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Abstract

We propose a simple method to identify the effects of unilateral and non-discriminatory trade policies on bilateral trade within a theoretically-consistent empirical gravity model. Specifically, we argue that structural gravity estimations should be performed with data that include not only international trade flows but also intra-national trade flows. The use of intra-national sales allows identification of the effects of non-discriminatory trade policies on the importer side (e.g. most favored nation tariffs) and on the exporter side (e.g. export subsidies), even in the presence of exporter and importer fixed effects. An important byproduct of our approach is that it can be used to recover estimates of the export-supply elasticity and of the import-demand elasticity. We demonstrate the effectiveness of our techniques in the case of MFN tariffs and "Time to Export" as representative determinants of trade on the importer and on the exporter side, respectively. Our methods can be extended to quantify the impact on trade of any country-specific characteristics as well as any non-trade policies.

JEL-Codes: F100, F130, F140, F470.

Keywords: gravity model, non-discriminatory trade policies, tariffs, subsidies, time to export, trade elasticity of substitution.

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"In the presence of importer and exporter fixed effects a variety of potentially interesting trade determinants can no longer be identified in a gravity equation. Notably, (1) anything that affects exporters' propensity to export to all destinations (such has having hosted the Olympics or being an island), (2) variables that affect imports without regard to origin, such as country-level average applied tariff, and (3) sums, averages, and differences of country-specific variables. If any variables of these three forms is added to a trade equation estimated with importer and exporter fixed effects, programs such as Stata will report estimates with standard errors. However the estimates are meaningless."

(Head and Mayer, 2014, pp. 157-158)

1 Introduction

Owing to its theoretical microeconomic foundations and remarkable predictive power, the structural gravity model has become the workhorse in the empirical trade literature that studies the effects of various determinants of bilateral trade flows and the impact of trade policies in particular.[1] However, as is evident from the opening quote of our study, despite its popularity and empirical success, the structural gravity equation cannot be used to identify the impact of any unilateral and non-discriminatory trade policies both on the importer side (e.g. MFN tariffs) and on the exporter side (e.g. export subsidies).[2]

This deficiency of the gravity model poses important challenges to comprehensive quantitative trade policy analysis because much of today's trade policy landscape is in fact shaped by various unilateral and non-discriminatory measures. MFN tariffs and export subsidies are but two classic examples. More importantly, as emphasized in a series of public speeches by the former Director General of the World Trade Organization (WTO) Pascal Lamy,[3] the world trade system has evolved from a state of protection (with the producer in mind) to a state of precaution (with the consumer

[1]The structural gravity equation has been derived from a series of alternative theoretical foundations including, but not limited to, Armington-CES, Ricardian, Hekscher-Ohlin, monopolistic competition, heterogeneous firms, intermediate goods, and dynamic settings. The corresponding empirical gravity equation consistently delivers strong fit (of 60 to 90 percent) with aggregate data but also with sectoral data for both goods and for services. We refer the reader to Anderson (2011), Costinot and Rodríguez-Clare (2014), Head and Mayer (2014), and Yotov et al. (2016) for recent gravity surveys.

[2]As pointed out by Head and Mayer (2014), the effects of such policies cannot be identified within the structural gravity model because they are perfectly collinear with and absorbed by the importer and/or by the exporter fixed effects, which have to be included in gravity estimations to control for the multilateral resistance terms of Anderson and van Wincoop (2003).

[3]See for example the WTO News Speech Release at https://www.wto.org/english/news_e/sppl_e/sppl243_e.htm, as well as the reactions to Lamy's speeches at https://invisiblegreenhand.wordpress.com/2015/03/18/the-new-world-trade-order-is-about-precaution-not-protection-pascal-lamy/, and at http://www.institutionalinvestor.com/article/3589010/asset-management-macro/free-trade-has-more-support-than-many-think-says-pascal-lamy.html.

in mind), where unilateral trade policies such as sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBTs) are more prominent and more relevant than ever. Similar to the trade policies summarized in the opening quote, the non-discriminatory nature of the SPS measures and the TBTs does not allow identification of their impact on trade within a properly specified (with exporter and importer fixed effects) structural gravity equation.

Motivated by these challenges, the contribution of this paper is to propose a simple method to identify the impact of unilateral and non-discriminatory trade policies on bilateral trade flows within the structural gravity model. Our solution consists of a simple and theoretically-consistent adjustment to gravity estimations. Specifically, we argue that gravity regressions should be estimated with data that include not only international trade flows but also *intra-national* sales, too. As we demonstrate in the methodological Section 3.1, the use of intra-national trade allows identification of unilateral and non-discriminatory trade policies even in the presence of importer and exporter fixed effects, since the trade policies apply only to international trade flows, while the fixed effects are defined for both international as well as intra-national observations. In other words, our identification strategy relies on the fact that while trade policies may be unilateral and non-discriminatory, they only apply to international trade, and not to domestic sales.

We demonstrate the effectiveness of our methods in Section 3.3, where we obtain estimates of the effects of MFN tariffs and "Time to Export" (TTE) as representative unilateral and non-discriminatory policies on the importer and on the exporter side, respectively.[4] To perform the empirical analysis, we build a data set of consistently constructed international and intra-national manufacturing trade flows. Intra-national trade flows are calculated as apparent consumption, which is equal to the difference between the values of gross manufacturing production (which come from UNIDO's INDSTAT2 Industrial Statistics Database) and total exports (which come from the United Nation's COMTRADE database).[5]

[4]Data on MFN tariffs, as the most widely used tariff policy, come from UNCTAD's Trade Analysis Information System (TRAINS). On the exporter side, we focus on "Time to Export", defined as the number of days it takes to export a standardized cargo of merchandise. We use this variable because it is a non-discriminatory and country-specific determinant of exports for which data are available for many countries and over a long period of time. The TTE data come from the Doing Business Report within the World Development Indicators (WDI) Database of the World Bank.

[5]We offer a detailed description of our data in Section 3.2. It should be emphasized that databases that offer consistently constructed international and intra-national trade flows are more widely available and accessible nowadays. Two examples include the GTAP database and the WIOD database.

Our most important result is that we can indeed identify the estimates of the effects of both non-discriminatory trade-policy variables (MFN tariffs and TTE), in the presence of importer and exporter fixed effects, without any collinearity issues. In addition, we note that, in accordance with our intuition and despite the fact that our covariates were selected for methodological and demonstrative purposes, the estimates of the effects of MFN tariffs and "Time to Export" have the expected negative signs; they are statistically significant; and they also have plausible economic magnitudes. In particular, our preferred econometric specifications deliver estimates of the impact of MFN tariffs that are used to obtain structural values for the trade elasticity parameter of around 4.3 to 6.9, which are readily comparable to corresponding estimates from the existing literature.[6] Furthermore, our preferred estimates of the coefficient on "Time to Export" reveal that an additional day of time to export reduces trade flows by around 3.5 percent.

The contribution of this paper is related to several strands of the literature. First, from a methodological perspective, our approach improves on three existing methods to identify the impact of unilateral policies and country-specific characteristics within the gravity literature: (i) Numerous papers have used country-specific variables directly in a-theoretic empirical gravity models that do not control for the multilateral resistances (MRs) and, therefore, deliver estimates that are potentially biased and subject to the critique of Anderson and van Wincoop (2003). In relation to these papers, our methods allow identification of the effects of country-specific variables even in the presence of exporter and importer fixed effects, which control for the MRs; (ii) Some authors have constructed new *dyadic variables* as combinations of the country-specific variables of interest.[7] The coefficients of the new bilateral variables can be estimated in the presence of exporter and importer fixed effects. However, this approach does not allow for interpretation of the impact of the country-specific variables. Our contribution in relation to this literature is that our methods allow for direct identification and clear interpretation of the effects of country-specific variables without the need of bilateral transformations; (iii) Finally, a third group of papers have implemented a two-stage

[6]For example, Head and Mayer (2014) offer a summary meta-analysis estimate of the elasticity of substitution $\sigma = 6.13$.

[7]For example, Rauch and Trindade (2002) identify the effects of ethnic networks on bilateral trade by the product of the ethnicity share in the two counties. Similarly, Anderson and Marcouiller (2002) construct a dyadic ratio variable for the strength of institutions for defending trade. Djankov et al. (2010) estimate the impact of the ratio of time to export of two countries exporting to a third country by using the ratio of the two countries' exports.

estimation approach where, in the first step, the appropriate set of exporter and importer fixed effects are included in the gravity regression, and then, in the second step, the fitted values of the fixed effects are regressed on the policy variables of interest which could not be included in the first step.[8] Even if the first-stage fixed effects are estimated consistently,[9] the two-step approach has been criticized because its asymptotic properties have not yet been established formally. Furthermore, if the first-stage gravity estimates are obtained with the PPML estimator, which has become the standard for gravity regressions (see Santos Silva and Tenreyro, 2006), then the fixed effects can be predicted perfectly in the second stage by the the structural gravity terms (i.e. by size and the MRs, see Fally, 2015) and, therefore, identification of other country specific variables in the second stage is not possible.

Second, from a practical perspective and as emphasized above, our methods allow for identification of the impact of non-discriminatory and unilateral trade policies on the exporter side and on the importer side. Thus, our work contributes to the literature on the trade effects of MFN tariffs (see for example Augier et al., 2005) as well as to the literature concerning trade facilitation (see for examples Wilson et al., 2005; Martinez-Zarzoso and Márquez-Ramos, 2008; Djankov et al., 2010) by allowing for estimation of the effects of such policies directly within the structural gravity model. While the focus of the analysis in this paper is on *trade policies*, our methods can be extended and applied more broadly to obtain estimates of the effects on trade of any country-specific characteristics (e.g. size and institutions) as well as any non-trade policies (e.g. value added taxes and exchange rates), thus having much broader implications and contributing to a much wider literature.

Third, a potentially important byproduct of our approach is that it can be used to obtain estimates of the elasticity of substitution, which is the single most important parameter in the international trade literature, see Arkolakis et al. (2012). Since MFN tariffs are a direct price-shifter, gravity theory can be used to recover the elasticity of substitution directly from the estimate of the coefficient on MFN tariffs.[10] Thus, we contribute to the literature that aims at estimating trade

[8] Examples include Eaton and Kortum (2002), Head and Ries (2008), Anderson and Yotov (2012), and Head and Mayer (2014).

[9] Only recently the consistency of the model parameter estimates in nonlinear panel models with two types of fixed effects has been shown by Fernández-Val and Weidner (2016).

[10] We refer the reader to Heid and Larch (2016) for a formal derivation of the structural gravity system with tariffs.

elasticities.[11] While bilateral measures of effectively applied tariffs have previously been used to identify the trade elasticity in structural gravity frameworks, e.g. de Sousa et al. (2012), Egger and Larch (2012), Aichele et al. (2014), and Heid and Larch (2016) to date MFN tariffs have not been used as the literature so far has focused on estimating gravity models using *inter*national trade data only and, as noted above, the effects of MFN tariffs in such settings are absorbed by the importer or importer-time fixed effects in structural gravity models. The ability to use MFN tariffs has several practical advantages. Specifically, MFN tariffs are the predominant form of non-discriminatory trade policy. In addition, MFN tariff data are widely accessible and available over a long period of time and for a wide range of countries.

Fourth, with appropriate data on export support (e.g. with data on export subsidies, which may also take the form of direct price shifters), our methods can also be used to recover estimates of the export supply elasticities, which have been of significantly lower interest to the trade profession. Exceptions to this include Kee et al. (2004), Broda et al. (2006), Tokarick (2014), Imbs and Mejean (2015), and Imbs and Mejean (2017). The ability of our method to recover estimates of the import demand elasticities and of the export supply elasticities has broader implications for trade policy analysis because our approach enables researchers to perform general equilibrium simulation experiments with elasticity parameters that have been obtained within the same theory-consistent structural estimation framework.

Finally, our work is related to a literature that already has capitalized on some of the benefits of using intra-national trade flows within the structural gravity model.[12] For example: Anderson and van Wincoop (2003), de Sousa et al. (2012) and Anderson et al. (2015) use intra-national trade data to estimate border effects; Anderson and Yotov (2010) use intra-provincial and inter-provincial sales

[11] See for example Eaton and Kortum (2002), Anderson and van Wincoop (2003), Broda et al. (2006), Kee et al. (2008) and Simonovska and Waugh (2014). Costinot and Rodríguez-Clare (2014) and Head and Mayer (2014) provide discussions of the available estimates of the elasticity of substitution and trade elasticity parameter.

[12] While the current literature review focuses on the most closely related papers from a methodological perspective, we also note that our work is related to a recent and more broad literature that recognizes the importance of intra-national trade frictions. For example, Ramondo et al. (2016) demonstrate that the standard findings (i) that larger countries should be richer than smaller countries and (ii) that real income per capita increases too steeply with country size, disappear when intra-national trade costs are taken into account. Donaldson (2016) studies the implications of intra-national trade costs in the form of railroad network in India for productivity and welfare. Coşar and Demir (2016) and Coşar and Fajgelbaum (2016) consider the impact improvements in transportation infrastructure and internal geography when trade must pass through gateway locations.

to study the impact of trade liberalization within Canada; Yotov (2012) uses intra-national trade flows to resolve 'the distance puzzle' in international trade; Dai et al. (2014) employ domestic sales in order to identify the impact of free trade agreements; finally, Bergstrand et al. (2015) rely on intra-national trade flows in order to identify the impact of globalization and the evolution of international borders over time. A common feature of all of these studies is that they use intra-national trade flows data in order to identify the impact of *bilateral* variables within the structural gravity model. Thus, the analysis in none of the above-mentioned studies is subject to the challenges from the motivational quote of our paper. Instead, the contribution of our work is exactly to address these challenges by recognizing and highlighting the ability of the structural gravity model to identify the impact of *unilateral and non-discriminatory* trade policies.

The rest of the paper is organized as follows. Section 2 briefly reviews the structural gravity theory (in Section 2.1) and illustrates our identification strategy (in Section 2.2). Section 3 introduces our econometric specification (in Section 3.1), describes our data (in Section 3.2), and presents the empirical applications to MFN tariffs and TTE (in Section 3.3). Finally, Section 4 concludes with summary remarks and directions for possible extensions and future work.

2 Theoretical Foundation and Identification Strategy

We start with a brief review of the theoretical foundations of the structural gravity model. Then, more importantly, in Section 2.2 we discuss the issues with the identification of the effects of non-discriminatory trade policies within the structural gravity model and we offer a simple solution to overcome these challenges.

2.1 Theoretical Foundation

As demonstrated in the seminal paper of Arkolakis et al. (2012), and as summarized in the survey articles of Head and Mayer (2014) and Costinot and Rodríguez-Clare (2014), a large class of trade models lead to the following structural gravity equation for bilateral trade flows X_{ij} from country

i to j:

$$X_{ij} = \frac{Y_i}{\Omega_i}\frac{E_j}{P_j}\mathcal{T}_{ij}, \tag{1}$$

were $\mathcal{T}_{ij}$ is a function of bilateral trade costs between i and j, including both tariffs and non-tariff trade costs. Structural gravity models impose the condition that the value of production in country i equals its total sales to all countries, including domestic sales, $Y_i = \sum_j X_{ij}$, and that expenditure in country j equals the sum over all imports, $E_j = \sum_i X_{ij}$. Ω_i and P_j are outward and inward multilateral resistance terms which are defined by the following system of equations:

$$\Omega_i = \sum_m P_m^{-1}\mathcal{T}_{im}E_m, \quad P_j = \sum_m \Omega_m^{-1}\mathcal{T}_{mj}Y_m. \tag{2}$$

The same equations apply at the aggregate and sector level when according measures of sectoral production and expenditure are used.

The final step in defining an operational structural gravity model is to define bilateral trade costs $\mathcal{T}_{ij}$. In general, $\mathcal{T}_{ij}$ can be decomposed into two parts:

$$\mathcal{T}_{ij} = \tau_{ij}^{\epsilon_1}T_{ij}^{\epsilon_2}, \tag{3}$$

where τ_{ij} is a direct demand shifter, for example MFN tariffs, in which case τ_{ij} is equal to 1 + the *ad-valorem* MFN tariff rate. ϵ_1 is a direct measure of the demand elasticity with respect to price. In the Anderson and van Wincoop (2003) structural gravity framework,ϵ_1 is equal to $-\sigma$, the elasticity of substitution between varieties from different countries. T_{ij} is a measure of non-tariff barriers. Many researchers specify non-tariff barriers as a function of, inter alia, bilateral (log) distance between countries, whether countries share a common border, language, colonial history or trade agreement membership. In general,

$$T_{ij} = \prod_f t_{ij,f}^{\delta_f}, \tag{4}$$

where $t_{ij,f}$ denotes individual measures of non-tariff barriers as mentioned above, and δ_f is the corresponding tariff equivalent trade cost elasticity of barrier f. Again, in the Anderson and van Wincoop (2003) framework, ϵ_2 equals $(1-\sigma)$. The different elasticities between tariffs and non-tariff barriers stem from the fact that tariffs are paid by the consumer and hence are applied to the price of goods including trade costs, whereas non-tariff trade costs are borne by the producer.[13] As is well known by now (see e.g. Arkolakis et al., 2012 and Head and Mayer, 2014), using the Eaton and Kortum (2002) framework replaces $(1-\sigma)$ by $-\theta$, a parameter which measures the variability of productivity across countries. For expositional convenience, we will stick to the Anderson and van Wincoop (2003) framework from now on. However, we note that our methods to identify the impact of non-discriminatory trade policies are independent of the specific theoretical micro-foundations of the structural gravity model. Thus, for example, the elasticity of substitution between varieties that we will obtain in the empirical analysis below can also be interpreted as a method to estimate the technology parameter θ.

2.2 Identification Strategy

Our identification strategy is best demonstrated by an example. We first show that our method works in a cross-section setting, then we discuss an extension to applications with panel data. Consider a cross-sectional bilateral trade data set that consists of trade flows between three countries $\{A, B, C\}$, including both domestic sales as well as international trade flows. The goal is to demonstrate that we can estimate the effect of MFN tariffs on trade flows while controlling for the structural multilateral resistance terms by including a full set of exporter and importer fixed effects. The following is a representative relevant excerpt of the data matrix:

[13] The actual incidence of trade costs and tariffs is a different matter, see Anderson and Yotov (2010).

$$
\begin{array}{cccc}
\# & \text{exporter} & \text{importer} & \begin{array}{cccccccc} \eta_1 & \eta_2 & \eta_3 & \mu_1 & \mu_2 & \mu_3 & I & \ln\tau^{MFN}\times I \end{array} \\
\begin{array}{c} 1\\2\\3\\4\\5\\6\\7\\8\\9 \end{array} &
\begin{array}{c} A\\A\\B\\B\\C\\C\\A\\B\\C \end{array} &
\begin{array}{c} B\\C\\A\\C\\A\\B\\A\\B\\C \end{array} &
\begin{bmatrix}
1 & 0 & 0 & 0 & 1 & 0 & 1 & \ln\tau_B^{MFN} \\
1 & 0 & 0 & 0 & 0 & 1 & 1 & \ln\tau_C^{MFN} \\
0 & 1 & 0 & 1 & 0 & 0 & 1 & \ln\tau_A^{MFN} \\
0 & 1 & 0 & 0 & 0 & 1 & 1 & \ln\tau_C^{MFN} \\
0 & 0 & 1 & 1 & 0 & 0 & 1 & \ln\tau_A^{MFN} \\
0 & 0 & 1 & 0 & 1 & 0 & 1 & \ln\tau_B^{MFN} \\
1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 1 & 0 & 0
\end{bmatrix}
\end{array}
\qquad (5)
$$

Column one identifies the observations. Columns “exporter” and “importer” denote the respective exporting and importing country. η_1 to η_3 are the exporter dummies/exporter fixed effects, while μ_1 to μ_3 are the importer dummies/importer fixed effects. I is an indicator variable which is one if the trade flow is international, and zero for intra-national trade flows. The last column is our regressor of interest, i.e., the non-discriminatory unilateral MFN tariff vector τ^{MFN}, which, by definition, is set to zero for all intra-national trade flows. Note that when estimating structural gravity models we have to drop one of the exporter or importer dummies due to perfect collinearity. This is a standard collinearity concern, which is independent of trying to identify non-discriminatory trade policy. Without loss of generality, our choice in the subsequent analysis is to drop the fixed effect η_3. We note, however, that our methods apply regardless of this normalization choice.

We start with a brief demonstration of why standard gravity analyses are unable to identify the impact of non-discriminatory trade policies. Typically, researchers only use international trade flows, i.e. observations one to six. Hence, the corresponding data matrix can be represented as follows:

$$\begin{array}{ccc} \# & \text{exporter} & \text{importer} \\ 1 & A & B \\ 2 & A & C \\ 3 & B & A \\ 4 & B & C \\ 5 & C & A \\ 6 & C & B \end{array} \begin{array}{c} \begin{array}{cccccc} \eta_1 & \eta_2 & \mu_1 & \mu_2 & \mu_3 & \ln \tau^{MFN} \end{array} \\ \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & \ln \tau_B^{MFN} \\ 1 & 0 & 0 & 0 & 1 & \ln \tau_C^{MFN} \\ 0 & 1 & 1 & 0 & 0 & \ln \tau_A^{MFN} \\ 0 & 1 & 0 & 0 & 1 & \ln \tau_C^{MFN} \\ 0 & 0 & 1 & 0 & 0 & \ln \tau_A^{MFN} \\ 0 & 0 & 0 & 1 & 0 & \ln \tau_B^{MFN} \end{bmatrix} \end{array} \tag{6}$$

Inspection of the relationships in matrix (6) reveals that the non-discriminatory MFN tariff vector, $\ln \tau^{MFN}$, is perfectly collinear with the set of vectors of the importer dummies, μ_1, μ_2, and μ_3:

$$\mu_1 \ln \tau_A^{MFN} + \mu_2 \ln \tau_B^{MFN} + \mu_3 \ln \tau_C^{MFN} = \ln \tau^{MFN}. \tag{7}$$

Thus, due to perfect collinearity, it is impossible to identify the impact of MFN tariffs in a typical gravity specification that only uses international trade data and employs a proper set of exporter and importer fixed effects to control for the unobservable multilateral resistance terms. This is exactly the reason that motivated the opening quote in our paper by Head and Mayer (2014).

Next, we offer a simple (and theoretically consistent) adjustment to structural gravity specifications that will enable us to identify the effects of non-discriminatory trade policies, such as MFN tariffs, even in the presence of exporter and importer fixed effects. Specifically, we demonstrate that adding *intra-national* trade flow observations breaks the perfect multicollinearity from our previous example. Adding intra-national trade flows to matrix (6) obtains:

$$
\begin{array}{ccc}
\# & \text{exporter} & \text{importer} \\
1 & A & B \\
2 & A & C \\
3 & B & A \\
4 & B & C \\
5 & C & A \\
6 & C & B \\
7 & A & A \\
8 & B & B \\
9 & C & C
\end{array}
\begin{array}{c}
\begin{array}{ccccccc} \eta_1 & \eta_2 & \mu_1 & \mu_2 & \mu_3 & I & \ln\tau^{MFN}\times I \end{array} \\
\begin{bmatrix}
1 & 0 & 0 & 1 & 0 & 1 & \ln\tau_B^{MFN} \\
1 & 0 & 0 & 0 & 1 & 1 & \ln\tau_C^{MFN} \\
0 & 1 & 1 & 0 & 0 & 1 & \ln\tau_A^{MFN} \\
0 & 1 & 0 & 0 & 1 & 1 & \ln\tau_C^{MFN} \\
0 & 0 & 1 & 0 & 0 & 1 & \ln\tau_A^{MFN} \\
0 & 0 & 0 & 1 & 0 & 1 & \ln\tau_B^{MFN} \\
1 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0
\end{bmatrix}
\end{array}
\tag{8}
$$

Here, observations 7-9 represent the additional observations for intra-national trade. If MFN tariffs were perfectly collinear with the rest of the variables in matrix (8), then there would have to exist a non-zero solution, $\alpha_1^*, \alpha_2^*, ..., \alpha_7^*$, for the following system of equations:

$$\alpha_1^*\eta_1 + \alpha_2^*\eta_2 + \alpha_3^*\mu_1 + \alpha_4^*\mu_2 + \alpha_5^*\mu_3 + \alpha_6^* I + \alpha_7^* \ln\tau^{MFN} \times I = 0. \tag{9}$$

In other words, if MFN tariffs were perfectly collinear with the rest of the variables in matrix (8), then the vector $\ln\tau^{MFN} \times I$ could be expressed as a linear combination of the dummies:

$$\alpha_1\eta_1 + \alpha_2\eta_2 + \alpha_3\mu_1 + \alpha_4\mu_2 + \alpha_5\mu_3 + \alpha_6 I = \ln\tau^{MFN} \times I, \tag{10}$$

where $\alpha_1 = -\alpha_1^*/\alpha_7^*$, ..., $\alpha_6 = -\alpha_6^*/\alpha_7^*$.

We now prove that non-discriminatory tariffs are linearly independent from the dummies by contradiction.[14] Focus on observation 9 in matrix (8). To express the last column as a linear combination of the remaining columns, α_5 has to be equal to zero. In addition, to fulfill Equation (10) for observation 8, it follows that $\alpha_2 = -\alpha_4$. Similarly, it follows from observation 7 that $\alpha_1 = -\alpha_3$. We then can re-express Equation (10) in matrix form as:

[14]The remaining analysis is performed under the realistic assumption that there is sufficient variation in the MFN tariffs and they do take non-zero and different values, i.e., we exclude the trivial cases of multicollinearity.

$$
\begin{array}{ccc|ccccccccccccc}
\# & \text{exp.} & \text{imp.} & \alpha_1\eta_1 & + & \alpha_2\eta_2 & + & \alpha_3\mu_1 & + & \alpha_4\mu_2 & + & \alpha_5\mu_3 & + & \alpha_6 I & = & \ln\tau^{MFN}\times I \\
1 & A & B & \alpha_1 & + & 0 & + & 0 & + & -\alpha_2 & + & 0 & + & \alpha_6 & = & \ln\tau_B^{MFN} \\
2 & A & C & \alpha_1 & + & 0 & + & 0 & + & 0 & + & 0 & + & \alpha_6 & = & \ln\tau_C^{MFN} \\
3 & B & A & 0 & + & \alpha_2 & + & -\alpha_1 & + & 0 & + & 0 & + & \alpha_6 & = & \ln\tau_A^{MFN} \\
4 & B & C & 0 & + & \alpha_2 & + & 0 & + & 0 & + & 0 & + & \alpha_6 & = & \ln\tau_C^{MFN} \\
5 & C & A & 0 & + & 0 & + & -\alpha_1 & + & 0 & + & 0 & + & \alpha_6 & = & \ln\tau_A^{MFN} \\
6 & C & B & 0 & + & 0 & + & 0 & + & -\alpha_2 & + & 0 & + & \alpha_6 & = & \ln\tau_B^{MFN} \\
7 & A & A & \alpha_1 & + & 0 & + & -\alpha_1 & + & 0 & + & 0 & + & 0 & = & 0 \\
8 & B & B & 0 & + & \alpha_2 & + & 0 & + & -\alpha_2 & + & 0 & + & 0 & = & 0 \\
9 & C & C & 0 & + & 0 & + & 0 & + & 0 & + & 0 & + & 0 & = & 0
\end{array} \qquad (11)
$$

It is clear from system (11) that the equations corresponding to observations 7 to 9 fulfill the condition for perfect collinearity.

Next, focus on observations 1 and 6. From these two lines we see that they can only sum up to $\ln\tau_B^{MFN}$ if $\alpha_1 = 0$. This, in turn, implies that, from equations corresponding to observations 2 and 4, α_2 has to be equal to zero for perfect multicollinearity. Now we are left with α_6, which would have to take three different values in order to fulfill equations 1 to 6. Thus, the only solution for the system of equations in (10) is the trivial solution that $\alpha_1^* = ... = \alpha_7^* = 0$, implying that a non-discriminatory MFN tariff is linearly independent from the set of exporter and importer dummies when including intra-national trade flows.

The MFN tariff is an example for a non-discriminatory trade policy which is identical across all exporting countries for a specific importer. A similar line of reasoning can be applied to show that a non-discriminatory trade policy on the exporter side, such as export subsidies or time-to-export, can be identified. For brevity of exposition we delegate the detailed analysis of the collinearity issues on the exporter side to Appendix A.

Next, we extend the analysis to demonstrate that our methods can be used to identify simultaneously both, non-discriminatory importer policies as well as non-discriminatory exporter policies in the presence of the full set of exporter and importer fixed effects. The corresponding representative data matrix takes the form:

$$
\begin{array}{ccc}
\# & \text{exporter} & \text{importer} \\
1 & A & B \\
2 & A & C \\
3 & B & A \\
4 & B & C \\
5 & C & A \\
6 & C & B \\
7 & A & A \\
8 & B & B \\
9 & C & C
\end{array}
\quad
\begin{array}{c}
\begin{array}{cccccccc}
\eta_1 & \eta_2 & \mu_1 & \mu_2 & \mu_3 & I & \tau^{TTE} \times I & \ln \tau^{MFN} \times I
\end{array} \\
\begin{bmatrix}
1 & 0 & 0 & 1 & 0 & 1 & \tau_A^{TTE} & \ln \tau_B^{MFN} \\
1 & 0 & 0 & 0 & 1 & 1 & \tau_A^{TTE} & \ln \tau_C^{MFN} \\
0 & 1 & 1 & 0 & 0 & 1 & \tau_B^{TTE} & \ln \tau_A^{MFN} \\
0 & 1 & 0 & 0 & 1 & 1 & \tau_B^{TTE} & \ln \tau_C^{MFN} \\
0 & 0 & 1 & 0 & 0 & 1 & \tau_C^{TTE} & \ln \tau_A^{MFN} \\
0 & 0 & 0 & 1 & 0 & 1 & \tau_C^{TTE} & \ln \tau_B^{MFN} \\
1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0
\end{bmatrix}
\end{array}
\tag{12}
$$

Following the exposition of the previous case, we first note that perfect collinearity would exist if $\ln \tau^{MFN} \times I$ can be expressed as a linear combination of the dummies and $\tau^{TTE} \times I$, i.e., if:

$$
\alpha_1 \eta_1 + \alpha_2 \eta_2 + \alpha_3 \mu_1 + \alpha_4 \mu_2 + \alpha_5 \mu_3 + \alpha_6 I + \alpha_7 \tau^{TTE} \times I = \ln \tau^{MFN} \times I, \tag{13}
$$

where $\alpha_1 = -\alpha_1^*/\alpha_8^*$, ..., $\alpha_7 = -\alpha_7^*/\alpha_8^*$.

Focus on observation 9 in matrix (12). To express the last column as a linear combination of the remaining columns, α_5 has to be equal to zero. In addition, to fulfill Equation (13) for observation 8, it follows that $\alpha_2 = -\alpha_4$. Similarly, it follows from observation 7 that $\alpha_1 = -\alpha_3$. We then can re-express Equation (13) in matrix form as:

$$
\begin{array}{ccc|ccccccccccccccc}
\# & \text{exp.} & \text{imp.} & \alpha_1\eta_1 & + & \alpha_2\eta_2 & + & \alpha_3\mu_1 & + & \alpha_4\mu_2 & + & \alpha_5\mu_3 & + & \alpha_6 I & + & \alpha_7\tau^{TTE}\times I & = & \ln\tau^{MFN}\times I \\
1 & A & B & \alpha_1 & + & 0 & + & 0 & + & -\alpha_2 & + & 0 & + & \alpha_6 & + & \alpha_7\tau_A^{TTE} & = & \ln\tau_B^{MFN} \\
2 & A & C & \alpha_1 & + & 0 & + & 0 & + & 0 & + & 0 & + & \alpha_6 & + & \alpha_7\tau_A^{TTE} & = & \ln\tau_C^{MFN} \\
3 & B & A & 0 & + & \alpha_2 & + & -\alpha_1 & + & 0 & + & 0 & + & \alpha_6 & + & \alpha_7\tau_B^{TTE} & = & \ln\tau_A^{MFN} \\
4 & B & C & 0 & + & \alpha_2 & + & 0 & + & 0 & + & 0 & + & \alpha_6 & + & \alpha_7\tau_B^{TTE} & = & \ln\tau_C^{MFN} \\
5 & C & A & 0 & + & 0 & + & -\alpha_1 & + & 0 & + & 0 & + & \alpha_6 & + & \alpha_7\tau_C^{TTE} & = & \ln\tau_A^{MFN} \\
6 & C & B & 0 & + & 0 & + & 0 & + & -\alpha_2 & + & 0 & + & \alpha_6 & + & \alpha_7\tau_C^{TTE} & = & \ln\tau_B^{MFN} \\
7 & A & A & \alpha_1 & + & 0 & + & -\alpha_1 & + & 0 & + & 0 & + & 0 & + & 0 & = & 0 \\
8 & B & B & 0 & + & \alpha_2 & + & 0 & + & -\alpha_2 & + & 0 & + & 0 & + & 0 & = & 0 \\
9 & C & C & 0 & + & 0 & + & 0 & + & 0 & + & 0 & + & 0 & = & 0 & = & 0
\end{array}
\tag{14}
$$

System (14) implies that the equations corresponding to observations 7 to 9 fulfill the condition for perfect collinearity. Next, focus on observations 1 and 6. Assuming that $\tau_A^{TTE} \neq \tau_B^{TTE} \neq \tau_C^{TTE} \neq \ln\tau_A^{MFN} \neq \ln\tau_B^{MFN} \neq \ln\tau_C^{MFN} \neq 0$, we find the following solution (which can be checked by plugging in into observations 1 to 6): $\alpha_1 = \ln\tau_C^{MFN} - \ln\tau_A^{MFN}$, $\alpha_2 = \ln\tau_C^{MFN} - \ln\tau_B^{MFN}$, $\alpha_6 = \frac{\tau_A^{TTE}\ln\tau_C^{MFN} - \tau_C^{TTE}\ln\tau_A^{MFN}}{\tau_A^{TTE} - \tau_C^{TTE}}$, and $\alpha_7 = \frac{\ln\tau_A^{MFN} - \alpha_6}{\tau_A^{TTE}}$ with $\tau_A^{TTE} = \frac{\tau_B^{TTE}\ln\tau_A^{MFN} - \tau_C^{TTE}\ln\tau_A^{MFN} + \tau_C^{TTE}\ln\tau_B^{MFN} - \tau_B^{TTE}\ln\tau_C^{MFN}}{\ln\tau_B^{MFN} - \ln\tau_C^{MFN}}$. Thus, in theory, there could exist a realization of the data for which perfect collinearity would not allow identification of the impact of MFN tariffs and TTE simultaneously. Note however, that this would only happen if there were a specific functional dependence between the exporter-specific non-discriminatory trade policies across countries. This is unlikely to hold in practice as trade policies like tariffs are typically not set in such a systematic manner across countries.[15] In sum, we attach zero probability to the existence of a combination of data that satisfies these conditions, which implies that MFN tariffs are not perfectly collinear with the rest of the variables in (14).[16] Thus, we have demonstrated that it is possible to identify the effects of non-discriminatory

[15]Compare this to the typical dummy variable trap, where e.g., the dummy $FEMALE$ is a function of $1 - MALE$.

[16]There are other solutions for specific data constellations. For example, if $\ln\tau_B^{MFN} = \ln\tau_C^{MFN}$ and $\tau_B^{TTE} = \tau_C^{TTE}$, a solution is $\alpha_1 = \ln\tau_C^{MFN} - \ln\tau_A^{MFN}$, $\alpha_2 = 0$, $\alpha_6 = (\tau_A^{TTE}\ln\tau_C^{MFN} - \tau_C^{TTE}\ln\tau_A^{MFN})/(\tau_A^{TTE} - \tau_C^{TTE})$, $\alpha_7 = (\ln\tau_A^{MFN} - \alpha_6)/\tau_A^{TTE}$. In each of these cases to hold, there would either have to be one or more of the variables to be zero and/or the variables would have to take the same values for some of the observations. Therefore, with sufficient variation in the regressors of interest, we can rule these scenarios out.

export and import trade policy at the same time.

The arguments for identification of the effects of non-discriminatory MFN tariffs and TTEs in a cross-section setting that we presented thus far translate to the panel case, where the main difference is that controlling for the unobservable multilateral resistance terms requires the use of exporter-time and importer-time fixed effects. Intuitively, the panel setting can be decomposed into a sequence of cross-section matrices. Furthermore, our methods apply even in the presence of bilateral fixed effects.

To demonstrate the validity of our approach we consider a panel with only two time periods, however, it is straight-forward to extend the analysis to more years. With the two-period panel data, we can apply a first-difference strategy. This will wipe out all of the bilateral fixed effects and also requires us to express all remaining variables in changes. The system in changes that corresponds to Equation (9) is:

$$\alpha_1^*\Delta\mu_1 + \alpha_2^*\Delta\mu_2 + \alpha_3^*\Delta\mu_3 + \alpha_4^*\Delta\eta_1 + \alpha_5^*\Delta\eta_2 + \alpha_6^*\Delta I + \alpha_7^*\Delta\left(\ln\tau^{MFN} \times I\right) = 0. \tag{15}$$

Due to its identical structure, it is clear from Equation (15) that all of the arguments and steps that we took in order to demonstrate the validity of our methods in the cross-section case apply here as well.

3 Empirical Analysis

This section demonstrates the empirical validity of our methods with applications to actual data. Specifically, we consider two non-discriminatory trade policies. On the importer side, we obtain estimates of the effects of MFN tariffs within the structural gravity model. On the exporter side, we obtain estimates of the impact of 'Time To Export' as a representative country-specific and non-discriminatory trade determinant.

3.1 Econometric Specification

To implement our methods, we capitalize and extend on recent developments in the empirical gravity literature. Our departing point is the following estimating equation, which is based on Equation (1):

$$X_{ijt} = \exp\left[\beta_1 \ln \tau_{jt}^{MFN} \times I_{ij} + \beta_2 \tau_{it}^{TTE} \times I_{ij} + \mathbf{GRAV}_{ijt}\gamma + \eta_{it} + \mu_{jt} + \varepsilon_{ijt}\right], \forall i, j. \quad (16)$$

Here, X_{ijt} denotes nominal trade flows from exporter i to importer j at time t. In order to be as general as possible, we set up the estimating equation under the assumption that it will be implemented with panel data. However, in order to demonstrate the validity and robustness of our methods, we also implement Equation (16) in a cross-section setting. A very important difference between Equation (16) and the typical gravity equations from the related empirical literature is that (16) includes not only international trade observations, $(X_{ijt}, j \neq i)$, but internal trade flows observations (X_{iit}) as well. As demonstrated in the previous section, the addition of intra-national trade flows is the key adjustment that will enable us to identify the impact of non-discriminatory trade policies on bilateral trade within (16).

The regressors enter (16) exponentially because we follow Santos Silva and Tenreyro (2006) to estimate the gravity model with the Poisson Pseudo Maximum Likelihood (PPML) estimator. Santos Silva and Tenreyro (2006) demonstrate that, since trade flows exhibit a large degree of heteroscedasticity, estimating a log-linearized version of (16) leads to inconsistent parameter estimates due to Jensen's inequality. Therefore, they propose the use of PPML as an alternative that overcomes this deficiency of the standard OLS estimator. An additional advantage of the PPML estimator is that, since the gravity model is estimated in multiplicative form, PPML enables us to take advantage of the information that is contained in the zero trade flows. The use of any specific estimator does not play a role for the implementation of our methods and does not affect their effectiveness. However, in order to demonstrate the robustness of our approach, in the sensitivity analysis we also obtain estimates using the OLS estimator.

Turning to the covariates in (16): τ_{jt}^{MFN} is defined as one plus the uniform MFN tariff rate that country j levies on all imports that enter the country.[17] In order to emphasize that MFN tariffs do not apply to intra-national trade flows but only to imports from abroad, we interact $\ln \tau_{jt}^{MFN}$ with an indicator variable I_{ij}, which is equal to one for international trade and set to zero for intra-national trade. MFN tariffs fit our purpose perfectly because: (i) MFN tariffs represent a non-discriminatory trade policy; (ii) MFN tariffs are the prevailing form of trade protection via tariffs due to WTO rules; (iii) MFN tariffs are a direct price shifter, which implies that we can recover an estimate of the trade elasticity of substitution from the estimate on MFN tariffs within the structural gravity model; and (iv) finally, data on MFN tariffs is more reliable (as compared to data on other, non-tariff protection measures) as they are easier to measure and more widely available.

τ_{it}^{TTE} is defined as the number of days it takes to export a standardized cargo of merchandise, including the time it takes to go through all official procedures which have to be fulfilled to export the good. Similar to the case of MFN tariffs, we interact τ_{it}^{TTE} with the international border dummy I_{ij}. Thus, by construction, $\tau_{it}^{TTE} \times I_{ij}$ represents a non-discriminatory trade policy variable that only applies to exports.

$\mathbf{GRAV}_{ijt}$ is a vector of variables which includes all standard time-invariant gravity covariates (e.g. the log of bilateral distance, common language, etc.) as well as time-varying determinants of trade (e.g. regional trade agreements (RTAs)). We will experiment by replacing the time-invariant bilateral gravity variables with a full set of pair fixed effects.

Finally, η_{it} denotes the set of exporter fixed effects, which will control for the unobserv-

[17] In our data set, we apply the MFN tariff to all countries to ensure that it really is non-discriminatory across countries. However, we recognize that countries may apply different tariffs, e.g. various preferential rates. Furthermore, in principle, WTO-MFN tariffs only apply to WTO member states. However, many countries apply their MFN tariff also to non-WTO members, and non-WTO member countries report MFN, i.e., non-preferential, tariff rates in TRAINS. As of October 2017, the following countries are not members of the WTO: Algeria, Andorra, Azerbaijan, Bahamas, Belarus, Bhutan, Bosnia and Herzegovina, Comoros, Equatorial Guinea, Eritrea, Ethiopia, Holy See, Iran, Iraq, Kiribati, Lebanese Republic, Libya, Marshall Islands, Micronesia, Monaco, Nauru, North Korea, Palau, Palestine, San Marino, Sao Tomé and Principe, Serbia, Somalia, South Sudan, Sudan, Syria and Uzbekistan. In our data set, of these only Belarus, Eritrea, and Ethiopia are included. We make sure that the MFN tariff rates are non-discriminatory in our data set.

able outward multilateral resistances and also will absorb any other country-specific trade determinants on the exporter side. Similarly, μ_{jt} denotes the set of importer fixed effects, which will control for the unobservable inward multilateral resistances and also will absorb any other country-specific trade determinants on the importer side. ε_{ijt} is a remainder error term.

3.2 Data

In order to perform the empirical analyses, we construct an unbalanced panel data set for 68 countries for the years 2005 to 2012.[18] We start in 2005 because data on one of our main regressors of interest (time to export, TTE) are only available since 2005. We end in 2012 because the production data we need to construct intra-national trade flows end in 2012. Our data cover four key components, including: (i) international trade flows; (ii) intra-national trade flows; (iii) non-discriminatory trade policies; and (iv) standard gravity variables.

International Trade Flows. Data on international trade flows come from the United Nations' COMTRADE database, which is the standard and most comprehensive source for international trade flows data.[19] To create our data set, we keep every country pair observation which we observe at least twice such that the bilateral fixed effects do not perfectly predict bilateral trade flows by construction. We focus on manufacturing trade. The reason is the need to construct proper intra-national trade flows, which we discuss next.

Intra-national Trade Flows. Availability of intra-national trade flows data is crucial for the implementation of our methods. We construct domestic trade flows as apparent consumption, i.e. as the difference between the value of domestic production minus the value of total exports. While it is tempting to obtain aggregate domestic sales as the difference between GDP and total exports, we do not recommend this approach due to the inconsistency between the measure of GDP as value added and the measure of total exports as gross value.

[18]A list of the countries in our data set appears in Section B of the Appendix.

[19]We access UNCOMTRADE via the World Integrated Trade Solution (WITS) website at `http://wits.worldbank.org/default.aspx`.

In other words, in order to construct consistent intra-national trade flows, we need gross production value data. Therefore, we rely on the UNIDO's Industrial Statistics Database (INDSTAT2), which offers cross-country gross production manufacturing data.[20] We also note that, recently, more and more data sets include consistently constructed international and intra-national trade flows. Thus, the implementation of our methods is not limited to the data set that we use for the current analysis. The GTAP database and the WIOD database are two prominent examples.

Non-discriminatory Trade Policy Variables. In order to demonstrate the effectiveness of our methods, we employ two non-discriminatory trade policies; one on the importer side, and one on the exporter side. Our choice of a non-discriminatory importer trade policy is MFN tariffs. As noted earlier, while we do recognize (i) that in some cases countries apply different tariffs, e.g. various preferential rates, instead of MFN tariffs, and (ii) that, in principle, MFN tariffs only apply to WTO member states, in our data set we apply the MFN tariff to all countries to ensure that this variable really is non-discriminatory across countries. Data on MFN tariffs come from UNCTAD's Trade Analysis Information System (TRAINS) which we access via World Integrated Trade Solution (WITS).[21]

Our choice of a non-discriminatory exporter policy variable is time-to-export (TTE). It is part of the World Bank's *Doing Business* project which collects information about measures of business regulation, including policies which impact imports and exports, for a wide range of countries over time.[22] TTE measures the number of days it takes to actually export goods. This includes three distinct parts: 1.) the time it takes to gather all domestic documents needed for exports, 2.) the time to proceed through customs and comply with border regulations, and 3.) the time of domestic transport to the final port of embarkment. The data are collected via questionnaires sent out to exporting firms, port, and customs authorities as well as domestic freight companies. Time measurement of the raw data is

[20] UNIDO's INDSTAT2 database can be accessed via http://www.unido.org/en/resources/statistics/statistical-databases.html.

[21] See `wits.worldbank.org`.

[22] Data can be downloaded at `http://databank.worldbank.org/data/`.

done in hours and is then transformed to days.[23] The TTE variable is available beginning in 2005 only, which is therefore the start year of our panel data set. The crucial aspect of TTE is that it is by definition a non-discriminatory (export) trade policy as it applies to all export destinations in the same way, as there is only one value of TTE which is identical across all export destinations.

Other Data. We also use a series of control variables. In order to perform the main analysis with panel data, we employ bilateral fixed effects that absorb all time-invariant bilateral determinants of trade. However, we cannot use directional bilateral fixed effects in our cross-section regressions. Therefore, in this case, we rely on the set of standard gravity variables from the literature. Specifically, we use data on bilateral distance, common language, contiguity, and colonial ties, which are taken from CEPII's *Distances* Database (see Mayer and Zignago, 2011). An important advantage of CEPII's *Distances* Database for our analysis is that it provides population-weighted distances, which can be used to calculate consistently both bilateral distances as well as internal distances. Finally, our measure of regional trade agreements comes from Mario Larch's Regional Trade Agreements Database from Egger and Larch (2008).[24]

3.3 Estimation Results and Analysis

We demonstrate the effectiveness of our methods in several steps. We start with a standard cross-section specification, where the only non-discriminatory trade policy variable of interest is MFN tariffs. Then, we extend the specification to a panel setting, which is estimated with standard gravity variables and with bilateral fixed effects. In the next step we obtain simultaneously estimates of MFN tariffs, as a representative non-discriminatory trade policy on the importer side, and of TTE, as a representative non-discriminatory trade policy on the exporter side. The empirical analysis concludes with a series of sensitivity experiments,

[23]For a description of the data, see Djankov et al. (2010) and http://www.doingbusiness.org/Methodology/Trading-Across-Borders.

[24]It can be accessed via http://www.ewf.uni-bayreuth.de/en/research/RTA-data/index.html.

where we test the robustness of our findings with respect to the definition of our tariff variable as well as by employing different samples and different estimators.

A first set of estimation results are reported in Table 1. All estimates that are reported in Table 1 are obtained with the PPML estimator and with a complete set of exporter and importer fixed effects. In order to construct the key covariate of interest, we use simple averages of MFN tariffs across products. Column (1) of Table 1 reports cross-section results for 2012. The estimates on the standard gravity covariates are in accordance with our prior expectations and they are readily comparable to corresponding indexes from the literature.[25] This establishes the representativeness of our sample. More important for our main purposes, the results from column (1) demonstrate that we can obtain estimates of the impact of MFN tariffs, as a representative unilateral and non-discriminatory trade policy, even when we have included the complete set of exporter and importer fixed effects. From an economic and policy perspective, our results show a highly statistically significant negative estimate for MFN tariffs (-12.042, std.err. 2.109), which implies that MFN tariffs are indeed a significant impediment to international trade. As discussed in Section 2.1, depending on the micro-economic foundations used to derive structural gravity, the estimate of -12.042 implies an elasticity of substitution of 12.042 or an import-demand elasticity with respect to MFN tariffs of -12.042.[26]

Column (2) of Table 1 reports estimation results from an unbalanced yearly panel of 68 countries from 2005 to 2012 using PPML and simple averages of MFN tariffs. In combination with gravity theory, the use of panel data requires proper control for the multilateral resistances with exporter-time and importer-time effects, which we employ in column (2). The most important result from column (2) is that, as was the case with cross-section data,

[25] We refer the reader to Head and Mayer (2014) who offer a meta analysis study of more than 2500 gravity estimates from 159 papers.

[26] In addition, we note that the structural value of the trade elasticity parameter that is recovered from the estimate on the coefficient on tariffs in the gravity model depends on the interpretation of tariffs in the definition of trade costs. Studies that treat tariffs as iceberg trade costs would deliver structural values of 11.042 and -11.042 of the elasticity of substitution and of the import-demand elasticity, respectively. We refer the reader to Larch and Yotov (2016) for a detailed discussion of the structural interpretation of the estimates on tariffs in gravity equations.

we are able to identify the impact of MFN tariffs even in the presence of the exporter-time and importer-time effects in a panel setting. The estimate of the coefficient on MFN tariffs is again highly statistically significant. In terms of economic magnitude, with a value of -9.703, our MFN tariff estimate is a bit smaller in absolute magnitude than the corresponding estimate from column (1), however, it is still in the upper tail of comparable estimates from the existing literature.[27]

A possible explanation for the large MFN tariff estimate may be that trade policies, such as tariffs or whether two countries sign a regional trade agreement, are not randomly assigned across countries.[28] Therefore, both the RTA regressor as well as our measure for the non-discriminatory trade policy, τ_{it}^{MFN}, are potentially endogenous. Matching techniques to correct for the selection bias are hampered by violations of the stable unit treatment value assumption (SUTVA) as trade policy has by definition general equilibrium and third country effects via its impact on trade creation and diversion (see e.g. Viner, 1950 and Imbens and Wooldridge, 2009). Instrumental variables which fulfill the necessary exclusion restriction are hard to come by at the country or industry level. We therefore follow Baier and Bergstrand (2007) and include bilateral (directed) country-pair effects to control for the endogeneity of trade policy in column (3).

As discussed in the analytical identification Section 2.2, the inclusion of pair fixed effects does not prevent identification of the impact of unilateral and non-discriminatory trade policies in structural gravity equations. Accordingly, once again, in column (3) of Table 1 we are able to identify the estimate of the coefficient of MFN tariffs. The estimate on MFN tariffs is still highly statistically significant. Furthermore, consistent with the endogeneity analysis from Baier and Bergstrand (2007), when we control for the unobserved directional bilateral

[27] Existing elasticity estimates from the related literature usually vary between 2 and 12. Head and Mayer (2014) offer a summary meta-analysis estimate of $\sigma = 6.13$. We refer the reader to Eaton and Kortum (2002), Anderson and van Wincoop (2003), Broda et al. (2006) and Simonovska and Waugh (2014), Costinot and Rodríguez-Clare (2014), and Head and Mayer (2014) for discussion of the available estimates of the elasticity of substitution and trade elasticity parameter.

[28] See e.g. the arguments in Trefler (1993) and Magee (2003). For example, countries which are closer have a significantly higher probability of signing an RTA, see e.g. Baier and Bergstrand (2004) and Egger et al. (2011).

effects, the estimate drops to -6.854, which is readily comparable to the corresponding estimates of the elasticities of substitution and the import demand elasticities, which we summarized in Footnote 27.

The last two columns of Table 1 offer results from two robustness experiments. Specifically, in column (4) we use 3-year intervals instead of each year. The motivation for this experiment is that trade flows may need time to adjust in response to trade policy changes, c.f. Cheng and Wall (2005). As can be seen from Table 1, the specification with 3-year intervals is still able to identify an estimate of the coefficient on MFN tariffs, but delivers an estimate that is larger than the corresponding index from column (3). The last column of Table 1 reports estimation results that are obtained by treating non-reported trade flows as missing values instead of replacing them with zeros as in the previous columns. This leads to a loss of 901 observations. However, with a point estimate of -6.851, the coefficient on MFN tariffs is virtually identical to the -6.854 value from column (3).

The results that we present in Table 2 replicate the specifications from Table 1, but after adding as an additional regressor time-to-export (TTE), which is our representative non-discriminatory unilateral trade policy on the exporter side. Two main findings stand out from Table 2. First, and most important from an econometric perspective, we are able to identify an estimate of the impact of TTE in each column of Table 2, while, at the same time, we are still able to identify estimates of the impact of MFN tariffs. Second, from an economic and policy perspective, we obtain negative and highly statistically significant estimates of the impact of TTE across all specifications in Table 2. As with MFN tariffs, the estimates from the panel specification with bilateral fixed effects lead to smaller TTE estimates in absolute value. In terms of economic magnitude, our preferred estimate from column (3) of Table 2 (-0.035, std.err. 0.005), suggests that an additional day of time to export reduces trade flows by 3.5 percent.

We finish the analysis with several robustness experiments. Panels A and B of Table 3 reproduce the results from the specifications from Tables 1 and 2, respectively, but using the

OLS estimator and logarithmized trade flows as dependent variable instead of the PPML estimator and trade flows in levels. Since the OLS estimator automatically eliminates all zero trade flows, there is no need to report separately the estimates that treat non-reported values as zeros or as missing, because those estimates are identical by construction. Therefore, we do not reproduce the results from the last columns of Tables 1 and 2 in Table 3. Most importantly, the estimates from Table 3 confirm that we can identify the effects of unilateral and non-discriminatory trade policies on the importer and on the exporter side. In addition, we find that, overall, both non-discriminatory policies are significant and have negative effects on trade flows. Generally, the estimates for the MFN tariffs become larger in absolute values, as do the time-to-export coefficients. The latter, however, are not consistently statistically significant across all specifications.

Finally, Panels A and B of Table 4 reproduce the regression results from the specifications given in Tables 1 and 2, respectively, after replacing the average MFN tariff with weighted MFN tariffs, where the weights are the observed levels of trade. It is well known that using weighted trade flows may lead to an endogeneity problem if policy makers set tariffs as a reaction to the level of trade flows. Still, weighted tariffs are often used as an alternative measure of tariffs. As can be seen from the estimates in Table 4, using weighted instead of simple average tariffs does not change any of our results qualitatively and hardly matters quantitatively. Mainly, estimates of the MFN tariff become a little bit larger in absolute values.

To summarize, the empirical analysis in this section demonstrate that our proposed method works well, produces sensible estimates, and can be fruitfully applied in realistic gravity data sets.

4 Conclusion

The effects of unilateral or non-discriminatory trade policies are interesting and important both for academics as well as for policy makers. In this paper we propose a simple method to identify the trade effects of such policies within structural gravity models, which employ complete sets of theoretically-motivated fixed effects on the importer and on the exporter side. We demonstrate the validity of our methods and illustrate the effectiveness of our approach by evaluating the trade effects of most favored nation (MFN) tariffs and time-to export as representative determinants of bilateral trade on the importer side and on the exporter side, respectively. A series of sensitivity experiments (e.g., panel vs. cross section, OLS vs. PPML, alternative measure of the regressors, etc.) demonstrate the robustness of our methods and findings. In addition to quantifying the impact of non-discriminatory trade policies, our method can be extended to identify the effects of a wide range of interesting and policy relevant *country-specific* determinants to trade within the structural gravity model.

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Table 1: On the Impact of MFN Tariffs on International Trade

	(1)	(2)	(3)	(4)	(5)
	2012	2005-2012	2005-2012	2005, 2008, 2011	2005-2012
	Cross-section	Panel	Pair FEs	Intervals	Missing
I_{ij}	-1.821***	-1.755***			
	(0.179)	(0.061)			
$\ln(DIST)_{ij}$	-0.745***	-0.809***			
	(0.045)	(0.016)			
$CONTIG_{ij}$	0.397***	0.354***			
	(0.089)	(0.033)			
$COMLANG_{ij}$	0.357***	0.428***			
	(0.096)	(0.034)			
$COLONY_{ij}$	0.158	0.017			
	(0.094)	(0.038)			
$\ln \tau_{jt}^{MFN,simple}$	-12.042***	-9.703***	-6.854***	-9.668***	-6.851***
	(2.109)	(0.624)	(1.015)	(0.913)	(1.015)
RTA_{ijt}	0.387***	0.262***	0.092**	0.106**	0.092**
	(0.074)	(0.028)	(0.035)	(0.036)	(0.035)
Bilateral FEs			X	X	X
Missings set to 0	X	X	X	X	
N	4188	34474	34276	12746	33375

Notes: This table reports gravity estimates using a PPML estimator for 68 countries in 2012 in column (1) and an unbalanced panel from 2005 to 2012 in columns (2), (3), and (5). Column (4) uses every third year. Dependent variable are bilateral trade flows, X_{ijt}, including domestic trade. Trade flows are calculated as the average of reported trade flows from country i to j if COMTRADE reports both imports and exports; if only imports or exports are observed, these are used. Non-reported international trade flows are set to zero except in column (5). Constructed domestic trade flows are set to missing if negative. All regressions include exporter(-year) and importer-(year) fixed effects. In addition, columns (3) to (5) also include directional country-pair fixed effects. Standard errors are robust for the cross-sectional regression and clustered at the country-pair for the panel regressions and are reported in parentheses. * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$. See main text for further details.

Table 2: On the Impact of MFN Tariffs and Time-to-Export on International Trade

	(1)	(2)	(3)	(4)	(5)
	2012	2005-2012	2005-2012	2005, 2008, 2011	2005-2012
	Cross-section	Panel	Pair FEs	Intervals	Missing
I_{ij}	-1.030***	-1.172***			
	(0.255)	(0.066)			
$\ln(DIST)_{ij}$	-0.773***	-0.795***			
	(0.049)	(0.016)			
$CONTIG_{ij}$	0.423***	0.378***			
	(0.090)	(0.036)			
$COMLANG_{ij}$	0.297**	0.306***			
	(0.094)	(0.034)			
$COLONY_{ij}$	0.130	0.017			
	(0.099)	(0.040)			
$\ln \tau_{jt}^{MFN,simple}$	-11.369***	-8.124***	-4.265***	-7.479***	-4.265***
	(2.111)	(0.651)	(0.946)	(1.065)	(0.946)
τ_{it}^{TTE}	-0.068***	-0.066***	-0.035***	-0.029***	-0.035***
	(0.011)	(0.003)	(0.005)	(0.005)	(0.005)
RTA_{ijt}	0.351***	0.315***	0.071*	0.090*	0.071*
	(0.080)	(0.028)	(0.034)	(0.035)	(0.034)
Bilateral FEs			X	X	X
Missings set to 0	X	X	X	X	
N	4188	34474	34276	12746	33375

Notes: This table reports gravity estimates using a PPML estimator for 68 countries in 2012 in column (1) and an unbalanced panel from 2005 to 2012 in columns (2), (3), and (5). Column (4) uses every third year. Dependent variable are bilateral trade flows, X_{ijt}, including domestic trade. Trade flows are calculated as the average of reported trade flows from country i to j if COMTRADE reports both imports and exports; if only imports or exports are observed, these are used. Non-reported international trade flows are set to zero except in column (5). Constructed domestic trade flows are set to missing if negative. All regressions include exporter(-year) and importer-(year) fixed effects. In addition, columns (3) to (5) also include directional country-pair fixed effects. Standard errors are robust for the cross-sectional regression and clustered at the country-pair for the panel regressions and are reported in parentheses. * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$. See main text for further details.

Table 3: On the Impact of MFN Tariffs and Time-to-Export on International Trade. OLS Estimates.

	Panel A: Replication of the Estimates from Table 1				Panel B: Replication of the Estimates from Table 2			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	2012	2005-2012	2005-2012	2005, 2008, 2011	2012	2005-2012	2005-2012	2005, 2008, 2011
	Cross-section	Panel	Pair FEs	Intervals	Cross-section	Panel	Pair FEs	Intervals
I_{ij}	-1.005	-1.398***			0.758	-0.052		
	(0.538)	(0.149)			(0.573)	(0.156)		
$\ln(DIST)_{ij}$	-1.318***	-1.346***			-1.324***	-1.345***		
	(0.053)	(0.018)			(0.053)	(0.018)		
$CONTIG_{ij}$	0.336	0.282***			0.338	0.291***		
	(0.176)	(0.058)			(0.176)	(0.058)		
$COMLANG_{ij}$	0.822***	0.752***			0.814***	0.746***		
	(0.103)	(0.036)			(0.103)	(0.036)		
$COLONY_{ij}$	0.744***	0.721***			0.739***	0.715***		
	(0.140)	(0.050)			(0.140)	(0.050)		
$\ln \tau_{jt}^{MFN,simple}$	-21.363**	-14.973***	-6.607**	-9.632**	-19.215**	-9.054***	-4.954	-8.491**
	(8.175)	(1.563)	(2.408)	(3.043)	(6.658)	(1.363)	(2.682)	(3.176)
τ_{it}^{TTE}					-0.138***	-0.106***	-0.020	-0.013
					(0.038)	(0.007)	(0.017)	(0.014)
RTA_{ijt}	0.487***	0.376***	-0.018	0.018	0.478***	0.367***	-0.018	0.018
	(0.072)	(0.026)	(0.061)	(0.085)	(0.072)	(0.026)	(0.061)	(0.085)
Bilateral FEs			X	X			X	X
Missings set to 0	X	X	X	X	X	X	X	X
N	4056	33349	33262	12365	4056	33349	33262	12365

Notes: This table reports gravity estimates using OLS for 68 countries in 2012 in columns (1) and (5) and an unbalanced panel from 2005 to 2012 in columns (2), (3), (6), and (7). Columns (4) and (8) use every third year. Dependent variable are logged values of bilateral trade flows, $\ln X_{ijt}$, including domestic trade. Trade flows are calculated as the average of reported trade flows from country i to j if COMTRADE reports both imports and exports; if only imports or exports are observed, these are used. Non-reported international trade flows are dropped. Constructed domestic trade flows are set to missing if negative. All regressions include exporter(-year) and importer-(year) fixed effects. In addition, columns (3), (4), (7) and (8) also include directional country-pair fixed effects. Standard errors are robust for the cross-sectional regression and clustered at the country-pair for the panel regressions and are reported in parentheses. * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$. See main text for further details.

Table 4: MFN Tariffs and Time to Export—Robustness Checks: Weighted MFN Tariffs

	Panel A: Replication of the Estimates from Table 1					Panel B: Replication of the Estimates from Table 2				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	2012	2005-2012	2005-2012	2005, 2008, 2011	2005-2012	2012	2005-2012	2005-2012	2005, 2008, 2011	2005-2012
	Cross-section	Panel	Pair FEs	Intervals	Missing	Cross-section	Panel	Pair FEs	Intervals	Missing
I_{ij}	-1.934***	-1.858***				-1.183***	-1.269***			
	(0.165)	(0.061)				(0.242)	(0.066)			
$\ln(DIST)_{ij}$	-0.750***	-0.798***				-0.776***	-0.787***			
	(0.045)	(0.017)				(0.048)	(0.017)			
$CONTIG_{ij}$	0.403***	0.372***				0.428***	0.391***			
	(0.088)	(0.036)				(0.090)	(0.039)			
$COMLANG_{ij}$	0.387***	0.474***				0.327***	0.346***			
	(0.094)	(0.035)				(0.093)	(0.035)			
$COLONY_{ij}$	0.128	0.022				0.101	0.023			
	(0.095)	(0.039)				(0.101)	(0.040)			
$\ln \tau_{jt}^{MFN,weighted}$	-14.606***	-13.732***	-5.963***	-10.293***	-5.966***	-13.450***	-11.272***	-4.155**	-8.696***	-4.159**
	(2.406)	(0.957)	(1.404)	(0.945)	(1.405)	(2.446)	(0.963)	(1.280)	(0.909)	(1.280)
τ_{it}^{TTE}						-0.065***	-0.065***	-0.036***	-0.024***	-0.036***
						(0.011)	(0.004)	(0.005)	(0.005)	(0.005)
RTA_{ijt}	0.359***	0.264***	0.100**	0.094**	0.100**	0.328***	0.315***	0.074*	0.082*	0.074*
	(0.075)	(0.029)	(0.036)	(0.035)	(0.036)	(0.081)	(0.029)	(0.034)	(0.035)	(0.034)
Bilateral FEs			X	X	X			X	X	X
Missings set to 0	X	X	X	X		X	X	X	X	
N	4188	34474	34276	12746	33375	4188	34474	34276	12746	33375

Notes: This table reports gravity estimates using a PPML estimator for 68 countries in 2012 in columns (1) and (6) and an unbalanced panel from 2005 to 2012 in columns (2), (3), (5), (7), (8), and (10). Columns (4) and (9) use every third year. Dependent variable are bilateral trade flows, X_{ijt}, including domestic trade. Trade flows are calculated as the average of reported trade flows from country i to j if COMTRADE reports both imports and exports; if only imports or exports are observed, these are used. Non-reported international trade flows are set to zero except in columns (5) and (10). Constructed domestic trade flows are set to missing if negative. All regressions include exporter(-year) and importer-(year) fixed effects. In addition, columns (3) to (5) and (8) to (10) also include directional country-pair fixed effects. Standard errors are robust for the cross-sectional regressions and clustered at the country-pair for the panel regressions and are reported in parentheses. * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$. See main text for further details.

Appendix

A Non-Discriminatory Export Policy

In this Appendix we show that we can identify a non-discriminatory trade policy on the exporter side, such as export subsidies or time-to-export (TTE), when using international and intra-national trade flows. TTE is chosen to illustrate our methods in the current analysis because the same variable is used as a representative non-discriminatory policy on the exporter side in the empirical analysis. The methods that we develop here apply equally to any non-discriminatory policy on the exporter side, e.g. export subsidies, export promotion fairs, etc. The following is the corresponding representative data matrix that only includes observations for international trade flows:

$$\begin{array}{ccc} \# & \text{exporter} & \text{importer} \\ 1 & A & B \\ 2 & A & C \\ 3 & B & A \\ 4 & B & C \\ 5 & C & A \\ 6 & C & B \end{array} \begin{array}{c} \begin{array}{cccccc} \eta_1 & \eta_2 & \mu_1 & \mu_2 & \mu_3 & \tau^{TTE} \end{array} \\ \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & \tau_A^{TTE} \\ 1 & 0 & 0 & 0 & 1 & \tau_A^{TTE} \\ 0 & 1 & 1 & 0 & 0 & \tau_B^{TTE} \\ 0 & 1 & 0 & 0 & 1 & \tau_B^{TTE} \\ 0 & 0 & 1 & 0 & 0 & \tau_C^{TTE} \\ 0 & 0 & 0 & 1 & 0 & \tau_C^{TTE} \end{bmatrix} \end{array} \tag{17}$$

Inspection of the relationships in the data set matrix (17) supports the claim of Head and Mayer (2014) that the non-discriminatory time to export is perfectly collinear with the set of dummies, as $\eta_1\tau_A^{TTE} + \eta_2\tau_B^{TTE} + (\mu_1 + \mu_2 + \mu_3 - \eta_1 - \eta_2)\tau_C^{TTE} = \tau^{TTE}$.

Similar to the case of MFN tariffs, adding observations for intra-national trade flows breaks the perfect multicollinearity in the case of a representative non-discriminatory trade policy on the exporter side. Adding intra-national trade flows to matrix (17) results in the following data matrix:

$$
\begin{array}{ccc|ccccccc|}
\# & \text{exporter} & \text{importer} & \eta_1 & \eta_2 & \mu_1 & \mu_2 & \mu_3 & I & \tau^{TTE} \times I \\
1 & A & B & 1 & 0 & 0 & 1 & 0 & 1 & \tau_A^{TTE} \\
2 & A & C & 1 & 0 & 0 & 0 & 1 & 1 & \tau_A^{TTE} \\
3 & B & A & 0 & 1 & 1 & 0 & 0 & 1 & \tau_B^{TTE} \\
4 & B & C & 0 & 1 & 0 & 0 & 1 & 1 & \tau_B^{TTE} \\
5 & C & A & 0 & 0 & 1 & 0 & 0 & 1 & \tau_C^{TTE} \\
6 & C & B & 0 & 0 & 0 & 1 & 0 & 1 & \tau_C^{TTE} \\
7 & A & A & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\
8 & B & B & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\
9 & C & C & 0 & 0 & 0 & 0 & 1 & 0 & 0
\end{array} \tag{18}
$$

where the observations for intra-national trade flows are observations 7-9. If TTE were perfectly collinear with the rest of the variables in matrix (18), then there has to exist a non-zero solution, $\alpha_1^*, \alpha_2^*, ..., \alpha_7^*$, for the following system of equations:

$$\alpha_1^*\eta_1 + \alpha_2^*\eta_2 + \alpha_3^*\mu_1 + \alpha_4^*\mu_2 + \alpha_5^*\mu_3 + \alpha_6^*I + \alpha_7^*\tau^{TTE} \times I = 0, \tag{19}$$

i.e., $\tau^{TTE} \times I$ can be expressed as a linear combination of the dummies.

We now prove that the non-discriminatory TTE variable is linearly independent from the dummies by contradiction.[29] To facilitate exposition, rewrite Equation (19) as:

$$\alpha_1\eta_1 + \alpha_2\eta_2 + \alpha_3\mu_1 + \alpha_4\mu_2 + \alpha_5\mu_3 + \alpha_6 I = \tau^{TTE} \times I, \tag{20}$$

where $\alpha_1 = -\alpha_1^*/\alpha_7^*$, ..., $\alpha_6 = -\alpha_6^*/\alpha_7^*$. Focus on observation 9 in matrix (18). To express the last column as a linear combination of the remaining columns, α_5 has to be equal to zero. In addition, to fulfill Equation (20) for observation 8, it follows that $\alpha_2 = -\alpha_4$. Similarly, it follows from observation 7 that $\alpha_1 = -\alpha_3$. We then can re-express Equation (20) in matrix form as:

[29] Assuming that there is variation in TTE and they do take non-zero and different values.

$$
\begin{array}{ccc|ccccccccccccc}
\# & \text{exp.} & \text{imp.} & \alpha_1\eta_1 & + & \alpha_2\eta_2 & + & \alpha_3\mu_1 & + & \alpha_4\mu_2 & + & \alpha_5\mu_3 & + & \alpha_6 I & = & \tau^{TTE}\times I \\
1 & A & B & \alpha_1 & + & 0 & + & 0 & + & -\alpha_2 & + & 0 & + & \alpha_6 & = & \tau_A^{TTE} \\
2 & A & C & \alpha_1 & + & 0 & + & 0 & + & 0 & + & 0 & + & \alpha_6 & = & \tau_A^{TTE} \\
3 & B & A & 0 & + & \alpha_2 & + & -\alpha_1 & + & 0 & + & 0 & + & \alpha_6 & = & \tau_B^{TTE} \\
4 & B & C & 0 & + & \alpha_2 & + & 0 & + & 0 & + & 0 & + & \alpha_6 & = & \tau_B^{TTE} \\
5 & C & A & 0 & + & 0 & + & -\alpha_1 & + & 0 & + & 0 & + & \alpha_6 & = & \tau_C^{TTE} \\
6 & C & B & 0 & + & 0 & + & 0 & + & -\alpha_2 & + & 0 & + & \alpha_6 & = & \tau_C^{TTE} \\
7 & A & A & \alpha_1 & + & 0 & + & -\alpha_1 & + & 0 & + & 0 & + & 0 & = & 0 \\
8 & B & B & 0 & + & \alpha_2 & + & 0 & + & -\alpha_2 & + & 0 & + & 0 & = & 0 \\
9 & C & C & 0 & + & 0 & + & 0 & + & 0 & + & 0 & + & 0 & = & 0
\end{array}
\qquad (21)
$$

System (21) reveals that the equations corresponding to observations 7 to 9 fulfill the condition for perfect collinearity.

Now focus on observations 1 and 2. These two lines can only sum up to τ_A^{TTE} if $\alpha_2 = 0$. This in turn implies that, from the equations corresponding to observations 3 and 4, α_1 has to be equal to zero for perfect multicollinearity. Now we are left with α_6, which would have to take three different values to fulfill equations 1 to 6. Hence, the only solution for the system of equations in (21) is the trivial solution that $\alpha_1^* = ... = \alpha_7^* = 0$, implying that a non-discriminatory export policy is linearly independent from the set of exporter and importer dummies when including intra-national trade flows.

B List of Countries

The following countries are included in our panel data set: Albania, Armenia, Australia, Austria, Bangladesh, Belarus, Brazil, Bulgaria, Canada, China, Colombia, Denmark, Egypt, Eritrea, Ethiopia, Fiji, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Jordan, Kenya, Republic of Korea, Kuwait, Kyrgyzstan, Latvia, Lithuania, Republic of Macedonia, Malawi, Malaysia, Mauritius, Mexico, Moldova, Morocco, Nepal, New Zealand, Pakistan, Peru, Philippines, Poland, Portugal, Russian Federation, Senegal, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Ukraine, United Kingdom, United States, and Vietnam.