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The Effects of SPSs and TBTs on Innovation: Evidence from Exporting Firms in Viet Nam

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Abstract: *Sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBTs) in destination markets may affect firms' performance. In this paper, we examine how meeting foreign standards affects exporting firms' innovation, reflected in the product quality, production processes, skills, and technological acquisition. The analysis relies on official regulations on non-tariff measures released by the United Nations Conference on Trade and Development (UNCTAD) and panel data for manufacturing firms in Viet Nam during 2013–2015. To correct for the potential endogeneity of SPS measures and TBTs and measurement errors, we use the number of SPS measures and TBTs imposed on other Association of Southeast Asian Nations (ASEAN) Member States as an instrument variable. Our results indicate that a higher number of SPS measures and TBTs applied by destination countries increases the probability of Vietnamese exporting firms' skill acquisition. SPS measures also have higher positive impacts on product quality improvement and skill acquisition in the food processing sector. The SPS measures and TBTs have larger impacts on small firms than large firms. Foreign firms tend to acquire more technology and skills than domestic firms when facing SPS measures and TBTs by importing countries. Higher SPS measures and TBTs have more effects on the probability of acquiring skills by state-owned firms. However, the propensity of product quality and technological acquisition of non-state firms is much higher than that of state-owned firms when facing a greater level of SPS measures and TBTs.*

Keywords: trade, non-tariff measures, innovation
JEL Classification: F14, O33

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1. Introduction

During the last few decades, the use of non-tariff measures (NTMs), such as sanitary and phytosanitary (SPS) measures[1] and technical barriers to trade (TBTs),[2] has increased to support a wide range of development strategies, domestic priorities, and public policy objectives, including those related to the achievement of the Sustainable Development Goals. Although many forms of NTMs are justifiable, they have raised barriers to trade as they are not always transparent and because they impose numerous compliance costs (de Melo and Nicita, 2018).

While the investigation of NTMs is of significant interest to developed countries, it is a crucial issue for developing countries, for which the discriminatory effect of NTMs is expected to be even stronger. Indeed, meeting the requirements dictated by NTMs is often more costly for developing countries. It involves larger efforts and more cumbersome procedures for firms from the developing world than firms from developed countries. However, a limited number of studies examines this key issue for developing countries. Until now, most of them have focused on the impacts of different NTMs on firm exports (e.g. Disdier, Fontagné, and Mimouni (2008); Fontagné et al. (2015); Otsuki, Wilson, and Sewadeh (2001)) and export diversification (e.g. Chen, Wilson, and Otsuki (2008); Shepherd and Wilson (2013)). Little is known about how firms adjust their production processes and innovation to adapt to new standards.

The economic literature has not provided a clear prediction concerning the impacts of SPS measures and TBTs imposed by destination countries on exporting firms' innovation. On the one hand, SPS measures and TBTs impose standards on exporting products that exert compliance costs on exporting firms. To stay in the market, firms may choose to undertake innovations to adapt their products to new regulations. Even if exporting firms can satisfy more stringent product standards, higher foreign demand for exporting products may result in higher sales, and exporting firms may have more resources to innovate. On the other hand, SPS

[1] SPS measures 'refer to measures affecting areas such as restrictions for substances, hygienic requirements, or other measures for preventing dissemination of diseases. It also includes all conformity assessment measures related to food safety, such as certification, testing and inspection, and quarantine' UNCTAD (n.d.).

[2] TBTs 'refer to measures such as labelling and other measures to protect the environment. It also includes conformity assessment that relates to technical requirements such as certification, testing and inspection' UNCTAD (n.d.).

measures and TBTs may decrease exporting firms' incentives to upgrade technologically by reducing the benefits they could gain from innovating. In these cases, firms may choose not to innovate, exit markets, or divert their exports to other markets where they already export. In this way, SPS measures and TBTs may not have an impact on firms' innovation.

The purpose of this paper is to study the effects of SPS measures and TBTs applied by destination markets on exporting firms' innovation in a developing country. We combine (i) a new database on official regulations on NTMs, released by the United Nations Conference on Trade and Development (UNCTAD) in collaboration with other organisations, to identify the SPS measures and TBTs; and (ii) panel data on manufacturing firms in Viet Nam in 2013–2015. We ask whether the SPS measures and TBTs imposed by destination markets affect firms' demand for innovation to adapt to new regulations. Particularly, this paper intends to answer the following questions: Do exporting firms innovate when facing an increase in SPS measures and TBTs from destination markets? With a higher number of SPS measures and TBTs, do small firms innovate more than large firms? Does a higher number of SPS measures and TBTs make exporting firms have more technological and skill acquisition?

The results of ordinary least squares (OLS) estimation reveal that SPS measures and TBTs in foreign markets make exporting firms invest more in innovation. They particularly affect firms' skill acquisition. SPS measures also have significant impacts on product quality improvement and skill acquisition in the food processing sector. Moreover, small firms tend to have a greater product quality improvement and acquire more technology and skills than larger firms when facing SPS measures and TBTs by importing countries. Foreign firms tend to acquire more technology and skills than domestic firms when facing SPS measures and TBTs. Higher SPS measures and TBTs have more effects on the probability of acquiring skills of state-owned firms. However, with a greater level of SPS measures and TBTs, the propensity of product quality and technological acquisition of non-state firms is much higher than that of state-owned firms.

Nonetheless, these relationships may not be causal because of measurement errors or omitted variable problems. To address such potential endogeneity, we use the number of SPS measures and TBTs faced by Association of Southeast Asian Nations (ASEAN) Member States (AMS) as an instrument for the number of SPS measures and TBTs imposed on Vietnamese exporting firms. The results of the instrumental variables (IV) approach suggest that the number of SPS measures and TBTs has a positive impact on exporting firms' innovation.

This paper makes two main contributions to the empirical literature. First, it complements the few existing studies that examine the impacts of NTMs at the firm level from developing countries (e.g. Chen, Wilson, and Otsuki (2008); Otsuki, Wilson, and Sewadeh (2001)). Second, to the best of our knowledge, this is one of the first studies examining the impact of SPS measures and TBTs on innovation in a developing country.

The paper is organised as follows. Section 2 provides a conceptual framework. Section 3 discusses our data, along with descriptive analyses of innovations by exporting firms and the technical measures that they face, and then presents the empirical model strategy. Section 4 gives the estimation results. Section 5 summarises the key findings and presents policy recommendations.

2. Conceptual framework

In this section, we discuss the channels through which SPS measures and TBTs could affect innovations by exporting firms. This discussion provides guides for the later empirical framework and analysis.

First, SPS measures and TBTs impose regulations on exporting products that exert compliance costs on exporting firms. Many of them require improved production processes and investment in new technology (UNCTAD, 2013). To stay in the market or even expand the market share as other firms withdraw, firms may choose to have some innovations (such as product adaptation or upgrading) to adapt to new regulations.

The second possibility is that SPS measures and TBTs could positively affect innovations. Since not all SPS measures and TBTs hurt trade, some new standards may enhance exports – particularly in technologically advanced sectors – when they reduce information asymmetries and increase information flows between exporters and importers; and these benefits outweigh the costs of compliance (UNCTAD, 2013). In this way, exporting firms may increase their outputs and have more resources to innovate.

The third potential effect is that SPS measures and TBTs may decrease exporting firms' incentives to upgrade technologically by reducing the benefits they could gain from innovating. In these cases, firms may choose not to innovate, exit the market, or divert their exports to other markets where they already export (multi-destination firms). The higher the compliance costs of the SPS measures and TBTs, the higher the probability of trade diversion to other exporting markets (Fontagné and Orefice, 2018). Moreover, meeting SPS standards or overcoming TBTs often requires long-term investments that are not available to many firms in developing countries, particularly smaller firms. In this case, SPS measures and TBTs may not impact firms' innovation.

The current economic literature has not provided a clear prediction about the effects of SPS measures and TBTs on innovation. While a higher number of SPS measures and TBTs encourage exporting firms to innovate to adapt to new standards, some firms may choose not to invest in innovation or exit the market if the compliance costs are greater than the benefits of potentially higher import demand.

3. Empirical methodology

3.1. Data sources and description

Firms' innovation

The innovation data come from three rounds of the Viet Nam Technology Survey carried out by the General Statistics Office of Viet Nam. This database gathers detailed information on the innovation and technological acquisition of a sample of Vietnamese manufacturing enterprises annually from 2013 to 2015. It covers a representative sample of manufacturing firms contained in the larger Enterprise Surveys, administered annually by the General Statistics Office.

We define firms' innovation as whether firms implement new production processes or new product improvement, or have knowledge acquisition in the workplace. In our empirical work, we use various proxies to measure whether these processes are implemented, such as the application of new technology, improvement of an existing product, and technological and skill acquisition. Of these, skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience. We construct a measure that takes on the binary values of 0 and 1, where 0 corresponds to firms that do not have innovation and 1 corresponds to firms that do have innovation. To examine the impacts of SPS measures and TBTs by importing countries on domestic firms' innovation and acquisition, we restrict our sample to exporting firms in that period.

Table 1 summarises firms' innovation. A high ratio of exporting firms has an improvement in production process and product quality, with nearly 70% of exporting firms having production process improvement and 75% with an improvement in product quality. However, only a small number of exporting firms have technological and skill acquisition over the same period.

Table 1: Descriptive Statistics

Variable	2013	2014	2015	Average
Ln (number of SPS measures and TBTs)	5.68	4.40	4.46	4.71
	(1.37)	(1.58)	(2.05)	(1.82)
Production process improvement (:=1)	0.70	0.65	0.68	0.67
	(0.46)	(0.48)	(0.47)	(0.47)
Product quality improvement (:=1)	0.75	0.75	0.75	0.75
	(0.46)	(0.43)	(0.43)	(0.43)
Technological acquisition (:=1)	0.18	0.27	0.26	0.24
	(0.38)	(0.44)	(0.44)	(0.43)
Skill acquisition (:=1)	0.18	0.21	0.17	0.19
	(0.38)	(0.41)	(0.38)	(0.39)
Ln (output)	9.85	9.15	9.15	9.31
	(1.65)	(1.96)	(2.01)	(1.93)
Ln (employment)	5.24	4.61	4.58	4.74
	(1.36)	(1.50)	(1.54)	(1.51)
Ln (labor productivity)	4.00	3.93	4.03	3.99
	(1.91)	(1.85)	(1.94)	(1.90)
Ln (TFP)	1.44	1.30	1.39	1.37
	(0.79)	(0.83)	(0.87)	(0.84)
Number of observations	2,231	3,714	3,977	9,922

SPS = sanitary and phytosanitary, TBT = technical barrier to trade, TFP = total factor productivity.
Note: Skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience.
Source: Authors' calculations.

SPS measures and TBTs

The data on the number of SPS measures and TBTs at the Harmonised System (HS) 6-digit detailed product level are extracted from the UNCTAD Trade Analysis Information System (TRAINS) NTM database. TRAINS collects official regulations on the NTMs applied by each country, classified into three categories – technical, non-technical, and export measures. Multiple measures can be recorded at the product-country-partner level. The database also includes information about the start and end years when NTMs are applied. The NTMs in the data set are divided into 16 chapters (from A to P), following the international classification of

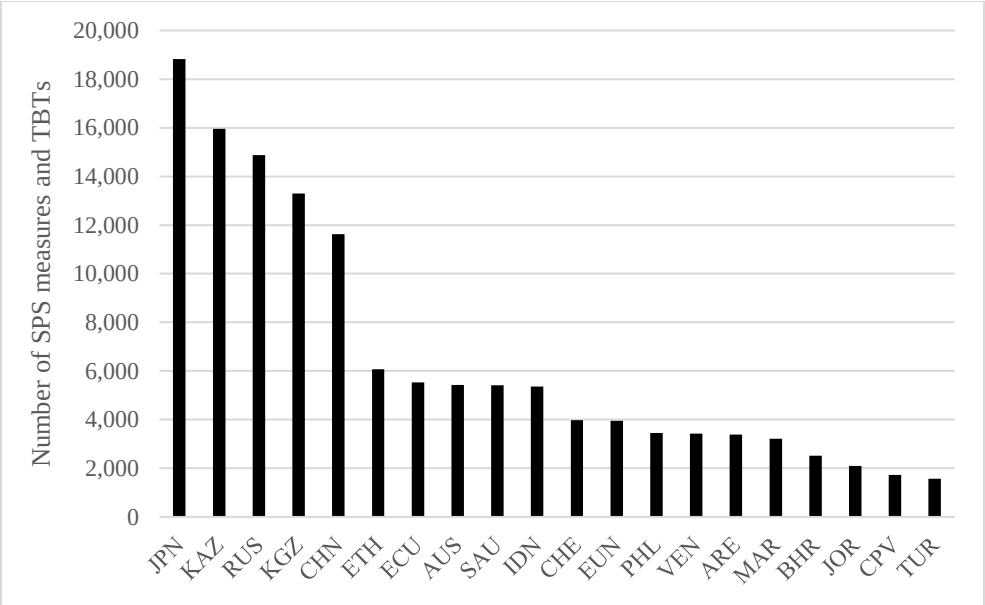
NTMs. Each chapter is further differentiated into subgroups to allow for a more detailed classification of the measures.

We limit our consideration to NTMs in chapters A and B of the Multi-Agency Support Team (MAST) classification – SPS measures and TBTs applied by importing countries on Vietnamese exports during 2013–2015 – to make them consistent with the period of the technological surveys. Although the TRAINS NTM database does not provide information on the restrictiveness of SPS measures and TBTs, the number of measures imposed by importing countries on a given HS6 product can be seen as a proxy for their restrictiveness. In practice, it is expected that the higher the number of SPS measures and TBTs, the more costly and therefore more difficult for an exporter to enter a product destination market (Disdier, Gaigné, and Herghelegiu, 2018).

We converted the product classifications to the corresponding International Standard Industrial Classification (ISIC) 4-digit level so that we can merge the HS 6-digit product-level NTM data with the firm-level data set.

According to the UNCTAD TRAINS database, Japan imposed the most SPS measures and TBTs on Vietnamese exports in 2013–2015 (Figure 1). It can be observed that the European Union, China, and other main trading partners had much fewer TBTs and SPS measures on Vietnamese exports than Japan in that period. Although the effect of such measures on imports also depends on their restrictiveness, the number of measures alone implies the complexity of the import regulatory system of a given market.

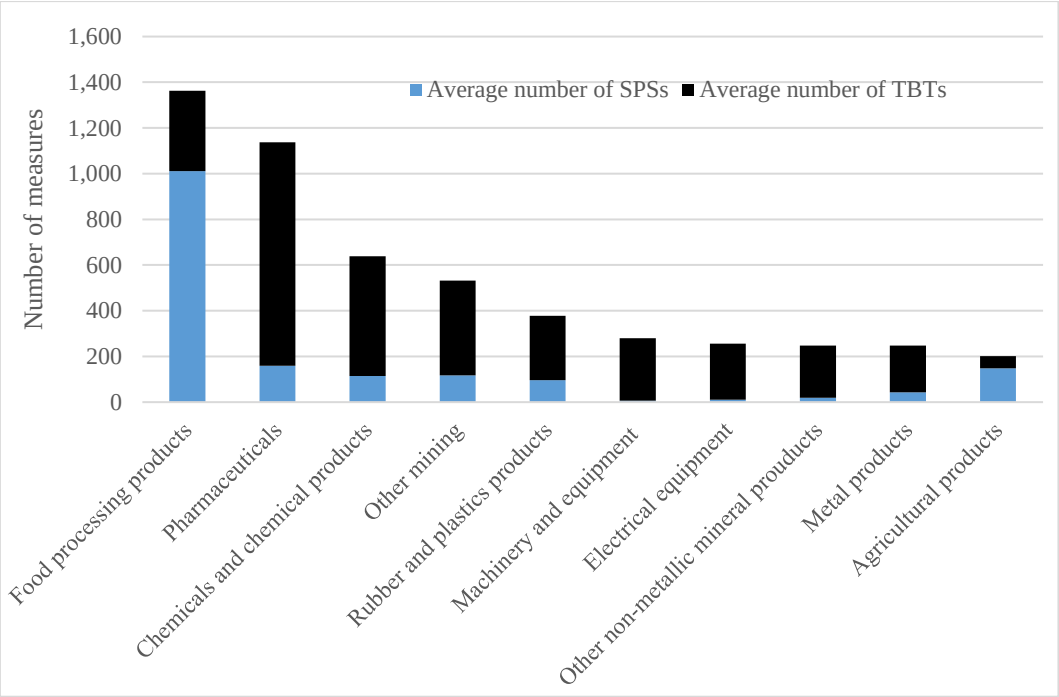
Figure 1: Number of SPS Measures and TBTs Applied by Foreign Countries to Vietnamese Exporting Products, 2013–2015



ARE = Argentina, AUS = Australia, BHR = Bahrain, CHE = Switzerland, CHN = China, CPV = Cape Verde, ECU = Ecuador, ETH = Ethiopia, EUN = European Union, IDN = India, JOR = Jordan, JPN = Japan, KAZ = Kazakhstan, KGZ = Kyrgyzstan, MAR = Mauritius, PHL = Philippines, RUS = Russia, SAU = Saudi Arabia, SPS = sanitary and phytosanitary, TBT = technical barrier to trade, TUR = Turkey.
Source: Authors' calculations from UNCTAD (n.d.), TRAINS: The Global Database on Non-Tariff Measures. https://trains.unctad.org (accessed 22 March 2020).

Figure 2 demonstrates that the average number of SPS measures on agricultural products, especially food processing products, is far higher than on other manufactured products. In other sectors, the number of SPS measures is significantly lower than the number of TBTs; and most of the technical measures applied to Vietnamese exports are TBTs. Pharmaceutical products were subject to the most TBTs, followed by chemicals and chemical products.

Figure 2: Average Number of SPS Measures and TBTs Applied by Foreign Countries on Vietnamese Exporting Products by Sector, 2013–2015



SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Source: Authors' calculations from UNCTAD (n.d.), TRAINS: The Global Database on Non-Tariff Measures. https://trains.unctad.org (accessed 22 March 2020).

3.2. Empirical model

OLS estimates

We begin by estimating the relationship between the number of TBTs and SPS measures and the exporting firms' innovation. Our baseline estimating equation is:

$$y_{ijt} = \alpha + \beta NTM_{jt} + \gamma X_{ijt} + \sigma_i + \varphi_t + \varepsilon_{ijt} \quad (1)$$

where y_{ijt} is the firm-level outcome of interest (which includes a range of firms' innovation, and technological and skill acquisition) *i* in sector *j* at time *t*. The key variable of interest in the model, NTM_{jt}, is measured by a log of the number of ongoing SPS measures and TBTs that have been applied by importing countries to products in sector *j* at time *t*. X_{ijt} are firm characteristics, which include firm ages and dummies for firms' ownership (which are private firms, firms with state capital, and firms with foreign capital). δ_i and φ_t are firm and time fixed effects. The model

is estimated by a linear probability model to avoid the incidental parameter problem. The standard errors are clustered at the industry level throughout the analysis, allowing for intra-group correlation over time.

Our goal is to identify β in equation (1). If NTMs are exogenous, the OLS estimate of β indicates the impact of NTMs on firms' innovation. A positive value of β implies that NTMs promote innovation by firms; otherwise, NTMs do not have a beneficial effect. However, certain unobserved firm and sectorial attributes may be correlated with both innovation and NTMs. These could make OLS estimation of β from equation (1) biased and inconsistent. In addition, our SPS measures and TBTs are measured at the 4-digit industry level, and our dependent variable is at the firm level. As the main independent variable measure is an aggregation of NTMs at the industry level, some of them may not be directly relevant to the firms' innovation. These factors mean that NTM data may contain large measurement errors, which may bias our NTM coefficient downwards.

One way to reduce the endogeneity bias, particularly the omitted unobservable sectorial attributes problem, is to use the fixed effect. The main advantage of the fixed-effect model is that it explicitly controls for sectorial fixed effects and removes the bias caused by time-invariant sectorial characteristics. However, the fixed-effect model cannot resolve the endogeneity bias caused by unobserved time-varying firm characteristics and can make the attenuation biases due to measurement errors more severe.

Instrumental variable estimates

To address potential endogeneity concerns and measurement errors, we instrument for Ln (number of SPS measures and TBTs) by using Ln (number of SPS measures and TBTs faced by AMS). Countries such as Indonesia, the Philippines, and Thailand, which show similar patterns of exports to Viet Nam and face a similar level of NTMs, are included in the ASEAN sample. The idea is that most of the SPS measures and TBTs are non-discriminatory regulations which apply to all countries. Therefore, these measures are not only applied to Vietnamese exporters, but have the same impacts on the exports of other AMS. Moreover, the number of SPS measures and TBTs faced by AMS is less likely to have direct impacts on Vietnamese exporting firms' innovation.

Our first stage specification is as follows:

$$NTM_{jt} = \omega + \delta NTM_{jt}^{ASEAN} + X'_{ijt}\pi + \mu_i + \sigma_t + \epsilon_{ijt} \quad (2)$$

where the variable NTM_{jt}^{ASEAN} is the number of SPS measures and TBTs in sector *j* and year *t* faced by other AMS. *X* is a vector of the time-varying firm and sector-specific variables. We also control for firm and year fixed effects, so the specification is capturing firm time-invariant effects and common global time trends that affect all countries in the region.

4. Empirical results

4.1. OLS estimates

Before examining the main outcomes of interest, which are different measures of firms' innovation, we show how NTMs correlate with a range of firm outcomes. Table 2 shows the results from regressions of firm-level outcomes (output, employment, labour productivity, and total factor productivity (TFP)), where labour productivity is calculated as the ratio between value added and employment. We use the Olley–Pakes methodology to compute TFP to control for both the sample selection bias and the simultaneity bias (Olley and Pakes, 1996). Year dummies and sectorial fixed effects are included to control for specific trends affecting manufacturing firm outcomes. In all estimations, standard errors are adjusted for the clustering of observations of the same industry. Other controls are the firms' age and dummies for firms' ownership (i.e. private firms, firms with state capital, and firms with foreign capital). In the results in the next section, we generally use the largest possible sample of non-missing observations. Sample sizes differ between columns within a table primarily because of different samples for the variables due to missing data.

Table 2: SPS Measures and TBTs and Firms' Performance

Variable	(1) Ln (output)	(2) Ln (employment)	(3) Ln (labor productivity)	(4) Ln (TFP)
Ln (number of SPS measures and TBTs)	-0.018**	0.000	-0.006	-0.020*
	(0.008)	(0.006)	(0.024)	(0.011)
R-squared	0.012	0.011	0.009	0.019
Ln (weighted number of SPS measures and TBTs)	-0.021	0.003	-0.043	-0.023*
	(0.014)	(0.009)	(0.041)	(0.013)
R-squared	0.011	0.011	0.010	0.018
Other variables	Yes	Yes	Yes	Yes
Observations	9,897	9,922	9,887	9,216
Number of firms	4,623	4,634	4,623	4,469
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes

SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Standard errors are robust to heteroskedasticity and clustered at the industry level. Other variables include firm age and dummies for firm ownership (which are private firms, firms with state capital, and firms with foreign capital). The weighted number of SPS measures and TBTs is the number of SPS measures and TBTs multiplied by the share of product exports over the total exports. ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.
Source: Authors' calculations.

The result in the upper panel of column (1) shows that the correlations between NTM and Ln (output) are negative and significantly different from zero, showing that SPS measures and TBTs imposed by foreign markets have detrimental effects on exporting firms. Similarly, we find that the higher the number of SPS measures and TBTs that firms expose, the lower their TFP, as presented in column (4). These results are consonant with findings from previous studies, which show that NTMs hurt exporting firms' performance (e.g. Fontagné et al. (2015); Hu et al. (2019)). However, SPS measures and TBTs do not affect the firms' employment and labour productivity.

We also check whether the results are sensitive to the different levels of exposure to SPS measures and TBTs. Exporting firms may face different impacts depending on the intensity of measures. To check this possibility, in the lower panel of Table 2, we correlate the similar firm outcomes with Ln (weighted number of SPS measures and TBTs), of which the weighted number of SPS measures and TBTs is measured by the number of SPS measures and TBTs in a product multiplied by the share of product exports over total exports. The results in the lower panel in columns (1) and (4) provide similar findings. The number of weighted SPS measures and TBTs is negatively associated with the firms' output and TFP, although only the coefficient of our main variable in column (4) is statistically significant.

We now turn to an examination of the estimated effects of SPS measures and TBTs on exporting firms' innovation. The OLS results on the impact of SPS measures and TBTs on exporting firms' innovation are reported in Table 3. We start by examining how SPS measures and TBTs affect firms' innovation without correcting for endogeneity. In all of the regressions, we control for year dummy effects, and the standard errors are clustered at the industry level. We also control for firms' ages and ownership dummies.

Table 3: SPS Measures and TBTs and Firms' Innovation (OLS Estimates)

Variables	(1) Production process improvement	(2) Product quality improvement	(3) Technological acquisition	(4) Skill acquisition
Ln (number of SPS measures and TBTs)	0.006	0.009	0.006	0.012***
	(0.006)	(0.006)	(0.004)	(0.004)
R-squared	0.005	0.004	0.003	0.010
Ln (weighted number of SPS measures and TBTs)	-0.003	0.008	0.006	0.006
	(0.008)	(0.007)	(0.005)	(0.007)
R-squared	0.005	0.004	0.003	0.008
Other variables	Yes	Yes	Yes	Yes
Observations	9,922	9,922	9,922	9,922
Number of firms	4,634	4,634	4,634	4,634
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes

OLS = ordinary least squares, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience. Standard errors are robust to heteroskedasticity and clustered at the industry level. Other variables include firm age and dummies for firm ownership (which are private firms, firms with state capital, and firms with foreign capital). The weighted number of SPS measures and TBTs is the number of SPS measures and TBT multiplied by the share of product exports over the total exports. ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.
Source: Authors' calculations.

We observe a positive relationship between the main variable and several measures of innovation. However, the number of SPS measures and TBTs only has a statistically significant impact on the firms' skill acquisition. In particular, the imposition of 1% of SPS measures and TBTs increases the probability of exporting firms' skill acquisition by 1.2%. This result is consistent with the hypothesis that restrictive SPS measures and TBTs act as an additional cost in foreign markets and make exporting firms adapt by increasing the technological transfer from foreign customers to the firms' workers in the form of skills and experience. It is also consonant with the finding by Disdier, Gaigné, and Herghelegiu (2018) that the enforcement of quality standards by destination markets improves the quality of consumption goods exported by French exporting firms. When we turn our estimation to the weighted number of SPS measures and TBTs, the coefficients become insignificant; however, the coefficients are positively correlated with the propensity to acquire new skills by firms.

4.2. IV estimates

To correct for the potential endogeneity of SPS measures and TBTs and measurement errors, we used the IV method. As discussed earlier, SPS measures and TBTs imposed on other AMS are a potential instrument for the prediction of the level of SPS measures and TBTs applied to Vietnamese exports, as it may correlate with the number of SPS measures and TBTs imposed by destination markets on Vietnamese exports, but they may not directly affect innovation by exporting firms in Viet Nam. Therefore, we make use of Ln (number of SPS measures and TBTs faced by AMS) as an instrument for Ln (number of SPS measures and TBTs) faced by Vietnamese exporting firms.

Table 4 presents our IV results. The reported coefficient in the lower panel is the first-stage results.

Table 4: SPS Measures and TBTs on Firms' Innovation (IV Estimates)

Variable	(1) Production process improvement	(2) Product quality improvement	(3) Technological acquisition	(4) Skill acquisition
Ln (number of SPS measures and TBTs)	0.005	0.008	0.005	0.011**
	(0.007)	(0.006)	(0.004)	(0.005)
	First stage: Ln (number of SPS measures and TBTs)			
Ln (number of SPS measures and TBTs faced by ASEAN Member States)	0.99***	0.99***	0.99***	0.99***
	(0.005)	(0.005)	(0.005)	(0.005)
Other variables	Yes	Yes	Yes	Yes
Observations	9,922	9,922	9,922	9,922
Number of firms	3,686	3,686	3,686	3,686
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes
F-statistic for an excluded instrument: 6,091				

ASEAN = Association of Southeast Asian Nations, IV = instrumental variables, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience. Standard errors are robust to heteroskedasticity and clustered at the industry level. Other variables include firm age and dummies for firm ownership (which are private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In the 1st stage of IV estimation, Ln (number of SPS measures and TBTs faced by ASEAN Member States) is used as an instrument for Ln (number of SPS measures and TBTs). ASEAN Member States include Indonesia, the Philippines, and Thailand. The F-statistic for an excluded instrument is larger than 10, implying that the instrument is strong (see Staiger and Stock (1997)).
Source: Authors' calculations.

The instrument has the expected sign: the coefficient of Ln (number of SPS measures and TBTs faced by AMS) is positive and highly significant for Ln (number of SPS measures and TBTs) faced by Vietnamese exporting firms. In addition, the F-statistic of an excluded instrument is well above the critical values identified by Staiger and Stock (1997), showing that a weak instrument is not our concern. The second stage results for the effects on the firms' innovation are presented in the upper panel. As shown in Table 4, the impact of SPS measures and TBTs on firms' skill acquisition is still positive and significant. Moreover, the magnitude of the coefficient is almost the same.

4.3. Heterogeneity

Firms may respond differently to different types of NTMs. SPS measures may have different effects on firms' innovation than TBTs. We ran a separate regression for each type of technical measure. In Table 5, we examine the relationship between SPS measures and firms' innovation in the food processing sector, which is subject to the most SPS measures. Chen, Wilson, and Otsuki (2008) found that testing procedures and lengthy inspection processes harm developing country firms' propensity to export, and this effect is larger for agricultural firms that produce perishable goods. Otsuki, Wilson, and Sewadeh (2001) analysed the effect of EU aflatoxin standards on selected African exports and found a significant negative impact on their exports of cereals, dried fruits, and nuts.

Table 5: SPS Measures and Firms' Innovation in Food Processing Sector

Variable	(1) Production process improvement	(2) Product quality improvement	(3) Technological acquisition	(4) Skill acquisition
OLS estimation				
Ln (number of SPS measures)	0.015	0.060***	0.011	0.051**
	(0.023)	(0.012)	(0.016)	(0.020)
IV Estimation				
Ln (number of SPS measures)	0.009	0.060***	0.004	0.052***
	(0.018)	(0.011)	(0.012)	(0.020)
Other variables	Yes	Yes	Yes	Yes
Observations	1,595	1,595	1,595	1,595
Number of firms	745	745	745	745
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes
F-statistic for an excluded instrument: 794				

ASEAN = Association of Southeast Asian Nations, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.

Notes: Skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience. Standard errors are robust to heteroskedasticity and clustered at the industry level. Other variables include firm age and dummies for firm ownership (which are private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In the 1st stage of IV estimation, Ln (number of SPS measures and TBTs faced by ASEAN Member States) is used as an instrument for Ln (number of SPS measures and TBTs). ASEAN Member States include Indonesia, the Philippines, and Thailand. The F-statistic for an excluded instrument is larger than 10, implying that the instrument is strong (see Staiger and Stock (1997)).

Source: Authors' calculations.

The OLS estimates of SPS measures are reported in the upper panel of Table 5. In column (2), the coefficient suggests that a 1% increase in the number of SPS measures is associated with a 6% increase in the probability of product quality improvement. The result in column (4) shows that SPS measures make exporting firms acquire more skills. In particular, a 1% increase in SPS measures increases the probability of exporting firms' skill acquisition by 5.1%. Similarly, the results from IV estimation indicate a positive and significant relationship between the number of SPS measures and the firms' product quality improvement and skill acquisition in the food processing sector

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Table 6: TBTs and Firms' Innovation

Variable	(1) Production process improvement	(2) Product quality improvement	(3) Technological acquisition	(4) Skill acquisition
OLS estimation				
Ln (number of TBTs)	0.000	0.005	0.002	0.005
	(0.006)	(0.005)	(0.003)	(0.004)
IV estimation				
Ln (Number of TBTs)	0.005	0.008	0.005	0.010**
	(0.007)	(0.006)	(0.004)	(0.005)
Other variables	Yes	Yes	Yes	Yes
Observations	9,922	9,922	9,922	9,922
Number of firms	4,634	4,634	4,634	4,634
Firm fixed effects	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes
F-statistic for an excluded instrument: 508				

ASEAN = Association of Southeast Asian Nations, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.

Notes: Skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience. Standard errors are robust to heteroskedasticity and clustered at the industry level. Other variables include firm age and dummies for firm ownership (which are private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In the 1st stage of IV estimation, Ln (number of SPS measures and TBTs faced by ASEAN Member States) is used as an instrument for Ln (number of SPS measures and TBTs). ASEAN Member States include Indonesia, the Philippines, and Thailand. The F-statistic for an excluded instrument is larger than 10, implying that the instrument is strong (see Staiger and Stock (1997)).

Source: Authors' calculations.

In Table 6, we consider the relationship between the number of TBTs and a range of innovation outcomes. The result in IV estimates in column (4) indicates that the number of TBTs has positive and statistically significant effects on skill acquisition. In particular, a 1% increase in SPS measures increases the probability of exporting firms' skill acquisition by 1%.

The effects of SPS measures and TBTs may be heterogeneous across firms. On the one hand, large firms may have a higher probability of exporting and may have better resources to invest in innovation to improve their competitiveness and market penetration. Besides, they may have a higher probability of surviving in markets where the technical measures have been imposed and take advantage of the reduced competition in such a market. On the other hand, large firms can move resources from unaffected product markets to the market imposing SPS measures and TBTs because they are more productive; therefore, they may be more likely to overcome the fixed or variable cost of an SPS or TBT without many innovations. The results in the upper panel of Table 7 confirm the above prediction that the impact of SPS measures and TBTs is more profound for small firms, while large firms are less affected by the impact of SPS measures and TBTs. The results are confirmed as we use IV estimation, as shown in the lower panel. Larger firms are less likely to have a higher probability of product quality improvement, and technological and skill acquisition.

Table 7: SPS Measures and TBTs and Firms' Innovation by Firm Size

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Small firms				Large firms			
Variable	**Production process improvement**	**Product quality improvement**	**Technological acquisition**	**Skill acquisition**	**Production process improvement**	**Product quality improvement**	**Technological acquisition**	**Skill acquisition**
OLS estimation								
Ln (number of SPS measures and TBTs)	0.007	0.013**	0.011**	0.012**	0.001	-0.004	0.001	0.007
	(0.008)	(0.006)	(0.004)	(0.005)	(0.009)	(0.014)	(0.008)	(0.008)
R-squared	0.006	0.003	0.003	0.008	0.001	0.003	0.002	0.012
IV estimation								
Ln (number of SPS measures and TBTs)	0.006	0.012**	0.012***	0.011**	0.003	-0.002	-0.001	0.009
	(0.009)	(0.006)	(0.004)	(0.005)	(0.009)	(0.014)	(0.008)	(0.009)
R-squared	0.008	0.003	0.005	0.010	0.005	0.007	0.007	0.013
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,303	7,303	7,303	7,303	2,619	2,619	2,619	2,619
Number of firms	3,681	3,681	3,681	3,681	1,121	1,121	1,121	1,121
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic for an excluded instrument in (1)–(4): 6,898								
F-statistic for an excluded instrument in (5)–(8): 3,844								

ASEAN = Association of Southeast Asian Nations, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.

Notes: Skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience. Small firms have up to 300 employees. Standard errors are robust to heteroskedasticity and clustered at the industry level. Other variables include firm age and dummies for firm ownership (which are private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In the 1st stage of IV estimation, Ln (number of SPS measures and TBTs faced by ASEAN Member States) is used as an instrument for Ln (number of SPS measures and TBTs). ASEAN Member States include Indonesia, the Philippines, and Thailand. The F-statistics for excluded instruments are larger than 10, implying that the instrument is strong (see Staiger and Stock (1997).

Source: Authors' calculations.

We further examine the impact of SPS measures and TBTs by dividing the sample into foreign and domestic exporting firms. Relative to domestic firms, foreign-owned firms are more likely to use advanced technology and are often highly productive. Therefore, firms with different ownership may respond to SPS measures and TBTs differently. The findings are presented in Table 8. In the upper panel, we find that the effect on technological and skill acquisition is stronger in foreign-owned firms. This may be because foreign-owned exporting firms are more willing than domestic firms to make technological and skill changes to meet new standards and requirements and higher competition. The second possibility is that domestic firms may choose to divert their exports to markets with lower standards or pay more attention to the domestic market. Therefore, their demand for technological and skill changes is lower. The findings from IV estimation in the lower panel also indicate that foreign firms tend to have more technological and skill acquisition when they face a higher number of SPS measures and TBTs.

Table 9 presents the results, differentiated by state-owned firms and other firms. The results are mixed. Findings in columns (4) and (8) indicate that higher SPS measures and TBTs have more effects on state-owned firms' probability of acquiring skills than that of other firms. However, the product quality and technological acquisition of non-state firms are much higher than those of state-owned firms when facing a greater level of SPS measures and TBTs, as shown in columns (2)–(3) and (6)–(7). The higher coefficient magnitudes for non-state firms may reflect greater responsiveness in other firms compared with state-owned enterprises in facing more SPS measures and TBTs. This may be because non-state firms, which have a more flexible organisational structure, can react more quickly when a new situation arises. The IV estimates in the lower panel provide similar results.

Table 8: SPS Measures and TBTs and Firms' Innovation by Firm Ownership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Foreign firms				Domestic firms			
Variable	**Production process improvement**	**Product quality improvement**	**Technological acquisition**	**Skill acquisition**	**Production process improvement**	**Product quality improvement**	**Technological acquisition**	**Skill acquisition**
OLS estimates								
Ln (number of SPS measures and TBTs)	-0.001	0.012	0.012**	0.012*	0.009	0.007	0.003	0.011**
	(0.008)	(0.008)	(0.006)	(0.007)	(0.009)	(0.009)	(0.006)	(0.005)
R-squared	0.001	0.003	0.003	0.008	0.008	0.005	0.002	0.011
IV estimates								
Ln (number of SPS measures and TBTs)	-0.001	0.010	0.011*	0.012*	0.007	0.006	0.004	0.010*
	(0.008)	(0.008)	(0.006)	(0.007)	(0.009)	(0.009)	(0.006)	(0.006)
R-squared	0.001	0.003	0.002	0.008	0.008	0.005	0.002	0.011
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,547	3,547	3,547	3,547	5,411	5,411	5,411	5,411
Number of firms	1,301	1,301	1,301	1,301	2,381	2,381	2,381	2,381
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic for an excluded instrument in (1)–(4): 8,293								
F-statistic for an excluded instrument in (5)–(8): 3,770								

ASEAN = Association of Southeast Asian Nations, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.

Notes: Skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience. Standard errors are robust to heteroskedasticity and clustered at the industry level. Other variables include firm age. ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In the 1st stage of IV estimation, Ln (number of SPS measures and TBTs faced by ASEAN Member States) is used as an instrument for Ln (number of SPS measures and TBTs). ASEAN Member States include Indonesia, the Philippines, and Thailand. The F-statistics for excluded instruments are larger than 10, implying that the instrument is strong (see Staiger and Stock (1997)).

Source: Authors' calculations.

Table 9: SPS Measures and TBTs and Firms' Innovation by Firm Ownership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	State-owned firms				Non-state firms			
Variable	**Production process improvement**	**Product quality improvement**	**Technological acquisition**	**Skill acquisition**	**Production process improvement**	**Product quality improvement**	**Technological acquisition**	**Skill acquisition**
OLS estimates								
Ln (number of SPS measures and TBTs)	0.004	0.005	-0.004	0.017**	0.006	0.010**	0.012**	0.009**
	(0.010)	(0.013)	(0.007)	(0.008)	(0.006)	(0.005)	(0.006)	(0.004)
R-squared	0.009	0.008	0.005	0.008	0.003	0.003	0.002	0.010
IV estimates								
Ln (number of SPS measures and TBTs)	0.004	0.004	-0.005	0.016*	0.006	0.009*	0.012**	0.008*
	(0.010)	(0.013)	(0.007)	(0.008)	(0.006)	(0.005)	(0.006)	(0.004)
R-squared	0.009	0.008	0.005	0.008	0.003	0.003	0.002	0.010
Other variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,542	3,542	3,542	3,542	6,380	6,380	6,380	6,380
Number of firms	1,826	1,826	1,826	1,826	2,889	2,889	2,889	2,889
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic for an excluded instrument in (1)–(4): 5,637								
F-statistic for an excluded instrument in (5)–(8): 5,578								

ASEAN = Association of Southeast Asian Nations, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Notes: Skill acquisition is defined as the technological transfer from foreign customers to the firms' workers in the form of skills and experience. Standard errors are robust to heteroskedasticity and clustered at the industry level. Other variables include firm age. ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In the 1st stage of IV estimation, Ln (number of SPS measures and TBTs faced by ASEAN Member States) is used as an instrument for Ln (number of SPS measures and TBTs). ASEAN Member States include Indonesia, the Philippines, and Thailand. The F-statistic for excluded instruments are larger than 10, implying that the instrument is strong (see Staiger and Stock (1997)).
Source: Authors' calculations.

5. Conclusion

Our empirical analysis seeks to determine whether there is a relationship between SPS measures and TBTs and innovation by exporting firms. In particular, we examine whether firms innovate and invest in the production process and product quality improvement, as well as technological and skill acquisition, when facing SPS measures and TBTs imposed by importing countries. To do this, the paper combines a panel of Vietnamese exporting firms over 2013–2015 and a new UNCTAD TRAINS data set on SPS measures and TBTs imposed by foreign markets. We convert the product classifications to the corresponding ISIC 4-digit level so that we can merge the HS 6-digit product-level NTM data with the firm-level data set.

Our fixed-effects estimates show that the number of SPS measures and TBTs lowers firms' output and total productivity. The imposition of SPS measures and TBTs in a certain product increases the probability of exporting firms' skill acquisition. In particular, SPS measures and TBTs have larger impacts on small firms than large firms. SPS measures also have significant impacts on product quality improvement and skill acquisition in the food processing sector. In addition, foreign firms tend to acquire more technology and skills than domestic firms when facing SPS measures and TBTs. Higher SPS measures and TBTs have more effects on state-owned firms' probability of acquiring skills. However, the propensity of product quality and technological acquisition of non-state firms is much higher than that of state-owned firms when facing a greater level of SPS measures and TBTs.

To address the problem of potential endogeneity, we use the number of SPS measures and TBTs faced by AMS as an instrument for the number of SPS measures and TBTs imposed on Vietnamese exporting firms. The results from the IV approach confirm our results on the effects of SPS measures and TBTs on firms' innovation.

Our results have important implications from a policy perspective. The impact of NTMs, such as SPS measures and TBTs, on a firms' innovation highlights the challenges faced by governments in developing countries to negotiate and amend their domestic regulations to complement their commitments on tariffs in multilateral and regional agreements. Our results illustrate that governments which

negotiate to join trade agreements should take into account the importance of the fixed cost related to NTMs, along with their assistance for domestic firms, particularly small firms. In particular, governments could use policies to assist exporting firms in acquiring better skills and technology; improving the innovation system; and providing an enabling policy environment, including preferential access to finance, to allow them to acquire new technology and skills.

References

Cadot, O., M.J. Ferrantino, J. Gourdon, and J.D. Reyes (2018), *Reforming Non-Tariff Measures: From Evidence to Policy Advice, Directions in Development – Trade*. Washington, DC: World Bank.

Chen, X., J. Wilson, and T. Otsuki (2008), 'Standards and Export Decisions: Firm-Level Evidence from Developing Countries', *Journal of International Trade and Economic Development*, 17(4), pp.501–23.

Disdier, A.-C., L. Fontagné, and M. Mimouni (2008), 'The Impact of Regulations on Agricultural Trade: Evidence from the SPS and TBT Agreements', *American Journal of Agricultural Economics*, 90(2), pp.336–50.

Disdier, A.-C., C. Gaigné, and C. Herghelegiu (2018), 'Do Standards Improve the Quality of Traded Products?', *ECARES Working Papers*, No. 28. Brussels: Solvay Brussels School of Economics and Management (ECARES), Université libre de Bruxelles.

Fontagné, L. and G. Orefice (2018), 'Lets Try Next Door: Technical Barriers to Trade and Multi-Destination Firms', *European Economic Review*, 101, pp.643–63.

Fontagné, L., G. Orefice, R. Piermartini, and N. Rocha (2015), 'Product Standards and Margins of Trade: Firm Level Evidence', *Journal of International Economics*, 1, pp.29–44.

Hu, C., F. Lin, Y. Tan, and Y. Tang (2019), 'How Exporting Firms Respond to Technical Barriers to Trade', *World Economy*, 42(5), pp.1400–26.

de Melo, J. and A. Nicita (2018), 'Non-Tariff Measures: Data and Quantitative Tools of Analysis', *FERDI Working Paper,* No. 218. Clermont-Ferrand: Foundation for Studies and Research on International Development (FERDI).

Olley, S. and A. Pakes (1996), 'The Dynamics of Productivity in the Telecommunications Equipment Industry', *Econometrica,* 64(6), pp.1263–97.

Otsuki, T., J.S. Wilson, and M. Sewadeh (2001), 'Saving Two in a Billion: Quantifying the Trade Effect of European Food Safety Standards on African Exports', *Food Policy*, 26(5), pp.495–514.

Shepherd, B. and N. Wilson (2013), 'Product Standards and Developing Country Agricultural Exports: The Case of the European Union', *Food Policy,* 42, pp.1–10.

Staiger, D. and J. Stock (1997), 'Instrumental Variables Regression with Weak Instruments', *Econometrica*, 65(3), pp.557–86.

UNCTAD (n.d.), TRAINS: Non-Tariff Measures (NTMs) Based on Official Regulations. https://trains.unctad.org/forms/Methodology.aspx (accessed 20 January 2020).

UNCTAD (2013), *Non-Tariff Measures to Trade: Economic and Policy Issues for Developing*
Countries, Geneva: United Nations.

UNCTAD (2018), *Non-Tariff Measures: Economic Assessment and Policy Options for Development*. Geneva: United Nations.

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