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A quasi-experimental approach to assess the causal impact of NTMs on GVC-trade

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A quasi-experimental approach to assess the causal impact of NTMs on GVC-trade

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Abstract

This work aims to assess the causal impact of Non-Tariff Measures (NTMs) on the global value chain (GVC)- trade within the agricultural sector. To achieve this goal, we utilize a panel structure of NTMs data at the HS 6-digit product level from the WTO I-TPI database, coupled with EORA data for trade in value added. The analysis encompasses 172 countries over the period 1995-2015. To calculate trade restrictiveness, we employ both NTMs frequency and coverage indices, distinguishing between various NTMs categories. This study introduces three key innovations. Firstly, unlike conventional analyses, we focus on trade flows in value added rather than gross ones. This approach allows us to assess the impact of NTMs on GVCs-trade, that is trade involving intermediate products. Secondly, we differentiate between types of NTMs to better discern their effects on GVC-trade. Lastly, we employ quasi-experimental methods to address non-linearities and endogeneity issues, relying on continuous treatment. This methodological advancement represents a significant improvement in studying the causal effects of NTMs. Our results show that NTMs matter and that their impact on GVC-trade varies in a non-linear way with the level of intensity. Specifically, the imposition of NTMs on GVC-trade has a negative impact on exporting countries, applicable to various NTM types, albeit with differentiated effects that are less prominent when weighted by the importance of importing flows. The implications of this study are significant: firstly, the omission of self-selection issues in analysing the effects of NTMs on GVC-trade can result in biased estimates; secondly, addressing the heterogeneity of NTMs is imperative. Thirdly, and crucially in GVC analysis, there are indirect effects on the domestic economy of the imposing country. This highlights the importance of the "chain effect" of trade policy, indicating that a restriction imposed by one country not only hampers partner countries' exports but also affects the imposing country itself through value chain linkages.

Keywords: non-tariff measures, GVC-trade, agriculture sector, quasi-experimental methods

JEL-codes: F13, F14, Q17

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1. Introduction

In recent decades, there has been a substantial increase in the use of non-tariff measures (NTMs). Initially, NTMs were synonymous with quantitative restrictions like quotas, voluntary export restraints and non-automatic licensing, but this is no longer the case. NTMs have evolved to a point where such quantitative restrictions have largely been phased out and replaced by measures designed to address non-trade regulatory objectives such as product safety, environmental protection, national security, or intellectual property protection (Cadot and Gourdon, 2016; Hoekman and Nicita, 2018).

All NTMs‐ intentionally or unintentionally ‐have direct or indirect effects on trade costs by altering the volume, direction, or product composition of international trade (De Melo and Nicita, 2018). The economic literature highlights the ambiguous effect of NTMs on trade. Some NTMs can have a positive impact. Sanitary and phytosanitary measures can contribute to quality improvement, which could revive trade; some technical barriers to trade – such as labelling requirements – provide additional information to consumers, potentially shaping consumption patterns and increasing confidence that, in turn, might favour trade. Conversely, the effect is negative for other types of NTMs – such as quotas and prohibitions – as they have a significant restrictive and distorting impact on international trade. As a result, NTMs have been placed at the center of the current debate on trade policy.

The growing interest has several reasons. NTMs have become a key determining factor of international trade, particularly in relation to market access. The importance of NTMs has increased in relative terms as tariff barriers were progressively reduced through multilateral negotiations. Furthermore, NTMs have increasingly become part of trade negotiations within the WTO, affecting the policy space that allows countries to pursue their development goals.

The increasing importance of NTMs also calls for a deeper understanding of the economic effects of NTMs. This work aims to contribute to this goal by assessing the causal impact of NTMs on agriculture global value chain (GVC)-trade. We use the term "GVC trade" to denote trade involving intermediate products.[1] In the context of GVCs, the adoption of NTMs not only affects the immediate trading partners but also generates indirect consequences through inter-country and inter-industry linkages. To analyse this impact comprehensively, we combine the panel structure of NTMs data at the HS 6-digit product level from the WTO Integrated Trade Intelligence Portal (I-TIP) database with the EORA data for trade in value added. The analysis covers up to 172 countries for the period 1995-2015. In order to compute trade restrictiveness, we apply both the NTMs frequency and coverage indices, also differentiating for NTMs categories, whereas to compute GVC indicators (both backward and forward linkages), we apply Borin and Mancini (2019)'s decomposition method to trade in value added.

This work aims to contribute to a greater understanding of the role of NTMs in distributing the benefits of involvement in GVCs. Within the GVC analysis, some key issues include differentiating between NTMs on intermediate and final goods, as well as distinguishing

[1] "GVC trade" measures the value of goods and services exported by a sector or a country that crosses more than one border, whereas "traditional trade" is the value of goods and services that crosses just one border (see Hummels et al., 2001; Borin and Mancini, 2019).

between NTMs that impose costs on the importer and those that impose costs on the exporter (Webb et al., 2020). In addition, important policy implications can be derived for reaping the benefits of participating in GVCs efficiently and minimizing the trade costs imposed by NTMs.

Results show that NTMs matter and that their impact on GVC-trade varies in a non-linear way with the level of intensity. Specifically, a consistent negative relationship is identified between the intensity of NTMs imposed by importing countries and the exporter's agriculture GVC-trade. This negative relationship exhibits variability across different NTMs, with aggregated NTMs, TBTs, and SPSs demonstrating a less pronounced average negative effect at low levels of index intensity. Conversely, NTMs like EXS, TRQ, and QRS consistently manifest a negative effect, even at low levels of treatment intensity. When considering NTMs weighted for importing flows, the negative impact on agricultural GVC trade is less pronounced.

To the best of our knowledge, this is the first study investigating the relationship between NTMs and GVC trade in a panel setting, adopting impact evaluation techniques. The novelty of the study is threefold: first, unlike most analyses, we consider trade flows in value added rather than gross ones. In this way, we can evaluate the effect of NTMs on GVCs-trade, which is the value of goods and services exported by a sector or a country that crosses more than one border; second, we differentiate the types of NTMs to better distinguish their effects on GVC-trade; and third, we apply quasi-experimental methods to overcome non-linearities and endogeneity issues and rely on continuous treatment (Baier and Bergstrand 2009). This last point represents a substantial methodological improvement in the study of the causal effects of NTMs. There is a potential endogeneity bias (i.e., self-selection) in estimating the effect of trade policies since these policy measures are not exogenous random variables and are likely to be endogenously determined by and correlated with the country-pair trade flows and their determinants (Baier and Bergstrand 2007). The pervasiveness of the problems hampers the assessments of NTMs especially when one seeks to capture the effects of the full range of NTMs characterizing countries' regulatory structures. The combination of non-random selection trade policy and omitted non-linearities can bias estimates, ultimately influencing also policy recommendations.

The structure of the paper is as follows. Section 2 presents a survey of the most relevant studies investigating the trade effects of NTMs, with a focus on GVCs. Section 3 explains the matching technique applied in this work, Section 4 presents the data and variables, Section 5 shows the empirical analysis and comments on the outcomes, and Section 6 concludes.

2. Literature review

Various methodologies have been developed by economists to quantify NTMs and evaluate their impacts on international trade. Empirically, the trade effects of NTMs have been quantified mainly through two approaches: a) by ex-post analyses, that is, estimating their observed impact on trade[2]; b) by ex-ante analyses, that is, predicting their potential yet unobserved impact on trade. Studies modelling the impact of various types of qualitative and quantitative NTMs on trade values, quantities, and prices are abundant in the literature (for a detailed review, see Ederington and Ruta, 2016; Cadot and Gourdon, 2016; Cadot et al., 2018; Jafari and Britz, 2018; Fontagné and Orefice, 2018; and among the most recent ones, see Liu et al., 2019; Webb et al., 2020). The literature provides conflicting evidence on the impact of NTMs on trade based on gravity estimations and applied general equilibrium model simulations. Focusing on the analyses carried out during the last decade, some studies found that NTMs foster trade (e.g., Xiong and Beghin, 2011; Rindayati and Kristriana, 2018), in particular on the intensive margin (Bao and Qiu, 2012; Crivelli and Gröschl, 2016).

It is noteworthy to see how Non-Tariff Measures can serve to guarantee adherence to particular standards, signalling enhanced product quality and subsequently mitigating transaction costs which, in turn, might positively influence both trade values and volumes, as evidenced by Beghin et al. (2012), Blind et al. (2013), and Bratt (2014). On the other hand, evidence is provided also on the adverse effects of NTMs on trade (e.g., Hoekman and Nicita, 2011; Beghin et al., 2015; Enbaby et al., 2016; Darhyati et al., 2017; Jordan, 2017; Grundke and Moser, 2019). Furthermore, in some cases, empirical evidence struggled in highlighting a clear direction, showing mixed results (Disdier et al., 2015; Crivelli and Groeschl, 2016; Ferraz et al., 2018). Studies focusing on the impact of NTMs on agriculture and food trade also show mixed results. Li and Beghin (2012), for instance, undertook a meta-analysis to scrutinize the variability in the estimated impacts of technical measures on trade within agri-food and manufacturing sectors by devoting attention to Sanitary and Phytosanitary Standards (SPS), Technical Barriers to Trade (TBT), and Maximum Residue Levels (MRL). They found that agriculture and food industries tend to be more impeded or less enhanced by these measures and barriers than other sectors. SPS regulations on agricultural and food trade flows from developing exporters to high-income importers are more likely to be trade impeding than similar barriers in North–North trade.

Further evidence on the heterogeneous impact of NTMs on the agri-food trade - has been provided by several scholars during last 15 years. Some indicate that NTMs negatively affect trade (e.g., Peterson et al., 2013; Dal Bianco et al., 2016), others estimate a positive effect of NTMs on trade (e.g., Cardamone, 2011), with numerous empirical works questioning the existence of a definite direction of the impact of such measures on trade (e.g., Xiong and Beghin, 2011; Beckman and Arita, 2016). More recently, Santeramo and Lamonaca (2019)

[2] In literature, the trade effects of NTMs are mainly assessed by mean of ex-post gravity model estimation, which is the benchmark for analysing the effects of policy measures on trade.

conducted a meta-analysis to review empirical studies on the effect of NTMs on agri-food trade in order to disentangle potential determinants of heterogeneity in estimates. They confirm mixed results: some characteristics of the studies are correlated with positive significant estimates, whereas others covary with significant negative estimates. Such heterogeneity reflects the different types of and proxies for NTMs, the aggregation level of the analyses, data samples, model specifications, and other differences in methodology and publication processes.

Studies examining the relationship between NTMs and GVCs, or even the relationship between tariffs and GVCs, remain limited.[3] Previous studies that had examined the relationship between trade policy measures, mainly tariffs, and international fragmentation of production generally found a negative effect of input tariffs on imports of intermediate and capital goods (e.g., Alfaro et al., 2016; Liu et al., 2019; Ornelas and Turner, 2012). Conversely, Brandt and Morrow (2017) examined the impact of import tariffs adopted by China on the organization of its exports, distinguished in ordinary and processing trade. They show how lower levels of protection for intermediate inputs did not clearly impact on domestic value-added foreign value-added ratios. Falling input tariffs cause an increase in both the gross export share and the share of Chinese domestic content in gross exports.

In recent years, the impact of NTMs on GVC has been attracting increased attention from scholars, although this is still primarily grey literature. Cadestin et al. (2016) analyse the impact of rules of origin and NTMs on GVC integration in the Latin American region. Using the empirical work shows that, on average, NTMs used by Latin American countries impose additional costs equivalent to a tariff of roughly 15% for intermediate products. This suggests that there is benefit in exploring scope for mutual recognition, or harmonisation of technical regulations or conformity-assessment procedures. Franssen and Solleder (2016) investigate the effects of NTMS on countries' engagement in international value chains, employing a comprehensive multi-country product-level regulatory database by the ITC, UNCTAD and World Bank. The researchers have distinguished goods according to their end-use and examined the association between the regulatory distance on intermediate products imported export values downstream of the same value chain. The findings reveal a negative relationship, showing how NTMs can influence trade dynamics across various stages of the international value chain. Webb et al. (2020) utilise different channels to model the effect of different types of NTMs. They first obtain econometric estimates of the effect of different types of NTMs on imports into major ASEAN countries. In this way, they identify the types of NTMs that have significant negative effects on both intermediate inputs and final consumption. Next, they consider whether the NTMs have an impact on costs for importers or for exporters. Finally, they simulate an NTMs liberalisation using a CGE model but allowing for analysis of NTMs at different parts of the supply chain. Results show that such liberalisation increases the income of all countries, particularly that of the major ASEAN countries. Plant products and animal products are the sectors that show the largest expansion of trade. A modest decrease in output in major ASEAN countries is found as imports become relatively cheaper. Korwatanasakul and

[3] Another aspect of the literature delves into the inverse relationship, specifically examining how GVCs influence trade policy both theoretically and empirically (see Antràs and Staiger, 2012; Blanchard, 2010; Ornelas and Turner, 2008, 2012; Ludema et al., 2021). However, only a limited number of works specifically focus on NTMs (see Blanchard et al., 2016; Bown et al., 2021; and Raimondi et al., 2023).

Baek (2021) examine the impact of NTMs on GVC participation using an additional compliance requirement indicator as a relative proxy for NTMs and the OECD Inter-Country Input–Output Table to estimate trade in value added. They conduct a cross-sectional analysis at the industry level covering thirty countries. They find that, while NTMs and tariffs both negatively impact backward GVC participation, the impact of NTMs is greater than that of tariff measures. They conclude stating that policies that reduce trade costs from policy barriers, especially NTMs, can help promote GVC participation. Lastly, Ghodsi and Stehrer (2022) analyse the effects of NTMs along GVCs. The authors estimate bilateral ad-valorem equivalents (AVEs) of TBTs and SPSs and derive cumulative bilateral trade restrictiveness measure by incorporating these AVEs alongside tariffs, accounting for GVC linkages. By using a structural gravity model on both gross and value-added exports, their analysis reveals that tariffs have exert a more pronounced influence on exports compared to NTMs. Moreover, their findings corroborate extant literature, indicating the presence of both trade-facilitating and trade-impeding effects.

3. Methodology

The use of impact evaluation methods is motivated by the growing concerns about the validity of standard-fixed effects estimator as the best tool for causal inference in applied panel data analyses, such as the gravity equations traditionally implemented by the literature in assessing the impact of trade policy (Imai and Kim, 2011), included NTMs.

It is worth noting that a more rigorous estimate of the actual impact of NTMs is essential to derive an accurate assessment of this kind of trade policy measure. In this respect, the application of a generalized version of the propensity score matching technique proposed in this analysis, namely the generalized propensity score – GPS – (Hirano and Imbens, 2004; Imai and van Dyk, 2004) brings clear advantages. Firstly, it lets us control for the endogeneity bias due to the fact that NTMs are not exogenous random variables and are likely to be endogenously determined by and correlated with the country-pair trade flows and their determinants (Baier and Bergstrand 2007). Recent empirical works have addressed the endogeneity issue attached to trade policies by relying on impact evaluation methods and, in particular, using non-parametric matching techniques (Baier and Bergstrand, 2009; Egger et al., 2008; Montalbano and Nenci 2014; Magrini et al., 2017a; Magrini et al., 2017b). Secondly, it allows assessing the impact of trade measures characterized by different intensities. Thirdly, by exploiting the longitudinal dimension of panel data, it lets us incorporate time-varying confounders into non-parametrically matching estimator leading to a more efficient estimate of the average causal impact of NTMs. Fourthly, it helps us to isolate the impact of NTMs from any other event specific to the country pairs and takes also into account the presence of non-linearities in the relationship among NTMs measures, trade flows and the covariates. Finally, it does not need an untreated control group with similar characteristics – which is mandatory with the binary treatment matching techniques – but creates a set of internal control groups for different treatment intensities.

The GPS method has been recently applied to various impact evaluation problems lacking experimental conditions. To the best of our knowledge, this is the first application of GPS to assess NTM's impacts on GVC-trade.

In the application of the Generalized Propensity Score (GPS) methodology, we posit the existence of a vector of covariates, denoted as X, a continuous treatment received, denoted as $\tau \in [\tau_0, \tau_1]$, and a potential outcome, $\tau \in [\tau_0, \tau_1]$. Our objective is to estimate an average dose-response function (DRF) able to assess the value of the outcome variable conditional on the values of the treatment variable. This can be expressed as follows:

$$D(\tau) = E[Y(\tau)] \qquad (1)$$

Following Hirano and Imbens (2004), we define GPS as:

$$R = r(\tau, X) \qquad (2)$$

where R is the propensity score and r is the conditional density of the treatment given the covariates.

The implementation of the GPS method requires a two-step approach. In the first step, for each unit, we compute the ex-ante conditional probability of receiving specific treatment.

Since our analysis aims at evaluating the impact of measures such as NTMs Frequency indices and Coverage Ratios are percentage and have values that can be reported in the [0,1] interval, differently from Hirano and Imbens (2004) and Imai and van Dyk (2004) – and in line with Nenci and Vurchio (2023) – we estimate the generalized propensity score by using the Bernoulli log-likelihood following Papke and Wooldridge (1996) and Guardabascio and Ventura (2014).[4,5] More precisely, Papke and Wooldridge (1996) specify a class of functional forms for $E(T = \tau|X)$ and estimate the parameters using a Bernoulli QML estimator of β, namely the Generalized Linear Model by assuming, for all i,

$$E(T_i|X_i) = F(\beta' X_i) \qquad (3)$$

[4] It is worth noting the presence of different works highlighting how the treatment variable may not be normally distributed. This leads to the and consequently adopt GPS techniques with continuous treatment variables ranging between 0 and 1 (e.g., Fryges and Wagner 2008 and Fryges 2009 that use the exports-to-sales ratio).

[5] We test the respect of the balancing property by following Magrini *et al* (2017) and Nenci and Vurchio (2023), by organizing the data in a group-and-strata structure so we can compare observations between different treatment groups across GPS strata. That is, for each treatment group j and each observation i we compute the probability of having the median treatment of the group $j(T_M^j)$, i.e. $\hat{R}_i(T_M^j, X_i)$. We then plot these GPS values in group j against those not in group j and eliminate those observations in groups other than j that lie outside the common GPS support.

where $F(\cdot)$, in our case, is a logit function. In such a context, the estimation procedure defines the Bernoulli log-likelihood function as

$$l_i(\beta) \equiv T_i \log\{F(\beta' X_i)\} + (1 - T_i)\log\{1 - F(\beta' X_i)\} \quad (4)$$

and maximizes the sum of $l_i(\beta)$ over all N using the GLM. For the purpose of our analysis, following Guardabascio and Ventura (2014), we estimate GPS, based on the Bernoulli log-likelihood function in (4), as

$$R = F\left(\hat{\beta}' X\right) \quad (5)$$

In the subsequent step, we proceed to ascertain the conditional expectation of the outcome by modelling it as a function dependent upon two scalar variables: the treatment level (τ) and the Generalized Propensity Score ($R = r(\tau, X)$). Subsequently, we derive the average Dose-Response Function (DRF) of the outcome by averaging the conditional expectation across various levels of the treatment, in the manner described below:

$$D(\tau) = E\left[\alpha\left(\tau, r(\tau, X)\right)\right] \quad (6)$$

with the parameters α are those estimated. It is noteworthy that, in the conventional panel setting, each observation is paired with the mean of all other observations in the same year, irrespective of their treatment status, as elucidated by Imai and Kim (2011). However, in matching methodologies, provided that balancing conditions are met, every observation is exclusively matched with those belonging to the same Generalized Propensity Score (GPS) stratum, signifying similarity in observable characteristics. In any case, in such context the precise method employed for estimating the GPS is of secondary significance, as long as sufficient covariate balance is attained, in accordance with the insights of Kluve et al. (2012).

The accuracy of Generalized Propensity Score (GPS) estimates and the effectiveness of the non-parametric approach hinges upon the validity of a set of assumptions inherent in impact evaluation literature. Primarily, the first assumption pertains to the randomness of the treatment, commonly referred to as "unconfoundedness" or the "ignorability of the treatment." This assumption posits that, given observable characteristics, the treatment can be considered as randomly assigned. When of analyzing trade preferences, unconfoundedness becomes a pivotal assumption, given that the selection of countries participating in preferential agreements is unlikely to be random, as evidenced in works by Baier and Bergstrand (2007) and Egger et al. (2008). Imbens (2000) establishes that if treatment assignment is weakly unconfounded based on observed covariates, it remains weakly unconfounded when conditioned on GPS. Thus, the combination of this property with the balancing property ensures that treatment assignment can be deemed as random in a non-experimental setting.

Another essential condition for validity is the "overlap assumption," necessitating a sufficient balance of observations between treatment and control groups. However, in the context of GPS utilization, the absence of reliance on control groups obviates this concern. Instead, the approach involves operating across GPS strata that represent various treatment intensities on a continuous distribution. Consequently, the methodology allows for the testing of alternative group and strata structures to assess the respect of the balancing property.

Lastly, another standard validity condition is SUTVA (Stable Unit Treatment Value Assumption). This is formed by two separate issues. The first one is the "unique treatment assumption". The second one is the "non-interference assumption", i.e., possible biases in the relationship between treatment and outcomes due to interfering events and/or "spill-over" effects. In our empirical analysis we control for the possible set of unobservable confounding effects by controlling for different country characteristics referred to both exporting and importing countries.

4. Data and variables

Our empirical strategy aims to evaluate the impact of NTMs (i.e., the treatment) on agricultural GVC trade (i.e., the outcome). In this work, the treatment is measured, alternatively, as the NTMs frequency index and the coverage ratio computed for all NTMs typologies as well as by categories of NTMs. To do this, we rely on NTMs information notified to the World Trade Organization through the Integrated Trade Intelligence Portal (I-TIP), which allows us to differentiate between various NTM types, including technical barriers to trade (TBTs), sanitary and phytosanitary (SPS) measures, Export Subsidies (EXS), Tariff-rate quotas (TRQ), and Quantitative Restrictions (QRS). I-TIP WTO data are retrieved using the Ghodsi et al., (2017) data and are available for the time span 1995- 2019.

Our analysis focuses on trade in value-added as the *outcome variable*. More precisely, our study aims to understand the impact of NTMs on countries' *forward GVC* participation. This participation measure captures how economies participate in the worldwide fragmented production processes. Specifically, the *forward GVC* participation indicator is measured as the domestic value added contained in intermediates exported to a partner country that are then re-exported to a third economy.

Our *treatment variables* are frequency indices and coverage ratios. They are the most common methods used to assess the prevalence of NTMs and their effects on international trade. These indices are based on inventory listing of observed NTMs and provide simple but useful tools to illustrate the types and number of NTMs that countries apply on aggregate imports as well as across different sectors (De Melo and Nicita, 2018). They have a value ranging from a minimum of 0 to a maximum of 1.

The frequency index accounts for the presence of NTM and summarizes the percentage of products to which one or more NTMs are applied. The index is computed as follows:

$$FI_{i,a} = \frac{\sum D_{i,a,j} M_{i,a,j}}{\sum M_{i,a,j}} \quad (7)$$

where the frequency index of NTMs between imposing country i and affected country a is given by the share of imported Harmonized System products (j) affected by at least one NTM. Hence, $D_{i,a,j}$ is a dummy variable reflecting the presence of at least one NTM and $M_{i,a,j}$is a dummy variable denoting the existence of trade flow for product j from country a to country i. The index is computed on all the 6-digit HS agricultural products (sector 1 in EORA26 dataset).

Also the coverage ratio accounts for the presence of NTMs, but it measures the importance of such measures on overall imports. It computes the share of trade that is subject to NTMs and is computed as:

$$CR_{i,a} = \frac{\sum D_{i,a,j} V_{i,a,j}}{\sum V_{i,a,j}} \quad (8)$$

where $D_{i,a,j}$ is again a dummy variable reflecting the presence of at least one NTM affecting products in the 6-digits HS code i and $V_{i,a,j}$ is the value of the imposing country i imports from the affected country a.

In order to enrich our analysis, we have computed our NTMs indices on imports of both exporting and importing countries and we have considered all the NTMs and – separately – technical barriers to trade (TBTs), Sanitary and Phyto-Sanitary measures (SPS), Export Subsidies (EXS), Tariff-rate quotas (TRQ), and Quantitative Restrictions (QRS).[6]

The covariates used during the first step of our GPS matching procedure are selected following the previous literature on agricultural trade policies (e.g. Anderson *et al*, 2013 and Magrini *et al.* 2017) and trade preferences (Baier and Bergstrand, 2004 and Magrini *et al.*, 2016). By following Baier and Bergstrand (2004), we control for the difference in the GDP level between trading partners since countries with similar levels of income have a higher probability of concluding preferential trade agreements. Further controls are the country size, proxied by the imposing country population and its square, and – in line with Magrini *et al* (2016) and Magrini *et al* (2017) – proxies of NTMs imposing country comparative advantage in agricultural products in order to take into consideration eventual "anti-comparative advantage" trade policies patterns (Swinnen, 2010; Anderson et al 2013). These proxies are the agricultural Total Factor Productivity (TFP) and the symmetric Balassa index of country specialization referred to the agricultural sector. In the analysis, we also control for supply-side specialization, as we expect different trade policies according to the type of partner country. This includes the exporter country's agricultural TFP and Balassa index. Moreover, we take into consideration both imposing and affected countries' effectively applied weighted average agricultural tariffs

[6] We attempted also to perform our analysis by considering separately antidumping duties (ADP), safeguard measures (SFG), special safeguards (SSG), and state-trading enterprises (STEs) but the low number of observations did not allow us to perform a reliable GPS analysis.

to isolate the effect of non-tariff from tariff measures. We also include a set of regional and year fixed effects. Details on the source of data are reported in the appendix.

Trade in value added is influenced by trade policy measures faced at different stages of the value chain. In this work, we estimate the direct impact of NTMs imposed by the importer on the GVC-trade of the exporter. This impact indirectly influences the importer as well, as it relies on these inputs for its exports to third countries. To such extent, since the GVC trade – computed using Borin and Mancini (2019)'s methodology – consists of trade in value added flowing from an exporter country to an importer one, we take into consideration as covariates both variables referred to exporting economies and importing economies.

Table 1 reports the descriptive statistics of the variables included in the analysis.

Table 1: Descriptive statistics

Outcome variables	Obs.	Mean	Std Dev	Min	Max
Forward GVC trade (millions of $)	145,367	7.000	44.000	0.000	2,488.000
Alternative Treatment variables					
Bilateral Frequency Index (all NTMs, importing country)	148,196	50.627	29.973	0.439	100.000
Bilateral Frequency Index (TBT, importing country)	118,331	47.918	29.306	0.513	100.000
Bilateral Frequency Index (SPS, importing country)	126,184	45.656	29.191	0.439	100.000
Bilateral Frequency Index (EXS, importing country)	29,064	17.691	23.764	0.424	100.000
Bilateral Frequency Index (QRS, importing country)	31,947	32.154	28.971	0.524	100.000
Bilateral Frequency Index (TRQ, importing country)	34,293	14.472	19.912	0.505	100.000
Bilateral Coverage Ratio (all NTMs, importing country)	148,196	56.840	39.413	0.000	100.000
Bilateral Coverage Ratio (TBT, importing country)	118,331	54.855	39.308	0.000	100.000
Bilateral Coverage Ratio (SPS, importing country)	126,184	49.316	39.934	0.000	100.000
Bilateral Coverage Ratio (EXS, importing country)	29,064	25.397	34.281	0.000	100.000
Bilateral Coverage Ratio (QRS, importing country)	31,947	30.828	38.447	0.000	100.000
Bilateral Coverage Ratio (TRQ, importing country)	34,293	22.452	32.824	0.000	100.000
Control variables					
abs.GDP difference (PPP2017, trillion of $)	144,147	2060.758	3783.364	0.002	22,491.934
Population (million, importing country)	148,196	84.740	235.753	0.081	1,407.745
Agriculture TFP (importing country)	141,949	94.169	13.212	33.000	170.000
Agriculture TFP (exporting country)	142,610	95.409	14.412	29.000	254.000
Simm. Balassa Index in agri products (importing country)	109,782	-0.017	0.523	-0.995	0.925
Simm. Balassa Index in agri products (exporting country)	110,922	0.180	0.534	-0.997	0.947
Effectively applied tariff (weig. average, importing country)	120,030	8.771	20.690	0.000	2,406.000
Effectively applied tariff (weig. average, exporting country)	107,775	10.796	23.340	0.000	2,406.000

5. Empirical analysis: GPS Estimation and Balancing Property

The first step of our empirical exercise is to regress our measures of NTMs intensity on a set of pre-treatment observable characteristics to compute the generalized propensity score as reported in equation 5. As the treatment variables are shared with values ranging from 0 to 1, by following Papke and Wooldridge (1996) we adopt fractional logit estimates to compute the first stage. This allows us to ignore any test on the normal distribution of treatment variable errors. Following Magrini et al (2017a), we restrict our sample by eliminating those observations which can be considered as ‘untreated’ cases (i.e., for each estimation, when the treatment is equal to zero or missing). Treatment and control variables are 1-year lagged with respect to outcome variables.

Table 2: Generalized Propensity Score estimates for Frequency Indices (FI) as treatment variable

Dependent variable: Frequency Index	All NTMs	TBT	SPS	EXS	TRQ	QRS
GDP difference (ln)	-0.066***	-0.060***	-0.039***	-0.305***	-0.197***	-0.043***
	(0.003)	(0.004)	(0.004)	(0.012)	(0.007)	(0.013)
Population of imp. country (ln)	0.250***	-0.351***	0.509***	1.647***	-0.091	3.373***
	(0.042)	(0.051)	(0.054)	(0.592)	(0.085)	(0.183)
Population of imp. country (ln) ^ 2	-0.002*	0.013***	-0.011***	-0.045***	0.004	-0.092***
	(0.001)	(0.001)	(0.002)	(0.017)	(0.002)	(0.005)
Agricultural TFP of exp. country (ln)	-0.106***	-0.110***	0.044	-0.282**	-0.087	-0.435***
	(0.035)	(0.040)	(0.038)	(0.126)	(0.109)	(0.161)
Agricultural TFP of imp. country (ln)	0.179***	0.079*	0.252***	-0.631***	-1.207***	-6.355***
	(0.035)	(0.040)	(0.040)	(0.148)	(0.080)	(0.339)
Simm.Balassa Index of exp.country (ln)	-0.221***	-0.180***	-0.194***	0.133***	0.045	-0.290***
	(0.011)	(0.012)	(0.012)	(0.040)	(0.033)	(0.033)
Simm.Balassa Index of imp.country (ln)	0.168***	0.267***	0.160***	0.701***	0.111***	0.027
	(0.009)	(0.010)	(0.009)	(0.034)	(0.025)	(0.029)
Average tariff on agri product (imp.country, ln)	-0.313***	-0.281***	-0.500***	-0.129	1.627***	0.601***
	(0.045)	(0.052)	(0.053)	(0.206)	(0.089)	(0.090)
Average tariff on agri product (exp.country, ln)	-0.033	0.021	0.032	0.617***	0.135	0.096
	(0.041)	(0.044)	(0.042)	(0.138)	(0.110)	(0.136)
Constant	-2.539***	3.249***	-6.188***	-4.614	9.625***	-1.093
	(0.425)	(0.516)	(0.539)	(5.257)	(0.987)	(2.111)
Regional fixed effects - Yes						
Year fixed effects - Yes						
N	59,001	49,262	50,650	13,197	16,649	9,134

*Robust standard errors in parenthesis. Level of significance: * p<0.1; ** p<0.05; *** p<0.01.*

Table 3: Generalized Propensity Score estimates for Coverage Ratios as treatment variable

Dependent variable: Coverage Ratio	All NTMs	TBT	SPS	EXS	TRQ	QRS
GDP difference (ln)	-0.022***	-0.026***	0.009*	-0.228***	-0.136***	-0.015
	(0.005)	(0.006)	(0.005)	(0.014)	(0.011)	(0.019)
Population of imp. country (ln)	0.708***	0.232***	0.880***	1.766***	-0.911***	4.626***
	(0.062)	(0.075)	(0.078)	(0.491)	(0.119)	(0.314)
Population of imp. country (ln) ^ 2	-0.015***	-0.004*	-0.023***	-0.050***	0.028***	-0.124***
	(0.002)	(0.002)	(0.002)	(0.014)	(0.003)	(0.008)
Agricultural TFP of exp. country (ln)	-0.176***	-0.252***	0.022	-0.470***	-0.210	-0.584***
	(0.048)	(0.053)	(0.052)	(0.132)	(0.129)	(0.208)
Agricultural TFP of imp. country (ln)	0.234***	0.181***	0.425***	-0.779***	-1.570***	-7.942***
	(0.049)	(0.057)	(0.057)	(0.157)	(0.109)	(0.490)
Simm.Balassa Index of exp.country (ln)	-0.158***	-0.085***	-0.184***	0.344***	0.287***	-0.438***
	(0.015)	(0.017)	(0.017)	(0.048)	(0.042)	(0.045)
Simm.Balassa Index of imp.country (ln)	0.103***	0.212***	0.114***	0.766***	0.629***	0.068
	(0.013)	(0.014)	(0.014)	(0.041)	(0.032)	(0.043)
Average tariff on agri product (imp.country, ln)	-0.637***	-0.631***	-1.029***	-0.146	3.857***	0.330***
	(0.066)	(0.078)	(0.090)	(0.224)	(0.121)	(0.123)
Average tariff on agri product (exp.country, ln)	-0.118*	-0.054	0.001	0.947***	-0.193	-0.533***
	(0.062)	(0.067)	(0.066)	(0.150)	(0.162)	(0.202)
Constant	-7.106***	-1.960***	-11.118***	-4.790	17.456***	-6.209*
	(0.621)	(0.740)	(0.773)	(4.448)	(1.266)	(3.301)
Regional fixed effects - Yes						
Year fixed effects - Yes						
N	59,001	49,262	50,650	13,197	16,649	9,134

*Robust standard errors in parenthesis. Level of significance: * p<0.1; ** p<0.05; *** p<0.01.*

Table 2 and *Table 3* report the results for the first stage, with different treatment variables based on the Frequency Index and the Coverage Ratios metrics, respectively. Trading countries with a higher absolute GDP difference are usually associated with a lower NTMs intensity. As expected, frictions to trade are higher when the difference in GDP is lower and this is in line with the expected positive association between GDP similarity and preferential trade agreements (except for the case of SPS and QRS when CI is the treatment). Such evidence is robust at 1 % level for almost all the specifications reported in the two tables with first-stage estimates. Country size of the imposer country is positively and statistically associated with the intensity of NTMs as measured by both indices when considering all the NTMs measures together. It is again positive for the single NTMs (except for TRQ) when measured using the coverage ratio index. The relationship is less homogeneous when considering the single NTMs when measured using the frequency index. Importing countries with high levels of agricultural TFP show a strong association with a high intensity of NTMs when all NTM measures are considered together, both using frequency index and coverage ratio index. Conversely, exporter countries exhibit a low intensity of NTMs. However, estimates related to individual types of NTMs show mixed results. Similar findings are observed for the Symmetric Balassa Index, which serves as a proxy for the comparative advantages of countries in the agriculture sector.

Tariffs on agricultural products imposed by importing countries exhibit a negative association with NTMs when all NTM measures are considered together, whether using the frequency index or coverage ratio index. However, when tariffs are linked to exporting countries, the relationship becomes more mixed and less significant.

The second step in our impact evaluation exercise is to test the “balancing property”. We tested the holding of the “balancing property” by conducting a series of two-sided t-test across groups of observations. We have divided our set of observation in four approximately similar-sized groups based on the treatment variables’ values. The difference across the treatment groups with respect to the covariates unconditional to GPS values are significant and do not assure the validity of the empirical exercise. Instead, by conditioning the value of the GPS over 12 strata and imposing the common support condition, we can realistically assert that the balancing property is respected.

Tables 4 and *Table 5* present the t-statistics values of the differences in in the covariates before and after GPS correction. These values are provided for all and each specific type of NTM, measured through the frequency index and coverage ratio, respectively. When examining the frequency indices across all NTMs, the t-test indicates the rejection of the null hypothesis of equal means in only 3 out of 36 cases at a significance level of 1%. However, when shifting attention to the coverage ratios of NTMs, more robust results emerge, as the t-test does not reject the null hypothesis in any case. Focusing on individual types of NTMs, consistent robustness is observed in all cases when utilizing the coverage ratio and in almost all cases when employing the frequency index, except for TBT and SPS (1 out of 36 cases each).
The last step is to estimate the DRF to assess whether there is a causal link between NTMs changes and GVC-trade.

Table 4: Differences in the covariates by treatment levels before and after balancing on the GPS (T-tests for equality of means) – Frequency Index

	Before balancing				***After balancing***			
				Frequency Index - All NTMs				
GDP difference (ln)	***29,005***	***-23,905***	***-29,033***	***24,451***	***3,347***	-1,743	-1,875	2,294
Population of imp. country (ln)	***92,395***	***-9,141***	***-47,882***	***-33,248***	***2,737***	-1,211	-2,397	1,153
Population of imp. country (ln) ^ 2	***89,759***	***-6,933***	***-47,659***	***-33,243***	***2,740***	-1,143	-2,394	1,118
Agricultural TFP of exp. country (ln)	***24,449***	2,463	***-5,336***	***-21,602***	-0,283	-0,174	0,231	-0,137
Agricultural TFP of imp. country (ln)	***28,391***	***-8,719***	***-9,715***	***-9,372***	0,927	-0,920	-0,082	0,191
Simm.Balassa Index of exp.country (ln)	***4,974***	***-9,039***	2,087	1,908	0,543	-0,742	0,361	0,405
Simm.Balassa Index of imp.country (ln)	***35,570***	***6,655***	***-10,008***	***-33,351***	-1,295	0,373	0,748	-1,281
Average tariff on agri product (imp.country, ln)	1,390	***10,286***	***-8,783***	***-2,779***	-0,356	1,260	-0,762	-0,134
Average tariff on agri product (exp.country, ln)	***-3,202***	***-10,784***	***10,515***	***3,766***	1,012	-1,002	0,536	0,512
	37.067	*37.032*	*37.718*	*36.379*	*13.996*	*16.630*	*16.262*	*11.993*

	Before balancing				***After balancing***			
				Frequency Index - TBT				
GDP difference (ln)	***21,836***	***-22,727***	***-27,961***	***29,838***	***2,725***	-1,804	-2,008	1,564
Population of imp. country (ln)	***52,604***	***-9,243***	***-29,698***	***-14,123***	1,938	-0,986	-1,613	0,253
Population of imp. country (ln) ^ 2	***51,391***	***-7,874***	***-29,593***	***-14,376***	1,952	-0,928	-1,641	0,216
Agricultural TFP of exp. country (ln)	***16,251***	***3,228***	***-5,087***	***-14,990***	0,049	-0,383	-0,256	0,284
Agricultural TFP of imp. country (ln)	***21,203***	***-8,443***	***-8,708***	***-4,170***	1,192	-0,949	-0,302	0,372
Simm.Balassa Index of exp.country (ln)	***3,794***	***-6,255***	0,699	1,501	0,301	-0,480	-0,004	0,527
Simm.Balassa Index of imp.country (ln)	***35,280***	***7,684***	***-10,029***	***-35,358***	-0,407	0,547	0,472	-0,716
Average tariff on agri product (imp.country, ln)	***4,524***	***6,568***	***-6,654***	***-4,244***	0,058	0,648	-0,484	0,041
Average tariff on agri product (exp.country, ln)	***-3,448***	***-7,954***	***9,341***	1,966	0,525	-0,648	0,564	0,381
	31.576	*27.590*	*32.321*	*26.844*	*13.391*	*12.697*	*13.951*	*9.164*

	Before balancing				***After balancing***			
				Frequency Index - SPS				
GDP difference (ln)	***24,585***	***-12,828***	***-31,860***	***20,214***	***2,778***	-0,855	-2,249	1,808
Population of imp. country (ln)	***70,604***	***-12,738***	***-38,486***	***-18,302***	2,152	-1,220	-2,111	1,124
Population of imp. country (ln) ^ 2	***69,047***	***-11,536***	***-38,025***	***-18,485***	2,117	-1,163	-2,075	1,068
Agricultural TFP of exp. country (ln)	***20,425***	***7,581***	***-2,748***	***-25,336***	-0,581	0,277	0,423	-0,418
Agricultural TFP of imp. country (ln)	***26,364***	***-4,348***	***-9,609***	***-11,791***	0,516	-0,397	-0,392	0,273
Simm.Balassa Index of exp.country (ln)	***5,954***	***-9,962***	1,667	2,325	0,637	-0,647	0,408	0,247
Simm.Balassa Index of imp.country (ln)	***30,324***	***5,336***	***-10,918***	***-25,712***	-0,659	0,486	0,205	-0,635
Average tariff on agri product (imp.country, ln)	***-6,495***	2,214	0,673	***3,505***	-0,950	0,623	-0,214	-0,407
Average tariff on agri product (exp.country, ln)	2,193	***-11,533***	***5,316***	***4,368***	1,017	-1,061	0,328	0,717
	31.546	*31.676*	*31.487*	*31.475*	*12.672*	*14.265*	*13.613*	*10.065*

	Before balancing				***After balancing***			
				Frequency Index - EXS				
GDP difference (ln)	***-39,843***	***-11,831***	***13,408***	***40,120***	-0,639	0,193	1,071	0,964
Population of imp. country (ln)	***-14,077***	***4,130***	***8,731***	1,134	-1,266	0,911	1,247	-0,022
Population of imp. country (ln) ^ 2	***-15,794***	***4,450***	***9,430***	1,821	-1,363	0,964	1,273	-0,010
Agricultural TFP of exp. country (ln)	***4,881***	***4,249***	-0,842	***-8,485***	-0,120	0,405	0,150	0,025
Agricultural TFP of imp. country (ln)	0,762	***-3,764***	0,412	***2,666***	0,473	-0,358	0,351	-0,101
Simm.Balassa Index of exp.country (ln)	***16,014***	2,430	***-8,310***	***-10,048***	1,050	-0,445	-0,855	1,087
Simm.Balassa Index of imp.country (ln)	***14,911***	***6,368***	-0,203	***-21,840***	0,083	0,083	0,154	-0,862
Average tariff on agri product (imp.country, ln)	***6,010***	1,783	***-11,139***	***3,094***	0,258	0,224	-0,906	-0,038
Average tariff on agri product (exp.country, ln)	***-4,877***	-0,712	***5,881***	-0,077	-0,023	0,216	0,355	0,390
	7.267	*7.530*	*7.302*	*6.965*	*4.066*	*3.768*	*2.973*	*2.333*

	Before balancing				***After balancing***			
				Frequency Index - TRQ				
GDP difference (ln)	***-35,384***	***-16,119***	***11,518***	***41,987***	0,445	-0,127	0,395	1,276
Population of imp. country (ln)	***-13,694***	***-11,811***	***9,251***	***16,617***	0,319	-0,733	0,931	1,681
Population of imp. country (ln) ^ 2	***-13,462***	***-11,798***	***8,972***	***16,655***	0,395	-0,714	0,855	1,583
Agricultural TFP of exp. country (ln)	***4,679***	-0,320	-1,995	-2,390	0,201	-0,285	-0,017	0,261
Agricultural TFP of imp. country (ln)	***-12,714***	***-8,032***	***6,952***	***14,078***	-1,246	-0,610	1,466	1,284
Simm.Balassa Index of exp.country (ln)	***17,837***	1,407	***-4,032***	***-15,443***	0,335	-0,559	0,306	0,286
Simm.Balassa Index of imp.country (ln)	***-14,415***	-2,324	***15,071***	1,708	-2,467	-0,442	2,191	1,468
Average tariff on agri product (imp.country, ln)	***19,040***	***7,269***	***-9,422***	***-18,376***	1,449	0,022	-1,206	0,075
Average tariff on agri product (exp.country, ln)	***-5,826***	1,431	***4,004***	0,555	-0,205	0,344	0,425	0,667
	8.759	*8.589*	*8.907*	*8.038*	*4.885*	*4.587*	*4.154*	*2.888*

	Before balancing				***After balancing***			
				Frequency Index - QRS				
GDP difference (ln)	***4,527***	***-9,184***	***3,368***	0,999	0,264	-0,103	0,092	0,117
Population of imp. country (ln)	***14,624***	-0,955	1,240	***-16,885***	0,429	0,386	0,329	-0,295
Population of imp. country (ln) ^ 2	***13,661***	-1,232	1,257	***-15,512***	0,423	0,386	0,307	-0,273
Agricultural TFP of exp. country (ln)	***11,475***	***-8,204***	***-9,317***	***7,190***	0,637	-0,521	-0,607	0,238
Agricultural TFP of imp. country (ln)	***14,471***	***-13,091***	***-14,873***	***15,939***	0,943	-0,876	-0,938	0,391
Simm.Balassa Index of exp.country (ln)	***-6,482***	-1,357	***3,449***	***5,138***	-0,058	0,053	-0,024	0,128
Simm.Balassa Index of imp.country (ln)	-2,165	0,342	***4,079***	-2,306	-0,671	0,395	0,309	-0,238
Average tariff on agri product (imp.country, ln)	***5,604***	***2,618***	-1,878	***-7,180***	0,279	-0,032	-0,089	0,231
Average tariff on agri product (exp.country, ln)	***-7,194***	***-4,341***	***9,355***	2,173	0,017	0,041	0,188	0,054
	8.285	*7.722*	*9.968*	*5.972*	*3.184*	*2.031*	*2.256*	*1.587*

Note: own computation. Common support has been imposed for each first stage estimation, according to the treatment variable adopted. Bold values reject the null hypothesis at 1 %.

Table 5: Differences in the covariates by treatment levels before and after Balancing on the GPS (T-tests for equality of means) – Coverage Ratio Index

	Before balancing				*After balancing*			
				Coverage Ratio - All NTMs				
GDP difference (ln)	**32,271**	**-25,532**	**-36,140**	**29,594**	2,248	-2,135	-1,912	**3,016**
Population of imp. country (ln)	**61,093**	**3,746**	**-39,244**	**-25,095**	1,124	-1,035	-1,328	1,053
Population of imp. country (ln) ^ 2	**59,187**	**4,339**	**-38,361**	**-24,716**	1,127	-0,990	-1,316	1,000
Agricultural TFP of exp. country (ln)	**11,346**	**10,001**	**4,271**	**-25,637**	-0,317	0,454	0,416	-0,685
Agricultural TFP of imp. country (ln)	**10,910**	**2,632**	-2,000	**-11,365**	0,304	-0,057	0,163	-0,454
Simm.Balassa Index of exp.country (ln)	-1,111	**13,068**	**-3,430**	**-8,558**	-0,369	0,450	0,170	0,111
Simm.Balassa Index of imp.country (ln)	**21,346**	**8,127**	**-4,205**	**-25,663**	-0,714	0,290	0,562	-1,407
Average tariff on agri product (imp.country, ln)	-2,552	1,513	**-4,111**	**5,195**	-0,232	0,440	-0,555	0,245
Average tariff on agri product (exp.country, ln)	**-3,944**	**-7,019**	**12,363**	-1,564	0,472	-0,395	0,974	-0,464
	37.049	*37.049*	*37.049*	*37.049*	*14.182*	*15.957*	*17.017*	*11.793*

	Before balancing				*After balancing*			
				Coverage Ratio - TBT				
GDP difference (ln)	**22,469**	**-24,306**	**-30,305**	**32,331**	1,756	-1,876	-1,878	2,532
Population of imp. country (ln)	**34,835**	**-2,616**	**-23,699**	**-8,401**	0,707	-0,817	-0,942	0,773
Population of imp. country (ln) ^ 2	**33,564**	-2,207	**-22,956**	**-8,295**	0,711	-0,784	-0,935	0,730
Agricultural TFP of exp. country (ln)	**5,713**	**10,364**	**2,999**	**-19,089**	-0,374	0,552	0,133	-0,337
Agricultural TFP of imp. country (ln)	**10,666**	0,774	**-3,733**	**-7,557**	0,551	-0,233	-0,055	-0,124
Simm.Balassa Index of exp.country (ln)	**7,746**	**10,329**	**-6,807**	**-11,330**	0,176	0,036	-0,044	0,434
Simm.Balassa Index of imp.country (ln)	**21,198**	**8,006**	**-4,114**	**-25,454**	-0,102	0,019	0,308	-1,034
Average tariff on agri product (imp.country, ln)	**-4,712**	0,135	1,074	**3,466**	-0,318	0,282	-0,123	0,034
Average tariff on agri product (exp.country, ln)	-1,762	**-6,302**	**10,338**	-2,446	0,424	-0,280	0,965	-0,528
	29.583	*29.583*	*29.583*	*29.582*	*12.309*	*13.294*	*13.700*	*9.918*

	Before balancing				*After balancing*			
				Coverage Ratio - SPS				
GDP difference (ln)	**26,082**	**-17,027**	**-32,764**	**23,870**	1,898	-1,046	-1,892	1,911
Population of imp. country (ln)	**39,190**	-1,459	**-25,667**	**-11,900**	0,938	-0,691	-0,901	0,708
Population of imp. country (ln) ^ 2	**37,979**	-1,285	**-24,682**	**-11,863**	0,901	-0,655	-0,836	0,654
Agricultural TFP of exp. country (ln)	**16,171**	**10,311**	**2,942**	**-29,509**	-0,435	0,349	0,575	-0,777
Agricultural TFP of imp. country (ln)	**18,578**	1,347	**-5,500**	**-14,110**	0,141	-0,431	-0,234	0,204
Simm.Balassa Index of exp.country (ln)	**-4,733**	**11,313**	1,168	**-7,796**	-0,536	0,379	0,361	0,187
Simm.Balassa Index of imp.country (ln)	**17,612**	**4,910**	**-5,716**	**-17,257**	-0,127	-0,110	0,039	-0,721
Average tariff on agri product (imp.country, ln)	**-14,105**	-2,276	**5,312**	**10,944**	-0,928	0,022	0,454	-0,170
Average tariff on agri product (exp.country, ln)	-0,584	**-5,526**	**6,787**	-0,710	0,486	-0,324	0,642	-0,145
	31.546	*31.546*	*31.546*	*31.546*	*12.866*	*13.759*	*14.190*	*9.789*

	Before balancing				*After balancing*			
				Coverage Ratio - EXS				
GDP difference (ln)	**-20,244**	**-3,173**	**-3,378**	**27,274**	-0,162	0,762	-0,420	0,861
Population of imp. country (ln)	**-16,261**	**5,139**	**4,248**	**6,809**	-0,588	0,767	0,526	0,177
Population of imp. country (ln) ^ 2	**-17,332**	**5,389**	**4,780**	**7,085**	-0,639	0,789	0,568	0,169
Agricultural TFP of exp. country (ln)	**-6,872**	**4,533**	**8,892**	**-6,588**	-0,913	0,254	0,984	-0,052
Agricultural TFP of imp. country (ln)	**-10,779**	1,548	**3,871**	**5,356**	-0,890	0,645	0,219	-0,029
Simm.Balassa Index of exp.country (ln)	**8,700**	**5,216**	-0,236	**-13,545**	0,441	0,166	-0,462	0,742
Simm.Balassa Index of imp.country (ln)	**14,177**	**6,185**	-0,048	**-20,372**	0,421	-0,066	0,002	-0,327
Average tariff on agri product (imp.country, ln)	**14,083**	**-5,822**	**-10,791**	2,091	1,243	-0,749	-0,697	-0,075
Average tariff on agri product (exp.country, ln)	**5,855**	0,652	**-6,011**	-0,595	0,541	0,096	-0,574	0,209
	7.266	*7.266*	*7.266*	*7.266*	*3.717*	*3.372*	*3.416*	*2.648*

	Before balancing				*After balancing*			
				Coverage Ratio - TRQ				
GDP difference (ln)	**-14,126**	**-6,915**	-0,225	**21,540**	0,621	0,361	-0,568	1,113
Population of imp. country (ln)	**-10,262**	**3,968**	**3,305**	**2,976**	-0,501	0,321	0,693	0,517
Population of imp. country (ln) ^ 2	**-9,537**	**3,590**	**2,785**	**3,151**	-0,419	0,289	0,635	0,486
Agricultural TFP of exp. country (ln)	**-4,117**	1,471	**4,107**	-1,454	-0,426	0,113	0,325	0,089
Agricultural TFP of imp. country (ln)	**-17,689**	**-3,481**	**6,293**	**14,819**	-1,477	0,564	0,931	-0,013
Simm.Balassa Index of exp.country (ln)	-0,071	**6,249**	**6,665**	**-12,758**	-0,734	-0,016	0,844	0,214
Simm.Balassa Index of imp.country (ln)	**5,041**	**7,700**	**3,387**	**-16,069**	-1,258	-0,645	1,084	0,323
Average tariff on agri product (imp.country, ln)	**22,718**	**11,712**	0,099	**-36,836**	1,120	0,468	-0,780	-0,309
Average tariff on agri product (exp.country, ln)	**-9,641**	-0,496	**5,516**	**4,886**	-0,301	0,237	0,547	0,698
	8.574	*8.573*	*8.573*	*8.573*	*4.684*	*4.247*	*4.154*	*3.475*

	Before balancing				*After balancing*			
				Coverage Ratio - QRS				
GDP difference (ln)	**11,713**	**-2,864**	**-7,058**	-1,776	0,817	-0,404	-0,375	0,122
Population of imp. country (ln)	**14,637**	**6,188**	-1,980	**-18,899**	0,912	-0,153	-0,208	-0,108
Population of imp. country (ln) ^ 2	**14,720**	**5,701**	-2,369	**-18,093**	0,893	-0,172	-0,232	-0,086
Agricultural TFP of exp. country (ln)	**3,072**	-2,512	**-4,767**	**4,200**	0,353	-0,211	-0,289	-0,114
Agricultural TFP of imp. country (ln)	**3,552**	**-5,228**	**-8,778**	**10,428**	0,620	-0,254	-0,619	-0,042
Simm.Balassa Index of exp.country (ln)	**-19,707**	**-6,086**	**18,977**	**7,942**	-0,986	0,148	1,315	-0,170
Simm.Balassa Index of imp.country (ln)	**-4,327**	**3,918**	0,500	0,038	-0,403	0,275	0,001	0,009
Average tariff on agri product (imp.country, ln)	**7,323**	**4,238**	**-6,334**	**-5,263**	0,379	0,114	-0,531	0,181
Average tariff on agri product (exp.country, ln)	**-5,045**	**-7,895**	**7,223**	**6,027**	0,047	-0,201	0,318	-0,013
	7.987	*7.987*	*7.987*	*7.986*	*2.693*	*2.363*	*2.023*	*1.998*

Note: own computation. Common support has been imposed for each first stage estimation, according to the treatment variable adopted. Bold values reject the null hypothesis at 1 %.

We test a polynomial parameterization of the conditional expectation of the outcome as a function of the observed treatment and the estimated GPS. This analysis is conducted for all NTMs in aggregate, as well as for each specific NTM. Both the frequency index and coverage ratio index are used as treatment variables. While the GPS coefficients control for selection bias in the different treatment intensities, the interaction term shows the marginal impact of the treatment relative to the GPS. Thus, if there were selection bias between the intensity of NTMs and the *forward* GVC trade, both the GPS and the interaction coefficients would be statistically significant. The confidence intervals are obtained by assuming robust standard errors.

The results are summarized in *Tables 6* and *7*. The coefficients of the GPS and the interaction terms are almost always highly significant, confirming the hypothesis about the existence of self-selection into different NTMs intensities. The coefficients and their significance, on the other hand, show the existence of statistically relevant impact of the treatment variables on forward GVC participation.

Table 6 - Dose-response function for Frequency Indices as treatment variables

Dependent variable: Forward GVC trade at t+1	All NTMs	TBT	SPS	EXS	TRQ	QRS
FI	2.308***	2.968***	5.321***	-26.415***	-22.214***	-20.947***
	(0.419)	(0.519)	(0.431)	(0.631)	(0.582)	(0.748)
FI^2	-6.147***	-9.282***	-15.361***	48.916***	31.775***	35.900***
	(0.878)	(1.051)	(0.935)	(1.856)	(1.868)	(1.928)
FI^3	-2.470***	0.567	4.089***	-28.885***	-16.662***	-24.418***
	(0.533)	(0.637)	(0.584)	(1.309)	(1.367)	(1.318)
FI*GPS	9.127***	8.122***	8.569***	-2.141	5.063**	12.489***
	(0.420)	(0.563)	(0.531)	(1.335)	(2.210)	(1.002)
GPS	-15.556***	-26.159***	-45.301***	-2.886	-41.053***	21.537***
	(4.477)	(6.790)	(5.880)	(2.132)	(3.460)	(4.340)
GPS^2	39.650***	57.328***	117.228***	0.741	190.730***	-73.430***
	(9.812)	(15.739)	(14.772)	(12.898)	(24.219)	(14.210)
GPS^3	-38.664***	-53.725***	-107.649***	20.054	-318.300***	58.530***
	(6.938)	(11.892)	(12.034)	(22.394)	(50.026)	(14.558)
Constant	1.000	3.814***	4.991***	3.128***	4.889***	1.072***
	(0.659)	(0.952)	(0.758)	(0.100)	(0.144)	(0.411)
R^2	0.16	0.16	0.16	0.38	0.38	0.22
N	58,584	48,953	50,372	13,029	16,440	9,018

*Robust standard errors in parenthesis. Level of significance: * p<0.1; ** p<0.05; *** p<0.01.*

Table 7 - Dose-response function for Coverage Ratio Indices as treatment variables

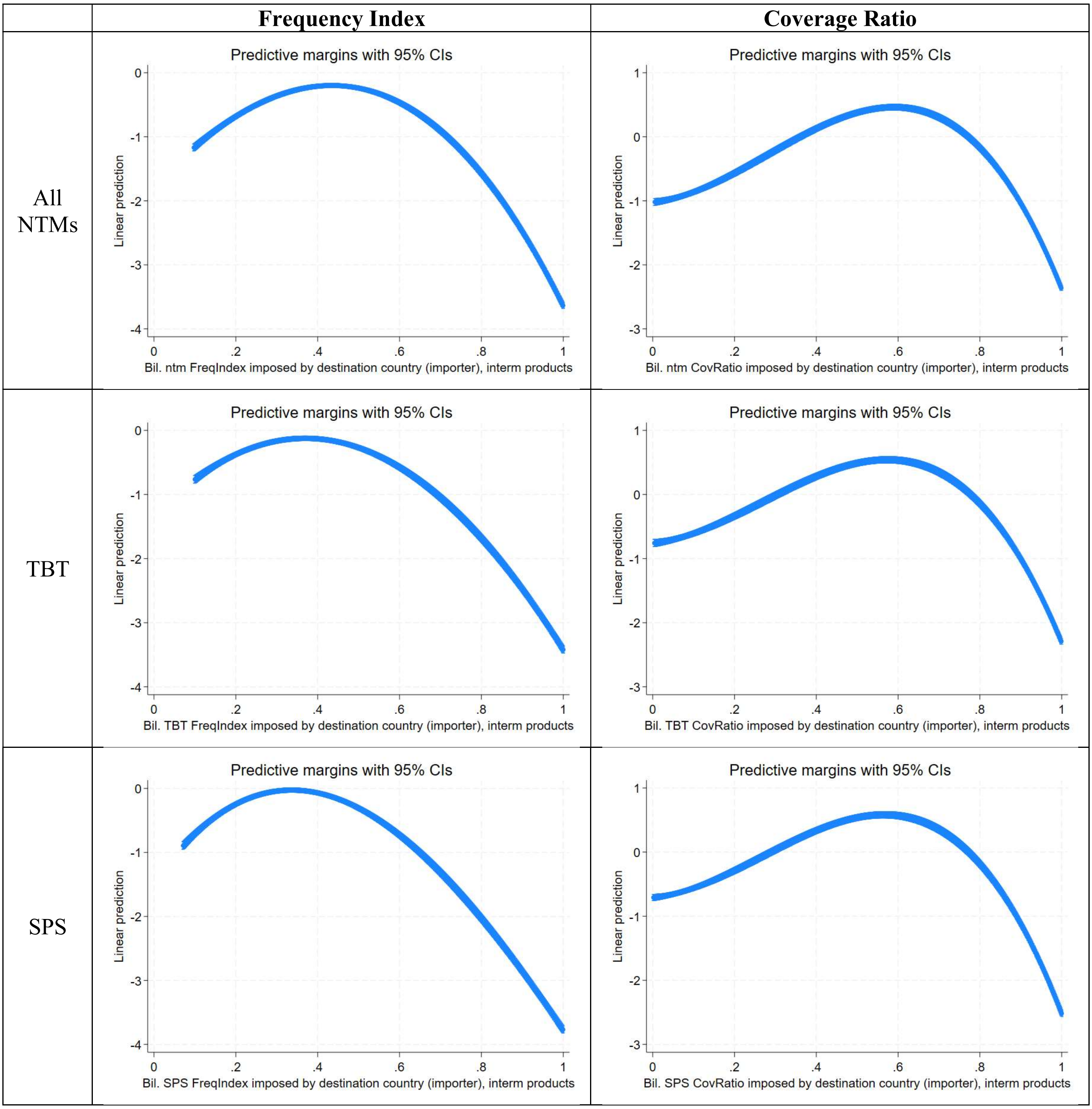
Dependent variable: Forward GVC trade at t+1	All NTMs	TBT	SPS	EXS	TRQ	QRS
CR	-1.567***	-1.275***	-1.262***	-1.098*	-4.622***	-8.082***
	(0.339)	(0.390)	(0.340)	(0.575)	(0.512)	(0.818)
CR^2	10.601***	9.472***	9.998***	1.352	12.052***	15.417***
	(0.762)	(0.841)	(0.802)	(1.644)	(1.480)	(2.265)
CR^3	-12.600***	-11.706***	-12.403***	-4.552***	-12.294***	-12.463***
	(0.491)	(0.544)	(0.530)	(1.160)	(1.048)	(1.566)
CR*GPS	3.954***	3.703***	4.007***	2.264***	4.380***	7.206***
	(0.281)	(0.372)	(0.325)	(0.723)	(0.537)	(0.669)
GPS	-13.473***	-9.357	-8.024*	5.846**	-2.470**	16.719***
	(4.105)	(7.870)	(4.520)	(2.365)	(1.186)	(2.402)
GPS^2	38.210***	29.556*	17.040	-39.711***	-12.402***	-53.175***
	(8.278)	(15.969)	(10.731)	(10.037)	(4.540)	(8.191)
GPS^3	-31.141***	-27.866***	-13.656*	50.020***	18.775***	39.445***
	(5.382)	(10.563)	(8.228)	(12.611)	(4.860)	(8.415)
Constant	0.138	0.149	0.723	1.402***	1.939***	-0.078
	(0.654)	(1.260)	(0.612)	(0.162)	(0.083)	(0.209)
R^2	0.11	0.11	0.11	0.18	0.16	0.13
N	58,652	48,971	50,361	13,049	16,486	9,037

*Robust standard errors in parenthesis. Level of significance: * p<0.1; ** p<0.05; *** p<0.01.*

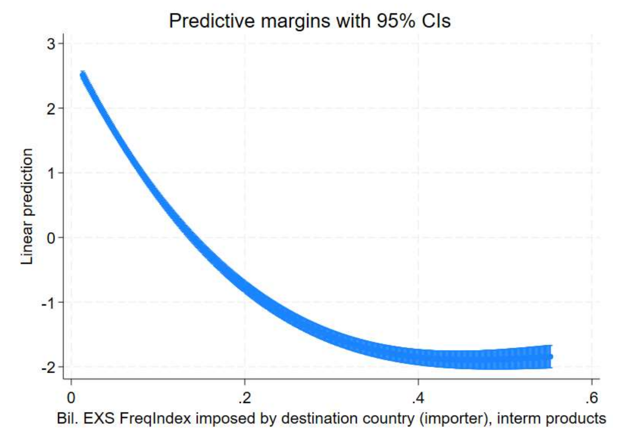
Figure 1 illustrates the dose-response functions depicting the causal relationship between different types of NTMs imposed by importing countries and the *forward* GVC trade of exporting countries. This analysis is conducted considering both the frequency index and the coverage ratio index as treatment variables.

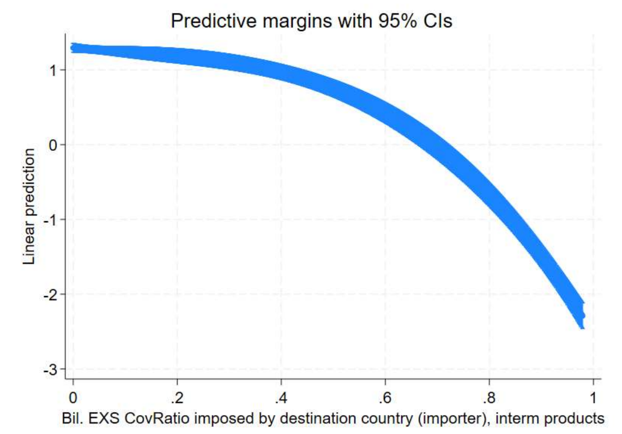
By examining the DRF associated with the frequency index, we observe a negative relationship between the intensity of all the NTMs imposed by the importing country and the export flows of the exporter's GVC-type agricultural products as the coefficient associated to the impact of treatment is always lower than zero regardless of the intensity. This is mainly driven by the impact of TBT and SPS on trade, as evident from the similar concave evolution in the DRF relative to these two non-tariff measures. Although the average effect is consistently negative, the negative effect is pronounced at low and – particularly – at high levels of index intensity, with the peak in the function – that identifies the value for which the impact is closer to zero – varying between 35% and 45% according to the measure considered. Frequency indices higher than 65% are associated to a zeroing in trade flows. The impact of EXS, TRQ and QRS on exporter forward participation as captured by the frequency indices is positive for low levels of protection, then turning negative for higher levels. The threshold for the change in the impact is different between measures and can be approximatively identified in 15% for EXS and TRQ and in 20% for QRS. The evolution of the impact of the treatment is monotonically decreasing. Also for the coverage ratios of all NTMs, SPS and TBT the treatment has a concave-shaped evolution, with the peak evidenced in correspondence of a value of 60%. Peculiarly, for intermediate values of coverage ratios the impact of NTMs on trade is even positive (from approximately 40% to 80%). With respect to the impact of coverage ratios built on EXS, TRQ and QRS measures, the impact is initially positive, then becoming negative, without exhibiting any change in the dynamic of the impact with the change in treatment intensity.

Figure 1: Impacts of Importer-Imposed NTMs on the Forward GVC of the Exporter (ln)

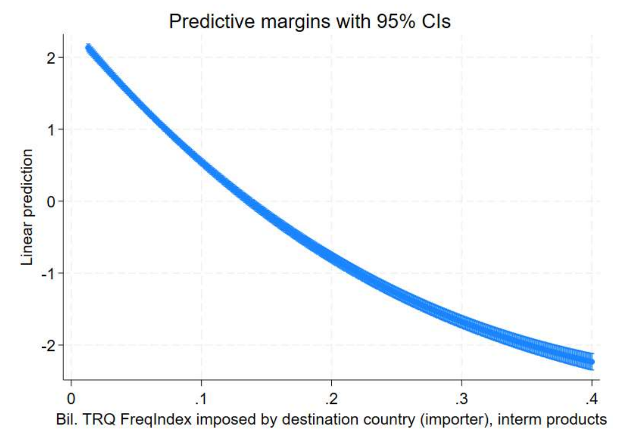


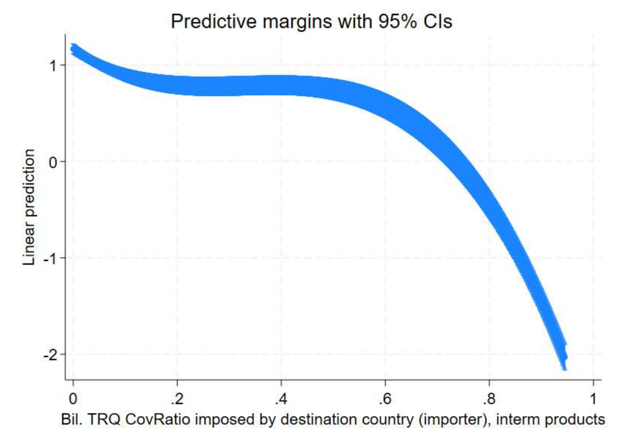
EXS


Predictive margins with 95% CIs
Linear prediction
3
2
1
0
-1
-2
0
.2
.4
.6
Bil. EXS FreqIndex imposed by destination country (importer), interm products

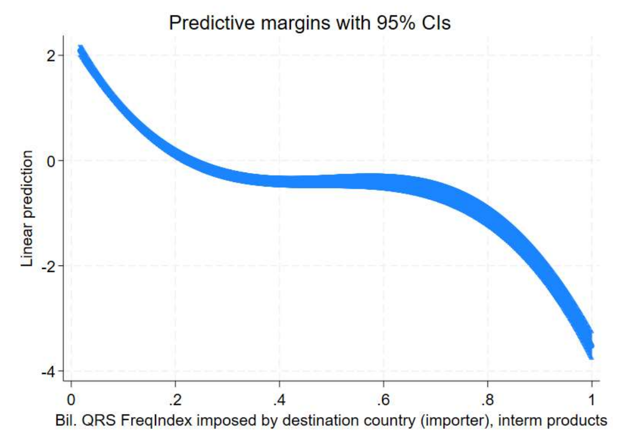

Predictive margins with 95% CIs
Linear prediction
1
0
-1
-2
-3
0
.2
.4
.6
.8
1
Bil. EXS CovRatio imposed by destination country (importer), interm products

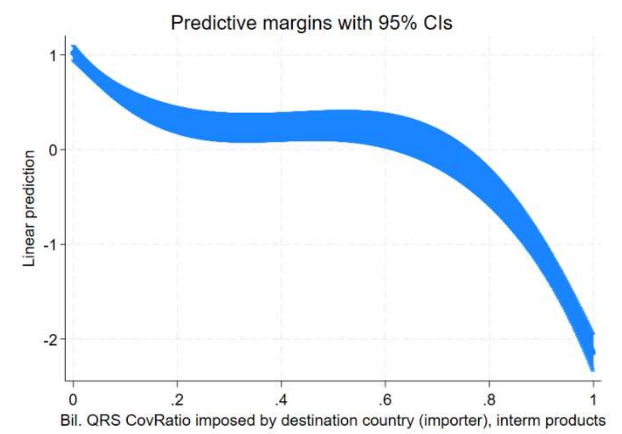
TRQ


Predictive margins with 95% CIs
Linear prediction
2
1
0
-1
-2
0
.1
.2
.3
.4
Bil. TRQ FreqIndex imposed by destination country (importer), interm products


Predictive margins with 95% CIs
Linear prediction
1
0
-1
-2
0
.2
.4
.6
.8
1
Bil. TRQ CovRatio imposed by destination country (importer), interm products

QRS


Predictive margins with 95% CIs
Linear prediction
2
0
-2
-4
0
.2
.4
.6
.8
1
Bil. QRS FreqIndex imposed by destination country (importer), interm products


Predictive margins with 95% CIs
Linear prediction
1
0
-1
-2
0
.2
.4
.6
.8
1
Bil. QRS CovRatio imposed by destination country (importer), interm products

6. Conclusions and policy implications

NTMs have become a pivotal factor in international trade, especially in terms of market access, playing a crucial role in both bilateral and multilateral trade negotiations. The increasing significance of NTMs necessitates a more comprehensive understanding of their effects. However, the NTM landscape is characterized by vast diversity and complexity. The economic literature has extensively explored the impact of NTMs on trade between countries, aiming to estimate the magnitude and direction of these effects. Despite numerous empirical studies published in the last decade, a unanimous conclusion on the effects of NTMs remains elusive. This ambiguity is particularly evident in the realm of exchanges within GVCs. NTMs can pose substantial barriers, especially within the context of GVCs.

The goal of this study is to contribute to the comprehension of the effects of various NTMs on GVC-trade flows, with a specific focus on intermediate exports of agricultural products. We employed the GPS, a non-parametric method for causal inference in quasi-experimental settings with continuous treatment, to shed light on this complex and multifaceted phenomenon. Given that the selection of NTMs is not arbitrary and is influenced by national attitudes to intervene in the domestic market, the use of GPS allows for addressing potential sources of selection bias that may impact empirical estimates. Our results show that NTMs matter and that their impact on GVC-trade varies in a non-linear way with the level of intensity. Specifically, a heterogeneous relationship is identified between the intensity of NTMs imposed by importing countries and the exporter's agriculture GVC-trade. Frequency indices capture a negative relationship between the aggregated measure of NTMs and with SPS and TBT in particular. Such measure built on Export Subsidies (EXS), Tariff-rate quotas (TRQ), and Quantitative Restrictions (QRS) show a monotonic dynamic in the treatment intensity, showing an impact that from positive turns negative for values higher than 15-20%. When considering NTMs weighted for importing flows, the intensity of NTMs restrictiveness changes only slightly, with threshold values relative to the change in the impact varying according to the type of measure considered.

The implications of this study are significant: firstly, the omission of self-selection issues in analysing the effects of NTMs on GVC-trade can result in biased estimates; secondly, addressing the heterogeneity of NTMs is imperative. Thirdly, and crucially in GVC analysis, there are indirect effects on the domestic economy of the imposing country as it relies on these inputs for its exports. This highlights the importance of the "chain effect" of trade policy, indicating that a restriction imposed by one country not only hampers partner countries' exports but also affects the imposing country itself through value chain linkages.

References

Alfaro, L., P. Conconi, H. Fadinger, and A.F. Newman (2016). 'Do Prices Determine Vertical Integration?', *The Review of Economic Studies*, 83(3), pp.855–88.

Anderson, K., G. Rausser, and J. Swinnen (2013). Political Economy of Public Policies: Insights from Distortions to Agricultural and Food Markets. *Journal of Economic Literature* 51 (2): 423–77.

Antràs, P., Staiger, R.W., 2012. Offshoring and the Role of Trade Agreements. Am. Econ. Rev. 102 (7), 3140–3183.

Baier, S. L., and Bergstrand J. H., (2009). Estimating the Effects of Free Trade Agreements on International Trade Flows Using Matching Econometrics. *Journal of International Economics* 77:63–76.

Baier, S. L., and Bergstrand, J. H., (2007). Do Free Trade Agreement Actually Increase Members' International Trade?, Journal *of International Economics* 71: 72–95.

Bao, X. and L.D. Qiu (2012). 'Bonus vetus OLS: A Simple Method for Approximating International Trade Cost Effects Using the Gravity Equation', *Journal of International Economics*, 77(1), pp.77–85.

Beckman, J. and Arita, S. (2016) 'Modeling the Interplay between Sanitary and Phytosanitary Measures and Tariff-rate Quotas under Partial Trade Liberalization', *American Journal of Agricultural Economics,* Vol. 99(4), (2016) pp. 1078–1095.

Beghin, J., A.C. Disdier, and S. Marette (2015). 'Trade Restrictiveness Indices in the Presence of Externalities: An Application to Non-Tariff Measures', *The Canadian Journal of Economics*, 48(4), pp.1513–36.

Beghin, J., A.C. Disdier, S. Marette, and F. van Tongeren (2012). 'Welfare Costs and Benefits of Nontariff Measures in Trade: A Conceptual Framework and Application', *World Trade Review*, 11(3), 356–75.

Bia, M., and A. Mattei. 2008. A Stata Package for the Estimation of the Dose-Response Function through Adjustment for the Generalized Propensity Score. Stata Journal 8 (3): 354–73.

Blanchard, E. J., Bown, C. P., & Johnson, R. C. (2016). Global supply chains and trade policy (No. w21883). National Bureau of Economic Research.

Blanchard, E., 2010. Reevaluating the Role of Trade Agreements: Does Investment Globalization Make the WTO Obsolete? J. Int. Econ. 82 (1), 63–72.

Blind, K., A. Mangelsdorf, and J.S. Wilson (2013). 'Mutual Recognition of Accreditation: Does It Matter to Trade? Evidence from the Food, Beverage, and Tobacco Industry', *Frontiers of Economics and Globalization*, 2, pp.291–310.

Bora, B., Kuwahara, A., and Laird, S., (2002). "Quantification of Non-tariff Measures". UNCTAD, Policy Issues in International Trade and Commodities Study Series No. 18, New York.

Borin, A., and Mancini, M., (2019). "Measuring What Matters in Global Value Chains and Value-Added Trade". World Bank Policy Research Working Paper 8804.

Bown, C.P., Erbahar, A., Zanardi, M., 2021. Global Value Chains and the Removal of Trade Protection. Eur. Econ. Rev. 140, 103937.

Brandt, L. and P.M. Morrow (2017). 'Tariffs and the Organization of Trade in China', *Journal of International Economics*, 104(C), pp.85–103.

Bratt, M. (2014). 'Estimating the Bilateral Impact of Non-Tariff Measures (NTMs)', *Working Paper WPS*, No. 14-01-1, Geneva: University of Geneva.

Cadestin, C., Gourdon, J., and Kowalski, P. (2016). *Participation in global value chains in Latin America*. OECD Trade Policy Papers: Retrieved from OECD website: http://www.oecd-ilibr ary.org/conte nt/worki ngpap er/5jlpq 80ts8 f2-en

Cadot, O., and Gourdon, J. (2016). Non-tariff measures, preferential trade agreements, and prices: new evidence. Review of World Economics, 152(2), 227-249.

Cadot, O., Gourdon, J., and Van Tongeren, F. (2018). Estimating Ad Valorem Equivalents of Non-Tariff Measures: Combining Price-Based and Quantity-Based Approaches. OECD Trade Policy Papers, No. 215, OECD Publishing, Paris. http://dx.doi.org/10.1787/f3cd5bdc-en

Cardamone, P. 'The effect of preferential trade agreements on monthly fruit exports to the European Union', *European Review of Agricultural Economics*, Vol. 38(4), (2011) pp. 553-586.

Crivelli, P. and J. Gröschl (2016). 'The Impact of Sanitary and Phytosanitary Measures on Market Entry and Trade Flows', *The World Economy*, 39(3), pp.444–73.

Darhyati, A.T., S. Suharno, and A. Rifin (2017). 'Impact of Non-Tariff Measure on Indonesian Cacao Exports', *International Journal of Agriculture System*, 5(2): 175–84.

Dal Bianco, A., Boatto, V.L., Caracciolo, F. and Santeramo, F.G. 'Tariffs and non-tariff frictions in the world wine trade', European Review of Agricultural Economics, Vol. 43(1), (2016) pp. 31- 57.

De Melo, J., and Nicita, A. (Eds.) (2018). *Non-tariff measures: economic assessment and policy options for development*. United Nations Conference on Trade and Development.

Disdier A-C, Fontagné L and Cadot O (2015). North-South Standards Harmonization and International Trade. *The World Bank Economic Review* 29(2): 327–52.

Ederington, J., and Ruta, M. (2016). Nontariff measures and the world trading system. In K. Bagwell, and R. Staiger (Eds.). Handbook of commercial policy (pp. 211–277). North-Holland.

Egger, H., Egger, P. .and Greenaway, D., (2008). "The Trade Structure Effects of Endogenous Regional Trade Agreements." *Journal of International Economics* 74: 278–298.

El-Enbaby, H., R. Hendy, and C. Zaki (2016). 'Do SPS Measures Matter for Margins of Trade? Evidence from Firm-Level Data', *Applied Economics*, 48(21), pp,1949–64.

Ferraz, L., Ribeiro, M., and Reitel, M. (2018). Comparative Advantages and the Uneven Effects of Non-Tariff Measures. In De Melo, J., and Nicita, A. (Eds.) (2018). *Non-tariff measures: economic assessment and policy options for development*. United Nations Conference on Trade and Development.

Fontagné, L., and Orefice, G. (2018). Let's try next door: Technical Barriers to Trade and multi-destination firms. *European Economic Review*, *101*, 643-663.

Franssen, L. and O. Solleder (2016). 'How do NTMs Affect Countries' Participation in International Value Chains?', *International Trade Centre Working Paper Series*, No. WP-05-2016E, Geneva: International Trade Centre.

Fryges, H., (2009). The export–growth relationship: estimating a dose-response function. *Appl. Econ. Lett.* 16, 1855–1859.

Fryges, H., Wagner, J., (2008). Exports and productivity growth: first evidence from a continuous treatment approach. *Rev. World Econ*. 144, 695–722.

Ghodsi, M., and Stehrer, R. (2022). Trade policy and global value chains: tariffs versus non-tariff measures. *Review of World Economics*, 1-30.

Gourdon, J., (2014). "CEPII NTM-MAP: A Tool for Assessing the Economic Impact of Non-Tariff Measures," Working Papers 2014-24, CEPII research center.

Grundke, R., and Moser, C. (2019). Hidden protectionism? Evidence from non-tariff barriers to trade in the United States. *Journal of International Economics*, *117*, 143-157.

Hirano, K., and Imbens, G. W., (2004). The propensity score with continuous treatments. In Applied Bayesian Modeling and Causal Inference from Incomplete-data Perspectives: An Essential Journey with Donald Rubin's Statistical Family, edited by Andrew Gelman and Xiao-Li Meng, 73–84. Chichester: John Wiley and Sons.

Hoekman B and Nicita A (2011). Trade Policy, Trade Costs, and Developing Country Trade. *World Development* 39(12): 2069–079.

Hoekman, B., and Nicita, A. (2018). Non-tariff measures and trade facilitation: WTO disciplines and policy space for development. In De Melo, J., and Nicita, A. (Eds.) (2018). *Non-tariff measures: economic assessment and policy options for development*. United Nations Conference on Trade and Development.

Hummels, D., Ishii, J., Yi, K.-M., 2001. The Nature and Growth of Vertical Specialization in World Trade. Journal of International Economics, 54 (1), 75–96.

Imai, K., and Kim I. S., (2011). *Understanding and Improving Linear Fixed Effects Regression Models for Causal Inference*. Technical Report. Princeton, NJ: Department of Politics, Princeton University.

Imai, K., and van Dyk, D. A., (2004). Casual Inference with General Treatment Regimes: Generalizing the Propensity Score, Journal *of the American Statistical Association*, 99: 854–866.

Jafari, Y., and Britz, W. (2018). Modelling heterogeneous firms and non-tariff measures in free trade agreements using Computable General Equilibrium. *Economic Modelling*, 73, 279-294.

Jordan, A.C. (2017). 'Impact of Non-Tariff Measures on Trade in Mauritius', *Foreign Trade Review*, 52(3), pp.185–99.

Korwatanasakul, U., and Baek, Y. (2021). The effect of non-tariff measures on global value chain participation. *Global Economic Review*, *50*(3), 193-212.

Kluve, J., H. Schneider, A. Uhlendorff, and Z. Zhao (2012). Evaluating Continuous Training Programmes by Using the Generalized Propensity Score. *Journal of the Royal Statistical Society: Series A* (Statistics in Society) 175 (2): 87–617.

Liu, C., Lin, D., Liu, J., and Li, Y. (2019). Quantifying the effects of non-tariff measures on African agri-food exporters. Agrekon, 58(4), 451-471.

Liu, Q., L.D. Qiu, and C. Zhan (2019). 'Trade Liberalization and Domestic Vertical Integration: Evidence from China', *Journal of International Economics*, 121(C).

Ludema, R. D., Mayda, A. M., Yu, Z., & Yu, M. (2021). The political economy of protection in GVCs: Evidence from Chinese micro data. Journal of International Economics, 131, 103479.

Magrini, E., Montalbano, P., and Nenci, S., (2017a). Are EU trade preferences really effective? An impact evaluation assessment of the Southern Mediterranean Countries' case. *International Review of Applied Economics,* 31(1), 126-144.

Magrini, E., Montalbano, P., Nenci, S., and Salvatici, L., (2017b). Agricultural (dis) incentives and Food Security: Is there a Link?. *American Journal of Agricultural Economics*, 99(4), 847-871.

Montalbano, P., Nenci, S., 2014. Assessing the trade impact of the European neighbourhood policy on the EU-MED free trade area. *Appl. Econ*. 46 (7), 730–740

Nenci S. and D. Vurchio (2023), Modeling country-sectoral spillovers in generalized propensity score matching: An empirical test on trade data, *Economic Modelling*, Volume 124, 106293, ISSN 0264-9993 (2023).

Ornelas, E. and J.L. Turner (2008). 'Trade Liberalization, Outsourcing, and the Hold-Up Problem', *Journal of International Economics*, 74(1), pp.225–41.

Ornelas, E. and J.L. Turner (2012). 'Protection and International Sourcing', *Economic Journal*, 122(559), pp.26–63.

Papke, L.E., Wooldridge, J.M., 1996. Econometric methods for fractional response variables with an application to 401(k) plan participation rates. J. Appl. Econom. 11, 619–632.

Peterson, E., Grant, J.H., Roberts, D. and Karov, V. 'Evaluating the trade restrictiveness of phytosanitary measures on US fresh fruit and vegetable imports', *American Journal of Agricultural Economics,* Vol. 95(4), (2013) pp. 842-858.

Raimondi, V., Piriu, A., Swinnen, J., & Olper, A. (2023). Impact of global value chains on tariffs and non-tariff measures in agriculture and food. Food Policy, 102469.

Rindayati, W. and O.W. Kristriana (2018). 'Impact Analysis of Non-tariff Measures on Indonesian Tuna Exports to Major Destination Countries', *Jurnal Manajemen dan Agribisnis*, 15(2), pp.172–85.

Santeramo, F. G., and Lamonaca, E. (2019). The effects of non-tariff measures on agri-food trade: A review and meta-analysis of empirical evidence. *Journal of Agricultural Economics*, *70*(3), 595-617.

Swinnen, J.F. 2010. The Political Economy of Agricultural and Food Policies: Recent Contributions, New Insights, and Areas for Further Research. *Applied Economic Perspectives and Policy* 32 (1): 33–58.

Webb, M., Strutt, A., Gibson, J., and Walmsley, T. (2020). Modelling the impact of non-tariff measures on supply chains in ASEAN. *The World Economy*, *43*(8), 2172-2198.

Xiong, B. and J.C. Beghin (2011). 'Disentangling the Demand-Enhancing Effect and Trade-Cost Effect of Technical Measures in Agricultural Trade among OECD Countries', *Iowa State University Working Paper*, No. 11019. Ames, IA: Iowa State University.