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Are Non-Tariff Measures and Tariffs Substitutes? Some Panel Data Evidence

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Abstract

The question of the substitutability or complementarity between non-tariff measures (NTMs) and tariffs is unresolved in the extant literature. Using newly available detailed estimates of ad-valorem equivalent (AVE) of NTMs over time, this paper examines this relationship for a sample of 80 economies for 4949 products at the 6-digit HS level over the period 2003-2015. This data allows a panel data methodology to be employed, with the relationship between NTMs and tariffs being investigated in both levels and changes. The data also allows for the modelling of the lagged adjustment of NTMs to tariffs, which is consistent with a causal relationship and sensibly represents the nature of administrative decision-making process involved in implementing NTM changes. It also allows other specific, fixed effects affecting the relationship to be captured. Trade policy substitution is found overall when the models are estimated in both levels and changes, with this holding for both OECD and non-OECD countries. There is, as is to be expected, some heterogeneity across products/sectors, with stronger substitution in the case of products with above average tariff cuts as a result of the Uruguay Round. The measured elasticity of NTM increase with respect to tariff decline is relatively small, but given much higher levels of NTM than tariff protection in general the results indicate fairly complete substitution between policy instruments in absolute terms.

Key words: Non-tariff measures, tariffs, substitutes, complements, trade policy

JEL: F13, F14

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1. Introduction

The decline in tariffs over the past two decades due to tariff liberalization associated with multilateral, bilateral and regional trade agreements, prompts the question as to what has happened to other trade policy instruments given or as a result of these tariff cuts (Baldwin, 2016 ; Bown, 2014; Hoekman and Nicita, 2011). The incidence and level of non-tariff measures (NTMs) are widely documented as having grown over the same period (Ghodsi *et al.*, 2017; Nicita and Gourdon, 2013; Niu et al., 2018; WTO, 2012). It is natural to consider whether NTMs have risen in general and for reasons unrelated to tariff reforms, or whether NTMs have increased because of tariff cuts and with greater increases in the use of NTMs being on tariff lines where tariff rates have been cut most. Of course an overall picture of falling tariffs and increased use of NTMs may hide mix relations at the product or country level, with complementarity (declining tariffs and NTMs) in some cases and a preponderance of areas where instrument substitution prevails.

There is not a clear consensus on this issue to be found in the existing empirical literature. Although a significant number of studies find trade policy substitution between tariffs and NTMs, this finding is sometimes weak and found mostly for developing countries. Further a number of studies identify a heterogeneous relationship determined by country or product characteristics (Beverelli *et al.*, 2014; Bown and Tovar, 2011; Broda *et al.*, 2008; Feinberg and Reynolds, 2007; Herghelegiu, 2018; Kee *et al.*, 2009; Ketterer, 2016; Limão and Tovar, 2011; Moore and Zanardi, 2011; Orefice, 2017; Ronen, 2017; WTO, 2012). Indeed a few studies conclude that a significant complementary relationship between the two trade policy instruments (Dean *et al.*, 2009; Goldberg and Pavcnik, 2005; Lee and Swagel, 1997; Trefler, 1993).

This paper contributes to this literature by examining the NTM-tariff relationship at a disaggregated 6-digit harmonized system (HS) level over the period 2003-2015 for a sample of 80 economies for 4949 products, using newly available data on non-tariff measures and detailed estimates of ad-valorem equivalent (AVE) of NTMs over time. Given the availability of estimates over time across economies and products, we adopt

a panel data methodology to investigate the NTM-tariff relationship in levels and changes. Our empirical approach allows us to draw inference about the causal link between current NTMs and lagged tariffs at the detailed product level. Further, the panel nature of the data allows us to control for product-country and time specific fixed effects, and increase precision in the capturing of the NTM-tariff relationship at the product level.

The present paper makes a number of contributions relative to the existing literature. Our approach uses ad-valorem equivalents (AVEs) of core NTMs and common metric therefore across alternative trade policy instruments, both non-tariff and tariff in nature. This is achieved by using estimates of AVEs of NTMs, computed using the methodology of Kee et al. (2009), at discrete points in time as a first step (i.e., 3-year intervals over the period 2003-2015) (Niu et al.,2018). We obtain the tariff equivalent of NTMs affecting each product in each importing economies at each point in time, and can thus directly compare the relative effects on imports of changing NTMs to instead changing tariffs (Ronen, 2017). This NTM measure has the merit of being estimated econometrically and of dealing explicitly with potential endogeneity of NTMs with respect to imports (and the current or contemporaneous tariff), delivering a 'clean' non-tariff measure at the product level. It is this AVEs of NTMs that is then used to model the NTM-lagged tariff relationship.

In contrast, most extant empirical studies employ proxy measures of NTMs that are not directly comparable to tariff rates. In effect, much of this literature focuses on the 'incidence' of NTMs to establish the NTM-tariff link, where they estimate how tariffs affect the probability of NTMs being deployed (see Beverelli *et al.*, 2014; Feinberg and Reynolds, 2007; Herghelegiu, 2018; Ketterer, 2016; Limão and Tovar, 2011; Moore and Zanardi, 2011; Orefice, 2017), or the extent of NTMs through frequency and coverage ratios (see Broda *et al.*, 2008; Lee and Swagel, 1997; WTO, 2012). The studies by Kee *et al.* (2009), Limão and Tovar (2011) and Ronen (2017) are rare examples that work directly with tariff equivalents of NTMs. However, as outlined below, an important limitation facing these studies is the absence of information on

NTMs over time and the associated constraint of having model the NTM-tariff relationship in cross section only. .

In the present study we are able to empirically model the usage of trade policy instruments over time. The NTM-tariff relationship is investigated in both 'levels' and 'changes'. The latter allow us to model how countries have adjusted NTM usage in response to changes in tariffs. Moreover, the data structure allows for the explicit modelling of the NTM-lagged tariff relationship. This has the technical advantage of reducing concerns over simultaneity (and endogeneity) issues associated with current or contemporaneous NTMs and tariffs. It also gives greater credibility to any causal interpretation of the impact of lagged tariffs on the AVE of NTMs, in particular in the context of political economy processes and administrative implementation of adjustments in NTMs that can be expected to take time. This is in contrast to existing studies that have confined their estimation to one point in time (see Kee *et al.*, 2009; Lee and Swagel, 1997; Limão and Tovar, 2011; Ronen, 2017), or eschewed the kind of dynamic aspects of policy adjustment that a panel framework allows.[1]

A final contribution and merit of our study is that it is 'comprehensive' in nature. It is comprehensive in that our tariff equivalent NTMs incorporates the effects of all core NTMs, namely, price controls, quantity controls, monopolistic measures, and technical measures. It is comprehensive also in terms its disaggregated product (6-digit HS level) coverage. A disaggregated study of the NTM-tariff relationship has been argued to be preferable over broader industry analysis, as the latter is likely to mask the effect at individual product lines and thus provide an inaccurate estimated coefficient on the relationship (see Feinberg and Reynolds, 2007; Ketterer, 2016). Some previous studies have been narrowly focused on a single specific NTM instrument, such as antidumping, and/or conducted at an industry or sectoral level of disaggregation (see

[1] Several studies use tariff 'changes' as their main explanatory variable (see Herghelegiu, 2018; Moore and Zanardi, 2011; Orefice, 2017), with some solely focused on tariff 'reduction' (see Beverelli *et al.*, 2014; Feinberg and Reynolds, 2007; Ketterer, 2016), while others use tariff 'levels' (see Kee *et al.*, 2009; Ronen, 2017; WTO, 2012).

Beverelli *et al.*, 2014; Feinberg and Reynolds, 2007; Lee and Swagel, 1997; Limão and Tovar, 2011; Moore and Zanardi, 2011; Orefice, 2017).

The paper is structured as follows. Section 2 reviews the relevant theoretical and empirical literature. Section 3 sets out the empirical specification, data and empirical strategy. The empirical findings are presented in Section 4, while Section 5 concludes.

2. Literature

Several studies have explored the relationship between tariffs and NTMs. In general, there is no consensus, with some theoretical work and empirical work concluding that tariff and NTMs are substitutes, while other studies find them to be complements.

Starting with the theoretical stream of the literature, according to the influential 'Law of Constant Protection', in order to reach their policy goals, governments operate target levels of overall protection towards import products (Bhagwati, 1988). Even with reduction in tariffs through successive multilateral and regional trade agreements, governments can turn to greater use of NTMs to keep overall protection at the targeted level. The prediction of the law is that tariffs and NTMs are substitutes.

Several attempts at theoretically grounding the NTM-tariff link have been made. Yu (2000) provides a political economy explanation of tariff reduction and the NTM-tariff trade-off. Trade policy substitution is found to be absent with foreign competition, unless vested interests from import-competing firms contribute to government welfare so as to outweigh informed consumers' preference for less trade protection. Anderson and Schmitt (2003) set up a model to analyze how trade liberalization affects trade policy. They find that when both tariffs and quotas are constrained due to trade agreements commitments, then antidumping policies (as non-tariff barrier), are likely to be employed; with quotas being the predominant NTB, if only tariffs are constrained. Addressing the question of policy choice between tariffs and NTBs, Limão and Tovar (2011) show that tariff reduction commitments increase the likely adoption of NTBs and their restrictiveness. Governments are willing to make such commitments even if it means shifting to less efficient NTBs, as it can raise their political bargaining value vis-à-vis special interest groups.

There are also a few studies suggesting a complementary relationship between tariffs and NTMs. Vousden (1990) suggests that, depending on the level of pre-existing tariff protection, the joint impact of a quota and a tariff on domestic prices could lead to complementarity. Another explanation for complementarity can be found in the 'special interest politics' model of Grossman and Helpman (1994) where the implementation of trade policies are influenced by the lobby behaviour of interest groups, where increased lobbying for certain important sectors drives up *both* tariff and the NTM protection.

The study of Essaji (2010) provides a rare example of a theoretical piece that illustrates the possibility of both complementarity and substitutability being at work. Setting up a model where the government's objective function depends on consumer surplus, domestic firm's profits, consumption externality and the tariff revenue, he studies how a tariff reduction could affect technical regulations imposed on foreign firms. He finds that if the government cares about the negative externality from consuming poor quality products, a tariff reduction could lead to higher technical regulations, as the NTM's marginal impact on the consumption externality is important. With the concern about the negative externality, then increased technical regulations will substitute for a tariff reduction. However, if the foreign firm has a significant domestic presence then a tariff reduction implies consumers face lower prices and improved consumer surplus. Though the technical regulation favours the domestic firm and shifts profits to it, because consumer surplus is so important, the government could raise welfare not by raising the NTM but *easing* it with tariff cuts. Therefore, we have the technical regulation and tariffs as complements.

Notwithstanding the above theoretical works, the question of the NTM-tariff relationship remains an empirical one. Using an endogenous trade protection lens Trefler (1993) investigates how trade policy instruments affect US import policy. He finds tariffs and NTMs affect imports in the same direction, suggestive that tariffs and NTBs are complement to each other. Lee and Swagel (1997) extend the endogenous protection explanation by using industry-level data on production, trade flows and trade

barriers for 41 countries. By regressing NTBs on tariffs, they find a significant positive complementary link between tariffs and NTBs.

Goldberg and Pavcnik (2005) in their study of trade liberalization in Colombia find a positive NTM-tariff link, whereby NTMs were not replacements for tariffs. Dean *et al.* (2009) use city-level retail data to estimate the price effect of NTMs directly on 47 consumer products for more than 60 countries in the year 2001. Generally, a higher tariff for a product is associated with a higher probability of NTB implementation, depicting NTMs and tariffs as complements – though this result doesn't hold for all product categories.

A few studies explore the relationship between tariffs and a specific type of NTM, such as antidumping (AD) measures. Feinberg and Reynolds (2007) study the spread of AD after a comprehensive tariff reduction. They find that tariff reduction after the Uruguay Round increased the probability of a country implementing antidumping measures. In other words, the antidumping measures substitute for tariffs. Following in similar vein, with a focus on AD, Moore and Zanardi (2011) examine how cuts in applied tariff rates affected AD initiations for 35 countries over the period 1991 to 2002. They find that tariff reductions do not increase the probability of AD initiations in general. However, trade policy substitution is observed for a few developing economies who rely heavily on AD. Notwithstanding this finding, the investigation by Bown and Tovar (2011) of trade reforms in India reveal that large tariff cuts did raise the usage of AD and safeguards as alternative policy instruments. Such trade policy substitution of specific NTMs for tariff cuts is also reported by Ketterer (2016) for the EU, again in the context of AD investigations.

Another stream of this empirical literature examines NTMs as specific trade concerns (STCs) for Technical Barriers to Trade (TBT) and Sanitary and Phytosanitary Measures (SPS). Beverelli *et al.* (2014) show that policy substitution between tariffs and SPS are observed for both developed and developing world, but in the TBT sample this holds only in developed countries. Orefice (2017) reports that as a consequence of tariff cuts, SPS and TBT measures are used to restrict trade. Herghelegiu (2018)

documents substitutability between NTMs and tariffs, where products that experience tariff reductions increase the probability of being subjected to NTM protection.

This finding of 'substitutability' has been confirmed by Broda *et al.* (2008) in their broader examination of NTMs. They show the United States set higher NTMs following its GATT/WTO tariff commitments, given the limited ability to use tariffs. An empirical investigation of the NTM-tariff relationship reported in the *2012 World Trade Report* (see WTO, 2012), highlights a negative link between coverage and frequency measures of NTMs with tariffs, for both SPS and TBT, across countries and HS2 sectors.

After their estimation of AVEs of NTMs, Kee *et al.* (2009) use three sets of simple regressions, to examine the relationship between their estimated AVEs of NTMs and tariffs. Though their estimation with either country fixed effects *or* product fixed effects included reveal a positive tariff-NTM relationship, when *both* country fixed effects and product fixed effects are controlled for, the correlation between tariffs and NTMs becomes negative, suggesting policy substitution.

Two studies ground their estimation of the NTM-tariff relationship on the Kee *et al.*'s methodology to estimate AVEs of NTMs, namely Limão and Tovar (2011) and Ronen (2017). The former exploits the variation in tariff constraints to examine the impact on NTMs for Turkey. They find evidence of substitution between the two trade policy instruments with tariff commitments – due to WTO and trade agreements with the EU – leading to higher AVEs of NTMs. However, their finding is of incomplete trade policy substitution as NTMs only partially offset for reduced tariff protection. Ronen (2017) reports NTMs substituting for tariffs mostly for developing economies, but complement each other in the case of the high income economies. A key feature of all three of these studies is that the estimated NTM-tariff relationship is derived from a cross section estimation strategy.

In summary, extant studies have generally eschewed the use of a tariff equivalent of NTMs that is directly comparable to tariffs. Some of these studies have also tended to focus on specific NTM measures and used more aggregated industry-level data. Furthermore, although panel estimation is used in some studies, this is not the case for

those studies closest to the present one, namely ones using AVEs of NTMs and common metric for measuring the trade barrier effect of the two trade policy instruments.

3. Empirical methodology and data

Empirical specification

The empirical model used to investigate the relationship between tariffs and NTMs at the product line level over time is:

$$NTM_{nct} = \alpha + \beta_1 Tariff_{nct-1} + \delta_{nc} + \tau_t + \epsilon_{nct}, \quad (1)$$

where NTM_{nct} represents the estimated AVEs of NTMs for product n in country c at time t. α is the constant intercept term in the above regression. $Tariff_{nct-1}$ is the tariff rate for product n in country c at time $t-1$, with the sign of β_1 indicating the nature of the relationship between NTMs and tariffs. $\beta_1 > 0$ indicates that higher (lagged) tariff and NTM protection coexist for products across countries and time, or in other words, these policy instruments are complements. By contrast, $\beta_1 < 0$ is consistent with NTMs substituting for tariffs, while $\beta_1 = 0$ that there is no relationship between tariffs and NTMs. δ_{nc} is a dummy for product n and country c which controls for the product-country specific effects. This fixed effect controls for products and countries that are more likely to be affected by higher levels of tariffs and AVEs of NTMs for historical and political economy reasons. τ_t represents the time-specific effects included to capture time variant factors and shocks affecting all economies, such as the 2008 financial crisis, that affect world trade and trade policies over time. ϵ_{nct} is the error term. Both NTMs and tariffs are estimated after applying natural logarithms, strictly as $ln\ (1 + NTM)$ in order to avoid the dropping of zero observations where tariffs are zero (for the model in levels) or not subject to change between periods (for the model in changes) .

Given that we have information on tariffs and AVEs over time, we can also investigate the response of NTM implementation to tariff change. In addition to the above model that explores the tariff - NTM relationship in 'levels', we explore how tariff changes affect NTMs. This estimation of the model in terms of 'changes' over time rather may be viewed as capturing the decision-making procedure of trade policy

makers and providing stronger evidence of a causal relationship, with the substitutability or complementarity between tariffs and NTMs being a reflection of governments' ability and tendency to adjust policies when market conditions *change*. The 'dynamic' version of the model becomes:

$$\Delta NTM_{nct} = \alpha + \beta_1 \Delta Tariff_{nct-1} + \delta_{nc} + \tau_t + \epsilon_{nct} \quad (2)$$

where NTM_{nct}, $Tariff_{nct}$, δ_{nc}, τ_t are as previously defined.

Note that we use *lagged tariffs* (levels or changes) as the right-hand side variable in both versions of the model. This is in order to capture the delays in the trade policy decision-making and implementation process, with changes (often falls in this period) in tariffs inducing lobbying by domestic interest groups, possible threats of retaliation by trade partners, administrative review, bureaucratic approval and possibly implementation of new or additional NTMs; the 'delayed' as opposed to contemporaneous relationship between tariffs and NTMs providing a more appropriate basis for inferring a causal effect of the change in policy instrument and an alternative policy instrument. Further note that time *t* in our analysis represents discrete points in time with 3-year intervals over the period 2003-2015; 2003, 2006, 2009, 2012 and 2015 to be precise. This allowed for the smoothing of year-specific shocks in the measurement of the AVEs of NTMs, and captures the slow changing nature of trade policy (see Amiti and Khandewal, 2013).

The estimates of AVEs of NTMs we use in the estimation of the NTM-tariff relationship have the merit of being econometrically estimated as a first step, such that concerns about the endogeneity of NTMs with respect to imports and importantly *tariffs* is directly confronted. The estimation of the AVEs of NTMs follows Kee *et al.* (2009) to obtain tariff equivalent of NTMs at discrete points in time. First, 'constrained' imports, with the effect of tariffs allowed for, is taken as the dependent variable. Then the incidence of NTMs (the key explanatory variable) is further instrumented and several controls included in each estimated import demand function. The instruments include lagged change in imports and exports, and GDP-weighted NTMs for five closest neighbours, while the controls used are domestic support, several GDP,

labour/GDP, capital/GDP, and land/GDP, an island dummy and the weighted distance to the world market. The estimation is carried out over a 3-year span, averaging trade flows and other continuous variables to smooth out year-specific shocks. This procedure is reported in full in Niu et al. (2018), which also provides some robustness checks and summary information by country and industry.

As part of the robustness analysis we exploit variation in policy commitments enshrined in the WTO negotiations affecting specific sectors. In particular, as documented by Schott (1994), different forms of tariff reduction apply from the agreements of the Uruguay Round. The Uruguay Round (UR) followed an ad hoc approach to cut tariffs on a sector-by-sector basis and countries had to cut tariff rates on average by about one-third of their pre-UR level. For some sectors, however, tariff cuts were mandated through a request-and-offer approach, the so-called "zero-for-zero". "Zero-for-zero" negotiations took place for some specified product sectors in which the main developed countries first reduced their tariffs to zero, followed by developing countries making substantial reduction for the same products (Schott, 1994). Therefore, products with higher than average tariff reduction (for peak tariffs) and with "zero-for-zero" measures are defined as highly affected sectors, while the remaining products are defined as less affected sectors. We adopt this splitting of the sample by product to re-estimate the models (1 and 2) to explore whether there is a stronger relationship between tariffs and NTMs for the product set where larger tariff cuts were imposed on individual countries by the multilateral negotiations. These higher cut sectors might be viewed as ones where countries were more constrained and where (for the current purpose) the cuts were more exogenous to national level trade policy setting.

Data

The data for the incidence of NTMs used to estimate the AVEs in the first stage comes from UNCTAD's TRAINS (Trade Analysis Information System) database but which uses the new Multi-Agency Support Team (MAST) system to classify NTMs, as opposed to the old Trade Control Measures (TCMCS). The ability to track NTMs systematically over time and use a panel estimation to explore the tariff-NTM

relationship is a distinctive feature of this new database. Following Kee *et al.* (2009) and Niu *et al.* (2018), the AVEs of NTMs are estimated for 80 economies, with EU countries treated as one, for altogether 4949 products at 6-digit HS level over the period 2003 to 2015 at three year intervals (2003, 2006, 2009, 2012 and 2015).[2] The effectively applied tariff rate is used to measure tariffs using the data obtained from the UNCTAD'S TRAINS database at HS 6-digit product level.

The list of economies in our sample, separated in to non-OECD and OECD economies, is listed in Appendix Table A-1. The information on AVEs and overall protection is further summarized in Niu et al. (2018) and the detailed product level estimated AVEs at the product level for all countries and products is available at: www.nottingham.ac.uk/gep/links/index.

4. Empirical results

Figure 1 presents a summary depiction of the NTM-tariff relationship over the whole period across countries, seemingly showing a positive relationship between AVEs of NTMs and tariffs, suggestive of a complementary relationship overall. Figure 2 shows the evolution over time of the overall average tariff and average AVE of NTMs for the full sample; revealing tariff levels to have been subject to constant slow decline, with NTMs fluctuating but generally higher at the period end than at the start. This is suggestive of substitution by NTMs for the decline in tariffs, with non-tariff protection becoming the increasingly dominant source of protection overall.

Table A-1 reports the summary statistics on average tariffs and AVEs, grouping economies as OECD and non-OECD. The average AVE of NTMs (column 1) and applied tariff rate (column 2), again confirms that NTM protection level was much higher than tariffs and growing in importance over the time period for both OECD and non-OECD countries. Average tariff rates decreased consistently over the sample period for non-OECD countries. Tariff rates in OECD countries declined a little initially

[2] The EU countries are treated as a single identity because EU countries negotiate as a whole in multilateral trade agreements and individual EU countries cannot set their trade policy. We take the simple average of AVEs of NTMs at the product level for all EU countries.

and stayed constant thereafter. For our sample period bound and applied tariff rates in the developed world had already been substantially reduced such that that there was limited scope for further reduction. Both the average tariff rate and AVE level (and therefore level of overall protection) were also much higher in general in non-OECD than OECD economies. This is in contrast to the argument of Hoekman and Nicita (2011) that NTMs increase with income per capita, mirroring the declining importance of tariffs; an argument that would lead one to expect a greater likelihood of substitution between these trade policy instruments for developed than developing countries.

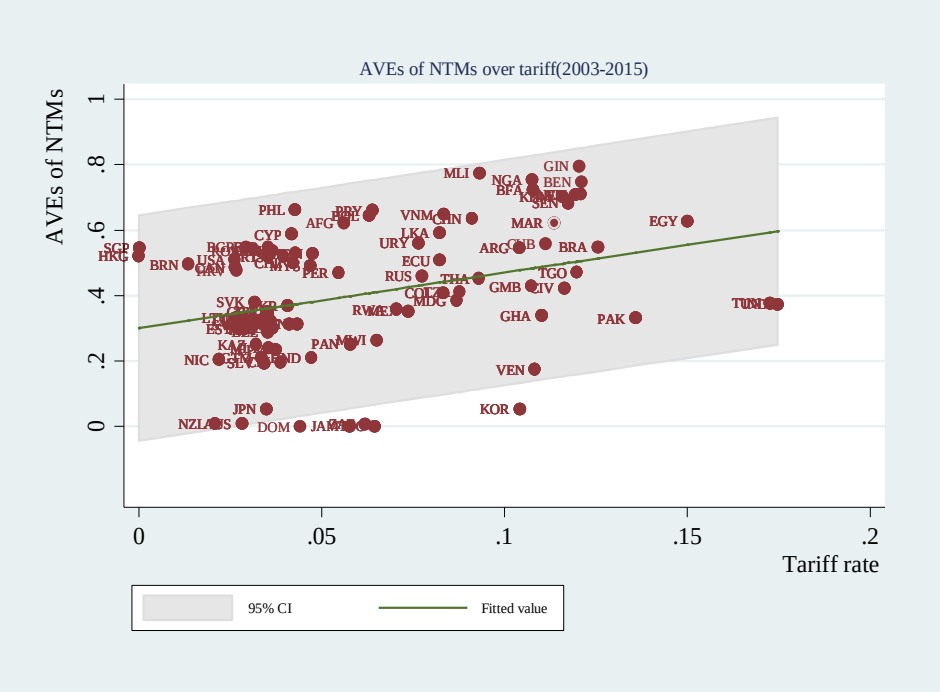

Figure 1: Average AVEs of NTMs over average tariff by country over the whole period (in coefficient form)

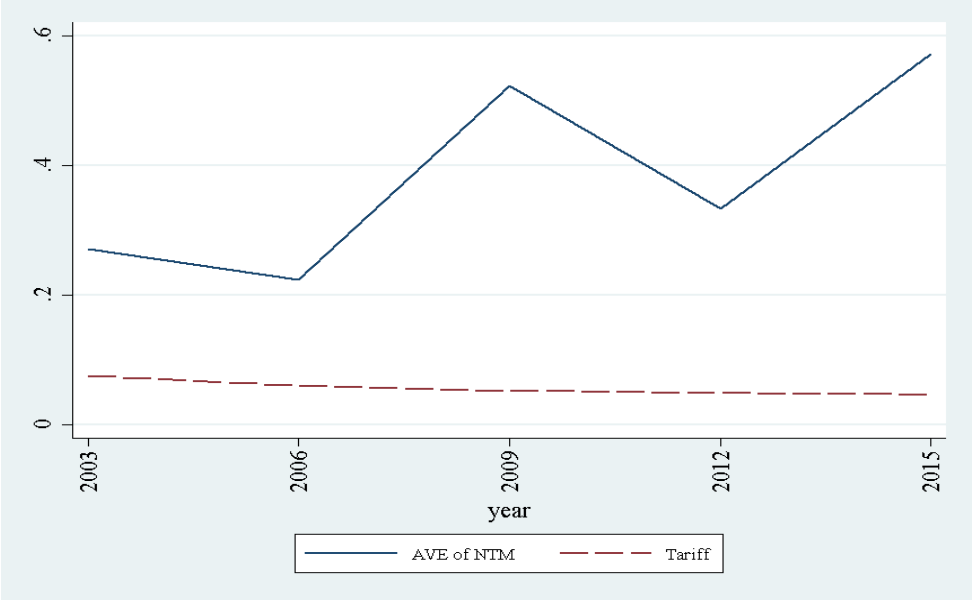

Figure 2: Evolution of Tariffs and AVE of NTMs across time (2003-2015)

Table 1 reports the base estimates of eq. (1), with AVEs regressed on lagged levels (columns 1, 2 and 3) and changes in tariffs (columns 4, 5 and 6); in each case initially without fixed effects, then with only product-country fixed effects and finally with both product-country and time fixed effects included in the specification. In levels, the pooled OLS regression with no fixed effects controlled for (col.1) generates a positively signed and statistically significant coefficient on the tariff variable, suggesting trade policy substitution. However, the sign on lagged tariff levels becomes significantly negative for the panel estimation with product-country fixed effects (col.2), though the magnitude of the negative coefficient is reduced markedly by the inclusion also of time fixed effects (col.3). For the alternative specification using lagged changes in tariffs as the explanatory variable, a negative and significant coefficient is obtained with or without fixed effects and for the alternative configurations of the fixed effects. Overall, therefore, our estimated base panel models provide evidence consistent with a substitutional relationship between tariffs and NTMs for the full sample of countries

over this time period, with falling tariffs (typically) being followed by rises in NTM levels.[3]

Table 1: Base Results: AVEs of NTMs Regressed on Lagged Tariffs (Levels and Changes)

Independent variable	Dependent variable: $\ln(1+\text{NTM}_t)$			Dependent variable: $\ln(1+\Delta\text{NTM}_t)$		
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(1+\text{tariff}_{t-1})$	0.18***	-0.24***	-0.07***			
	（0.00）	(0.01)	(0.01)			
$\ln(1+\Delta\text{tariff}_{t-1})$				-0.05***	-0.06***	-0.02**
				（0.01）	（0.01）	(0.01)
Constant	0.25***	0.28***	0.27***	-0.01***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	952,183	952,183	952,183	754,245	754,245	754,245
Product-Country Effects	NO	YES	YES	NO	YES	YES
Time-specific Effects	NO	NO	YES	NO	NO	YES
R-squared	0.002	0.002	0.03	0.0001	0.0001	0.04
Wald Test p-value	0.00	0.00	0.00	0.00	0.00	0.00
Country-product group		253,227	253,227		228,487	228,487

Note: Regressions in columns 1 and 4 are uses pooled OLS. Regressions in columns 2-3 and 5-6 are estimated using panel fixed effects approach, which are product-country specific effects. Time dummies are included in regressions in columns 3 and 6. Robust standard errors in parentheses. ***, **, * stand for significance at the 1%, 5%, and 10% level.

[3] A similar conclusion is drawn if separate product and country effects are used rather than product-country fixed effects.

Given the greater use of tariffs and greater overhang of bound over applied tariffs in developing countries and given the possibility of greater administrative capacity in developed countries to implement NTMs, one might be concerned that the results in table 1 for the full sample hide important differences in the NTM-tariff relationship between developed and developing countries.[4] In Table 2 we explore heterogeneity in the NTM-tariff relationship between country groupings, specifically between sub-samples of OECD and non-OECD countries and using the preferred panel specification which includes both product-country and time fixed effects.

Table 2: AVEs of NTMs Regressed on Lagged Tariffs for OECD and non-OECD Countries (Levels and Changes)

Independent variable	Dependent variable: $ln(1+NTM_t)$		Dependent variable: $ln(1+\Delta NTM_t)$	
	OECD	Non-OECD	OECD	Non-OECD
	(1)	(2)	(3)	(4)
$\ln(1+tariff_{t-1})$	-0.10***	-0.07***		
	(0.02)	(0.01)		
$\ln(1+\Delta tariff_{t-1})$			-0.05*	-0.01
			(0.03)	(0.01)
Constant	0.17***	0.29***	-0.09***	0.004
	(0.003)	(0.001)	(0.005)	(0.002)
Observations	203,542	748,641	161,168	593,077
Product-Country Effects	YES	YES	YES	YES
Time-specific Effects	YES	YES	YES	YES
R-squared	0.04	0.03	0.04	0.04
Country-product group	51,089	202,138	49,355	179,132

Note: The regressions are re-run for sub-samples by dividing economies into OECD and non-OECD for lagged tariff, levels and changes. Robust standard errors in parentheses. ***, **, * stand for significance at the 1%, 5%, and 10% level.

The finding of policy substitution from the full sample holds in general for both OECD and non-OECD countries. A negative coefficient is found on the lagged tariff variable in both the levels and changes specification for both OECD and non-OECD countries, and with significance in all but column 4 (the changes specification applied to non-OECD countries). The fact that an absolutely larger coefficient is obtained in both the levels and changes models for OECD countries and that an insignificant coefficient is obtained for non-OECD countries in the case of the non-OECD countries indicates that there is stronger support for the substitutes relationship between NTMs

[4] The requirements for tariff reduction in multilateral negotiations have been different for developed and developing countries, including in the Uruguay Round, (Schott, 1994). Although Moore and Zanardi (2011) found that tariff reductions resulted in higher anti-dumping NTM incidence for developing economies, there are range of NTMs such are product standards that are more likely to be applied by developed countries.

and tariffs for OECD countries than for non-OECD countries. Taken together these findings reveal some divergence from extant studies, which predominantly find NTM-tariff policy substitution to be a developing country phenomenon (see Moore and Zanardi, 2011; Ronen, 2017). It should be noted, however, that previous work tends to be concerned with the trade-off between tariffs and a specific type of NTM or to be reliant on cross-country evidence only. Here our finding is based on a comprehensive measure of NTMs and on estimates from a panel of cross country and over time information.

We also explore heterogeneity in the NTM-Tariff relationship across different sectors, as identified on the basis of commitments under the Uruguay Round (agreed in 1994 and implemented over 6 (10) years post-agreement by developed (developing) countries. In general, an ad hoc approach to cut tariffs on a sector-by-sector basis was adopted in the Round, with (industrial) countries required to cut their tariff rates to about average one-third of the original level. For some sectors, tariff cuts were mandated through a request-and-offer approach, the so-called 'zero-for-zero'. 'Zero-for-zero' negotiations took place for some specified product sectors in which the main industrial countries first reduced their tariffs to zero, followed by developing countries making substantial reduction for the same products (Schott, 1994). We split sample into two groups: products with above average tariff cuts and products with below average tariff cuts. The first type includes products with above average tariff cuts as well as products with zero-for-zero commitments, while the second type includes the rest of the products.[5] Products with above average tariff reduction cover 67% of the sample while products with below average tariff reduction cover about 33%. Given the differences in commitments and implementation speed between developed and developing countries, we retain the OECD/non-OECD sub-samples for the implementation of this split product/sector. Indeed one might anticipate evidence of a stronger substitutional relationship between NTMs and tariffs for sectors subject to

[5] Product groups with above-average tariff cuts are: metals; mineral products, precious stones and metals; electric machinery; wood, pulp, paper, and furniture; nonelectric machinery; chemicals and photographic supplies; and "other" manufactured articles. Products with zero-for-zero commitments are: pharmaceuticals, construction equipment, steel, distilled spirits, certain furniture, medical equipment, farm machinery, beer, toys and paper.

larger tariff cuts, and possibly some difference between country types.[6] The results of this additional sample-splitting are reported in Table 3.

Table 3: AVEs of NTMs Regressed on Lagged Tariffs for Different Sectors and Economies (Levels and Changes)

PANEL A: OECD countries	Dependent variable: $ln(1+NTM_t)$		Dependent variable: $ln(1+\Delta NTM_t)$	
	Above average UR cut	Below average UR cut	Above average UR cut	Below average UR cut
	(1)	(2)	(3)	(4)
$\ln(1+tariff_{t-1})$	-0.20***	-0.07***		
	(0.03)	(0.02)		
$\ln(1+\Delta tariff_{t-1})$			-0.08	-0.03
			(0.06)	(0.03)
Constant	0.17***	0.17***	-0.07***	-0.13***
	(0.00)	(0.00)	(0.01)	(0.01)
Observations	131,583	71,959	105,661	55,507
Product-Country Effects	YES	YES	YES	YES
Time-specific Effects	YES	YES	YES	YES
R-squared	0.06	0.02	0.06	0.02
Country-product group	32,440	18,649	31,513	17,842
PANEL B: Non-OECD countries	Dependent variable: $ln(1+NTM_t)$		Dependent variable: $ln(1+\Delta NTM_t)$	
	Above average UR cut	Below average UR cut	Above average UR cut	Below average UR cut
	(5)	(6)	(7)	(8)
$\ln(1+tariff_{t-1})$	-0.18***	0.01		
	(0.01)	(0.01)		
$\ln(1+\Delta tariff_{t-1})$			-0.01	-0.03**
			(0.01)	(0.01)
Constant	0.30***	0.28***	0.02***	-0.04***
	(0.00)	(0.00)	(0.00)	(0.00)
Observations	509,777	238,864	408,908	184,169
Product-Country Effects	YES	YES	YES	YES
Time-specific Effects	YES	YES	YES	YES
R-squared	0.05	0.01	0.05	0.02
Country-product group	135,352	66,786	121,159	57,973

Note: The regressions are for sub-samples splitting economies into OECD and non-OECD and sectors into sectors with above average tariff cuts based on the Uruguay Round and those with a below average tariff cut. Robust standard errors in parentheses. ***, **, * stand for significance at the 1%, 5%, and 10% level.

The results in Table 3 continue to provide evidence in support of a substitutional relationship between tariffs and NTMs, with negative signs (with one exception of an insignificant positive sign) on the lagged tariff variable in levels or changes specification and for above and below average UR tariff cuts for both OECD and non-OECD countries. There is, however, interesting variation in significance levels and the magnitude of the estimated coefficient in different sub-samples. In the levels

[6] This is for the same reasons as indicated above for differences in the overall relationship for OECD and non-OECD countries and/or because the speed and degree of implementation of the tariff cuts differed between these country groups.

specification there is an absolutely larger, and consistently significant, negative coefficient in the case of above average tariff-cutting sectors for both OECD and non-OECD countries. By contrast, there is a smaller (albeit still significant) substitutional effect found for below average tariff cutting sectors in the case of the OECD countries and no significant relationship in the case of the non-OECD countries for the low cut sectors; evidence therefore consistent with a stronger and more comprehensive substitutional relationship for OECD than non-OECD countries. This conclusion does not hold in the case the changes model. All the estimated coefficients on the tariff variable are negative, but only significant in the case of below average cut sectors in the case of non-OECD countries. By taking changes the sample period is truncated, however, and importantly the change in the dependent variable starts with the change over the period 2006 – 2009 which is after the scheduled full implementation of the UR tariff cuts (2000 for OECD countries and 2004 for non-OECD countries). This constrains the usefulness of the changes model to comment on the heterogeneity which we wish to explore. The levels model is more constructive for the purpose at hand, and offers results in line with expectations.

5. Conclusions

With the proliferation of multilateral and bilateral trade agreements in recent years, tariffs have fallen to a relatively low level and NTMs are increasingly used as the main instrument of trade policy. In this paper, the aim is to formally investigate whether NTMs overall are substituting for tariffs, using directly comparable tariff equivalent NTMs at the product-level for 80 countries over the period of 2003 to 2015. We employ a panel methodology to investigate this relationship across countries and time, allowing for the lagged adjustment of NTMs to tariffs (modelled in levels and changes). This empirical strategy offers a credible basis for offering a causal interpretation to the estimated relationship between the AVEs of NTMs and tariff rates at the detailed product level, using AVEs of NTMs estimated in consistent and rigorous manner.

In summary, our findings are strongly consistent with trade policy substitution being present between NTMS and tariffs for the sampled countries and sample period, with effect tending to be stronger for OECD than non-OECD countries and for those sectors/products subject to higher than average multilateral tariff cuts. With both our variables in natural logarithms we can interpret the coefficients on the tariff variable in our estimated models as elasticities. The average elasticity for the observed substitution

relationship is apparently low overall, and not absolutely greater than about -0.2 for specific sub-samples. One might conclude therefore that the NTM-tariff relationship is one subject to *imperfect* and *incomplete* trade policy substitution. It needs to be recognized, however, that tariff levels are on average much lower than the tariff-equivalent of NTMs, as demonstrated in Fig. 1 and in Table A-1. With average tariffs typically of 10% or less in this period, a 10% decline in tariffs involves an absolute decline in tariffs of 1% point or less. With an average AVE of NTMs typically in excess of 40%, an elasticity of -0.2 involves a 0.8% percentage point increase at least in in the AVE for each 10% decrease in tariffs. In absolute terms, therefore, the trade policy substitution much more complete!

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Appendix

Table A-1: Summary Statistics: Average AVE and Tariff (coefficient form: 2003-2015)

Country Category	Countries (ISO3)	Year	NTM (1)	Tariff (2)
Non-OECD countries	AFG, ARG, BEN, BFA, BOL, BRA, BRN, CHN, CIV, COL, CPV, CRI, CUB, CYP, CZE, DOM, ECU, EGY, EST, GHA, GIN, GMB, GTM, HKG, HND, HRV, HUN, IDN, IND, JAM, KAZ, KHM, LBN, LKA, LTU, LVA, MAR, MDG, MLI, MLT, MUS, MWI, MYS, NER, NGA, NIC, NPL, PAK, PAN, PER, PHL, POL, PRY, RUS, RWA, SEN, SGP, SLV, SVN, TGO, THA, TTO, TUN, TZA, UKR, URY, VEN, VNM, ZAF	2003	0.46	0.11
		2006	0.43	0.09
		2009	0.76	0.09
		2012	0.53	0.08
		2015	0.69	0.07
OECD countries	AUS, CAN, CHL, EUN, ISR, JPN, KOR, MEX, NZL, TUR, USA	2003	0.25	0.06
		2006	0.27	0.04
		2009	0.42	0.04
		2012	0.31	0.04
		2015	0.53	0.04

Notes：

1. The second column shows “ISO3” codes for countries in each category. The available country list for each year can be found in the supplementary material Table A2-1.
2. The difference is taken for the same country-product over the last year and then averaged.