP of Vietnam (*Ingdpv*) as importer capture the effects of agricultural demand and supply capacity. They are expressed in current US dollars and collected from the World Bank Databank. The bilateral distance between importing and exporting countries is the proxy to the transportation costs. Respectively, *colony* and *contig* are the invariant variables to capture the cultural and historical proximity between country pairs. The trade policy variables are represented by tariff (*t*) and regional trade agreements (denote *rta*). The applied tariff was extracted from the tariff database of International Trade Centre (ITC). The dummy variable for bilateral or regional FTA applied in this study is notified by WTO and obtained from the Regional Trade Agreements Information System.

The key variables representing technical measures include sanitary and phytosanitary measures (*sps*) and technical barriers to trade (*tbt*). The SPS and TBT variables are extracted from non-tariff measures database collected by UNCTAD and The Economic Research Institute for ASEAN and East Asia (ERIA). The database is based on official regulations and documents including international conventions adopted by ASEAN countries. The database is the first official resource collected, validated and stored non-tariff measures data of Vietnam.

The study also includes dummy variables indicating the product groups (such as '*animal*' – live animal and origin animal products with HS01-04; '*plant*' – live plant and origin plant products with HS05 -14; '*process*' – agricultural processed products with HS15 – 24) and the country group ('*developing*' indicate that the exporting country is a developing country or '*developed*' indicate the exporting country is a developed country). The dummy variables interact with each of the trade policy variables (tariff, SPS and TBT). The estimation aims to examine the effects of technical non-tariff measures on the different agricultural products and the trade creation or trade diversion by exporting partners.

5.2. Research method

The study aims to measure the effect of SPS and TBT on Vietnam's agricultural imports at the intensive and extensive margin. The study also examines the impact on specific product groups namely live animal and animal origin products, vegetable and plant products, and agricultural-processed products. The reason to categorize these groups is based on the hypothesis that the effect of technical measures is different across products and across partners.

The gravity model has developed a solid theoretical foundation by Helpman et al. (2008). The empirical specification of the gravity equation account for firm heterogeneity, trade asymmetries and fixed trade cost. The estimation suggests the decision to export and the volume of trade are not independent variables. With the panel data, the zero-trade value account for 63,43% (30018 observations of zero value at HS4 digit). The Heckman two-stage estimation could solve the two econometric issues of the gravity model as sample selection bias and heteroscedasticity. The sample selection bias is caused by the large number of zero trade volumes in bilateral trade across partners and products. In particular, the first step proposes the Probit equation to observe the presence of zero flows. The results from selection models define whether the variables impact to the decision of export. By accumulating the inverse Mills ratio (λ) representing the unobserved errors in the first step, the coefficients in the second step are estimated using GLS regression for panel data with year-fixed effects to estimate the effects on trade expansion. The model is defined as:

Selection equation

$$Z_i = \beta_0 + \beta_1 \ln(t_{it}^k + 1) + \beta_3 SPS_{ik} + \beta_4 TBT_{ik} + \beta_5 \ln Dist_{ij} + \beta_6 R_{ij} \quad (1)$$

Outcome equation

$$\ln(H_i | Z_i = 1) = \beta_0 + \beta_1 \ln Y_{ijt} + \beta_2 \ln(t_{it}^k + 1) + \beta_3 SPS_{ik} + \beta_4 TBT_{ik} + \beta_5 RTA_{ijt} + \gamma_t + u_{ijk} \quad (2)$$

Where the dependent variable in the probit model is the probability of positive export on product *k* from country *j* to Vietnam (*i*) at time *t*. The dependent variable in the outcome equation is the natural logarithm of import value, where *j* denotes the exporting countries (20 countries – in Appendix 1) and *i* is importing country (*i* = Viet Nam), *k* denotes the product at the HS4 (*k* covers from HS01 to 24, except

Table 3. Descriptive statistics of some main variables.

Variable	Obs	Mean	Std. dev	Min	Max
Ingdpv	47,320	7.452345	.3266651	6.803866	7.906649
Ingdpe	47,320	9.823404	1.069393	6.909215	11.3898
ln($t + 1$)	47,320	.1258961	.1351101	0	1.10572
sps	47,320	51.05917	60.45138	1	430
tbt	47,320	14.43195	17.21923	1	127
dist	47,320	8414.063	5331.323	990.7018	18603.05
contig	47,320	.05	.2179473	0	1
colony	47,320	.05	.2179473	0	1
rta	47,320	.4384615	.4962038	0	1

HS03 or categorized agricultural products following the definition of WTO). To test the hypothesis of two independent equations, since inverse Mills ratio (λ) is highly significant, indicating the rejection of hypothesis which suggests the existence of a sample selection bias. It means that the selection and outcome equation are dependent, and the estimation of a Heckman two-stage model is appropriate.

A set of independent variables for the gravity model includes $Dist_{ij}$ – geographical distance between i and j , R_{ij} are country-pair dummy variables absorbing all time-invariant determinants of bilateral trade costs such as $Contig$ - shared border, $Colony$ - colonial relationship. Y_{it} , Y_{jt} denote the GDP of Vietnam and exporting countries across time from 2007 to 2019. The main explanatory variables are SPS and TBT, which representing the number of SPS and TBT measures imposed by Vietnam at 4-digit product level over the 13-year period. Furthermore, the paper also performs the applied tariff on the model, accounting for the preferential tariff on Bilateral trade agreement or Regional trade agreement. Since 2015, Vietnam had bilateral trade agreement with Chile, China, India, Korea, Japan. Regional trade agreement namely AFTA (ASEAN Free Trade Agreement), Asean – Australia – New Zealand free trade agreement. So that rta is the dummy variable indicating the presence or absence of a regional or bilateral trade agreement between the countries, as well as the openness of Vietnam's trade policy. The descriptive statistics are shown in Table 3.

6. Empirical results and discussion

6.1. The effects of SPS and TBT on the extensive and intensive margin

Table 4 estimates the effects of technical measures (TBT and SPS) on agricultural products at the extensive margin (column 1) and intensive margin (column 2). In column 1, regarding the Probit equation, all explanatory variables are statistically significant (at 1%) with the expected sign. SPS and TBT have a highly significant positive impact on the probability of agricultural export firms' participation. The results correspond with the previous study by Chen et al. (2008) and Chen & Bao (2023). Technical measures imposed by Vietnam may not challenge foreign firms to market entry in the agricultural sector. The positive correlation between technical measures and the decision to market access can also be observed from the increasing demand for agricultural intermediate import perspective. Other variables that represent the trade relationship (rta) and common borders ($contig$), and historical variables ($colony$) have also promoted market openness. Tariff and distance have a negative impact on foreign firms' decision to participate in Vietnam's agricultural market as expected. The results are corresponding with literatures which evidences from developing countries (Chawarika et al., 2022; Esaku, 2021; Irshad et al., 2018).

In the outcome estimation (column 2), technical measures represent the significant heterogenous effects. It indicates that SPS create trade-restricting effects at the minimal coefficient, but TBT remain the positive effects on volume of imports. Firms are more adaptive with technical regulations imposed by Vietnam, they can more expand volume. As the results, TBT can increase both the extensive and intensive margins. Yet, the trade-promoting effect of technical measures at the intensive margin is minimal. The trade-restricting effects mainly stem from tariffs. The results show the significant correlation between SPS and TBT at the extensive (market entry) and intensive margins (market expansion). Vietnam has integrated widely and deeply in the regional trade agreements, thus it encourages to

Table 4. The aggregated effects of SPS and TBT on agricultural imports at the extensive and intensive margin.

VARIABLES	(1) selection module	(2) outcome module
lngdppcv		1.483*** (0.539)
lngdppce		0.287*** (0.0254)
Intariff	−0.844*** (0.169)	−0.696*** (0.136)
sps	0.00147*** (0.000457)	−0.000720** (0.000350)
tbt	0.00898*** (0.00143)	0.00293*** (0.00107)
lambda		−0.949*** (0.0636)
Indist	−0.761*** (0.0574)	
rta	0.133*** (0.0410)	
contig	1.787*** (0.195)	
colony	2.003*** (0.204)	
Insig2u	1.704*** (0.0421)	
Constant	5.415*** (0.514)	−10.95** (4.254)
Year fixed effect		Yes
Observations	47,320	47,320
Number of id	3,640	3,640

LR test of $\rho = 0$: $\text{chibar2}(01) = 2.6e + 04$ Prob > = $\text{chibar2} = 0.000$.

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

potential firms entering the market and facilitate to expand the scale to ensure intermediate products (inputs) for agricultural supply chain.

6.2. Estimation the effects of SPS and TBT by products

The effects of SPS and TBT on the import of three different agricultural products are estimated in Table 5. The results represent the heterogenous effects by types of measure and by product categories.

At the extensive margin on agricultural-processed products, two types of technical measures also have a positive sign, which reflects to encourage foreign firms to market entry. The product group primarily import agricultural intermediate products to serve agricultural exporting production (for example: animal feeding (HS2309), palm oil (HS1511), food preparation (2106), and cane and beet sugars (HS1701). The surprising point is that technical non-tariff measures are insignificant on agricultural-processed products at the intensive margin. On the other way, the regulatory measures do not have a significant net effect on supply or demand.

Regarding plant products, the effects of technical measures are diverged by types at both extensive and intensive margins. SPS measures impact negatively, while TBT measures affect positively at the extensive margin. The effects are highly significant at 1%. It is appropriate that plant products are the main subject of sanitary inspection and quarantine requirements to prevent pesticide residues. SPS measures are strong at-the-border policy instruments to monitor the hygiene of plant products. In contrast, technical requirements (TBT) bring positive impacts at the extensive margin but create trade-restricting effects at the intensive margin.

In terms of live animal and animal origin products, SPS measure has the converse signs in two margins. TBT measures are not statistically significant at the extensive margin, but they show a strong positive correlation with import value. Technical measures are not the obstacles to accessing the livestock market, but these measures affect to supervise trade flow in the sector. The sanitary regulations are also

Table 5. The effects of technical measures by product groups.

VARIABLES	Live animal products		Live plant products		Agricultural processed products	
	(1)	(2)	(1)	(2)		
Ingdppcv		1.476*** (0.540)		1.479*** (0.541)		1.477*** (0.540)
Ingdppce		0.253*** (0.0250)		0.270*** (0.0251)		0.257*** (0.0250)
Lntariff_animal	−1.675*** (0.506)	0.326 (0.362)				
sps_animal	0.00243** (0.00104)	−0.00208*** (0.000768)				
tbt_animal	−0.00330 (0.00329)	0.00638*** (0.00242)				
Lntariff_plant			−2.191*** (0.282)	1.206*** (0.242)		
sps_plant			−0.00187*** (0.000682)	−0.000326 (0.000483)		
tbt_plant			0.0191*** (0.00265)	−0.00404** (0.00198)		
Lntariff_process					0.0640 (0.182)	−0.903*** (0.141)
sps_process					0.00423*** (0.000865)	−0.000895 (0.000641)
tbt_process					0.00574*** (0.00221)	0.00142 (0.00154)
lambda		−0.856*** (0.0526)		−0.968*** (0.0600)		−0.835*** (0.0555)
Indist	−0.693*** (0.0581)		−0.701*** (0.0576)		−0.715*** (0.0559)	
rta	0.387*** (0.0369)		0.258*** (0.0387)		0.311*** (0.0380)	
contig	1.757*** (0.198)		1.758*** (0.196)		1.722*** (0.192)	
colony	2.069*** (0.208)		2.037*** (0.204)		2.007*** (0.197)	
Insig2u	1.716*** (0.0417)		1.697*** (0.0417)		1.650*** (0.0421)	
Constant	4.807*** (0.521)	−10.67** (4.267)	4.964*** (0.515)	−10.72** (4.268)	4.944*** (0.500)	−10.72** (4.265)
Year fixed effect		Yes		Yes		Yes
LR test of rho = 0:	2.6e + 04***		2.6e + 04***		2.5e + 04***	
Observations	47,320	47,320			47,320	

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; (1) – Selection model; (2) – Outcome model.

directly related to quarantine time, which has a negative influence on perishable products. Furthermore, Vietnam's livestock production lags that of other nations, resulting in a failure to fulfil domestic demand for certain products.

6.3. Empirical results of the disaggregated effects by trade partners

Table 6 report the effects of technical measures by trade partners with Vietnam by the interaction term between SPS and TBT measures and the dummy variables of developing or developed countries. The impact of SPS and TBT are differentiated between exporting partners. First, the coefficients of interaction between technical measures and the dummy variables of developed countries are statistically significant positive at extensive margin, indicating that technical measures imposed by Vietnam may not market barriers with exporting firms from countries that are more advanced regulatory systems. However, the coefficient of SPS measures imposed on developed countries is significant negative sign at the intensive margins. It suggests that SPS measures increase trade-restricting effects of agricultural imports from developed countries. The quarantine procedure for agricultural products can lead to the increasing variables costs in each shipment, then become trade-hindering effects on firms from developed nations. It is noticeable that the higher frequency of technical measures may promote buyer confidence, then increasing demand. Second, technical

Table 6. The effects of technical measures by countries.

VARIABLES	Developing countries		Developed countries	
	(1)	(2)	(1)	(2)
Ingdppcv		1.475*** (0.541)		1.492*** (0.539)
Ingdppce		0.247*** (0.0262)		0.334*** (0.0256)
Lntariff	−2.793*** (0.246)	1.566*** (0.234)	0.643*** (0.192)	−1.647*** (0.150)
sps	0.000394 (0.000674)	−0.000704 (0.000474)	0.00227*** (0.000611)	−0.00225*** (0.000443)
tbt	0.00306 (0.00213)	0.00330** (0.00145)	0.0125*** (0.00193)	0.00190 (0.00137)
lambda		−0.896*** (0.0588)		−0.927*** (0.0544)
Indist	−0.672*** (0.0573)		−0.770*** (0.0554)	
rta	0.275*** (0.0381)		0.313*** (0.0389)	
contig	1.859*** (0.196)		1.856*** (0.191)	
colony	1.892*** (0.206)		1.836*** (0.195)	
Insig2u	1.695*** (0.0416)		1.634*** (0.0421)	
Constant	4.772*** (0.513)	−10.61** (4.268)		−11.38*** (4.259)
Year fixed effects		Yes		Yes
LR test of rho = 0:	2.6e + 04***		2.6e + 04***	
Observations	47,320	47,320		47,320
Number of id	3,640	3,640		3,640

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; (1) – Selection model; (2) – Outcome model.

Table 7. Summary and comparison of the results across products and countries.

	Whole sample (Aggregated)		Live animal products		Live plant products		Agricultural processed products		Developing countries		Developed countries	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Technical measures												
SPS	+	−	+	−	−	NA	+	NA	NA	NA	+	−
TBT	+	+	NA	+	+	−	+	NA	NA	+	+	NA

Note. +, −, and NA, stand for positively significant, negatively significant, and insignificant respectively.

measures are insignificant in the trade relationship between Vietnam and developing countries. In these country pairs, tariff barriers dominate the monitoring of trade flows, instead of technical non-tariff policy.

7. Summary and conclusion

The paper analyses the effects of technical measures on market entry and market expansion of Vietnam's agricultural imports. The findings contribute to the literature on technical non-tariff measures in analysing firms' decisions to participate in and expand trade in Vietnam's agricultural market. In the empirical study of Vietnam as one of the leading agricultural exporters in the world, the study uses the import value to give a comprehensive perspective from demand sides. Regarding the results (Table 7), SPS and TBT have positive effects at the extensive margin while having heterogeneous effects at the intensive margin. TBT measures increase both the extensive and intensive margin of agricultural imports. These results do not correspond with some literature, but they support the conclusions of Chen & Bao (2023) that TBT can create a positive effect at the extensive and intensive of large and productive firms. Thus, Vietnam may attract large corporations to participate in the market and expand the volume. It suggests that large productive firms can easily adapt to TBT measures imposed by Vietnam and cover the compliance costs raised by TBT measures. On the other hand, SPS measures can increase the variable costs related to the quarantine procedures at the border then decrease the import value.

Technical measures also absorb the heterogeneity of product lines, then lead to differentiating effects across agricultural products. Regarding agricultural processed products, technical measures positively affect the probability of market entry, while affecting insignificant on the scale of demand. From the analysis, agricultural processed import products primarily focus on intermediate inputs for agricultural supply chain. The positive extensive margins of SPS and TBT measures indicate that Vietnam strongly depends on agricultural intermediate imports and is ready to market openness to adapt to the increasing demand. With live plant and plant-origin products, SPS measures decrease the probability of firms' participation while TBT measures create trade-restricting effects on the volume of imports. The results represent the protectionism of technical measures in this category known as Vietnam's major agricultural exports. In terms of live animal and animal – origin products, SPS measures may both increase the number of firms participating in Vietnam's livestock market and decrease the volume of trade. In contrast, TBT has insignificant effect at the extensive margin and positive sign at the intensive margin. The results show that technical measures are not the obstacles to entering the livestock sector. However, imposing SPS measures requires extended testing and quarantine procedures at the border, then increases the cost of each consignment. It indicates that SPS concerns related to human and animal health and safety restrict trade live animal and animal-origin products.

The results of SPS and TBT effects across countries support the prediction that Vietnam's agricultural imports primarily come from developed countries with the advantage of large-scale production. SPS and TBT increase the probability of imports from developed countries while having insignificant effects on developing countries. In addition, technical measures imposed by Vietnam may not challenge firms from developed countries, which often have more stringent non-tariff policies. However, the quarantine procedure related to SPS concerns may be the obstacle to increasing costs for firms from developed countries. In contrast, the increasing compliance cost of TBT regulations positively affects consumers' confidence in agricultural imports from developing countries.

From the policymaking perspective, the government should build more comprehensive and cohesive technical measures, particularly SPS and TBT measures, as the decisive factors in monitoring the agricultural trade balance. The government should maintain market openness to put competitive pressure on domestic firms to upgrade their quality and productivity. However, improving trade facilitation can diminish the cost arising from the customs clearance procedure related to SPS concerns. In addition, imposing SPS and TBT measures should consider the differentiating product categories and trade partners. Technical measures should be well-designed to filter the quality of import inputs for the agricultural supply chain in order to enhance high-value-added agricultural exports. In addition, technical measures should be implemented to facilitate multi-destination imports equally in the context of Vietnam's deeply integration. For firms' perspective, firms should build the strategic agricultural products which facilitated by government and with the increasing demand. To comply with technical measures, firms should invest fixed costs initially to transform or establish a sustainable and innovative production process, leading to increased competitiveness and productivity.

The paper has some limitations. The results are based on the assumption of the same stringency of types of measures and do not mention the quality of agricultural products. These issues are left for further analysis.

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Data availability statement

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

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Appendix 1.

List of exporting countries

ARG	Argentina
AUS	Australia
BRA	Brazil
CAN	Canada
CHE	Switzerland
CHL	Chile
CHN	China
DEU	Germany
ESP	Spain
FRA	France
GBR	United Kingdom
IDN	Indonesia
IND	India
JPN	Japan
KOR	Korea
MYS	Malaysia
NZL	New Zealand
RUS	Russia
THA	Thailand
USA	United States