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Abstract

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Amending the Trade Restrictiveness Index to Account for Market Imperfections: market structure and country size *

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ABSTRACT:
This paper proposes different, novel ways to calculate the trade restrictiveness index (TRI), the uniform trade cost level equivalent in terms of welfare effect to a set of heterogeneous trade costs across sectors and trading partners. Despite its inherent ability to capture second-best situations, the determination of the TRI when we depart from perfect competition and the small country assumption has been largely overlooked in the trade literature. A parsimonious framework is developed to account for external effects linked to market structure, as well as market imperfections linked to country size and associated terms of trade effects in the context of a TRI. The framework is used in an empirical investigation using a representative sample of importing countries, products and notified NTMs. The TRI is calculated with a quantitative trade model both in a small and large country setting and under different market structures (Armington, Ethier-Krugman, Melitz) for both tariffs and non-tariff measures (NTMs). Novel methodologies are proposed to estimate tariff elasticities based on the most favored nation (MFN) tariff margin and to calculate the NTMs based on the difference between actual trade and counterfactual trade in the absence of NTMs. The methodologies are applied to a cross section of trade in 120 countries and 57 sectors using the GTAP10 data for 2014. There are three principal results. First, the TRI calculated with the quantitative model in a small country setting is close to the TRI calculated with an approximate formula for smaller levels of trade costs, whereas the two deviate for larger levels of trade costs. Second, the impact of differences in market structure is limited. Third, the TRI in a small country setting deviates significantly from the large country TRI, which takes changes in the terms of trade into account. Keywords: Trade restrictiveness index, monopolistic competition, country size, NTMs

JEL codes: F12, F14

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1 Introduction

Both tariffs and non-tariff measures (NTMs) imposed by a country typically differ across sectors. To compare trade policies of countries, it is useful to have a measure of aggregate trade policies policies at the country-level. A simple average of trade costs over sectors would neglect the importance of the value of trade. It makes sense to give sectors with more trade should get more weight. However, trade weighted averages of trade costs give too little weight to sectors with large trade costs displaying low levels of trade. is Anderson and Neary have therefore in a series of publications proposed the so-called trade restrictiveness index (TRI), a welfare theoretic measure for the restrictiveness of trade policy of a country both on tariffs and NTMs (Anderson and Neary (1996), Anderson (1998), Anderson and Neary (2005)). The TRI is the uniform level of trade costs that would make consumers equally worse off as heterogeneous trade costs across sectors. The TRI can be calculated exactly with a general equilibrium model, searching for the uniform tariff generating equal welfare loss. Anderson and Neary propose to calculate the TRI under a set of assumptions: there is perfect competition, products are homogeneous, and the importing country is small such that it cannot affect prices on the world market. Under these assumptions, an appoximate formula can be employed: the TRI is a trade weighted average of the square of trade costs in the different sectors multiplied by the trade elasticity in each of the sectors. Henceforth, the TRI rises in the variance of trade costs and with large trade costs in sectors with large elasticities. Kee et al. (2009) calculate TRIs for 78 countries for both tariffs and NTMs employing the approximate formula.

In this paper we examine how the TRI changes if we deviate from the assumptions of perfect competition, homogeneous products, and small country. We employ a quantitative trade model to calculate the TRI in both small and large country settings under different market structures. More specifically, we work with the quantitative trade model in Bekkers and Francois (2017), which incorporates the three market structures Armington, Ethier-Krugman, and Melitz in a computable general equilibrium model. We start by estimating the gravity equation implied by the generic structure of trade under the three market structures based on the GTAP10 data for 2014. We propose a novel way to estimate the tariff elasticities. We use the tariff margin that members of free trade agreements (FTAs) enjoy relative to other trading partners. To do so, we include an interaction term of the most-favored nation (MFN) tariff and a dummy for not applying the MFN-tariff because countries are part of an FTA. Hence our tariff interaction variable captures the tariff margin FTA-members enjoy relative to the MFN tariff. The effect of the MFN tariff itself holding for trade between non-FTA partners is captured by importer fixed effects. This procedure enables us to structurally estimate tariff elasticities and calculate NTMs for 45 sectors and 120 countries.

We then use the estimated tariff elasticities and NTMs to determine the TRI employing the appoximate formula also used by Kee et al. (2009) for 120 regions in the GTAP10 database. Next, we use a smaller aggregation of countries to examine the differences between the TRI calculated with the approximate formula and the TRI calculated with the quantitative trade model under a small country assumption for the three market structures. In turn, we explore differences between small and large country TRIs for the three market structures.

The theory of the TRI developed by Anderson and Neary assumes that the importing country is small and cannot affect prices on the world market. But large countries can affect their terms of trade by imposing tariffs, driving down world prices of imported goods, and the uniform tariff in a large country setting will thus be different. Costinot and Rodriguez-Clare

(2013) show with simulations that the uniform tariff equivalent to varying tariffs is not unique. Welfare in importing country raising tariffs first rises and then declines. The beneficial terms of trade effect dominates at low levels of tariffs. For higher tariff levels the adverse welfare distortions dominate. Soderbery (2017) also examines the TRI in a large country setting. He calculates large country TRIs with an approximate formula taking into account upward sloping supply in exporters and thus the possibility of importers to drive down the exporter's supply prices. Soderbery (2017) focuses on HS4 manufacturing sectors with structurally estimated import demand and export supply elasticities. This paper therefore does not account for general equilibrium effects in a liberalizing importer on its exports. When a country reduces import costs, it will have to reallocate some of its resources from import-competing sectors to exporting sectors. The additional supply of exports drives down the prices of exports, thus adversely affecting the terms of trade of the country. This effect is present in our framework and we show that it matters quantitatively.

We get the following findings. First, both the tariff-TRI and the NTM-TRI calculated with the general equilibrium model under the small country approach is close to the TRI calculated with the approximate formula for small levels of tariffs and NTMs. However, when trade costs rise beyond ad valorem rates of 10% the two measures start to deviate. This seems to reflect that the approximate formula is based on a Taylor-approximation and thus becomes increasingly poor as trade costs rise. Second, the tariff-TRI calculated with the model under the large and small country approach differ significantly. Under the large country assumption the welfare effect of both homogeneous and heterogeneous tariffs is positive. Instead, under small countries the effect is negative for both homogeneous and heterogeneous tariffs. Hence, the equivalent homogeneous tariff level corresponds with a positive welfare effect for large countries, whereas it corresponds with a negative welfare effect for small countries. Third, for large countries we find like Costinot and Rodriguez-Clare (2013) that there are two homogeneous tariff levels generating identical welfare as the actual set of heterogeneous tariffs. Fourth, for NTMs the small and large country TRIs are more similar and there is only one level of homogeneous NTMs corresponding with heterogeneous NTMs. Although NTMs also generate terms of trade effects, they are dominated by the efficiency losses thus implying that NTMs always generate negative welfare effects. We have followed most of the literature here that NTMs generate pure waste and do not generate any rents for importers or exporters. In the latter case, also for NTMs the small and large country TRIs would deviate significantly. Fifth, there is only a limited impact of differences in market structure. So the TRIs are similar for the different market structures.

The paper is structured as follows. In Section 2 we map out the theoretical structure of our model and the theory to calculate the TRI. In Section 3 shows the results of gravity estimations on both tariff elasticities and NTMs. In Section 4 we present the tariff-related TRIs employing the formula, and employing the model under both small and large country for different market structures. Section 5 then goes into the NTM-related TRIs, comparing again formula with model under small and large country for different market structures. Section 6 concludes.

2 Theory

In this section we introduce formal definitions of the TRI and describe the quantitative trade model employed to calculate the TRI exactly under different market structures.

2.1 Theory: trade restrictiveness index

Following Feenstra (1995) and Kee et al. (2009) the trade restrictiveness index in importing country s, TRI_s^{tar}, is the homogeneous tariff leading to the same level of utility as a vector of heterogeneous tariffs across sectors i and trading partners r, $\{tar_{irs}\}$:

$$u_s\left(TRI_s^{tar}\right) = u\left(\{tar_{irs}\}\right) \tag{1}$$

In the same way, we can define the ad valorem equivalent (AVE) trade restrictiveness index of country s, TRI_s^{τ}, equivalent to a vector of heterogeneous AVE trade costs caused by NTMs in place in sectors i and in imports from country r, $\{\tau_{irs}\}$:

$$u_s\left(TRI_s^{\tau}\right) = u\left(\{\tau_{irs}\}\right) \tag{2}$$

We assume that the NTMs generate only efficiency costs. Hence, firms have to spend resources because of NTMs which can be considered waste and do not generate any revenues for the government. Since firms have to spend resources, the NTMs do affect the allocation of resources. Hence, NTMs affect only iceberg trade costs and in the next section we estimate the increase in iceberg trade costs as a result of NTMs in place.

An alternative would be to assume that part of the trade costs as a result of NTMs lead to rents for either importers or exporters, which would work similar as tariffs assuming the receivers of rents are equally important for welfare as government revenues. To clearly distinguish revenue generating trade costs such as tariffs from trade costs not generating any revenues, we stick to the assumption that NTMs generate only efficiency costs.

Following Kee et al. the TRI can be approximated as follows for a small country taking world prices as given:

$$TRI_s = \left(\frac{\sum_i \sum_r V_{irs} \varepsilon_i \left(t_{irs}\right)^2}{\sum_i \sum_r V_{irs} \varepsilon_i} \right)^{\frac{1}{2}} \tag{3}$$

As discussed more into detail in Kee et al. (2009), equation (3) shows that the TRI rises in the dispersion of tariffs across sectors, because of the squared tariff rate in the formula. Furthermore, the TRI also rises with a positive correlation between the tariff rate and the trade elasticity ε_i.

2.2 Quantitative trade model

We use an extension of the GTAP computable general equilibrium model with flexible market structure. In particular, we can switch between trade modelled as in Armington, as in Ethier-Krugman, and as in Melitz. All three structures feature constant elasticity of substitution (CES) preferences. Under Armington there is perfect competition and goods are differentiated by country of origin. Under Ethier-Krugman there is monopolistic competition, goods are differentiated by the firms producing them, and firms have a cost structure with increasing returns to scale assuming that firms are identical. The Melitz structure is like Ethier-Krugman, but firms have heterogeneous productivity. The model works with a representative household spending her income on private consumption, public consumption, and savings. There are multiple sectors, intermediate linkages, multiple production factors, investment and capital accumulation, import tariffs, export taxes, and a transport sector. Global savings are allocated to investment in different countries. The quantitative trade model employed is described into detail in Section 6 of Deliverable D42 of the Pronto project (Bekkers et al. (2017)), so it will not be discussed into detail here.

2.3 Modelling the small country case

We calculate the exact TRI using the computable general equilibrium model with three different trade structures, distinguishing between small and large countries. In the basic model each country is large in the sense that world market prices are not given but endogenous to changes in any of the countries. To capture the small country case we impose two sets of changes. First, to calculate the TRI of a country we keep prices, income, and production constant in all the trading partners of the country. Second, the terms of trade are held constant by endogenizing international capital flows. We need both changes for the following reason. CES preferences imply that countries (Armington) or firms (Ethier-Krugman/Melitz) have market power. Holding prices and demand in the rest of the world constant to mimic the small country case is not sufficient. This will keep prices on the import side constant but not on the export side. Therefore, it does not sterilize all terms of trade effects. A country reducing import tariffs will reallocate resources across sectors away from import-competing sectors towards the exporting sectors. And exporting more will imply that prices of the exported goods fall, thus affecting the terms of trade. To eliminate this effect in order to mimic a small-country setting with constant international prices we fix the terms of trade.

3 Gravity estimation: calculating tariff elasticities and ad valorem equivalents

3.1 Theoretical structure

Based on the generic trade structure we can write the gravity equation as follows in respectively the Armington and Ethier-Krugman model and in the Melitz model with v_{irs} the value of trade net of bilateral tariffs, itm_{irs} the international transport margin, te_{irs} export taxes, f_{irs} fixed trade costs, e^m_{is} the demand-side shifter on imports, p^m_{is} the price of imports, E^m_{is} the value of import demand, tp_{ir} production taxes, p^{ib}_{ir} the price of input bundles, and c^m_{ir} the supply-side shifter:

$$v^{arm,etk}_{irs} = \left(\tau_{irs} te_{irs} \left(1 + itm_{irs}\right)\right)^{1-\sigma_i} ta^{-\sigma_i}_{irs} \left(\frac{e^m_{is} p^m_{is}}{tp_{ir} p^{ib}_{ir} c^m_{ir}}\right)^{\sigma_i - 1} E^m_{is} \tag{4}$$

$$v^{mel}_{irs} = \left(\tau_{irs} te_{irs} \left(1 + itm_{irs}\right)\right)^{-\theta_i} ta_{irs}^{-\left(\theta_i + 1 + \frac{\theta_i - \sigma_i + 1}{(\sigma_i - 1)}\right)} f_{irs}^{-\frac{\theta_i - \sigma_i + 1}{\sigma_i - 1}} \left(\frac{e^m_{is} p^m_{is}}{tp_{ir} p^{ib}_{ir} c^m_{ir}}\right)^{\sigma_i - 1} E^m_{is} \tag{5}$$

In the Melitz model tariffs contain an additional coefficient, because of the assumption that tariffs are paid on marked-up prices (called revenue-shifting tariffs in for example Costinot and Rodriguez-Clare (2013)) as is practice in most countries.

We have the following general empirical gravity equation implied by equations (4)-(5) with minus signs before the tariff and trade elasticities, respectively $\varepsilon_i^{v,ta}$ and $\varepsilon_i^{v,te}$, implying that these elasticities are positive:

$$v_{irs}^{emp} = \exp\left(-\varepsilon_i^{v,ta} \ln ta_{irs} - \varepsilon_i^{v,te}\left(te_{irs}\left(1 + itm_{irs}\right)\right) + a_i^{tcc} \ln tcc_{irs} + a_i^{tcd} tcd_{irs} + \eta_{ir} + \upsilon_{is} + \varepsilon_{irs}\right) \tag{6}$$

The exporter and importer specific terms, respectively $\left(tp_{ir}p_{ir}^{ib}c_{ir}^{m}\right)^{1-\sigma_i}$ and $\left(e_{is}^{m}p_{is}^{m}\right)^{\sigma_i-1}E_{is}^{m}$, are absorbed empirically by the exporter and importer fixed effects, respectively η_{ir} and υ_{is}. tcc_{irs} and tcd_{irs} are vectors of respectively continuous and discrete biletaral observable gravity variables like distance (continuous) and common colony (discrete). Since the value of trade is net of import tariffs, the tariff elasticity, $\varepsilon_i^{v,ta}$, is equal to σ_i in the Ethier-Krugman/Armington model and equal to $\left(\theta_i + 1 + \frac{\theta_i - \sigma_i + 1}{\sigma_i - 1}\right)$ in the Melitz model. The trade elasticity, $\varepsilon_i^{v,te}$, the elasticity of v_{irs}^{emp} with respect to iceberg trade costs, τ_{irs}, is θ_i in the Melitz model and $\sigma_i - 1$ in the Armington and Ethier-Krugman models. We will discuss how to estimate the tariff elasticities based on GTAP10 trade data, including trade with self. This will give us the value of σ_i in the Armington and Ethier-Krugman models and one of the values of θ_i and σ_i in the Melitz model. In the latter model we complement the estimated tariff elasticity with assumptions about the granularity of the firm size distribution to identify both θ_i and σ_i.

To estimate the tariff elasticity, we write tariffs as follows:

$$ta_{irs} = \frac{ta_{is}^{MFN}}{ta_{is}D_{irs}^{NO-MFN}} \tag{7}$$

Hence, bilateral tariffs between country r and s is equal to the MFN tarriffs imposed by importer s, ta_{is}^{MFN}, unless no MFN tariffs are imposed on exporter r technically if the dummy D_{irs}^{NO-MFN} is equal to one. D_{irs}^{NO-MFN} is equal to one and so no tariffs are imposed when either there is an FTA between countries r and s or when trade is domestic, i.e. $r = s$. Since ta_{is}^{MFN} is importer-specific and does not vary by exporter r, it is captured by the importer fixed effect, υ_{is}. To prevent that our MFN-tariff term picks up the general effect (beyond tariffs) of either being part of an FTA or trading within borders, we include both an FTA-dummy, FTA_{irs}, and a dummy for trade with self, D^{Home}. Based on the discussion, we get the following empirical gravity equation:

$$v_{irs}^{emp} = \exp\left\{ -\varepsilon_i^{v,ta} \ln\left(\frac{1}{\left(ta_{is}^{MFN} D_{irs}^{NO-MFN} \right)} \right) + a_i^{tcc} \ln tcc_{irs} + a_i^{tcd} tcd_{irs} + \gamma FTA_{rs} + D^{Home} + \eta_{ir} + \upsilon_{is} + \varepsilon_i \right. \tag{8}$$

We include a large number of other bilateral control variables beyond FTAs, such as a variable measuring the difference in political system and a separate dummy for EU trade.

We calculate the size of NTMs based on the difference between the actual value of trade, v_{irs}^{actual}, between countries r and s in sector i and the counterfactual value of trade the two countries would have without NTMs, v_{irs}^{coufac}. To construct the value of counterfactual trade we calculate how much trade would take place if the level of trade costs were at the lowest level possible, based on the observed pattern of pair-wise NTMs as estimated in our dataset.

Based on v_{irs}^{actual} and v_{irs}^{coufac} we define the ad valorem equivalent of NTMs in place as the percentage change in iceberg trade costs associated with moving from counterfactual trade costs to actual trade costs in the theoretical gravity equations (4)-(5) for respectively the Armington and Ethier-Krugman models and the Melitz model. Hence, the NTMs are positive corresponding with associated reduction in trade flows (from counterfactual to actual trade flows):

$$\frac{v_{irs}^{actual}}{v_{irs}^{coufac}} - 1 = \left(\frac{\tau_{irs}^{actual}}{\tau_{irs}^{coufac}} \right)^{1-\sigma_i} - 1 \tag{9}$$

$$\frac{v_{irs}^{coufac}}{v_{irs}^{actual}} - 1 = \left(\frac{\tau_{irs}^{actual}}{\tau_{irs}^{coufac}} \right)^{-\theta_i} - 1 \tag{10}$$

We can invert these equations to solve for the percentage change in iceberg trade costs, using the relation between the structural parameters, σ_i and θ_i, and empirically estimated trade and tariff elasticities, $\sigma_i - 1 = \varepsilon_i^{v,ta} - 1 = \varepsilon_i^{v,te}$ (in Armington/Ethier-Krugman) and $\theta_i = \varepsilon_i^{v,te} = \varepsilon_i^{v,ta} - \frac{1}{\xi_i}$ (in Melitz):

$$AVE_{irs,etk/arm}^{NTM} = \left(\frac{v_{irs}^{coufac}}{v_{irs}^{actual}} \right)^{\frac{1}{\varepsilon_i^{v,te}}} = \left(\frac{v_{irs}^{coufac}}{v_{irs}^{actual}} \right)^{\frac{1}{\varepsilon_i^{v,ta} - 1}} \tag{11}$$

$$AVE_{irs,mel}^{NTM} = \left(\frac{v_{irs}^{coufac}}{v_{irs}^{actual}} \right)^{\frac{1}{\varepsilon_i^{v,te}}} = \left(\frac{v_{irs}^{coufac}}{v_{irs}^{actual}} \right)^{\frac{1}{\varepsilon_i^{v,ta} - \frac{1}{\xi_i}}} \tag{12}$$

Equations (11)-(12) show that using the trade elasticity, the elasticity of trade flows with respect to iceberg trade costs, leads to identical AVEs in the different models. However, since the relation between the tariff elasticity and the trade elasticity is different in the Armington/Ethier-Kugman models and the Melitz model, the $AVEs$ are different in the two models when based on the tariff elasticity. The reason is the following. The AVEs are defined based on the associated percentage change in iceberg trade costs. Hence, calculating the AVEs based on the tariff elasticity requires a conversion of the trade elasticity into the tariff elasticity.

3.2 Estimation results

We estimate equation (8) based on a cross-section of trade data between 120 countries in 2014 as collected by GTAP (GTAP10), including both international and domestic trade flows. We estimate the equation for 45 of the 57 GTAP-sectors by merging certain GTAP-sectors.

	goods	servs	nondurables	durables
lnDist	-0.428	-0.012	-0.465	-0.421
	(11.92)***	(0.59)	(15.63)***	(9.40)***
lnHindex	4.347	3.210	3.341	4.690
	(18.01)***	(23.63)***	(16.70)***	(10.90)***
POL	0.000	-0.000	0.000	-0.000
	(1.12)	(0.86)	(2.56)**	(0.61)
smctry	0.160	0.197	-0.046	0.266
	(0.97)	(1.48)	(0.28)	(1.37)
mass	-0.005	0.048	0.006	-0.009
	(0.53)	(6.71)***	(0.82)	(0.64)
EUN	0.298		0.042	0.493
	(1.76)*		(0.26)	(2.69)***
home	2.441	7.014	2.846	2.204
	(15.53)***	(98.70)***	(20.89)***	(12.82)***
Tmargin	-10.542		-9.553	-13.327
	(10.91)***		(10.88)***	(6.87)***
SDAT		0.336		
		(3.84)***		
STRImargin		-6.351		
		(17.98)***		
N	19,044	19,044	19,044	19,044
PseudoR2	0.9868	0.9980	0.9874	0.9831

	grn	v_f	osd	ocp	ctl	oag
lnDist	-0.815	-0.672	-0.916	-0.490	-0.865	-0.631
	(10.36)***	(11.01)***	(6.54)***	(8.04)***	(6.36)***	(8.66)***
lnHindex	3.906	4.734	4.062	4.283	2.297	6.209
	(6.58)***	(10.87)***	(6.10)***	(11.73)***	(3.42)***	(8.30)***
POL	0.000	0.000	-0.001	-0.000	0.000	0.000
	(1.55)	(1.20)	(3.36)***	(0.01)	(2.29)**	(1.50)
smctry	-0.005	-0.499	0.091	0.301	-0.564	0.326
	(0.02)	(2.02)**	(0.17)	(0.95)	(1.11)	(1.49)
mass	0.017	0.019	0.067	0.043	0.070	-0.003
	(1.02)	(1.29)	(3.97)***	(2.21)**	(2.23)**	(0.09)
EUN	2.066	1.759	1.985	0.634	2.285	0.517
	(5.91)***	(6.36)***	(4.51)***	(2.26)**	(4.71)***	(1.54)
home	4.802	3.913	3.856	4.161	7.150	5.115
	(14.52)***	(23.26)***	(10.29)***	(19.47)***	(18.43)***	(20.05)***
Tmargin	-3.197	-4.572	-2.136		-6.663	
	(5.51)***	(5.58)***	(2.99)***		(1.72)*	
N	19,044	19,044	19,044	19,044	19,044	19,044
PseudoR2	0.9846	0.9845	0.9709	0.9714	0.9928	0.9934

4 Tariff-related TRIs

In this section we show the tariff-related TRIs calculated both with the approximate formula and with the quantitative model for the large and small country cases and for the three trade structures (Armington, Ethier-Krugman, and Melitz).

4.1 Approximate formula

We start with TRIs calculated with the approximate formula. Figure 1 shows that the TRI displays large variation across countries and is strongly correlated with GDP per capita, which is in line with Kee et al. (2009). In the figure we have omitted some countries with very large TRIs. Table 1 provides summary statistics for the entire sample. The table shows that the TRI is obviously larger if we calculate the uniform tariff only for manufacturing sectors. The reason to do so is that services do not have tariffs. Using the GTAP trade elasticities leads to similar TRIs.

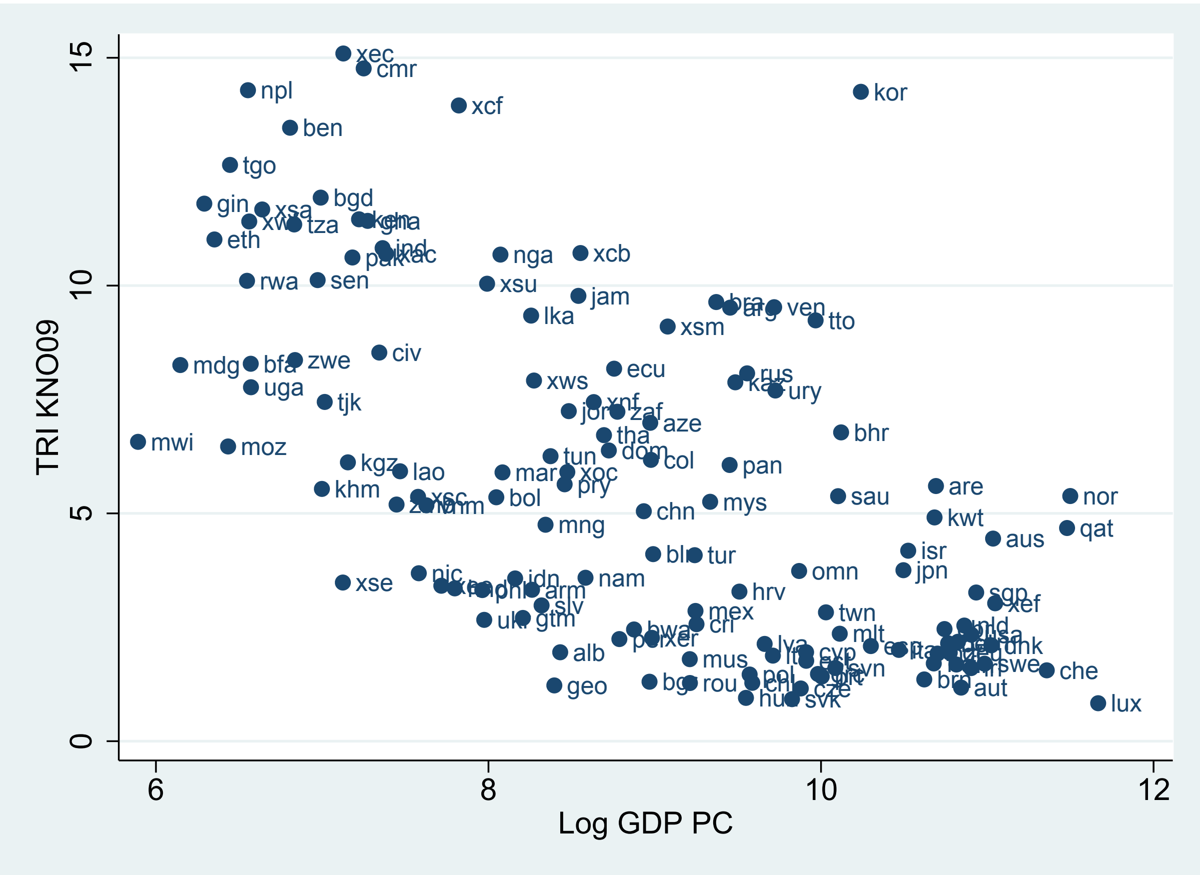

Figure 1: The relation between the TRI calculated with the approximate formula and GDP per capita

Table 1: Summary statistics TRI of tariffs calculated using approach of Kee, Nicita, and Olearraga (2009)

Variable	Obs	Mean	Stddev	Min	Max
TRI	137	6.32	5.37	0.83	34.07
TRI only manufacturing	137	7.15	5.87	0.92	34.71
TRI GTAP elasticities	137	6.56	5.58	0.94	34.80
TRI GTAP elas. only man.	137	7.52	6.17	1.08	35.81

4.2 Calculating the TRI: small versus large country

We calculate the exact TRI using the computable general equilibrium model with three different trade structures, distinguishing between small and large countries. In the basic model each country is large in the sense that world market prices are not given but endogenous to changes in any of the countries. To capture the small country case we impose two sets of changes. First, to calculate the TRI of a country we keep prices, income, and production constant in all the trading partners of the country. Second, the terms of trade are held constant by endogenizing international capital flows. We need both changes for the following reason. CES preferences imply that countries (Armington) or firms (Ethier-Krugman/Melitz) have market power. Holding prices and demand in the rest of the world constant to mimic the small country case is not sufficient. This will keep prices on the import side constant but not on the export side. Therefore, it does not sterilize all terms of trade effects. A country reducing import tariffs will reallocate resources across sectors away from import-competing sectors towards the exporting sectors. And exporting more will imply that prices of the exported goods fall, thus affecting the terms of trade. To eliminate this effect in order to mimic a small-country setting with constant international prices we fix the terms of trade.

Table 2: TRI calculated for small and large country case for three trade structures and compared with approximation method KNO09

Region	Code	Small country			Large country			TRI KNO09
		Armington	Eth-Krug	Melitz	Armington	Eth-Krug	Melitz	
East Asia	eaa	4.79	4.76	4.63	13.50	9.90	9.36	4.42
EFTA	eft	1.59	1.07	1.02	0.35	0.68	0.75	1.96
European Union	eu	2.08	2.02	1.95	1.29	1.51	1.71	2.39
Latin America	lam	6.57	6.99	6.84	5.53	5.22	5.58	7.02
North America	nam	2.80	3.15	2.82	1.55	0.98	1.02	2.79
Oceania	oce	2.73	3.02	2.99	1.87	1.09	1.17	3.66
Rest of World	row	6.23	6.27	6.22	5.24	6.92	7.66	6.11
Southeast Asia	sea	3.16	3.08	2.99	2.07	1.40	1.11	3.04
South Asia	soa	12.85	12.34	11.60	3.56	3.96	4.42	8.72
Sub Saharan Africa	ssa	10.22	10.59	10.40	3.68	5.03	5.80	9.83

To compare the TRI under small and large country for the three market structures with the TRI calculated with the approximate formula we use an aggregation with 11 regions and

10 sectors. Table 2 shows that the small country TRIs under different market structures are close to the the TRI calculated with the Kee et al. formula. The differences between the different market structures are also small and do not display a clear pattern. In some countries the Armington-TRI is smaller than the Ethier-Krugman and Melitz TRIs, whereas in other countries it is opposite. Figure 2 illustrates the differences between the simulated small country TRI and the calculated TRI with the formula. It is clear that the two are very close for small tariff levels but that differences become larger for larger tariff levels. In particular, the simulated TRI is larger than the calculated TRI for larger tariff levels.

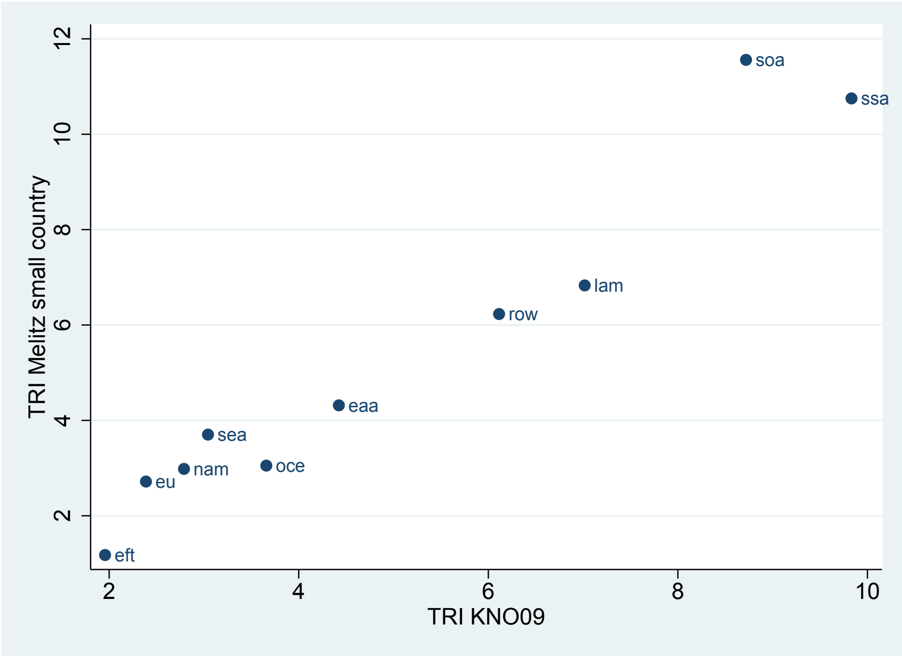

Figure 2: The relation between the TRI calculated with the approximate formula and the TRI calculated with the model in a small country setting

Table 2 shows that the large country TRIs are very different from the small country TRIs. For some countries they are smaller and for other countries they are larger. We should keep in mind that the TRI for a large country corresponds with a uniform tariff level, which is raising welfare for the country imposing the tariff. Figures 3 and 4 make this clear. In the figures we display the change in equivalent variation (EV) for uniform tariffs on the vertical axis as a function of the size of the uniform tariff for both the small country and large country case. We compare the varying EV as a function of the size of th uniform tariff with the constant EV corresponding with the actual level of heterogeneous tariffs, both under the small country and large country case. The intersection point of Small_uniform and Small_het gives us the TRI assuming a small country, whereas the intersection of Large_uniform and Large_het gives TRI for a large country. We have seen in the table that the TRI for a small country is close to the TRI as calculated with the Kee et al. formula. The TRI for a large country, however, typically deviates from the TRI for a small country. We find like Costinot and Rodriguez-Clare that for a large country the TRI is not unique. Welfare first rises with rising tariffs as a result of beneficial terms of trade effects, generating an intersection point and thus one value for the large-country TRI. At a certain level of tariffs the adverse distortionary effects starts to dominate, welfare falls again, thus generating another intersection point and a second value for the large-country TRI. For a small country the beneficial terms of trade effect is absent and welfare falls monotonically in the uniform tariff level, generating a unique intersection point and thus a unique value for the small-country TRI.

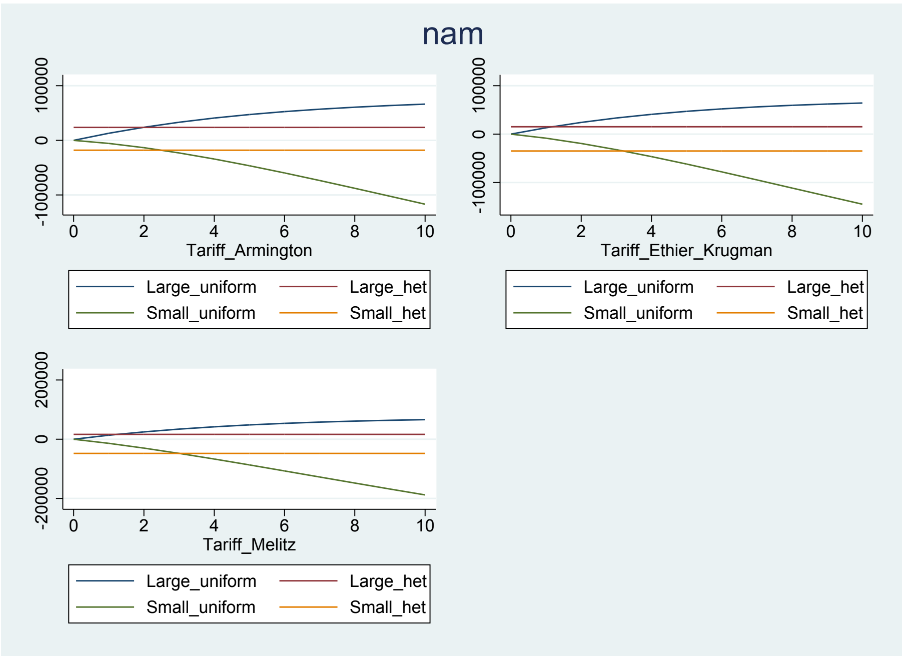

Figure 3: TRI tariffs for large and small country: North America

TRI for large and small country: interpretation

In the simulations we calculate the exact levels of the small country and large country TRIs by fixing the utility level in the importing country and endogenizing the uniform tariff level, both in small country and large country settings. The calculated TRIs are very close to the graphical intersection points in the figures. Since we run the simulations to generate the graphs only a discrete number of times the method where utility is "swapped" with the uniform tariff level as endogenous variable gives more precise values for the TRI.

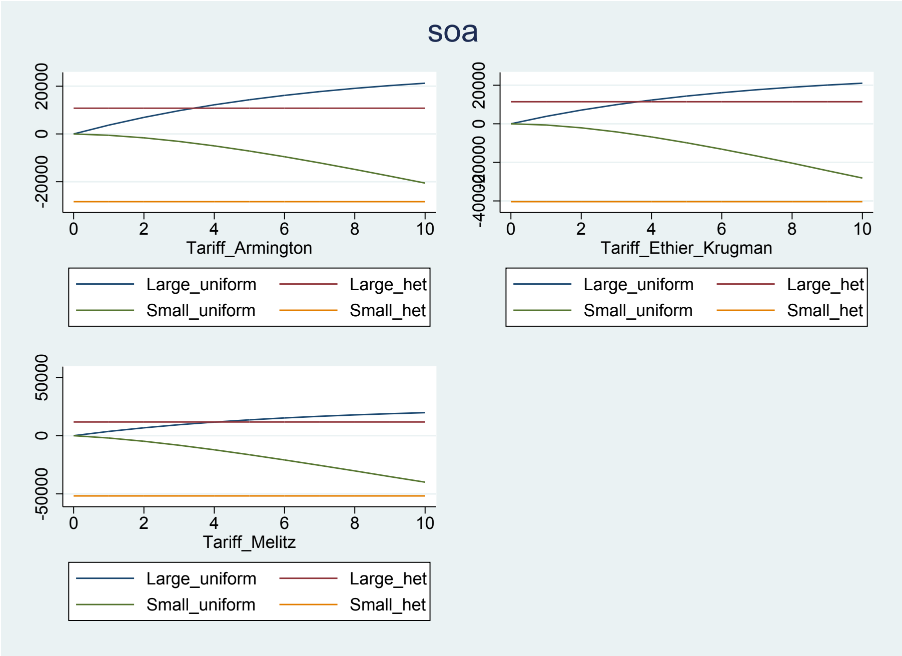

Figure 4: TRI tariffs for large and small country: South Asia

5 NTM-related TRIs

Calulating the TRI for NTMs

Table 3: TRI of hypothetical AVEs of NTMs calculated for small and large country case for three trade structures and compared with approximation method KNO09

Region	Code	Small country			Large country			TRI KNO09
		Armington	Eth-Krug	Melitz	Armington	Eth-Krug	Melitz	
East Asia	eaa	27.43	28.04	27.90	26.00	26.54	26.28	19.19
EFTA	eft	28.94	29.17	28.61	31.25	31.81	30.71	21.04
European Union	eu	28.78	29.91	29.71	27.82	28.56	28.15	18.98
Latin America	lam	33.41	32.94	32.25	35.71	34.42	33.54	20.32
North America	nam	29.09	29.06	28.62	29.09	28.90	28.21	19.69
Oceania	oce	30.99	31.05	30.55	32.96	31.09	30.04	20.34
Rest of World	row	32.17	29.23	28.25	35.87	34.25	33.42	21.65
Southeast Asia	sea	30.96	32.41	32.10	30.68	31.43	30.92	20.66
South Asia	soa	29.83	30.88	30.34	24.96	26.58	25.53	18.16
Sub Saharan Africa	ssa	36.70	36.33	35.04	40.94	44.10	43.61	21.85

In this experiment we assumed 50% iceberg trade costs in agriculture, 20% in manufactures, and 10% in services. We see in Table 3 that for these larger shocks the small country TRI is significantly larger than the TRI calculated with the aproximate formula, something also observed for the country with the largest tariff-TRIs. The table also makes clear that the small country and large country TRIs are much closer to each other for NTMs than for tariffs. This reflects that there are no government revenues affected in the case of NTMs and that the allocative efficiency gains for a liberalizing country are much larger.

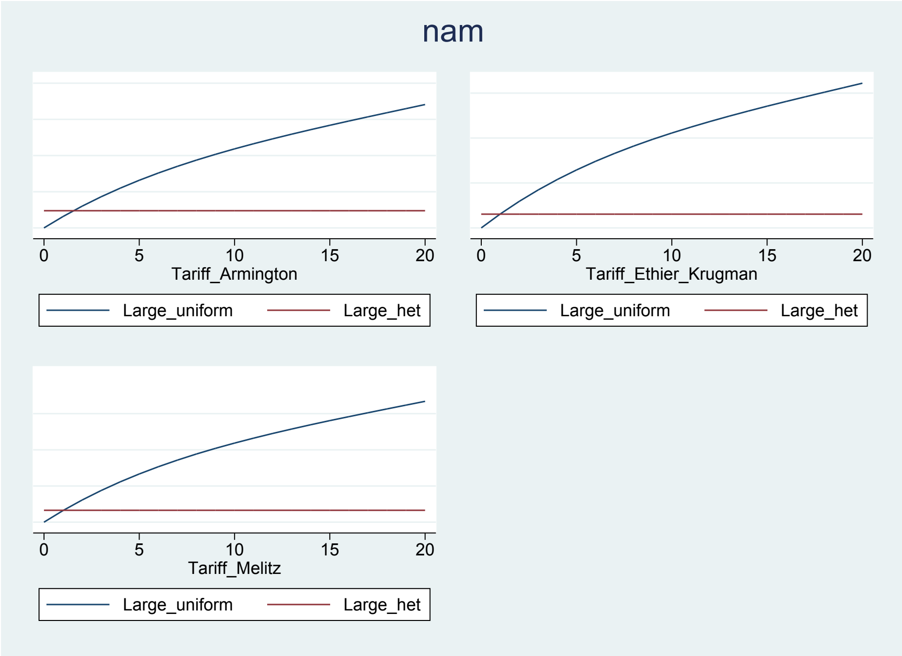

Figure 5: TRI tariffs for large and small country: North America

6 Concluding Remarks

In this paper we have studied different versions of the uniform tariff- and NTM-levels with an identical welfare effect as the actual heterogeneous tariffs and NTMs, the trade restrictiveness index (TRI). The scholars who introduced the concept of the TRI, Anderson and Neary (1996), Anderson (1998), assumed that the importing country is small in the world market (taking world prices as given) and that competition is perfect and goods traded are homogeneous. The main empirical application of the TRI, Kee et al. (2009), calculated the TRI with an approximate formula. We extended these approaches in three different directions, deviating from the assumption of homogeneous goods and perfect competition, deviating from the assumption of a small country, and calculating the TRI based on a quantitative trade model instead of using an approximate formula. We have also estimated the tariff elasticities structurally and calculated the size of NTMs based on the GTAP10 data for 2014 and a novel approach in the literature.

We have come to three main findings. First, the difference between the TRI calculated with the approximate formula and the TRI calculated with the quantitative trade model is small for small to moderate levels of trade costs. However, for trade costs larger than 10% the TRIs calculated with the two approaches start to diverge considerably. Second, the impact of trade/market structure on the TRI is limited. The three market structures (Armington, Ethier-

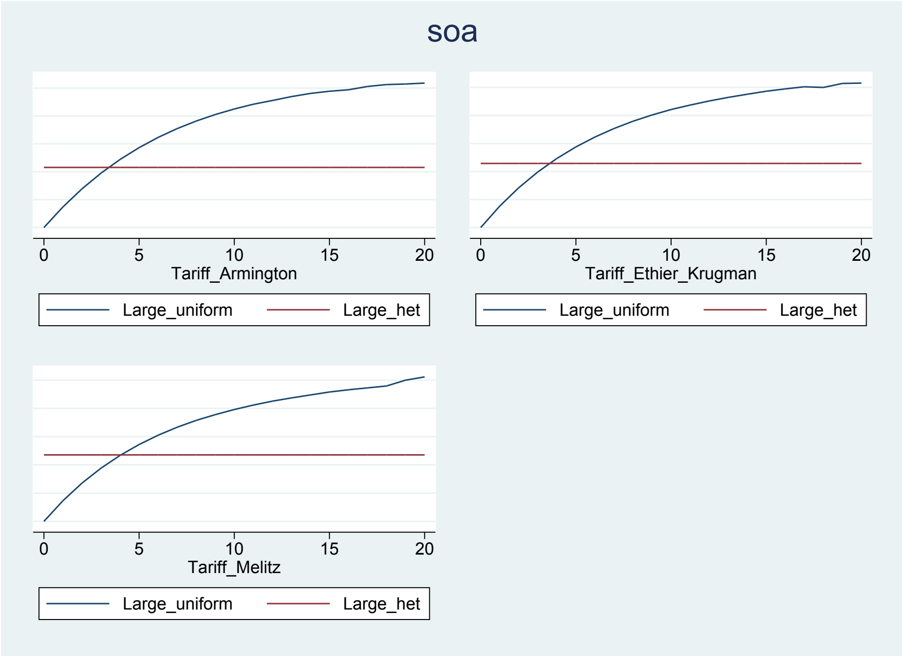

Figure 6: TRI tariffs for large and small country: South Asia

Krugman, and Melitz) generate similar values for the TRI. Third, the TRI is very different in small and large country settings, in particular for the tariff-TRI.

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