Nonparametric Effects of Tariff and Nontariff Policy Barriers in General Equilibrium

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Abstract

Most applied work in international economics treats trade policy (a) as a linear component of trade costs and (b) as an exogenous variable. This paper proposes a structural modelling approach that allows for the estimation of (possibly) non-parametric effects of trade policy using a propensity score method to account for the endogeneity bias of trade policy.

Keywords: Gravity models; Non-parametric and Semi-parametric Methods; Propensity Score Methods.

JEL-codes: F14, C23.

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1 Introduction

Modern applied international economic work operates under two fundamental assumptions: that bilateral trade flows directly and indirectly depend non-linearly on trade costs through structural relationships; and that trade costs can be linearly decomposed into their components. Quantitative work then quantifies the contributions of individual trade-cost factors to both trade costs and trade flows under these assumptions. Two problems in such work are the following. First, policy-related trade-cost components are endogenous to the extent that policy barriers are chosen depending on other fundamentals (mainly non-policy trade costs, factor endowments, and prevailing technology). Second, treating the endogeneity of trade costs in structural non-linear trade models complicates the econometric analysis considerably. For this reason, structural econometric work aimed at estimating models of bilateral trade, work on the causal effects of policy trade costs on trade flows, and work on non-(log)linear effects of trade-cost components on trade costs are pursued in separate, unintegrated strands of work.

This paper represents an attempt to unify these three lines of interest. We propose a two-step structural modelling approach, which is geared towards evaluating potentially non-parametric effects of the two most important policy barriers to goods trade – tariff and nontariff barriers – which are treated as random and determined by fundamental drivers of trade (non-policy trade costs, productivity, and factor endowments). The procedure decomposes trade flows into unilateral (country-specific) and bilateral (pair-specific) components in a first step and uses the bilateral component of trade flows as a dependent variable in a second step, where it is modelled as a non-parametric function of endogenous tariff and nontariff barriers of trade.

2 Methodology

2.1 Decomposing bilateral trade flows and trade costs

Let us use indices \( \{i, j\} = 1, \ldots, J \) to refer exporting and importing countries, and denote bilateral exports in sector \( s \) as \( X_{ij}^s \). Then, we may formulate the latter as

\[
X_{ij}^s = A_i^s B_j^s C_{ij}^s,
\]

where \( A_i^s \) and \( B_j^s \) are country-sector-specific factors and \( C_{ij}^s \) are country-pair-sector-specific ones. We will broadly associate the latter with trade-cost effects, noting, however, that \( C_{ij}^s \) includes effects of (Armington-type) consumer preferences in country \( j \) towards goods \( s \) from \( i \). Using \( S_i^s = \sum_{j=1}^J X_{ij}^s \) for total sales in sector \( s \) per country, \( E_i^s = \sum_{j=1}^J X_{ji}^s \) for total expenditure on goods from sector \( s \) in that country, and \( W_i^s \) for producer prices, we may specify \( A_i^s \equiv (W_i^s)^{\alpha_s} E_i^s \),
where \( \alpha_s \) is a demand elasticity parameter and \( F_i^s \) is a measure of the factor endowments and technology (or export potential) of sector \( s \) in country \( i \), and \( B_j^s \equiv E_j^s / (\sum_{k=1}^J A_k^s C_{kj}^s) \). The bilateral component \( C_{ij}^s \) relates to bilateral trade costs, \( D_{ij}^s \) by \( C_{ij}^s \equiv (D_{ij}^s)^{\alpha_s} \). For this, let us introduce the notation \( \{T_{ij}^s, N_{ij}^s, U_{ij}^s\} \) to refer to tariff policy, non-tariff policy, and residual trade costs, all of which are defined in a non-negative fashion. Most prevalent theoretical trade models lead to a structural gravity expression like (1). Typically, in these models, exogenous factors are country-sector fundamentals \( F_i^s \) (measuring factor endowments, productivity, etc.), expenditure shares \( \kappa_s \) and demand elasticity \( \alpha_s \) (derived from some utility function), and iceberg-type trade barriers \( D_{ij}^s \). It is, however, unlikely that policy-related trade barriers are exogenously determined and potentially, they depend on the same (exogenous) factors as bilateral trade flows. Assuming that policy-related trade barriers \( \{T_{ij}^s, N_{ij}^s\} \) are endogenously determined poses two (econometric) challenges. First, the endogeneity of policy variables has to be accounted for in the econometric model. Second, the unknown theoretical mechanism behind the determination of policy variable calls for a flexible (non-parametric) formulation thereof. Apart from that we keep the structure of common trade models meaning that any endogenously determined policy variable is some unknown function of the exogenous factors of the model.

For simplicity, let us use lower-case letters to generally refer to log-transforms of variables in levels so that we have \( a = \ln A \) for any generic variable \( A \). Then, we postulate

\[
d_i^s = h(t_i^s; n_i^s) + u_{ij},
\]

where \( h(\cdot) \) is some flexible function of its arguments. Defining a vector of endogenous treatments \( p_i^s = (t_i^s, n_i^s) \) this formulation leaves us with the following triangular simultaneous equation model:

\[
x_i^s = a_i^s + b_j^s + \alpha_s (h(p_i^s) + u_{ij}) + \epsilon_i^s,
\]

\[
p_i^s = g_s(f_i^s; f_j^s, \bar{f}_{-i,-j}; u_{ij}; \bar{u}_{-i,-j}) + \nu_i^s,
\]

where \( E(\epsilon_i^s | p_i^s) \neq 0 \) and \( E(\nu_i^s | f_i^s, f_j^s, \bar{f}_{-i,-j}, u_{ij}, \bar{u}_{-i,-j}) = 0 \). By making \( g_s(\cdot) \) sector specific we account for sectoral differences in the determination of trade costs (e.g. a country might be willing to bargain more if the share of imports is very high in a sector). Country fundamentals \( f_i^s \) and \( f_j^s \) are likely to be important if trade policy is strategically designed to protect certain sectors (e.g. with a significant voting potential). Exogenous non-policy barriers \( u_{ij} \) are relevant as they determine the effectiveness of policy barriers to some extent (e.g. policy trade barriers are more relevant if countries are geographically close to each other). Finally, by \( \bar{f}_{-i,j} = \frac{1}{n_{-i,j}} \sum_{k \neq i,j} f_k^s \) and \( \bar{u}_{-i,-j} = \frac{1}{n_{-i,-j}} \sum_{k,h \neq i,j} u_{kh} \) we account for the influence of countries other than \( i \) and \( j \) on

\footnote{Compare Krugman (1979), Eaton and Kortum (2002) or Melitz (2003) to name only a few.}
the trade policy choice of $i$ and $j$.\footnote{Compare e.g. how Baier and Bergstrand (2004) model PTA membership choice.} Note, that the reduced form (4) has no causal interpretation but it helps to identify the causal (direct) impact of policy variables $p_{ij}^s$ on trade flows $x_{ij}^s$. We summarize these determinants of trade policy in

$$q_{ij} = (f_i^s, f_j^s, \tilde{f}^s_{i,-j}, u_{ij}, \tilde{u}_{i,-j}).$$

Formally, this assumption is summarized by the weak unconfoundedness assumption:

$$x_{ij}^s(p) \perp \nu_{ij}^s \text{ for all } p \in \mathcal{P},$$

where $\mathcal{P}$ denotes the set of potential trade policy vectors. Note that by the stochastic term $\nu$ the trade policy treatment $p$ is random conditional on $q$ and governed by the density function $r(p,q) = f(\nu) = f(p|q)$.\footnote{Let us refer to some generic random variable by $x$, then putting indices denotes any realization thereof, $x_{ij}^s$.} Hence, we can rewrite (3)

$$x_{ij}^s = a_i^s + b_j^s + k(p_{ij}^s, r(p_{ij}^s, q_{ij}^s)) + \alpha_s u_{ij} + \omega_{ij},$$

where $E(\omega_{ij}^s|p_{ij}^s, q_{ij}^s, a_i^s, b_j^s) = 0$ and $k(p_{ij}^s, r(p_{ij}^s, q_{ij}^s)) = \alpha_s h(p_{ij}^s) + E(\epsilon_{ij}^s|p_{ij}^s)$.\footnote{Furthermore, let us denote the density of this random variable by $f(x)$.}

### 2.2 Empirical Implementation

In a first step we run a fixed effect regression with exporter and importer fixed effects only

$$x_{ij}^s = a_i^s + \alpha_s + q_{ij}^s,$$

where $\alpha_j^s = b_j^s + m(n_j^s)$ and $q_{ij}^s = q(c_{ij}^s, n_j^s)$. In our data, non-tariff barriers $N_j^s$ are bilateral only to the extent that they are assumed to be unity for a country’s sales to itself but they are importer-specific for all other bilateral trade flows. Hence, the flexible trade cost function contains importer specific terms that are captured in $\alpha_j^s$. Using $B_j^s = \frac{E_j^s}{\sum_{k=1}^n A_k^s C_{kj}}$ together with $C_{ij}^s = Q(C_{ij}^s, N_j^s)M(N_j^s)$ for all $i \neq j$ and $C_{ij}^s = 1$ for $i = j$, we can isolate

$$B_j^s = \frac{O_j^s}{A_j^s} \left[ \frac{E_j^s}{O_j^s} - \sum_{k \neq j} A_k^s C_{kj} \right].$$

With an estimate of $A_i^s$ and $B_j^s$ at hand we can back out the residual $C_{ij}^s = X_{ij}^s/A_i^s B_j^s$. Bilateral trade costs $D_{ij}^s = (C_{ij}^s)^{1/\alpha_s}$ as well as $F^s_i = A_i^s/(W_i^s)^{\alpha_s}$ are readily calculated using data on producer prices $W_i^s$ and importer price elasticities $\alpha_s$.

We are now able to model the reduced form (4) and estimate the conditional density $f(\nu_{ij}^s|q_{ij}^s)$. We will approximate $g_s(.)$ by a parametric polynomial with the order being determined by a Bayesian Information Criterion. For the conditional density we consider a bivariate
normal distribution as well as a non-parametric conditional density estimation. With an estimate of the conditional density at hand we approximate \( k(\cdot) \) both by a parametric polynomial and a trivariate kernel.

3 Effects of trade policy on bilateral trade flows

Equation (6) allows us to formulate the average trade policy component for a given vector \( p \) as

\[
\hat{k}(p) = E \left[ k(p, r(p, q^i_{ij})) \right].
\] (9)

We take this functional form and now vary \( p = \{t; n\} \) over the empirically supported range with lower bound \( \underline{p} = \{t; n\} \) and upper bound \( \overline{p} = \{T; \pi\} \). It is easiest to consider equally-sized cells in this two-dimensional trade-policy space. let us use index \( tn \) to refer to a specific element on that grid with specific generic policy values \( t \) and \( n \). We can fill these cells with the corresponding average trade policy component. Clearly, with \( m \) grid cells in \( t-n \)-space, there will be \( m \) values of hypothetical \( \hat{k}(p) \). This allows us to construct counterfactual outcomes for all observations in the dataset at all policy vectors we are interested in using the estimated conditional density.

We use (9) to obtain the average trade policy component of bilateral trade flows holding fixed interdependencies across countries other than \( i \) and \( j \). Using a grid of policy vectors \( p = t, n \) we calculate the conditional density of \( p, r(p, q^i_{ij}) \), for all observations and approximate the expectation by the average over all observations

\[
\hat{k}(p) = \frac{1}{J} \sum_{i=1}^{J} \sum_{j=1}^{J} k(p, r(p, q^i_{ij})).
\] (10)

We may then take the latter \( m \) values and construct \( m \) hypothetical (or counterfactual) values of bilateral trade flows using the general equilibrium constraints establishing market clearing and stating that

\[
X_{ij,tn}^s = (W_i^s)^{\alpha_s} F_i^s \frac{E_j^s}{\sum_{k=1}^{J} (W_k^s)^{\alpha_s} F_k^s C_{kj,tn}^s} C_{ij,tn}^s
\] (11)

where all variables indexed \( tn \) indicate that variables change due to the use of \( \{t; n\} \) instead of the observed or actual \( \{t_{ij}; n_{ij}\} \). Then, using the counterfactual \( C_{ij,tn} \) instead of \( C_{ij} \) in (11) obtains counterfactual trade flows \( X_{ij,tn} \), of which there exist \( m \) values for all combinations of \( t \) and \( n \). Hence, there is a two-dimensional surface relating all values \( \{t; n\} \) to \( X_{ij,tn} \).

4 Data

For the empirical application we use data on bilateral trade flows at the 6-digit level from WITS and tariff data from TRAINS for the year 2010. We calculate fob unit prices using export values
Figure 1: $\hat{k}(p)(\cdot)$ over an evenly distributed 10 by 10 grid of tariff and non-tariff barriers.

(as reported by the exporter) and reported quantities to approximate producer prices. Import demand elasticities and ad valorem equivalents for non-tariff barriers are taken from Kee, Nicita and Olarreaga (2008) and Kee, Nicita and Olarreaga (2009), respectively. We take data on other trade barriers such as distance, common language etc. from CEPII.

5 Preliminary Results and Concluding Remarks

Figure 1 shows a clear non-linear and non-monotonic relationship of tariff and non-tariff barriers on the dose-response function $\hat{k}(p)$. Clearly, this preliminary result suggests that counterfactual trade flows will be affected in a non-linear fashion by policy variables while most empirical studies consider this relationship to be linear.

References


