Received: 25 December 2022 | Accepted: 4 April 2024

DOI: 10.1111/sjpe.12383

ORIGINAL ARTICLE

Scottish Journal of Political Economy WILEY

The diverse effects of non-tariff measures on free trade agreements: Global empirical evidence from binary response models

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Abstract

We examine how non-tariff measures (NTMs) affect the formation of free trade agreements (FTAs), using data from 114 countries over the period 1986–2019 and applying binary response models. Splitting NTMs into eight categories, some tend to be restrictive, some promotive and some neutral, in terms of their effects on FTA formation. Technical measures tend to encourage, while non-technical measures tend to discourage, country-pairs to join FTAs. Aggregating all NTMs into one variable would give rise to weak conclusions. Our results for the 12 control variables are largely in line with those of previous studies on international trade flows or on FTAs but without considering NTMs.

KEYWORDS
binary response models, free trade agreements, non-tariff measures

JEL CLASSIFICATION
F5, F6, C4, C5

1 | INTRODUCTION

Free trade agreements (FTAs) have been playing an increasingly notable role in enhancing international trade flows across the globe (Baier & Bergstrand, 2009; Hayakawa & Kimura, 2015). As of 15 June 2021, 350 FTAs, including agreements in goods and/or services, are in force, while in 1990 there were only 50 FTAs put in practice

(WTO, 2021). The members of an FTA can enjoy preferential tariff rates or even no tariffs on certain goods and services traded among them. However, applied tariffs have declined substantially over the past two decades, and there has been an increasing use of non-tariff measures (NTMs) (Orefice, 2017). Indeed, by 30 June 2021, the number of NTMs had risen significantly to more than 9000 NTMs among WTO members wherein technical measures constitute the largest share of in-force NTMs (WTO, 2021). This changing nature of barriers to trade from tariffs to NTMs is the result of governments implementing NTMs to compensate for tariff cuts in their countries' regional and global trades. The advantages of NTMs include the protection of domestic consumers, some industries, and even national security interests (Orefice, 2017).

Extensive studies have been devoted to investigating the effects of trade liberalization via FTAs on economic growth (Ben-David & Loewy, 2003; Carbaugh, 2019; Huijskens, 2017; Todaro & Smith, 2020). There have also been many studies analysing the impacts of NTMs on international trade flows between pairs of countries (Egger et al., 2015; Ghodsi et al., 2017; Winchester, 2009). Of note is a recent study by Dhingra et al. (2023) exploring whether deep trade agreements (DTAs) can explain trade and welfare.[1] However, the effects of NTMs on the formation of FTAs have been neglected in the international trade literature including the above-cited studies. One reason for the void is likely that, whilst tariffs can be indicated more clearly in numbers or values, there is no officially agreed definition of NTMs (WTO, ITC and UNCTAD, 2022) and clauses of NTMs are often described ambiguously in legal and regulatory documents (Gourdon, 2014). Moreover, Banga (2017) points out that using AVEs (ad-valorem equivalences) of NTMs to estimate impact of regional trade agreements (RTAs) on GDP can be extremely misleading for policy makers.

Despite the above-said imperfectness of NTMs, this study examines empirically the diverse effects of NTMs on the establishment of FTAs. Hayakawa and Kimura (2015) document that both tariff rates and NTMs are much lower between FTA members than non-member countries. This finding opens questions of whether and what NTMs would encourage or discourage nations to form FTAs. To the best of our knowledge, these questions have not yet been addressed, which constitutes one of the motivations for us to fill the void left over from the literature.

Using data from 114 countries over the period 1986–2019 and applying binary response models (including probit and logit) based on the gravity framework, we show that some types of NTMs encourage, some discourage and some have negligible or no effects on, FTA formation. In regression analysis, we select such control variables as economic, geographical, cultural and institutional factors which have been used in previous studies on the determinants of international trade flows or FTAs (or RTAs; or preferential trade agreements, PTAs) without considering NTMs. This is to build upon prior research endeavours and findings while showing that the FTA effects of NTMs cannot be subsumed by those of the control variables. That is, our study adds to the literature on FTAs the first global evidence related to NTMs, beyond the conventional economic, geographical, cultural and institutional determinants. As another contribution, our results suggest that the widely-concerned endogeneity issue is not as serious as believed by previous studies on the nexus between trade flows and their various determinants using pooled cross-sectional and/or panel data regression techniques.

The rest of the paper is organized as follows. Section 2 reviews the most-closely-related studies on international trade, FTAs, tariff measures and NTMs. Section 3 describes data sources and econometric models before canvassing our opinions on the issues of potential endogeneity bias. Section 4 conducts empirical analyses based on pooled cross-section and panel estimations and discusses the policy implications of the results. Concluding remarks are offered in section 5.

[1]Dhingra et al. (2023) note that DTAs include a wide range of non-tariff measures and data on DTAs encompass non-tariff provisions, while proposing three measures for DTAs to capture varying types of trade agreement depth. Unlike them, we directly use 16 non-tariff measures classified by UNCTAD (2020) to capture non-tariff barriers. Thus, our study may also be viewed as an endeavour to probe into, to some degree, the impact of DTAs but on free trade agreements instead of trade and welfare as explored by Dhingra et al. (2023), although we do not explicitly use the term 'deep trade agreements'.

2 | RELATED LITERATURE

The literature on the joint subjects of international trade, FTAs, tariff and NTMs is vast. So, this section surveys only those works which are most relevant to our study.

A general question is: Why is it interesting to investigate NTMs in terms of their impacts on the establishment of FTAs? According to United Nations Conference on Trade and Development, NTMs are generally defined as trade policy instruments, other than ordinary customs tariffs, that have potential implications for trade flows, export-led growth and social welfare (UNCTAD, 2010). The policy instruments are intended to serve (i) public interests, such as the protection of public morals or health and lives of humans, animals, or plants; (ii) the pursuance of foreign policy or national security aims and (iii) the protection of the environment and historic treasure. In recent decades, there has been a considerable reduction in using tariffs as trade barriers, while a significant number of countries have increasingly imposed NTMs as alternative trade policy instruments (Niu et al., 2018). The largest share of in-force NTMs goes to technical measures, including sanitary and phytosanitary measures (SPS) and technical barriers to trade (TBT) (WTO, 2021). Moreover, due to their extreme diversity and complexity, NTMs are classified into 16 chapters (WTO, 2021). Given the increasing importance and applications of NTMs as policy measures, it is inappropriate to leave the NTM-FTA nexus out of empirical research endeavours.

Turning to other aspect of the general question raised above, i.e., FTAs, policymakers and academic researchers have perceived some benefits of forming FTAs. Non-economic benefits, such as stronger political ties, have been what free-trade supporters advocate (Congressional Budget Office, 2016; Lee, 2008). Most existing preferential trading arrangements were either created as economic arrangements in support of political goals or at least consistent with the diplomatic strategy of the founding countries. In other words, many RTAs (including FTAs) have been established with the initial purpose of stabilizing the political situation in the region, such as the EU and the ASEAN. Moreover, trade liberalization or openness to trade has been argued to have a positive impact on democracy on a long-term basis. López-Córdova and Meissner (2008) suggest that an autonomous move from autarky to a certain level of free trade could increase a country's democracy over a long run. Liu and Ornelas (2014) reaffirm this positive relationship and show that greater engagement in FTAs helps sustain democracy.

However, the perceptions of FTAs have been uneven across countries participating in an FTA. Some countries appear to have experienced positive FTA impacts, whilst their counterparts have undergone negative FTA effects, on their economic growth (Hur & Park, 2012). Job losses and increasing competition from foreign rivals are amongst the negative aspects that are more visible to the public eye. Huijskens (2017) outlines some non-economic costs of FTA, including the degradation of environment especially in developing countries partly due to the depletion of natural resources and the potential disappearance of indigenous cultures due to the rapid social development.

To summarize the above discussions, we believe that whether and how NTMs have promoted or impeded the formation of FTAs should be of interest to policymakers and trade economists who either endorse or oppose FTAs.

Concerning the economics of NTMs, Fugazza (2013) focuses on part of NTMs, i.e., technical measures, in terms of their economic impacts investigated by trade economists. Outlining theoretical analysis in a minimalist supply–demand diagram, the author concludes that the net effects on exporters' and importers' behaviour of technical regulations are ambiguous and so are an empirical issue, depending on whether the regulations' demand-enhancing effects outweigh or fall short of their trade-cost effects. However, the minimalist approach suffers serious shortcomings as a partial-partial equilibrium analysis and as a static analysis. Overcoming the shortcomings, many approaches to quantifying NTMs have been developed. Fugazza (2013) reviews seven methodologies, including inventory measures, price comparison, business surveys, quantity impact, gravity models, applied general equilibrium (AGE) models and cost–benefit analysis. Out of them, the author especially selects gravity and AGE models to review their generated empirical evidence of the impact of NTMs on trade, suggesting the relative importance of the two models. However, Banga (2017) discusses in detail the limitations of using computable general equilibrium (CGE, also known as AGE) models to estimate the impact of removal tariffs and non-tariffs measures on trade flows and GDP, with three criticisms highlighted. In view of this, our study opts for the gravity framework from which to derive probit and logit models and let the data speak about the sizes and signs of the coefficients on regressors including NTM variables. Notice that the gravity-equations-based articles cited in section 4 of Fugazza (2013) examine the trade effect, not the FTA effect, of NTMs. This suggests a void for our study to fill.

As noted above, on the import side, NTMs comprise non-technical and technical measures, with the latter being the bulk of NTMs. When examining the political economy of NTMs, Herghelegiu (2018) differentiates between non-technical and technical measures in terms of their effects on trade, hinging on the fact that NTMs serve both protectionist and legitimate purposes. According to the author, the two purposes result in different roles played by non-technical measures and technical measures. Specifically, the former as commercial policy instruments possess a trade restrictive character, while the latter may induce different effects on trade because they pursue both public and political economy objectives. The author notes that 'Technical measures are considered as restrictive only if they have been raised as concerns in the SPS and/or TBT Committees at the WTO' (See also Bacchetta et al., 2012). Put simply, non-technical measures tend to have a negative impact on trade and technical measures' impacts on trade should be at least non-negative unless they result in specific trade concerns. These conjectures motivate us to extend the trade effects of non-technical and technical measures to their FTA effects. Two corresponding questions are worth investigating: Do non-technical measures also discourage the formation of FTAs? Do technical measures encourage or discourage the formation of FTAs? One cannot directly infer the answers to the two questions from those related to trade effects.

Since the present study focuses on global FTAs as the variable to be explained, it should be useful to review the existing studies that also involve the variable, but our attention is paid to some resultant issues. This literature has two strands. One is concerned with the various economic effects of FTAs. Most research endeavours have been devoted to investigating how FTAs affect international trade flows. Summarizing the related empirical studies on international trade modelling over 10 years, Kepaptsoglou et al. (2010) present a table. The table shows that, in the gravity model exploited by researchers, the dependent variables in those studies are trade-related and one of the explanatory variables is FTA, because one aim of FTAs is supposed to promote trade between member countries by relaxing or removing existing trade barriers via FTAs. The authors observe that results of FTAs' trade effects are contradictory and point out that the ambiguity may stem from the problem of FTAs being endogenous in the gravity regression models employed. This endogeneity issue has been raised by Trefler (1993), Lee and Swagel (1997) and Baier and Bergstrand (2007) where the regressand of their gravity models is a trade-related variable while trade policy variables are used as regressors. As will become clearer later, the dependent variable of our gravity models is binary, not continuous as a trade variable. So, while we are aware of the issue, it is not as serious in our study as suggested in the literature. We will carry out more discussions on this matter in sections 3.2 and 4 where appropriate.

Another strand of the literature pertains to the determinants (not impacts) of FTA formation. In fact, research on this topic is still rare. To the best of our knowledge, Baier and Bergstrand (2004) is a pioneering study, which identifies what they called 'pure economic' determinants for predicting the probability of country-pairs joining FTAs. Briefly, in their study, geographical distance, the size and the similarity of real GDPs and the difference in capital-labour endowment ratios between two trading partners are shown to have economically and statistically significant effects on the likelihood of an FTA creation. Subsequent to Baier and Bergstrand's work are Egger and Larch (2008) and Cole and Guillin (2015). Exploring how PTA memeberships interdepend, Egger and Larch (2008) specify probit models with panel data or corss-section data to examine the roles played by economic factors similar to those used in Baier and Bergstrand (2004). Although the former two authors are mainly interested in how geographical distance diminishes the positive effect of pre-existing PTAs on newly established PTAs, we are only interested in their findings regarding the significance and signs of the chosen economic variables' coefficients – that is, almost all the included regressors have significant coefficient estimates with expected signs. Cole and Guillin (2015) investigate the determinants of FTAs and EIAs (economic integration agreements) by incorporating both economic and non-economic factors, with the latter including geographical, cultural and institutional factors etc. They find that some, if not all, of selected economic and non-economic variables significantly predict FTAs (EIAs). There are at least three implications of the above-cited three studies for our empirical investigations. First, whether and how NTMs affect the formation of FTAs have not been explored so far, a gap worth exploring. Second, since the dependent variable FTA is binary, binary response models such as probit and logit model are proper econometric tools. Third, when examining the not-yet-researched effects of NTMs on FTAs, previously-considered economic and non-economic factors should be appropriate candidates for us to choose as control variables.

3 | DATA AND METHODOLOGY

3.1 | Data sources

Table 1 presents the classification of NTMs with brief descriptions according to UNCTAD (2019). In total, there are 16 categories of NTMs, one related to exports ('A'), three to technical measures ('B' to 'D') and 13 to non-technical measures ('E' to 'P'). Each category of NTMs is denoted by a variable name in parentheses. Notice that several categories may appear under the same variable name – e.g., *OTH* includes 'H' through to 'P'. We then regroup 16 categories into eight in regression analyses, to be detailed in Table A2 in the Appendix A.

We use the trade dataset of 114 countries over the period from 1986 to 2019 and Table A1 in the Appendix A lists the countries included in our analysis. The main data sources are from CEPII, UNCOMTRADE (United Nations Commodity Trade), the UNCTAD Trade Analysis and Information System database (TRAINS) and Integrated Trade Intelligence Portal (ITIP Goods) of WTO. While UNCOMTRADE provides a comprehensive dataset of nations' real GDP and real GDP per capita, we obtained the data of geographical distance between pairs of countries (measured in kilometres), as well as the data on colonialism, common language and border sharing across countries from the CEPII database. In addition, we retrieve the number of established FTAs between reporting countries and their partners and the number of NTMs imposed by reporting nations from two main sources: the TRAINS of UNCTAD and the ITIP Goods of WTO.

3.2 | Regression model

To investigate how NTMs affect the likelihood of a country-pair entering and/or remaining in an FTA, we derive a dynamic binary response model from the gravity equation, as follows:

$$\mathrm{FTA}_t^* = \alpha + \sum_{k=1}^{8} \gamma_k \ln\left(\mathrm{NTM}_{k,t-1} + 1\right) + \boldsymbol{X}_{CONTROL,t-1}\boldsymbol{\beta} + z_{ij,t}, \;\; \mathrm{FTA}_t = 1\left[\mathrm{FTA}_t^* > 0\right] \tag{1}$$

where α is a constant, γ_k is the coefficient, $\boldsymbol{\beta}$ is a column vector of coefficients and $z_{ij,t} = \mu_{ij} + \xi_{i,t} + \nu_{j,t} + e_{ij,t}$ is the error term (with *ij* denoting a country-pair). The variables in model (1) are defined in Table A2 in the Appendix A.

Equation (1) indicates that the main interest of this study is in NTMs (i.e., $\ln(NTM_k + 1)$) while controlling for economic, geographical, cultural, and institutional factors contained in $\boldsymbol{X}_{CONTROL}$. We group the 16 chapters of NTMs (See Table 1) into eight types of NTMs and investigate whether and how each of them affects the probability of the concerned country-pair forming an FTA. Since the dependent variable in equation (1) is a binary indicator, we fit probit and logit models to the data and use Stata to implement estimations. In addition, because of possible zero NTM observations, we use $\ln(NTM_{k,t-1} + 1)$, following Roy (2014). Our underlying assumption is that $NTM_{k,t-1}$ are exogenous or are uncorrelated with $z_{ij,t}$ including omitted time-invariant unobservables μ_{ij}, to be discussed later.

TABLE 1 Classification of NTMs.

Exports	A. Export-related measures (*EXP*)	Imposed on exports such as taxes and export quotas, or export prohibitions
Imports		
Technical measures	B. Sanitary and phytosanitary measures (*SPS*)	Including a restriction for substance, hygienic requirements, or other measures for preventing the dissemination of diseases and others
	C. Technical barriers to trade (*TBT*)	Including labelling, marking, packaging restrictions to avoid contamination, or protect the environment, standards and quality requirements
	D. Pre-shipment inspection and other formalities (*INSP*)	Related to customs formalities
Non-technical measures	E. Contingent trade-protective measures (*CTPM*)	Aiming at unfair foreign trade practices, such as anti-dumping, countervailing and safeguard measures
	F. Non-automatic licensing, quotas, prohibitions and quantity-control measures other than for SPS or TBT (*QC*)	Licensing, quotas and other quantity control measures that are not SPS or TBT related
	G. Price-control measures, including additional taxes and charges (*PC*)	Controlling or affecting the prices of imported goods
	H. Finance measures (*OTH*)	Restrictions on the terms of payment of imports
	I. Measures affecting competition (*OTH*)	Including anti-competitive measures, such as state trading, sole importing agencies, or compulsory national insurance or transport
	J. Trade-related investment measures (*OTH*)	Restricting investment to balance imports
	K. Distribution restrictions (*OTH*)	Restrictions on the internal distribution of imported goods
	L. Restrictions on post-sales services (*OTH*)	Difficulties in allowing technical staff to enter the importing country to install or repair technological goods imported
	M. Subsidies (*OTH*)	Related to subsidies that affect trade
	N. Government procurement restrictions (*OTH*)	Restrictions on bidders trying to sell their products to a foreign government
	O. Intellectual property (*OTH*)	Related to issues arising from intellectual property rights
	P. Rules of origin (*OTH*)	Restricting the origin of products

Source: *International Classification of Non-Tariff Measures*, 2019 version, United Nations Conference on Trade and Development (UNCTAD, 2020).

The review of the political-economy theory of NTMs in section 2 suggests that we need to further examine the difference between non-technical measures and technical measures in terms of their effects on FTAs. To this end, we estimate equation (2) below:

$$\mathrm{FTA}_t^* = \alpha + \sum_{m=1}^{3} \gamma_m \ln\left(\mathrm{NTM}_{m,t-1} + \eta\right) + \mathbf{X}_{CONTROL,t-1}\boldsymbol{\beta} + z_{ij,t},\ \ \mathrm{FTA}_t = 1\left[\mathrm{FTA}_t^* > 0\right] \tag{2}$$

where $m = 1, 2, 3$. Specifically, NTM_1 denotes export-related measures *EXP*, NTM_2 non-technical measures *NTCM* (equal to the sum of 'E' through to 'P' according to Table 1) and NTM_3 technical measures *TCM* (equal to the sum of 'B' through to 'D', according to Table 1). All other variables and coefficients are defined as in equation (1).

In addition, we also consider aggregating all types of NTMs into one NTM variable, to compare the results with those of disaggregated eight types of NTMs and those of non-technical type and technical type of NTMs obtained via estimating equations (1) and (2) respectively. Under this consideration, we estimate equation (3) below:

$$\mathrm{FTA}_t^* = \alpha + \gamma \ln\left(\mathrm{NTM}_{t-1} + \eta\right) + \boldsymbol{X}_{CONTROL,t-1}\boldsymbol{\beta} + z_{ij,t}, \;\; \mathrm{FTA}_{ij,t} = 1\left[\mathrm{FTA}_t^* > 0\right] \tag{3}$$

where $NTM \equiv \sum_{k=1}^{8} \mathrm{NTM}_k$. All other variables and coefficients are defined as in equation (1).

There are two methods to estimate a model with cross-section and time-series observations. One is known as pooled cross-section data techniques and the other as panel data techniques. Regardless of whether RHS variables are endogenous, some studies have applied both to cross-check the estimation results. See, for example, Egger and Larch (2008). The two authors argue that the panel regressions control for time-invariant, unobservable effects, such as those embodied in μ_{ij} of our equation (1). We therefore follow their approach and estimate panel probit and logit models in addition to pooled cross-section ones for equation (1). The logit model uses the logistical distribution that has heavier tails than the standard normal distribution assumed by the probit model. This difference motivates us to cross-check qualitatively the results of the two models, because the assumption of a normal distribution for z_{ijt} may well be violated and the logit model can better accommodate discordant outlier observations.

3.3 | Endogeneity issue

Over about three decades, many researchers in the internal trade area have acknowledged potential endogeneity bias. For example, Baier and Bergstrand (2007) devote entire Section 3 to discussing it. Thus, we ought to pay serious attention to this issue. Baltagi (2021, p. 157) suggests several sources of endogeneity, including most importantly simultaneity and omitted variables. So, in this section, let us focus on the two sources relevant to our study.

In equation (1), all RHS covariates are lagged 1 year and so are unlikely correlated with the time-varying components (ξ_{it}, ν_{it} and e_{ijt}) in the *current* error term z_{ijt}. That is, the simultaneity problem can largely be ruled out.

Regarding the omitted-variable problem borne by μ_{ij}, this component of z_{ijt} is often referred to as time-invariant *country-pair* unobserved heterogeneity. Our study involves two groups of RHS regressors: *NTM* and $\boldsymbol{X}_{CONTROL}$. Below we discuss them in turn, with respect to the endogeneity issue.

First, as indicated at the beginning of Introduction, NTMs evolve (increase) rapidly over time regardless of the omitted *country-pair* unobserved heterogeneity (μ_{ij}) which is time-invariant. So, $NTM_{k,t}$ is unlikely correlated with μ_{ij}. Further, if $z_{ij,t}$ hence μ_{ij} is rather small as judged by a high pseudo-R^2 statistic, this can be taken to imply that the correlation between $NTM_{k,t}$ and μ_{ij}, if any, is negligible, so the resultant endogeneity issue is trivial.

As far as the variables in $\boldsymbol{X}_{CONTROL}$ are concerned, they have been widely used in studies with a focus on the determinants of bilateral trade. See, e.g., Baier and Bergstrand (2007), Yang and Martinez-Zarzoso (2014), Roy (2014) and Kepaptsoglou et al. (2010). Baier and Bergstrand (2007) argue that unobserved heterogeneity could highly correlate with the decisions of two countries to form an FTA, thereby leading to the endogeneity bias. Notice, however, that in their regression models, the regressand is a continuous trade-related variable, not a discrete FTA indicator in our study. To see why this fact is relevant to the endogeneity issue, let μ_{ij}^{trade} (equivalent to ε_{ij} used by Baier and Bergstrand (2007) in their equations (1) and (2)) denote the omitted time-invariant unobservables as a component of trade flows. Some researchers would believe that the RHS variables in our $\boldsymbol{X}_{CONTROL}$ are likely correlated with μ_{ij}^{trade} and so are endogenous. However, does the presence of correlation between $\boldsymbol{X}_{CONTROL}$ and μ_{ij}^{trade} naturally imply the presence of correlation between $\boldsymbol{X}_{CONTROL}$ and μ_{ij} in our case here? We address this question below.

Let us begin with FTA_{t-1} included in $\mathbf{X}_{CONTROL,t-1}$, but circuitously via discussing FTA_t. In equation (1), although the unobserved dependent variable FTA_t^* depends on $z_{ij,t}$ hence μ_{ij} (not on μ_{ij}^{trade}, a component of *trade flows* as the dependent variable in previous studies), the observable dependent variable FTA_t does not, for the following intuitive reason. Holding all else constant, as long as cross-country-pair variations in μ_{ij} do not make $\mathrm{FTA}_t^* > 0$ (or ≤0), FTA_t will remain constant at 0 (or 1), regardless of the variations in μ_{ij}. As a result, the correlation between FTA_t and μ_{ij} will be negligible even if not zero. Accordingly, in terms of econometric models, the warning that 'unobserved heterogeneity could highly correlate with the decision of two countries to form an FTA' (Baier & Bergstrand, 2007) is applicable to the correlation between FTA_t^* and μ_{ij} but is much less so to the correlation between FTA_t and μ_{ij} and hence to the correlation between FTA_{t-1} and μ_{ij}. We therefore argue that one should *not* overlook the difference between FTA_t^* and $FTA_{ij,t}$ and then resort straightaway to a fixed-effect panel binary response model in dealing with the said endogeneity bias associated with the coefficient on FTA_{t-1} (which is simply lagged FTA_t, not lagged FTA_t^*).

Turning to other variables than FTA_{t-1} in $\mathbf{X}_{CONTROL}$, many are time-invariant observables, such as dummy variables *WTOH*, *WTOF*, *DISTANCE*, *COMMONBORDER*, *COMMONLANGUAGE*, *COLONY* and *ALLIANCE*. The inclusion of them in the set of RHS regressors should help purify μ_{ij} such that the omitted time-invariant unobservables contained in it correlate, to the minimum degree, with these RHS regressors.[2] As for $RGDP_{sum}$, $RGDP_{sim}$, *DKL* and *SQDKL*, they are time-varying and so cannot have notable correlation with omitted time-invariant country-pair heterogeneity. This reasoning is the same as the above for $NTM_{ik,t-1}$. In addition, if the four predictive factors, together with the afore-mentioned dummy variables, contribute considerably to the explanatory power of all RHS regressors in a binary response model as reflected by high pseudo-R^2 values, the leftover unobserved country-pair heterogeneity would be greatly reduced (See Baier & Bergstrand, 2007, page 78). In this case, the concern about an endogeneity issue due to the omitted-variable problem should again become trivial. Section 4 will show that this is the case in our study.

Meanwhile, $z_{ij,t}$ in equation (1) encompasses possibly omitted time-related influences on the dependent variable in addition to omitted time-invariant country-pair heterogeneity. To address the resultant econometric issues, we include year dummies when estimating the equation and compute the corrected standard errors that are clustered by country pairs.

4 | EMPIRICAL ANALYSIS

Section 3.2 above has provided the main reason for applying both pooled cross-section and panel data techniques to the estimation of probit and logit models – that is, to cross-check the estimation results. In this section, therefore, we report respectively the results of the two estimation methods in turn, before exploring some relevant policy implications from the results.

4.1 | Pooled cross-section estimation results

Table 2 reports the results of pooled cross-section estimation of probit and logit models. From column 2 for the probit regression, one can see that three NTMs significantly and positively impact the likelihood of establishing or remaining in an FTA between a pair of countries, such as pre-shipment inspection $\ln(INSP_{t-1}+1)$ (0.0407 with $t=4.33$), sanitary and phytosanitary measures $\ln(SPS_{t-1}+1)$ (0.0369 with $t=4.21$) and technical barrier to trade

[2]In Egger and Larch's (2008) cross-sectional model (equation (2)), the dependent variable is an unobservable PTA* and it also appears on the RHS of the equation thereby causing an endogeneity issue. This endogeneity bias comes from simultaneity, not from the omitted-variable problem discussed here.

TABLE 2 Pooled cross-section estimation for disaggregated NTMs.

Regressors	Probit	Logit
$\ln(EXP_{t-1}+1)$	0.0033 (0.34)	0.0132 (0.53)
$\ln(INSP_{t-1}+1)$	0.0407*** (4.33)	0.1098*** (4.50)
$\ln(PC_{t-1}+1)$	−0.1129*** (−11.6)	−0.3083*** (−12.5)
$\ln(QC_{t-1}+1)$	−0.0322*** (−3.11)	−0.0748*** (−2.89)
$\ln(SPS_{t-1}+1)$	0.0369*** (4.21)	0.0677*** (2.83)
$\ln(TBT_{t-1}+1)$	0.0258*** (2.69)	0.0635** (2.49)
$\ln(CTPM_{t-1}+1)$	0.0157 (1.22)	0.0547* (1.78)
$\ln(OTH_{t-1}+1)$	−0.1140*** (−7.75)	−0.2978*** (−7.5)
FTA_{t-1}	5.7155*** (86.3)	12.590*** (59.2)
$RGDPsum_{t-1}$	0.0483*** (8.36)	0.0830*** (5.55)
$RGDPsim_{t-1}$	0.0420*** (6.72)	0.0621*** (3.73)
DKL_{t-1}	0.2024*** (7.05)	0.5415*** (7.36)
$SQDKL_{t-1}$	−0.0548*** (−6.80)	−0.1502*** (−7.26)
$WTOH_{t-1}$	0.2422*** (5.91)	0.6661*** (5.78)
$WTOF_{t-1}$	0.4682*** (9.87)	1.2685*** (9.20)
$DISTANCE_{t-1}$	−0.1366*** (−11.4)	−0.2713*** (−9.73)
$COMMONBORDER_{t-1}$	0.5995*** (6.85)	1.5182*** (7.78)
$COMMONLANGUAGE_{t-1}$	0.1586*** (6.26)	0.3988*** (6.31)
$COLONY_{t-1}$	−0.2395*** (−6.62)	−0.5787*** (−6.18)
$ALLIANCE_{t-1}$	0.0753*** (2.82)	0.1725*** (2.58)
Constant	−3.0940*** (−20.7)	−7.0739*** (−19.3)
Year dummies	Yes	Yes
Wald $\chi^2(52)$	20,669***	13,742***
Pseudo-R^2	0.911	0.911
No. of observations	293,705	293,705

Note: This table reports the estimation results of pooled cross-section probit and logit models for disaggregated eight types of NTMs. The dependent variable is the binary indicator FTA which equals one if countries *i* and *j* join or remain in a free trade agreement and zero otherwise. The regressors are defined in section 3.2. In parentheses are *t*-values based on standard errors adjusted for clusters. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

$\ln(TBT_{t-1}+1)$ (0.0258 with $t=2.69$). Export-related measures $\ln(EXP_{t-1}+1)$ (0.0033 with $t=0.32$) and contingent trade protective measures $\ln(CTPM_{t-1}+1)$ (0.0157 with $t=1.22$) also have a positive FTA effect although insignificant statistically. On the other hand, price control measures $\ln(PC_{t-1}+1)$ (−0.1129 with $t=-11.6$), quantity control measures $\ln(QC_{t-1}+1)$ (−0.0322 with $t=-3.11$) and other NTM measures $\ln(OTH_{t-1}+1)$ (−0.1140 with $t=-7.75$) tend to significantly reduce the probability for a country-pair to form an FTA. All these results are obtained while controlling for the 12 non-NTM variables, to be discussed later.

Column 3 of Table 2 is concerned with the estimation of the logit model, for cross-checking purposes. The signs of the estimated coefficients on the eight types of NTMs are basically comparable to those shown in column 2: $\ln(INSP_{t-1}+1)$, $\ln(SPS_{t-1}+1)$, $\ln(TBT_{t-1}+1)$, $\ln(EXP_{t-1}+1)$ and $\ln(CTPM_{t-1}+1)$ show a positive impact on FTA formation (the coefficient on $\ln(CTPM_{t-1}+1)$ now becomes significant at the 10% level), whereas $\ln(PC_{t-1}+1)$, $\ln(QC_{t-1}+1)$ and $\ln(OTH_{t-1}+1)$ have a significantly negative effect on FTA formation. Again, these results are achieved after controlling for the 12 non-NTM variables. So, the logit regression results are qualitatively very similar to the probit regression results. One notable result is that both models yield a high pseudo-R^2 (=0.911). As discussed earlier, Baier and Bergstrand (2007) use the pseudo-R^2 values of only 70% to point out that Baier and Bergstrand's (2004) estimated probit functions left considerable unobserved country-pair heterogeneity. In line with this spirit, our pseudo-R^2 values of greater than 90% suggest that the leftover time-invariant unobserved country-pair heterogeneity, if any, is considerably small. We take this as evidence that the concern about the endogeneity problem due to the above-said omitted heterogeneity can hardly be relevant to our study.

To sum up, the pooled cross-section probit and logit estimation results in Table 2 provide strong evidence for the positive FTA effects of *INSP*, *SPS*, and *TBT*, strong evidence for the negative FTA effects of *PC*, *QC*, *and OTH*, and no or weak evidence for the FTA effects of *EXP* and *CTPM*. Given these, we argue that the effects of the eight types of NTMs on a country pair in joining or remaining in an FTA are diverse. Recalling Section 2, Fugazza (2013) predicts that the net trade effects of technical measures are ambiguous for the behavior of exporters and importers. Considering all eight types of NTMs instead of just technical measures, our findings depict a clearer picture of the directions of their effects on FTAs than on trade, with FTAs reflecting government policy decisions rather than traders' behavior.

Since the present study is the first attempt to examine empirically the nexus between FTAs and NTMs, the above-reported results have no previous counterparts in the existing literature to compare with. However, in the literature there have been studies investigating the dependence of international trade flows as a continuous variable, or a new PTA as a binary variable, on the various variables we are using as control variables. This prompts us to compare our estimated coefficients associated with the control variables with those reported in the international trade literature, as a possible way to scrutinize how plausible our results are. Our discussions below are focused on those previous studies that have also employed some augmented gravity models as we do here.

Rows 10 to 21 (from FTA_{t-1} to $ALLIANCE_{t-1}$) of Table 2 display the coefficients on 12 control variables estimated using the probit and logit models. The control variables can be classified into economic and non-economic categories. Let us begin with economic control variables including FTA_{t-1}, $RGDPsum_{t-1}$, $RGDPsim_{t-1}$, DKL_{t-1}, $SQDLK_{t-1}$, $WTOH_{t-1}$ and $WTOF_{t-1}$. Regarding the lagged binary indicator FTA_{t-1}, its coefficient estimate is positive and highly significant economically and statistically. This is expected, since being already in an FTA strongly encourages the country-pair to remain in it. The second and third control variables $RGDPsum_{t-1}$ and $RGDPsim_{t-1}$ have positive and highly significant coefficients, suggesting that the larger is the total bilateral market size and the more similar is real GDP of the country-pair, the more likely they will join or remain in an FTA. These findings are consistent with Egger and Larch's (2008) to a varying degree. The coefficients on the fourth and fifth control variables DKL_{t-1} and $SQDKL_{t-1}$ are estimated to be positive and negative respectively and highly significant, indicating that the relation between *FTA* and *DKL* is nonlinear. Note that Egger and Larch (2008) predict theoretically a positive PTA effect of *DKL* (a proxy for the absolute difference in the capital-labour ratio between two countries) but a negative PTA effect of *SQDKL*. In line with the theoretical signs suggested, our results provide strong supportive evidence, although Egger and Larch's (2008) evidence failed to *consistently* support or reject the predictions. The last two economic control variables $WTOH_{t-1}$ and $WTOF_{t-1}$ are dummy variables representing the WTO memberships of respectively home and foreign country in a country-pair. Both the probit and logit regressions yield significant and positive FTA effects of the WTO memberships. Our results are comparable with Cyrus' (2021) that the WTO memberships induce a country-pair to join a RTA. Note, however, that we use two dummy variables for two countries respectively, while Cyrus (2021) uses just one which takes the value of one if *both* countries are WTO members and the value of zero otherwise. The advantage of our approach is that we can see separately how the WTO membership affects each country's probability to enter or stay in an FTA. The results demonstrate that foreign country's WTO membership has a greater positive effect on the likelihood than home country's: 0.4682 ($t=9.87$) > 0.2422 ($t=5.91$) with the probit model and 1.2685 ($t=9.20$) > 0.6661 ($t=5.78$) with the logit model.

The remaining five control variables (in rows 17–21 of Table 2) are non-economic, embracing geographical, cultural and institutional factors. They represent the various measures of impedance between the origin and the destination in a country-pair. $DISTANCE_{t-1}$ exhibits a negative FTA effect, consistent with Cyrus' (2021) results. $COMMONBORDER_{t-1}$ and $COMMONLANGUAGE_{t-1}$ have a positive effect, the former being inconsistent, while the latter being consistent, with Cyrus' (2021) results. $COLONY_{t-1}$ has a negative effect, which makes sense though inconsistent with Cyrus' (2021) results. $ALLIANCE_{t-1}$ has a positive FTA effect, not considered by Cyrus (2021). The signs of all these effects are expected, although some of them are not in line with those reported or overlooked in Cyrus (2021). Moreover, the effects are all compelling as evidenced by the corresponding coefficients estimated to be highly significant both economically and statistically under either the probit or the logit model.

The results discussed above for the 12 control variables demonstrate that they either largely make economic sense or basically agree with previous studies albeit of different topics than ours. Thus, our findings are plausible of the diverse effects of various NTMs on the probability of country-pairs forming FTAs.

Motivated by Herghelegiu (2018) reviewed in section 2, we are also interested in exploring the question of whether the FTA (not trade) effects of non-technical and technical measures point to different directions. Table 3 sets out the results with which to address this question. One can see that non-technical measures tend to significantly restrict the likelihood of FTA formation: the estimated coefficient of $\ln(NTCM_{t-1}+1)$ is −0.2573 (with $t=-9.47$) for the probit model and −0.6429 (with $t=-9.28$) for the logit model. Recalling Table 2, three non-technical measures ($\ln(PC_{t-1}+1)$, $\ln(QC_{t-1}+1)$ and $\ln(OTH_{t-1}+1)$) had significantly negative coefficients, while one ($\ln(CTPM_{t-1}+1)$) had an insignificant coefficient. Thus, the negative FTA effects of non-technical measures grouped together as revealed in Table 3 are due largely to the former three types. To sum up, if non-technical measures possess a trade-restrictive character (Herghelegiu, 2018), they also possess an FTA-restrictive character.

TABLE 3 Pooled cross-section estimation for export-related, non-technical and technical measures.

Regressors	Probit	Logit
$\ln(EXP_{t-1}+1)$	−0.0229*** (−2.70)	−0.0568*** (−2.70)
$\ln(NTCM_{t-1}+1)$	−0.2573*** (−9.47)	−0.6429*** (−9.28)
$\ln(TCM_{t-1}+1)$	0.2595*** (10.9)	0.6322*** (10.3)
FTA_{t-1}	5.7319*** (85.8)	12.612*** (58.9)
$RGDPsum_{t-1}$	0.0483*** (9.09)	0.0924*** (6.95)
$RGDPsim_{t-1}$	0.0443*** (7.39)	0.0748*** (4.72)
DKL_{t-1}	0.2139*** (7.41)	0.5866*** (7.85)
$SQDKL_{t-1}$	−0.0546*** (−6.71)	−0.1539*** (−7.29)
$WTOH_{t-1}$	0.2701*** (6.65)	0.7476*** (6.63)
$WTOF_{t-1}$	0.4650*** (9.96)	1.2556*** (9.22)
$DISTANCE_{t-1}$	−0.1188*** (−9.62)	−0.2315*** (−7.97)
$COMMONBORDER_{t-1}$	0.6190*** (7.17)	1.5637*** (8.21)
$COMMONLANGUAGE_{t-1}$	0.1599*** (6.38)	0.3959*** (6.32)
$COLONY_{t-1}$	−0.2582*** (−7.26)	−0.6336*** (−6.88)
$ALLIANCE_{t-1}$	0.0963*** (3.62)	0.2203*** (3.31)
Constant	−3.1731*** (−21.5)	−7.3734*** (−20.2)
Year dummies	Yes	Yes
Wald $\chi^2(47)$	19,107***	12,718***
Pseudo-R^2	0.911	0.910
No. of observations	293,705	293,705

Note: This table reports the estimation results of pooled cross-section probit and logit models for export-related, non-technical and technical measures. The dependent variable is the binary indicator FTA which equals one if countries *i* and *j* join or remain in a free trade agreement and zero otherwise. The regressors are defined in section 3.2. In parentheses are *t*-values based on standard errors adjusted for clusters. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

On the other hand, technical measures tend to increase the likelihood of FTA formation: the estimated coefficient of ln($TCM_{t-1}+1$) is 0.2595 (with $t=10.9$) for the probit model and 0.6322 (with $t=10.3$) for the logit model. This is consistent with Table 2 where three technical measures (ln($INSP_{t-1}+1$), ln($SPS_{t-1}+1$) and ln($TBT_{t-1}+1$)) were shown to have significantly positive coefficient estimates. Herghelegiu (2018) predicts that technical measures may induce *non-negative* trade effects under the condition that they have *not* been raised as concerns. Now, Table 3 suggests that the FTA effects of technical measures are unambiguously positive. Consequently, our results provide the first piece of empirical evidence pertaining to the political-economy theory of technical measures proposed by Herghelegiu (2018) though regarding their trade effects.

A further question worth exploring is this: What would be the FTA impacts of aggregate NTMs (i.e., all NTMs grouped together as a whole)? To address this question, we re-estimate the probit and logit models but with the eight types of NTMs replaced by their sum (i.e., $NTM=EXP+INSP+PC+QC+SPS+TBT+CTPM+OTH$) and use ln($NTM_{t-1}+1$) as the regressor to contain all NTMs. Adding '1' ($\eta=1$) to the argument of the log function is again to prevent the function from becoming not defined in case $NTM_{t-1}=0$.

Table 4 reports the pooled cross-section estimation results of the probit and logit models for aggregate NTMs. A striking observation is that an increase in the number of aggregate no-tariff measures will significantly reduce the likelihood of a country-pair having an FTA, as shown by the negative coefficient estimates in the Probit column (−0.0243 with $t=-3.87$) and the Logit column (−0.0739 with $t=-4.86$). As for the coefficient estimates of the 12 control variables, their signs are basically the same as in Table 2, except for $ALLIANCE_{t-1}$: its estimated coefficients were positive and significant in Table 2 but now become negative and insignificant in Table 4, across the Probit and

TABLE 4 Pooled cross-section estimation for aggregate NTMs.

Regressors	Probit	Logit
ln($NTM_{t-1}+1$)	−0.0243*** (−3.87)	−0.0739*** (−4.86)
FTA_{t-1}	5.6626*** (85.3)	12.388*** (58.7)
$RGDPsum_{t-1}$	0.0658*** (12.1)	0.1312*** (9.59)
$RGDPsim_{t-1}$	0.0536*** (8.80)	0.0928*** (5.77)
DKL_{t-1}	0.1237*** (4.43)	0.3504*** (4.93)
$SQDKL_{t-1}$	−0.0379** (−4.83)	−0.1099*** (−5.52)
$WTOH_{t-1}$	0.3635*** (8.99)	0.9645*** (8.59)
$WTOF_{t-1}$	0.4997*** (10.5)	1.3271*** (9.61)
$DISTANCE_{t-1}$	−0.2711*** (−17.7)	−0.6055*** (−16.3)
$COMMONBORDER_{t-1}$	0.3857*** (4.32)	0.9439*** (4.68)
$COMMONLANGUAGE_{t-1}$	0.1555*** (6.15)	0.3850*** (6.14)
$COLONY_{t-1}$	−0.3040*** (−8.34)	−0.7346*** (−7.68)
$ALLIANCE_{t-1}$	−0.0372 (−1.34)	−0.0914 (−1.33)
Constant	−2.1376*** (−12.7)	−4.7308*** (−11.5)
Year dummies	Yes	Yes
Wald $\chi^2(45)$	18,516***	12,912***
Pseudo-R^2	0.899	0.899
No. of observations	282,130	282,130

Note: This table reports the estimation results of pooled cross-section probit and logit models for aggregate NTMs. The dependent variable is the binary indicator FTA which equals one if countries *i* and *j* join or remain in a free trade agreement and zero otherwise. The regressors are defined in section 3.2. In parentheses are *t*-values based on standard errors adjusted for clusters. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

the Logit column. However, it is worth noting, based on the comparisons between Tables 2 and 4, that if one were to use aggregate NTMs, the diversity of their constituent categories would be disguised in terms of FTA effects.

Tables 2–4 pertain to the use of pooled cross-section data techniques. It should be of interest to also employ panel data techniques but with the population-averaged option, for disaggregated NTMs, non-technical and technical measures and aggregate NTMs respectively. Notice that the purpose of conducting panel regressions is not to deal with the concern about an endogeneity issue, because as discussed in section 3 the issue is not very relevant in our case here. Rather, one reason for applying population-averaged panel approach is that there may be dependency between the repeated measurements – i.e., our data observations may be correlated across time. In this case, the generalized estimating equations (GEE) method that is commonly used to estimate population-averaged effects for analysing a binary outcome should be preferred, since the standard errors from pooled cross-section models are biased when the independence assumption is violated (Hu et al., 1998). Moreover, according to Liang and Zeger (1986), the GEE approach has the advantage that even if the assumed correlation is misspecified it still provides consistent estimators of regression coefficients and their robust variances. Thus, fitting the GEE-based panel probit and logit models to the data is a way to robustify the results presented in Tables 2–4.

4.2 | Panel estimation results

Tables 5–7 set out the estimation results of panel probit and logit models for, respectively, disaggregated NTMs, non-technical and technical measures, and aggregate NTMs. Comparing Table 5 with Table 2, one can see that the coefficient estimates of all regressors are almost identical across the two tables under both the Probit and Logit columns. Thus, the results and conclusions remain unchanged for disaggregated NTMs, whether pooled cross-section regression or panel regression techniques are applied. The same observations can be made when comparing Table 6 with Table 3. So, the analyses of the FTA effects of technical and non-technical measures also remain unchanged with panel regressions.

However, the differences between Tables 7 and 4 are notable: while $\ln(NTM_{t-1}+1)$ had significant, negative coefficient in Table 4 for both the probit and logit models, its estimated coefficient becomes insignificant economically and statistically in Table 7 for the two binary response models, implying that aggregate NTMs would have no impacts on FTA formation. Moreover, while the coefficients of all control variables are qualitatively similar in terms of their signs and statistical significance across Tables 7 and 4, the coefficient of $ALLIANCE_{t-1}$ turns from being negative and insignificant in Table 4 to being positive and significant in Table 7. The above discussions suggest that grouping all NTMs together to examine their aggregate effects on FTA formation would yield sensitive results if one switched from pooled cross-section data techniques to panel data techniques.

In sum, comparisons between pooled cross-section and panel regressions enable us to conclude that the results of disaggregated NTMs and of technical and non-technical measures can be robustified but those of aggregate NTMs cannot. This provides one more reason for examining disaggregated NTMs as well as technical and non-technical measures, in addition to the reason noted above – i.e., if only investigating aggregate NTMs, the diversity of their constituent categories would be disguised in terms of FTA effects.

4.3 | Some policy implications of the results

The preceding two sub-sections provide empirical evidence on how NTMs affect the formation of FTAs. As reviewed in section 2, it has been agreed that NTMs are trade policy instruments that may have positive and negative implications for trade flows, export-led growth and social welfare. Meanwhile, however, there also exist uneven perceptions of FTAs across countries participating in FTAs. Therefore, exploring the policy implications of NTMs for FTAs, it may be proper to put our empirical results in the context of pros and cons of FTAs.

TABLE 5 Panel estimation for disaggregated NTMs.

Regressors	Probit	Logit
$\ln(EXP_{t-1}+1)$	0.0034 (0.35)	0.0133 (0.54)
$\ln(INSP_{t-1}+1)$	0.0405*** (4.17)	0.1098*** (4.50)
$\ln(PC_{t-1}+1)$	−0.1131*** (−11.3)	−0.3082*** (−12.5)
$\ln(QC_{t-1}+1)$	−0.0322*** (−3.08)	−0.0746*** (−2.89)
$\ln(SPS_{t-1}+1)$	0.0367*** (3.92)	0.0676*** (2.83)
$\ln(TBT_{t-1}+1)$	0.0259*** (2.62)	0.0633** (2.49)
$\ln(CTPM_{t-1}+1)$	0.0166 (1.27)	0.0550* (1.79)
$\ln(OTH_{t-1}+1)$	−0.1148*** (−7.92)	−0.2980*** (−7.45)
FTA_{t-1}	5.7045*** (85.6)	12.570*** (60.0)
$RGDPsum_{t-1}$	0.0484*** (8.12)	0.0829*** (5.54)
$RGDPsim_{t-1}$	0.0420*** (6.45)	0.0619*** (3.72)
DKL_{t-1}	0.2045*** (6.99)	0.5418*** (7.37)
$SQDKL_{t-1}$	−0.0554*** (−6.70)	−0.1503*** (−7.27)
$WTOH_{t-1}$	0.2439*** (5.83)	0.6657*** (5.79)
$WTOF_{t-1}$	0.4698*** (9.77)	1.2673*** (9.22)
$DISTANCE_{t-1}$	−0.1368*** (−11.7)	−0.2714 (−9.73)
$COMMONBORDER_{t-1}$	0.6291*** (7.08)	1.5237*** (7.82)
$COMMONLANGUAGE_{t-1}$	0.1631*** (6.41)	0.4001*** (6.34)
$COLONY_{t-1}$	−0.2434*** (−6.72)	−0.5786*** (−6.18)
$ALLIANCE_{t-1}$	0.0765*** (2.83)	0.1733*** (2.59)
Constant	−3.0906*** (−21.3)	−7.0587*** (−19.3)
Year dummies	Yes	Yes
Wald $\chi^2(52)$	24,932***	13,891***
No. of observations	293,705	293,705

Note: This table reports the estimation results of panel probit and logit models for disaggregated eight types of NTMs. The dependent variable is the binary indicator FTA which equals one if countries i and j join or remain in a free trade agreement and zero otherwise. The regressors are defined in section 3.2. In parentheses are t-values based on standard errors adjusted for clusters. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

Consistent across pooled cross-section and panel data techniques are our results that pre-shipment inspections (*INSP*), sanitary and phytosanitary measures (*SPS*) and *TBT* impact positively on FTA formation. The *INSP* measures are more relevant for agriculture products, wooden products, textiles and footwear, so governments of those mainly agricultural producing countries will consider strengthening such NTMs if they wish to join and/or remain in FTAs. The *SPS* measures include regulations and restrictions to protect human, animal or plant life or health and the *TBT* measures deal with all other technical regulations, standards and procedures. Gourdon (2014) notes that the large incidences of the *SPS* and *TBT* measures have raised concerns for some countries' exports. However, if FTAs can greatly enhance potential welfare gains and trade flows among member countries as shown by Baier and Bergstrand (2004, 2007, 2009), our findings suggest that the concerns may be overanxious and so should prompt FTA countries to implement the *SPS* and *TBT* measures.

Also consistent across pooled cross-section and panel data regressions are the results that price control (*PC*), quantity control (*QC*) and other (*OTH*) measures have negative effects on FTA formation. As such, the policy implications of these three non-technical measures are contrary to those of the three technical measures including *INSP*, *SPS* and *TBT* discussed above. Gourdon and Nicita (2013) document the distortionary effect of non-technical

TABLE 6 Panel estimation for non-technical and technical measures.

Regressors	Probit	Logit
$\ln(EXP_{t-1}+1)$	−0.0230*** (−2.72)	−0.0568*** (−2.70)
$\ln(NTCM_{t-1}+1)$	−0.2572*** (−9.55)	−0.6419*** (−9.30)
$\ln(TCM_{t-1}+1)$	0.2590*** (11.0)	0.6311*** (10.3)
FTA_{t-1}	5.7140*** (86.1)	12.562*** (60.7)
$RGDPsum_{t-1}$	0.0484*** (9.08)	0.0920*** (6.92)
$RGDPsim_{t-1}$	0.0443*** (7.15)	0.0744*** (4.70)
DKL_{t-1}	0.2168*** (7.36)	0.5871*** (7.87)
$SQDKL_{t-1}$	−0.0554*** (−6.63)	−0.1541*** (−7.32)
$WTOH_{t-1}$	0.2722*** (6.63)	0.7457*** (6.66)
$WTOF_{t-1}$	0.4672*** (9.92)	1.2526*** (9.27)
$DISTANCE_{t-1}$	−0.1191*** (−9.79)	−0.2318*** (−7.99)
$COMMONBORDER_{t-1}$	0.6605*** (7.55)	1.5760*** (8.32)
$COMMONLANGUAGE_{t-1}$	0.1663*** (6.62)	0.3989*** (6.37)
$COLONY_{t-1}$	−0.2635*** (−7.42)	−0.6329*** (−6.90)
$ALLIANCE_{t-1}$	0.0982*** (3.66)	0.2218*** (3.34)
Constant	−3.1660*** (−22.1)	−7.3327*** (−20.3)
Year dummies	Yes	Yes
Wald $\chi^2(47)$	23,548***	13,054***
No. of observations	293,705	293,705
No. of groups	12,879	12,879

Note: This table reports the estimation results of panel probit and logit models for export-related, non-technical and technical measures. The dependent variable is the binary indicator FTA which equals one if countries *i* and *j* join or remain in a free trade agreement and zero otherwise. The regressors are defined in section 3.2. In parentheses are *t*-values based on standard errors adjusted for clusters. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

measures on trade. Thus, countries wishing to reap potential welfare gains and increase trade flows while joining and/or remaining in FTAs should consider reducing or removing the *PC*, *QC* and *OTH* measures.

In addition, we have found some evidence that export-related (*EXP*) measures tend to negatively affect FTAs. Thus, lowering *EXP* (export taxes, quotas, or prohibitions) would help nations in forming FTAs if they wish to do so for, e.g., non-economic benefits such as sustaining democracy Liu and Ornelas (2014) or strengthening political ties (Lee, 2008).

It is also worth noting that non-technical provisions (*NTCM*) contribute negatively, while technical provisions (*TCM*) contribute positively, to the formation of an FTA, as generated by both pooled cross-sectional and panel regressions. These imply that FTAs, if to be promoted, could consider restraining non-technical provisions while impelling technical provisions.

To summarize the above discussions, our findings offer possible policy mixes which nations, whether being FTA members, could consider while catering for their needs pertinent to forming and/or remaining in FTAs.

A final policy implication of our results is that they can also be viewed, more or less, in the context of DTAs, but in terms of DTAs' effects on FTAs rather than on trade and welfare as investigated by Dhingra et al. (2023). This is because the two main measures of DTAs constructed by Dhingra et al. (2023) overlap, to some degree, the NTMs we are using albeit grouped in a different manner and to explain the likelihood of signing/renewing an FTA. Our

TABLE 7 Panel estimation for aggregate NTMs.

Regressors	Probit	Logit
$\ln(NTM_{t-1}+1)$	0.0011 (0.16)	−0.0115 (−0.71)
FTA_{t-1}	5.6883*** (88.2)	12.492*** (61.6)
$RGDPsum_{t-1}$	0.0550*** (10.3)	0.1076*** (8.04)
$RGDPsim_{t-1}$	0.0463*** (7.43)	0.0790*** (4.95)
DKL_{t-1}	0.2042*** (7.03)	0.5472*** (7.46)
$SQDKL_{t-1}$	−0.0535*** (−6.47)	−0.1472*** (−7.09)
$WTOH_{t-1}$	0.3188*** (7.86)	0.8653*** (7.79)
$WTOF_{t-1}$	0.4673*** (9.91)	1.2534*** (9.28)
$DISTANCE_{t-1}$	−0.1423*** (−12.2)	−0.2949*** (−10.6)
$COMMONBORDER_{t-1}$	0.6318*** (10.5)	1.4962*** (8.00)
$COMMONLANGUAGE_{t-1}$	0.1628*** (7.23)	0.3932*** (6.32)
$COLONY_{t-1}$	−0.2712*** (−7.63)	−0.6443*** (−7.02)
$ALLIANCE_{t-1}$	0.0739*** (2.83)	0.1559** (2.41)
Constant	−3.1400*** (−22.3)	−7.2145*** (−20.22)
Year dummies	Yes	Yes
Wald $\chi^2(45)$	25,493***	14,215***
No. of observations	293,705	293,705

Note: This table reports the estimation results of panel probit and logit models for aggregate NTMs. The dependent variable is the binary indicator FTA which equals one if countries i and j join or remain in a free trade agreement and zero otherwise. The regressors are defined in section 3.2. In parentheses are *t*-values based on standard errors adjusted for clusters. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels.

results imply that the impacts of different DTA measures (if using the term as in Dhingra et al., 2023) on signing/renewing an FTA do not point to the same direction.

5 | CONCLUSION

The main purpose of this study is to examine empirically whether and how NTMs affect the formation of FTAs. To this end, we consider three scenarios: (i) dividing 16 chapters of NTMs into eight types, largely following the practice in the literature; (ii) grouping the eight types into non-technical and technical measures as well as export-related measures, motivated by the political-economy theory of NTMs; and (iii) simply aggregating all NTMs for comparison purposes. Meanwhile, we fit probit and logit models to data from 114 countries over the period 1986–2019 and estimate the models using pooled cross-section and panel regression techniques respectively. The models include economic and non-economic variables as control variables in addition to the NTM variables, with non-economic control variables embracing geographical, cultural and institutional factors.

Our results demonstrate that splitting NTMs into eight categories, the *PC* measures, the *QC* measures and the *OTH* measures tend to be restrictive; the *INSP* measures, the *SPS* measures and the *TBT* measures tend to be promotive; and the *EXP* measures tend to be neutral, in terms of their effects on FTA formation. If classifying NTMs between the technical (*TCM*), non-technical (*NTCM*) and export-related (*EXP*) types, the *TCM* measures tend to encourage, while the *NTCM* measures tend to discourage, country-pairs to join FTAs, consistent with the political economy theory of NTMs albeit proposed previously for bilateral trade. Under this classification, there is some evidence for the *EXP* measures to negatively impact FTA. Aggregating all NTMs into one variable would give rise to weaker evidence rendering the conclusions indefinite. Finally, our regression results for the 12 selected control variables are largely in line with those of previous studies on international trade flows or on FTAs but without considering NTMs. This further corroborates our findings regarding the nexus between NTMs and FTA formation as outlined above.

ACKNOWLEDGEMENTS

We would like to thank the editor, David Jaeger and two anonymous referees for their useful and constructive comments. Excellent research assistance by Thang Vu is also gratefully acknowledged. The usual disclaimer applies. Open access publishing facilitated by Massey University, as part of the Wiley - Massey University agreement via the Council of Australian University Librarians.

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How to cite this article: Li, X.-M. (2024) The diverse effects of non-tariff measures on free trade agreements: Global empirical evidence from binary response models. *Scottish Journal of Political Economy*, 00, 1–21. Available from: https://doi.org/10.1111/sjpe.12383

APPENDIX A

TABLE A1 Countries in analysis.

Country	Income group	Number of FTAs	Country	Income group	Number of FTAs
Algeria	Lower middle income	2	Kazakhstan	Upper middle income	11
Antigua and Barbuda	High income	3	Kuwait	High income	3
Argentina	Upper middle income	8	Kyrgyzstan	Lower middle income	10
Australia	High income	17	Laos	Lower middle income	9
Austria	High income	46	Latvia	High income	46
Bahamas	High income	3	Lebanon	Upper middle income	4
Bahrain	High income	4	Liberia	Low income	1
Bangladesh	Lower middle income	5	Lithuania	High income	46
Barbados	High income	3	Luxembourg	High income	46
Belgium	High income	46	Malaysia	Upper middle income	15
Benin	Lower middle income	3	Mali	Low income	2
Bolivia	Lower middle income	4	Malta	High income	46
Botswana	Upper middle income	6	Mauritania	Lower middle income	1
Brazil	Upper middle income	9	Mauritius	High income	8
Brunei	High income	9	Mexico	Upper middle income	23
Bulgaria	Upper middle income	46	Morocco	Lower middle income	9
Burkina Faso	Low income	2	Myanmar	Lower middle income	8
Cape Verde	Lower middle income	1	Nepal	Lower middle income	3
Cambodia	Lower middle income	7	Netherlands	High income	46
Cameroon	Lower middle income	4	New Zealand	High income	13
Canada	High income	15	Nicaragua	Lower middle income	11
Chile	High income	27	Niger	Low income	2
China	Upper middle income	16	Nigeria	Lower middle income	2
Colombia	Upper middle income	15	Oman	High income	4
Costa Rica	Upper middle income	14	Pakistan	Lower middle income	10
Ivory Coast	Lower middle income	4	Palestine	N/A	4
Croatia	High income	46	Panama	High income	14
Cuba	Upper middle income	4	Papua New Guinea	Lower middle income	6
Cyprus	High income	46	Paraguay	Upper middle income	8
Czech Republic	High income	46	Peru	Upper middle income	20
Denmark	High income	46	Philippines	Lower middle income	11
Dominica	Upper middle income	3	Poland	High income	46
Ecuador	Upper middle income	7	Portugal	High income	46
El Salvador	Lower middle income	12	Qatar	High income	3
Estonia	High income	46	Romania	High income	46
Ethiopia	Low income	1	Russia	Upper middle income	12
Finland	High income	46	Saudi Arabia	High income	3

(Continues)

TABLE A1 (Continued)

Country	Income group	Number of FTAs	Country	Income group	Number of FTAs
France	High income	46	Senegal	Lower middle income	2
Gambia	Low income	1	Singapore	High income	27
Germany	High income	46	Slovakia	High income	46
Ghana	Lower middle income	4	Slovenia	High income	46
Greece	High income	46	South Korea	High income	20
Grenada	Upper middle income	3	Spain	High income	46
Guatemala	Upper middle income	9	Sri Lanka	Lower middle income	6
Guinea	Low income	2	Suriname	Upper middle income	3
Guyana	Upper middle income	4	Sweden	High income	46
Honduras	Lower middle income	11	Thailand	Upper middle income	14
Hong Kong	High income	8	Togo	Low income	2
Hungary	High income	46	Trinidad and Tobago	High income	4
India	Lower middle income	17	Tunisia	Lower middle income	8
Indonesia	Upper middle income	12	Turkey	Upper middle income	23
Ireland	High income	46	United Kingdom	High income	37
Israel	High income	10	Uruguay	High income	8
Italy	High income	46	United States	High income	14
Jamaica	Upper middle income	3	Venezuela	Upper middle income	3
Japan	High income	18	Vietnam	Lower middle income	15
Jordan	Upper middle income	8	Zimbabwe	Lower middle income	6

Source: CEPII, UNCOMTRADE, TRAINS and Integrated Trade Intelligence Portal (ITIP Goods) of WTO.

TABLE A2 Definitions of the variables used in equations (1)–(3).

FTA	A binary indicator which takes the value unity if the country-pair *ij* forms or remains in an FTA in year *t* (indicating $FTA_t^* > 0$) and zero otherwise (indicating $FTA_t^* \leq 0$), where FTA_t^* is unobservable and to be estimated. Data source for FTAs: The TRAINS-UNCTAD and the ITIP goods of WTO
NTM_k	The number of one of the eight types ($k = 1, 2, ..., 8$) of NTMs imposed by reporting country *i* vis-à-vis its partner country *j*, lagged 1 year. The eight types of NTMs include, as shown in Table 1, export-related measures ('A', *EXP*); sanitary and phytosanitary measures ('B', *SPS*); technical barriers to trade ('C', *TBT*); pre-shipment inspection and other formalities ('D', *INSP*); contingent trade protective measures ('E', *CTPM*); non-automatic licensing, quotas, prohibitions and quality-control measures other than for *SPS* or *TBT* ('F', *QC*); price-control measures, including additional taxes and changes ('G', *PC*) and all other measures ('H + I + J + K + L + M + N + O + P', *OTH*). Data source for NTMs: The TRAINS of UNCTAD and the ITIP Goods of WTO
$\boldsymbol{X}_{CONTROL}$	A row vector of control variables. We take 12 control variables from the international trade literature, as follows: 1. FTA_{t-1}, *FTA* lagged 1 year, to make model (1) dynamic. Data source for FTAs: See above 2. $GDPsum_{t-1} = \ln(GDP_{i,t-1} + GDP_{j,t-1})$ with *GDP* denoting real GDP, which proxies for the total bilateral market size of countries *i* and *j*. See Egger and Larch (2008). Data source for real GDP and real GDP per capita: UNCOMTRADE (United Nations Commodity Trade Statistics Database) 3. $GDPsim_{t-1} = \ln\left\{1 - \left[GDP_{i,t-1}/\left(GDP_{i,t-1} + GDP_{j,t-1}\right)\right]^2 - \left[GDP_{j,t-1}/\left(GDP_{i,t-1} + GDP_{j,t-1}\right)\right]^2\right\}$, which proxies for the similarity of countries *i* and *j* in terms of their real GDP. See Egger and Larch (2008). Data source for real GDP and real GDP per capita: See above 4. $DKL_{t-1} = \lvert\ln[(GDP/Population)_{i,t-1}] - \ln[(GDP/Population)_{j,t-1}]\rvert$, which measures the absolute difference in the log of real GDP per capita between countries *i* and *j* and proxies for the absolute difference in the capital-labour ratio between countries *i* and *j*. See Egger and Larch (2008). Data source for real GDP and real GDP per capita: See above 5. $SQDKL_{t-1} = DKL_{t-1}^2$. See Egger and Larch (2008) 6. $WTOH_{t-1}$ ($\equiv WTO_{i,t-1}$) is a dummy variable which takes the value unity if home country *i* is a member of WTO and 0 otherwise. Data source of WTO membership: The ITIP Goods of WTO 7. $WTOF_{t-1}$ ($\equiv WTO_{j,t-1}$) is a dummy variable which takes the value unity if foreign country (partner) *j* is a member of WTO and 0 otherwise. Data source of WTO membership: See above 8. $DISTANCE_{t-1}$ is the log of geographical distance between the capital cities of countries *i* and *j* in kilometres, lagged 1 year. Data source: The CEPII database 9. $COMMONBORDER_{t-1}$ is a dummy variable which takes the value one if countries *i* and *j* share border (i.e., are contiguous) and 0 otherwise. Data source: The CEPII database 10. $COMMONLANGUAGE_{t-1}$ is a dummy variable which takes the value one if countries *i* and *j* have the same official language and 0 otherwise. Data source: The CEPII database 11. $COLONY_{t-1}$ is a dummy variable which takes the value one if country *i* (*j*) used to be a colony of country *j* (*i*) and 0 otherwise. Data source: The CEPII database 12. $ALLIANC_{t-1}$ is a dummy variable which takes the value one if countries *i* and *j* are members of a political and/or military alliance or organization and 0 otherwise. Data source: The CEPII database