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Lerner Symmetry and Multilateral Resistance

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Lerner Symmetry and Multilateral Resistance

ABSTRACT: In this paper we examine Lerner symmetry. We extend the classic definition of Lerner symmetry to multilateral resistance in bilateral gravity models. This includes both extension of the theory based on bilateral deviations from the change in average exports, as well as analysis of a panel of global and bilateral trade data spanning 1988 to 2002. We employ selection modeling of bilateral trade flows to allow for the zero observed trade – aka missing trade – in our regressions. We find evidence at both the aggregate level, and also at the bilateral level, that import tariffs matter significantly for export performance. This reinforces the recent evidence on developing country export performance. Home market conditions matter empirically for performance in export markets.

KEYWORDS: Lerner symmetry, exports, zero-trade, gravity model

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1 Introduction

A classic result from trade theory on the two good model is that there is some correspondence or symmetry between import taxes and export taxes. This is known as Lerner symmetry. By extension, we can expect aggregate import protection to limit aggregate export performance. In this paper we examine this issue. We extend the classic definition of Lerner symmetry to multilateral resistance in bilateral gravity models. We also link Lerner symmetry to more recent theory on the welfare impact of trade based on the balance of trade function. This allows us to map the gains from trade and the impact of tariffs in trade offer space. We also explore this issue with a panel of global and bilateral trade data spanning 1988 to 2002. We employ selection modeling of bilateral trade flows to allow for the zero observed trade – aka missing trade – in our regressions. We find evidence at both the aggregate level, and also at the bilateral level, that import tariffs matter significantly for export performance. This reinforces the recent evidence on developing country export performance. Home market conditions matter empirically for performance in export markets.

The paper is organized as follows. Section 2 provides an overview of the relevant theory, with extension to include a dual representation – including the balance of trade function – and to include bilateral trade flows based on the expected value of deviations between aggregate export changes and bilateral changes. Section 3 provides empirical evidence.

2 Import policy and exports

In his classic paper, Lerner (1936) demonstrated that under perfect competition, full employment, balanced trade and in the absence of transport costs the imposition of import tariffs has the same effect as an export tax. This result has since been explored in the literature with alternative assumption sets. McKinnon (1966) extended the theorem to the three-commodity case with two import and one export good. The theorem was further extended to non-tradables (McDougall, 1970, Kaempfer and Tower, 1982, Canto, Kaempfer, and Tower, 1992), to a three-sector model with nontradables (Milner, 1995, McKay and Milner, 1997, Chen and Devereux, 1994), and a model with quantitative restrictions. Recent extensions have involved imperfect competition (Ray 1975), bilateral tariffs (Gardner and Kimbrough 1990), quantitative restrictions (Lpez and Panagariya, 1995) and the role of the trade balance (Blanchard 2005).

In this section we present a relatively general, duality-based representation of the basic Lerner result, offering a number of theoretical extensions, including introducing a mapping of trade volumes to welfare in offer space based on the trade expenditure function of Neary and Schweinberger (1988). We also link Lerner symmetry analytically to modern gravity model specifications, specifically the concept of multilateral resistance as developed by Anderson and van Wincoop (2003). This provides us with a set of estimating equations, both in aggregate and for bilateral gravity modeling of trade that incorporate import taxes as a source of multilateral resistance for exporters.

2.1 Mapping import tariffs to aggregate exports

We start with a single country, designated home, that can be characterized on the production side by a standard expenditure function, and on the revenue side by a GDP function. The usual assumptions are made about the numeric properties of the expenditure and revenue functions. (See Dixit and Norman, 1980).

$$e = e(\upsilon, \mathbf{P}) \tag{1}$$

$$r = r(\mathbf{P}, \mathbf{v}) \tag{2}$$

In equation (1), υ denotes national welfare, while $\mathbf{P}$ denotes the vector of internal prices. The expenditure function defines the minimum expenditure necessary, at prices $\mathbf{P}$, to achieve national welfare υ. In equation (2), r denotes the maximum value of national income achievable given the vector of factor endowments $\mathbf{v}$. The economy-wide condition for equilibrium requires that

$$Z = e - r \tag{3}$$

where $Z = 0$ with balanced trade, and where under more general conditions it represents the net trade balance. Starting from equation (3), known as the trade expenditure function (Neary and Schweinberger 1986), a general equilibrium expression for the matrix of imports can then be defined with equation (4), which we refer to as the offer function:

$$Z_{\mathbf{P}} = E_{\mathbf{P}} - r_{\mathbf{P}} \mid_{e(\upsilon,\mathbf{P})-r(\mathbf{v},\mathbf{P})=0} \tag{4}$$

In the context of models with two traded goods, (or under more general models with certain assumptions about two broad classes of goods), the offer function provides a dual definition of the classic offer curve. In models with more than two goods, it provides a definition of the n-dimensional offer surface defined over n-product space. Evaluated for a given level of υ, it provides compensated import demand. Evaluated in the context of the full general equilibrium system, it provides Marshallian import demand.

Working from equation (4), under the assumption of two traded goods M and X and evaluated in the context of the full general equilibrium system, trade equilibria are mapped in Figure 1 for imports and exports under various prices by curve OO. For any particular world price line $P*$ measured from the origin, the intersection of the price line and the offer curve gives us the level of trade at those prices. As drawn, the offer curve is well-behaved, in that it is strictly convex. This means that we have made certain implicit assumptions about the behaviour of the general equilibrium offer function. In particular, for expositional purposes we have ruled out changes in the sign of the slope of the offer surface over the range of economically interesting equilibria. As drawn in the figure, the intersection of the price line $P*$ with the offer curve OO at point a represents the equilibrium set of imports and exports.

What do import tariffs imply for exports (and for welfare)? In what follows, we offer a theoretical update to the standard mapping of trade and tariffs in offer curve space by also mapping welfare in offer space based on the trade expenditure function. Following Anderson and Neary (1992), the welfare impact of any trade costs – whether natural or policy induced – can be evaluated in general equilibrium using the trade expenditure function. In particular, when holding welfare constant, the trade expenditure function provides a measure of welfare in terms of the net transfer from the rest of the world necessary to compensate for the costs imposed, through changes in trade cost parameters, on achieving a given level of welfare. Assuming we have a tariff, with revenues from trade intervention, equation (3) must be modified as follows in equation (5):

$$\begin{aligned} b &= e - r - (e_{\mathbf{P}} - r_{\mathbf{P}})(\mathbf{P} - \mathbf{P}*) \\ &= Z - Z_{\mathbf{P}}(\mathbf{P} - \mathbf{P}*) \end{aligned} \tag{5}$$

In equation (5), the gap between world price $\mathbf{P}*$ and domestic price $\mathbf{P}$ represents the tariff on imports. As such, tariff revenues are given by $Z_{\mathbf{P}}\,(\mathbf{P} - \mathbf{P}*)$. Evaluating a discrete change in protection on the balance of trade function with a second-order Taylor Series expansion, and ignoring third derivatives (or identically assuming linearity of the price demand curve $Z_{\mathbf{P}}$), we have the following:

$$\Delta b = -Z_{\mathbf{PP}}(\mathbf{P} - \mathbf{P}*) - \frac{1}{2}\,Z_{\mathbf{pp}}(\Delta\mathbf{P}\,)^2 \tag{6}$$

When we start from the free-trade equilibrium (where $\mathbf{P} - \mathbf{P}* = 0$), we have

$$\Delta b = -\frac{1}{2}Z_{\mathbf{PP}}(\Delta\mathbf{P}\,)^2 \tag{7}$$

For simplicity of notation, we normalize work prices to unity. In this case, noting that $\Delta P = t$ and $Z_{PP} = \Delta M/\Delta P$, equation (7) can be rewritten for a given tariff as follows:

$$\Delta b = -\frac{1}{2}\frac{\Delta M}{\Delta P}(\Delta P\,)^2 = -\frac{1}{2}\Delta M\Delta P = -\frac{1}{2}t\Delta M \tag{8}$$

This approximation for the welfare impact of a tariff is represented in Figure 1. In the figure, a tariff shifts internal prices to $\tau P*$ where $\tau = (1+t)$. The implications of such a tariff are as follows (we assume all tariff revenue is either redistributed directly to consumers, or is otherwise spent like all other income). The internal price line intersects the free-trade offer curve at point c. If we are dealing with non-revenue generating trade costs, this is the equilibrium point. With tariff revenue c_d, additional tariff revenue is available which makes additional imports possible along the line d_d'. With government spending tariff revenue like other income, actual trade will then occur at some point like e. Hence, exports drop byΔX. From point e, our duality-based measure of the general equilibrium welfare effect of restricting trade can be projected as follows. Tracing a line through point b parallel to the tariff-ridden internal price line $\tau P*$, the distance between this line and the world price line measures the price impact of the tariff, ΔP. At the same time, the vertical distance from point e to the free-trade level of imports measures ΔM. Therefore, if we bisect the price change ΔP and multiply this by the change in imports ΔM, we then get the distance e_f', which measures $1/2 \Delta P \Delta M$, and represents our approximation of the welfare cost of protection. Tariff revenue is equal to e_h. It can be shown that a similar mapping can be made in the case where the government spends all tariff revenue on domestic goods. [1] If instead of tariffs we have increased trade costs, trade takes place directly at point c, and welfare costs are c_g as there are no tariff revenues to offset increased consumer costs.

[1] Indeed, for the range of tariffs up to the prohibitive tariff we could trace out all points like f' and produce a welfare schedule for various levels of trade in offer space.

2.2 Lerner symmetry and bilateral trade

The classic literature on Lerner symmetry (Lerner 1932) and our extension above using the trade expenditure function, emphasize aggregate trade. However, the recent empirical literature has taken advantage of the richness of bilateral trade data to explore the determinants of trade flows, and the impact of policy and natural trade barriers. In the context of the now standard Anderson and van Wincoop (2003) terminology, we are focusing on general or multilateral trade resistance terms, and would like to do so empirically using bilateral trade data. To do this we extend out basic theoretical framework above by introducing a CES-based aggregator for imports. In particular, we assume we can represent the composition of total imports as following from a representative CES aggregator for composite imports M.

$$M = \left[\sum_i \alpha_i m_i^\rho\right]^{1/\rho} \quad 1 > \rho > 0 \tag{9}$$

In equation (9), the terms α_i are the CES weights applied to imports indexed by source. The (Allen) substitution elasticity across imports will be $\sigma = 1/(1-\rho)$. Because we will be doing econometrics with trade data reflecting actual prices and industrial structure (i.e. with variety given by actual values in the cross-section), this specification is more general than it at first appears. In particular, the CES weights can follow from both an Armington view of the world, and also a variety-based view of the world with firm-level differentiation. In the latter case the α terms index available varieties by source. This means the estimation strategy we develop in this section is consistent with the underlying theoretical structure of monopolistic competition-based and Armington-based models of trade. Both can be represented as in equation (9), though with a different interpretation of the CES weights. (For example, see the derivations in Francois and Roland-Holst 1997). From first order conditions for maximization of composite M subject to expenditure E_M we can derive the following:

$$P_M = \left[\sum_i \alpha_i^\sigma \omega_i^{1-\sigma} \right]^{1/(1-\sigma)} \tag{10}$$

where ω are the border prices for imports from different markets indexed over i. Normalizing world prices (before any costs related to distance or policy) to unity, we can specify border price as then being inclusive of any distance-related cost factors γ:

$$\omega_i = \gamma_i \tag{11}$$

$$P_M = \left[\sum_i \alpha_i^\sigma \gamma_i^{1-\sigma} \right]^{1/(1-\sigma)} \tag{12}$$

As a final step to moving into the border we will assume there are also policy variables that raise the cost of imports, apart from any natural costs γ that follow from physical constraints or cultural differences. For simplicity we assume here these policy-linked costs are imposed at the border against all imports, effectively raising the price of delivered imports by the multiplier τ. Next, following de Melo and Robinson (1992) we introduce a second CES aggregator specified over imports and domestic absorption giving us a CES-based expenditure function – keeping the same substitution elasticity. (It adds to the complexity of the math, but not the basic result, to index tariffs across import suppliers and nest the CES aggregators with different substitution elasticities. We leave this to the motivated reader.) Our second, upper-nest CES function is as follows:

$$\upsilon = A \left[\beta_m M^{\rho} + \beta_d D^{\rho} \right]^{1/\rho} \;\; 1 > \rho > 0 \tag{13}$$

From our first order conditions for maximizing υ at a given level of expenditure E, the value of total import demand V^M can be shown, after some manipulation to equal:

$$V^M = \upsilon \left(\frac{\beta_m}{\tau} \right)^{\sigma} P_M^{1-\sigma} P_{\upsilon}^{\sigma} \tag{14}$$

where $P_{\upsilon} = e_{\upsilon}$ is the CES-based composite price index for υ. Normalizing quantities (selecting A so that $P_{\upsilon} = 1$ in the baseline data, and making substitutions), we then have the following:

$$V^M = \upsilon \left(\frac{\beta_m}{\tau} \right)^{\sigma} \left[\sum_i \alpha_i^{\sigma} \gamma_i^{1-\sigma} \right]^{(1)/(1-\sigma)} \tag{15}$$

Taking logs, we arrive at a global estimating equation for aggregate imports, corresponding to a specific form of equation (4) above.

$$\ln \left(V^M \right) = \ln \left(\upsilon \right) + \sigma \ln \left(\beta_m \right) + 1/\left(1 - \sigma \right) \ln \left(\sum_i \alpha_i^{\sigma} \gamma_i^{1-\sigma} \right) - \sigma \tau \tag{16}$$

We can turn this into an estimating equation for the total value of exports. Starting with equation (3), and assuming that $Z = 0$ or is at least independent (as a first-order approximation) with respect to tariffs, we then have $V^M = \mathbf{P}_X X = V^X$. Indeed this mapping is represented in Figure 1 for composite exports and imports.

Making a substitution into equation (16) we arrive at equation (17):

$$\ln\left(V^X\right) = \sigma \ln\left(\beta_m\right) + \ln\left(\upsilon\right) + 1/\left(1-\sigma\right)\ln\left(\sum_i \alpha_i^\sigma \gamma_i^{1-\sigma}\right) - \sigma\tau \tag{17}$$

Note that equation (17) points to the average import tariff as what Anderson and van Wincoop (2003) call multilateral resistance to trade. We are also interested in bilateral exports. Given prices, we can derive bilateral exports from the first order conditions for equation (9).

$$x_{ij} = V_j \left(\frac{\alpha_i}{\tau_{i,i}\gamma_{i,j}P_i}\right)^\sigma P_M^{\sigma-1} \tag{18}$$

We want to map the average rate of protection τ to bilateral exports, adding it to the estimating equation suggested by equation (18). We start by writing the percent change in exports (i.e. the derivative of the log of exports) as a function of bilateral exports x_{ij} that make up total exports. This is equation (19).

$$\hat{X}_i = \sum_j \theta_{ij}\hat{x}_{ij} \tag{19}$$

Adding to and subtracting $\hat{X}_i$ from the right hand side gives us

$$\hat{X}_i = \hat{X}_i + \sum_j \theta_{ij}\left(\hat{x}_{ij} - \hat{X}_i\right) \tag{20}$$

The last term in equation (20) is quantity-weighted deviations of individual changes from the average. By definition this sum is zero, meaning the expected value of these individual deviations is also zero. With some further manipulation, this can be rewritten as in equation (21).

$$\hat{x}_{ij} = \hat{X}_i - \left(\sum_{k \neq j} \theta_{ij}^{-1} \theta_{ik} \left(\hat{x}_{ik} - \hat{X}_i \right) \right) \tag{21}$$

Because the last set of terms in brackets, $\theta_{ik} \left(\hat{x}_{ik} - \hat{X}_i \right)$, has an expected value of zero, we can write the change in the value of bilateral exports $\hat{v}_{ij}^{v}$ in terms of the change in total exports:

$$\hat{v}_{ij}^{v} = \hat{x}_{ij} + \hat{P}_i = \hat{V}_i^{X} + \phi, \quad E\left(\phi\right) = 0 \tag{22}$$

Equation (22) tells us that factors affecting the overall level of trade, like the average import tariff, will affect bilateral exports as a multilateral effect.

3 Empirics

We now turn to an empirical analysis of the impact of import taxes on export performance. This includes aggregate trade and bilateral trade. Our estimation strategy involves specifying a sample selection model. Employing a sample selection model allows us to take account of the censoring process that leads to zero or missing bilateral trade flows. More precisely, in our estimating framework the outcome variable (the dependent variable in the second stage equation) is only observed if the defined selection criterion is met. In our case, the amount of the trade can only be observed if trade occurs. We therefore employ a sample selection estimation, combining the analysis of the probability of trade flows with the analysis of trade volumes. (Similarly, Felbermayr and Kohler (2004) employ a Tobit estimator to examine bilateral zeros.)

The recent empirical literature on Lerner-symmetry includes includes a mix of econometrics and CGE models. Tokarick (2006) uses a CGE model to quantify the extent to which import tariffs act as an export tax. Other papers have looked at the effects of import protection on particular export sectors in particular countries. This includes Schiff and Valdes (1992), Clements and Sjaastad (1984), and Manzur and Subramaniam (1995). More recently, in their empirical work on the role of the WTO in promoting trade, Subramanian and Wei (2007) invoke own-liberalization in their econometric model of the evolution of bilateral trade. We break from this literature by employing a sample selection estimator.[2]

3.1 Data

We work with a panel of bilateral trade, trade policy, geographic characteristics, and income data spanning from 1988 to 2002. Our trade and tariff data were obtained from the UN/World Bank WITS system (World Integrated Trade Solution). The data in WITS come, primarily, from the UNCTAD TRAINS and COM-

[2] When examining the global pattern of bilateral trade flows, one striking feature of the landscape is that many country pairs do not trade. In our sample 42% of importer-exporter pairings had zero bilateral trade. Thus, apart from analyzing the effects of different factors on worldwide trade, we also concentrate our attention on factors that may explain why trade does not occur at all. While some factors might be expected to be important in the decision on how much to import, the same factors may be differentially important when the trader decides whether he or she will import at all. And yet, these two decisions clearly are linked. Only if the trader decides to import can trade volumes be observed and hence examined. Analyzing the determinants of trade flows without taking into account potential trade which does not take place between country pairs may bias results. At a minimum, unobserved trade may contain information about the factors driving bilateral trade relationships.

TRADE systems and the World Trade Organization's integrated tariff database (IDB). The countries included in the sample are listed in the annex.[3] There are several country combinations for which trade is not reported. Following the recent literature, we assume that these missing observations from the database represent zero trade. (See Baldwin and Harrigan 2007, Coe et al 2002, Felbermayr and Kohler 2004, Santos and Tenreyro 2005.) We use import data as it is likely to be more reliable than export data since imports constitute a tax base and governments have an incentive to track import data. Whenever import data was missing we used mirrored export data if it was available (this represented only half percent of the observations). Trade data is deflated using the reporter country's GDP deflator. Income and population are taken from the World Development Indicators database. Geographic data, together with dummies for same language and colonial links, are taken from Clair et al (2004).[4] The distance data are calculated following the great circle formula, which uses latitudes and longitudes of the relevant capital cities.

[3]While trade data are available for a wide range of country pairs, the available tariff data are more limited. For this reason, we utilize a standard WITS procedure of matching the nearest adjacent year to represent otherwise missing tariff data. Interpolation is then used for wider gaps. A further complication is when tariff data are never reported for a country pair. In order to obtain an approximate tariff value applicable between these country pairs we then utilize the average applied tariff for the reporting countries for a given year.

[4]http://www.cepii.fr/anglaisgraph/bdd/distances.htm

3.2 Estimating Equations

For aggregate trade, our estimating equation is based on (17):

$$\begin{aligned} V^{X}{}_{it} &= \beta_0 + \beta_1 \ln gdp_{it} + \beta_2 \ln \ \ exporter \ \tau_{it} + \\ &\beta_3 \ln \ \ destination \ \tau_{it} + \beta_4 \ln distance_i + \varepsilon_{it} \end{aligned} \tag{23}$$

These results are reported in Table 1 and discussed below. Distance is the GDP-weighted distance from the world. We use GDP as an instrument for size and trade potential. The destination market tariff is the trade-weigted average tariff faced in export markets.

For bilateral trade we work with Heckman's selection model (Heckman 1979, Greene 2003), where we estimate the probability of trade occuring jointly with the determinans of the level of trade using maximum likelihood methods. This is based on the following two latent variable sub-models:

$$V^{X}{}_1 = \alpha' Z1 + u_1 \tag{24}$$

$$V^{X}{}_2 = \beta' Z2 + u_2 \tag{25}$$

where $Z1$ is a k-vector of regressors, $Z2$ is an m-vector of regressors, and u_1 and u_2 are the error terms which are jointly normally distributed, independently of $Z1$ and $Z2$, with zero expectations. The variable $V^{X}{}_1$ is only observed if $V^{X}{}_2 > 0$. The variable $V^{X}{}_2$ takes the value of one if $V^{X}{}_1$ is observed, while it is 0 if the variable $V^{X}{}_1$ is zero or missing. In our regressions $V^{X}{}_1$ is the value of imports, while $V^{X}{}_2$ is a dummy variable taking the value one if trade occurs while zero otherwise. The first equation shows how the value of imports is affected by different factors, while the second gives some insight into why trade occurs at all between two partner countries. In specifying the underlying structure of equation (23), or identically the right hand side variables that make up X, we rely on equations (18), and (22).[5] We cannot use both fixed importer and exporter effects in our panel regressions because we want to work with time-varying country-specific variables related to exporter trade policy, which precludes the use of time-varying country dummies. Instead, we include time specific and reporter (importer) country specific dummies. This forces us to include variables that are likely to be important determinants of the reduced-form exporter effects dummies in equation (**??**). From the gravity literature, we expect trade flows to be a function of importer and exporter size and income, as well as of determinants of bilateral trade costs like distance and tariffs. We also include exporter tariffs based on equations (18) and (22):

$$\begin{aligned} \ln {v^X}_{i,j,t} \quad = \quad & \alpha_0 + \alpha_1 \ln p\_pcGDP_{j,t} + \alpha_2 \ln r\_pcGDP_{i,t} + \alpha_3 \ln p\_POP_{j,t} \\ & +\alpha_4 \ln r\_POP_{i,t} + \alpha_5 \ln dist_{i,j} + \alpha_6 landlocked_i \\ & \alpha_7 comlang\_ethno_{i,j} + \alpha_8 colony_{i,j} \\ & +\alpha_9 \ln importer\tau_{i,j,t} + \alpha_{10} \ln exporter\tau_{j,t} + u_1 \end{aligned} \quad (26)$$

[5]There are many paths that lead to the now standard functional relationship we use here, inclusive of importer and exporter fixed effects and economic distance terms. SeeBaldwin and Harrigan (2007) for an overview. Also see Evenett and Keller 2002; Anderson 1979; Anderson and Marcoullier 2002, Anderson and van Wincoop 2003; and Deardorff 1988.

and for the selection estimation we assume that ${v^X}_{i,j,t}$ is observed when we have

$$\beta_0 + \beta_1 \ln p\_pcGDP_{j,t} + \beta_2 \ln r\_pcGDP_{i,t} + \beta_3 \ln p\_POP_{j,t} \qquad (27)$$
$$+\beta_4 \ln r\_POP_{i,t} + \beta_5 \ln dist_{i,j} + \beta_6 landlocked_i$$
$$+\beta_7 comlang\_ethno_{i,j} + \beta_8 colony_{i,j} + u_1 > 0$$

In equations (26) and (27), u_1 and u_2 have correlation ρ.[6] Equation (26) assesses the determinants of the bilateral trade and shows the main factors influencing the amount of trade, given trade occurred between the two trading partners. Equation (27) sets out the selection criteria and provides information on the factors that determine whether or not we observe trade between country pairs.

All of our right-hand side variables are summarized in Table 2. ${v^X}_{i,j,t}$ is country i exports from country j at time t. As a proxy for market potential, POP is included for partner (exporter) and reporter countries, as well as per-capita income $pcGDP$. These are standard gravity variables, as is distance $dist$ and tariffs T. For bilateral import protection, we use applied tariffs, $lnT_{i,j,t} = ln\,(1 + \tau_{i,j,t})$. $\tau_{i,j,t}$ indicates the applied tariff rate offered by importer i to exporter j in period t. As reporter specific fixed effects (non time-varying) are included in the regressions and these are highly correlated with the tariff data we regressed the log of the tariffs on the reporter dummies and retained the residuals. These residuals are used for the regressions and provide a measure of the effects of bilateral tariffs given other reporter specific characteristics. Distance is well established in the gravity

[6] Note that while included in the levels model, $\ln(T)$ is not included in the selection model. This choice is based on specification tests (it is never significant in our selection models), as reflected in our estimation for Table 6.

equation literature. (See for example Disidier and Head 2003, and Anderson and van Wincoop 2003.) The dummy *landlocked* takes the value of one if the importing country is landlocked and zero otherwise. Landlocked countries are expected to have higher transportation costs than countries with similar characteristics not being landlocked. **?** estimate that a representative landlocked country has transport costs approximately 50% greater than does a representative coastal economy. To capture historical and cultural linkages between trading partners several zero-one type dummy variables are included in the estimating equation. The variable *colony* takes the value of 1 if the exporting country j was a colony of the partner country i. A separate dummy, *comlang_ethno* captures if the traders of the two partner countries can speak the same language, or generally share the same linguistic heritage. Finally, there is a very high correlation between per-capita income and tariff rates. For this reason, we have regressed our tariff variables on per-capita income and employ the resulting error terms (i.e. the component of tariffs not explained by income levels) in the regressions. Our tariff indexes are therefore representative of deviations from income- or reporter-dummy conditional expected values for bilateral tariffs or average tariffs.

4 Results

Estimation results for the aggregate export flows are reported in Table 1. The dependent variable is export flows to the world. Two different sets of estimates are presented in Table 1. One is OLS-based. Because the Breusch-Pagan test suggests some problem with heteroskedasticity, we also present robust regression estimates.

Both also include time fixed effect variables (not shown). In both, GDP of the exporter country proxies for the size of the economy. To test the Lerner-symmetry the average import tariffs of the exporting country were included in the regressions (exporter tariffs). Based on our results the Lerner-symmetry cannot be rejected. We find that a country with higher import tariffs will have lower export flows. From these estimates, a one-percent increase in tariffs implies approximately a 1 percent drop in the value of exports, in aggregate. Distance from the global center of activity also enters significantly and with a negative sign. From the coefficients, a 1% increase in the import tariff is comparable to approximately a 4% increase in average distance.

Next we turn to bilateral trade flows. Two different specifications using Heckman estimates are presented in Table 3. While model 1 includes the average tariffs of the partner (exporter) country in both equations, model 2 only includes this variable in the first equation (the value of trade given that trade occurs) but not in the probit equation. Both specifications presented in Table 2 include time fixed effects and reporter (importer) fixed effects. Since reporter fixed effects are highly correlated with bilateral import tariffs of the reporter (importer) we regress the bilateral import tariffs of the reporter county on reporter dummies and retain the residuals for the regression (variable r_τ_r). Similarly $p\_AVG\_\tau_r$ are residuals representative of deviations from income of the partner country (exporter) of its average tariffs.

In the first equation where the dependent variable is the value of trade given that trade occurs all variables have the expected sign in both models. The level of development and size of both exporter and importer countries have a positive impact on the amount of trade between the two countries. Distance and being a landlocked country increase the costs of trade and therefore have a negative impact on exports while sharing a common language and having past colonial ties have a positive effect on bilateral export flows. Our bilateral distance coefficients are in the range of those reported in the bilateral gravity literature. Furthermore, Lerner-symmetry again cannot be rejected. Our results suggest that the higher the exporter country's average import tariffs the lower the value of bilateral exports. However, this does not hold for the second equation (probability of trading or not).

As a robustness check, we have also run the same specification employing a Tobit estimator. These results are presented in Table 4. Again, time and reporter fixed effects are included in the regressions. The results are very similar to those of the first equation of the Heckman estimates where the dependent variable is the value of trade. All gravity variables have the expected sign and significance. Both tariff variables are negative and significant indicating that both the bilateral import tariffs and the exporter country's own average import tariffs have a negative impact on the amount of trade between two countries.

References

Acemoglu, D., S. Johnson, and J.A. Robinson. (2001). "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review* 9(5): 1369-1401.

Alcala, F. and A. Ciccone (2001). "Trade and Productivity."CEPR discussion paper 3095.

Anderson, J. (1979). "A Theoretical Foundation for the Gravity Equation." *American Economic Review* 69(March): 106-116.

Anderson, J., and D. Marcouiller (2002). "Insecurity and the Pattern of Trade: An Empirical Investigation." *The Review of Economics and Statistics* 84: 342-352.

Anderson, J. and E. van Wincoop (2003). "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review* 93(1): 170-192.

Baldwin, R. and D. Taglioni (2006). "Gravity for Dummies and Dummies for Gravity Equations."CEPR discussion paper 5850.

Baldwin R, and J. Jarrigan (2007). "Zeros, Quality and Space: Trade Theory and Trade Evidence."CEPR discussion paper 6368.

Bhagwati, J. (1978). *Anatomy and Consequences of Exchange Control Regimes.* Cambridge, Mass.: Ballinger Publishing Co. for the National Bureau of Economic Research.

Blanchard, E.J. (2005). "Trade Imbalances, International Investment, and A Limitation of Lerners Symmetry Theorem. "SSRN Working Paper No764408.

Bougheas, S., Demetriades, P. and E. Morgenroth (1999). "Infrastructure, transport costs and trade." *Journal of International Economics* 47: 169-189.

Chang, R., Kaltani, L., and N. Loayza (2005). "Openness can be good for Growth: The Role of Policy Complementarities."World Bank policy research working paper no 3763. September.

Clair, G., G. Gaulier, T. Mayer, and S. Zignago (2004). "Notes on CEPII's distances measures."CEPII: Paris.

Coe, D.T., A. Subramanian, N.T. and Tamirisa (2002). "The missing globalisation puzzle."IMF Working Paper WP/02/171.

Deardorff, A. (1988). "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?" in J. Frankel ed., *The Regionalization of the World Economy.* University of Chicago for the NBER, 1998.

Depken II, C.A. and R.J. Sonora (2005). "Asymmetric Effects of Economic Freedom on International Trade Flows." *International Journal of Business and Economics* 4(2): 141-155.

Disdier, A.C. and K. Head (2003). "Exaggerated Reports on the Death of Distance: Lessons from a Meta-Analysis. " mimeo, TEAM, Université de Paris I Panthéon Sorbonne.

Dollar, D. and A. Kraay (2002). "Institutions, Trade, and Growth." *Journal of Monetary Economics.* 50: 133-162.

Dollar, D. and A. Kraay (2004). "Trade, Growth, and Poverty." *Economic Journal* 114: F22-F49.

Edwards, S. (1993). "Openness, Trade Liberalization, and Growth in Developing Countries." *Journal of Economic Literature* 31:3: 1358-1393.

Eicher, T. and A. Leukert (2005). "Institutions and Economic Performance: Endogeneity and Parameter Heterogeneity." University of Munich Department of Economics, Discussion Paper 2006-05.

Evenett, S.J. and W. Keller (2002). "On Theories Explaining the Success of the Gravity Equation." *Journal of Political Economy.* 110(2): 281-316.

Evenett, S. and A.J. Venables (2003). "Export Growth in Developing Countries: Market Entry and Bilateral Trade." working paper, London School of Economics.

Feenstra, R. (2004). *Advanced International Trade: Theory and Evidence.* Princeton University Press: Oxford.

Felbermayr, G.J. & W. Kohler (2004). "Exploring the Intensive and Extensive Margins of World Trade." CESifo Working Paper Series CESifo Working Paper No. 1276, CESifo GmbH.

Francois, J.F. and D. Roland-Holst (1997). "Scale Economies and Imperfect Competition." in J. Francois and K. Reinert, editors, *Applied Methods for Trade Policy Analysis: A Handbook.* Cambridge University Press: Cambridge.

Francois, J.F. and J. Woerz (2006). "Mixed complimentarity programming-based panel estimation of non-tariff barriers." World Bank discussion paper.

FREUND, C. AND B. BOLAKY (2002). "Trade, Regulations, and Growth."World Bank policy research working paper no. WPS 3255, November.

GREENAWAY, D. W. MORGAN, AND P. WRIGHT (2002). "Trade Liberalization and Growth in Developing Countries."*Journal of Development Economics* 67: 229-244.

GREENE, W.H. (2003). *Econometric Analysis: 5th edition* (Chapter 22). Prentice Hall: New Jersey.

GWARTNEY, J. AND R. LAWSON (2005). *Economic Freedom of the World: 2005 Annual Report*. The Fraser Institute: Vancouver. Data retrieved from www.freetheworld.com.

HAVEMANN, J. AND D. HUMMELS (2004). "Alternative Hypotheses and the Volume of Trade: the Gravity Equation and the Extent of Specialization." *Canadian Journal of Economics* 37(1): 199-218.

HECKMAN, J. (1979). "Sample Selection Bias as a Specification error."*Econometrica* 47: 153-161.

HERTEL, T.W., E. IANCHOVICHINA, AND B.J. MCDONALD (1997) "Multi-Region General Equilibrium Modeling."in J. Francois and K. Reinert, editors, *Applied Methods for Trade Policy Analysis: A Handbook*. Cambridge University Press: Cambridge.

HUMMELS, D. AND P.J. KLENOW (2005). "The Variety and Quality of a Nation's Exports. "*The American Economic Review* 95(3): 704-723.

IOANNIDES, Y., H. OVERMAN, E. ROSSI-HANSBERG, AND K. SCHMIDHEINY (2007). "The Effect of Information and Communication Technologies on Urban Structure. "CESifo Working Paper No. 2049.

KAUFMANN, D. A. KRAAY AND M. MASTRUZZI (2005). "Governance Matters IV: Governance Indicators for 1996-2004. " *World Bank Policy Research Working Paper Series* No. 3630.

KRUEGER, A. O. (1978). *Foreign Trade Regimes and Economic Development: Liberalization Attempts and Consequences.* Cambridge, Mass.: Ballinger Publishing Co. for the National Bureau of Economic Research.

LERNER, A. (1936). "The Symmetry Between Import and Export Taxes. "*Economica* 3(11): 306-313.

Mtys, L. (1997). "Proper Econometric Specification of the Gravity Model." *The World Economy* 20:363-368.

McKinnon, R. I. (1966). "Intermediate Products and Differential Tariffs: A Generalization of Lerner's Symmetry Theorem." *Quarterly Journal of Economics* 80(4): 584-615.

Obstfeld, M. and K. Rogoff (1995). "Exchange rate Dynamics Redux " *Journal of Political Economy* 102(June 1995): 624-660.

Ranjan, P. and J.Y. Lee (2003). "Contract Enforcement and the Volume of International Trade in Different Types of Goods."mimeo, UC Irvine.

Ray, E. J. (1975)."The Impact of Monopoly Pricing on the Lerner Symmetry Theorem" *Quarterly Journal of Economics* 89(4): 591-602.

Roberts, M.J. and J.R. Tybout (1997). "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs." *The American Economic Review* 87(4): 545-564.

Rodriguez, F. and D. Rodrik (1999). "Trade policy and economic growth: a skeptic's guide to the cross-national evidence."CEPR discussion paper 2143.

Rodrik, D., Subramanian, A. and F. Trebbi (2004). "Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development." *Journal of Economic Growth* 9: 131-165.

Sala-i-Martin, X. (2006)."The World Distribution of Income: Falling Poverty and... Convergence, Period. " *Quarterly Journal of Economics* 121(2): 351-398.

Santos Silva, J.M.C and S. Tenreyro (2005). "The Log of Gravity." *Review of Economics and Statistics* forthcoming.

Schiff, M. and A. Valdes (1992). *The Political Economy of Agricultural Pricing Policy. Volume 4, A Synthesis of the Economics in Developing Countries.* Baltimore, Maryland: Johns Hopkins University Press.

A. Subramanian and S. We (2007). "The WTO promotes trade, strongly but unevenly." *Journal of International Economics* 72: 151-175.

Tokarick, S. (2006). "Does Import Protection Discourage Exports?"IMF Working Paper No. WP/06/20.

Wacziarg, R. and K.H. Welch (2003). "Trade Liberalization and Growth: New Evidence. "NBER working paper 10152, December.

Wilson, J.S., Mann, C.L., and T. Otsuki (2004). "Assessing the potential benefit of trade facilitation : A global perspective." World Bank Working Paper no. WPS 3224.

World Bank (1987). *World Development Report 1987.* New York: Oxford University Press for the World Bank.

Table 1: Robust regressions: total exports to world

	OLS	robust regression
ln *gdp*	1.061	1.044
	(0.010)***	(0.009)***
ln AVG exporter τ	-1.363	-1.010
	(0.425)***	(0.376)***
ln AVG destination τ	-0.319	0.381
	(0.700)	(0.620)
ln *distance*	-0.109	-0.305
	(0.104)	(0.183)***
constant	26.517	-3.817
	(1.719)***	(0.870)***
observations	2,282	2,282
$F, Pr > 0$	679.56,.000	835.57, .000
OLS R^2	0.8509	

Source: Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%
model includes time dummies

Table 2: Bilateral trade regressions: variable description

$\ln p\_pcGDP$	log of per-capita GDP of partner
$\ln r\_pcGDP$	log of per-capita GDP of reporter
$\ln p\_POP$	log of population of partner (exporter)
$\ln r\_POP$	log of population of reporter (importer)
$\ln Dist$	the log of distance (km, great circle method)
$Landlocked$	landlocked partner
$Comlang\_ethno$	shared linguistic/cultural heritage
$Colony$	reporter and partner had colonial relations
$\ln importer\tau$	log of bilateral tariff: (1+t)
$\ln exporter\tau$	log of average exporter tariff: (1+t)

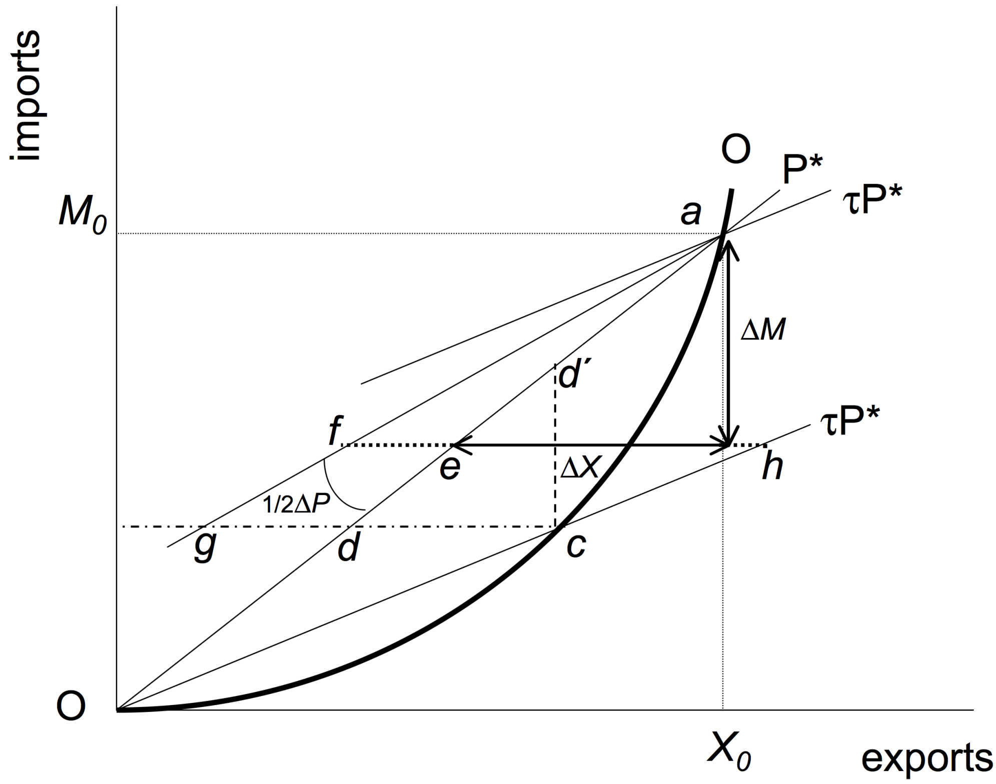

Figure 1: Import tariffs, exports, and gains from trade

Table 3: Heckman selection model regressions

	model 1		model 2	
	trade, value	Probit Pr(trade)	trade, value	Probit Pr(trade)
$\ln p\_pcGDP$	0.932***	0.152***	0.758***	0.177***
	(0.003)	(0.001)	(0.003)	(0.001)
$\ln p\_POP$	0.874***	0.121***	0.718***	0.151***
	(0.003)	(0.001)	(0.003)	(0.001)
$\ln r\_pcGDP$	2.253***	-0.026***	1.995***	-0.027**
	(0.039)	(0.008)	(0.034)	(0.009)
$\ln r\_POP$	1.043***	-0.453***	1.095***	-0.501***
	(0.088)	(0.020)	(0.077)	(0.022)
$\ln Dist$	-1.065***	-0.145***	-0.878***	-0.169***
	(0.006)	(0.001)	(0.005)	(0.002)
Landlocked	-0.297***	-0.088***	-0.229***	-0.076***
	(0.011)	(0.003)	(0.010)	(0.003)
Comlang_ethno	0.679***	0.066***	0.586***	0.091***
	(0.013)	(0.003)	(0.012)	(0.003)
Colony	0.600***	-0.081***	0.535***	-0.101***
	(0.030)	(0.013)	(0.024)	(0.014)
$\ln importer\ \tau$	-0.631***	.	-0.555***	.
	(0.062)	.	(0.051)	.
$\ln exporter\ AVG\ \tau$	-0.111**	0.247***	-0.150**	.
	(0.058)	(0.014)	(0.051)	.
number of observations	336,178	336,178	336,178	336,178

Source: own calculations. Standard errors in parentheses. Marginal effects are presented in the table.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Tobit regressions (marginal effects)

$\ln p\_percapita\_GDP$	1.130
	(0.003)***
$\ln r\_percapita\_GDP$	1.932
	(0.047)***
$\ln p\_POP$	1.079
	(0.003)***
$\ln r\_POP$	1.405
	(0.101)***
$\ln Dist$	-1.316
	(0.006)***
$Landlocked$	-0.379
	(0.014)***
$Comlang\_ethno$	0.838
	(0.014)***
$Colony$	0.890
	(0.032)***
$\ln importer\ \tau$	-0.582
	(0.076)***
$\ln exporter\ AVG\ \tau$	-0.365
	(0.069)***
$Constant$	-34.967
	(0.887)***
number of observations	206,100

Source: own calculations. Standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%

Annex Table A.1: Sample countries

	reporter & partner	
Albania	Guyana	Nepal
Argentina	Hong Kong, China	New Zealand
Australia	Honduras	Oman
Austria	Croatia	Pakistan
Belgium	Hungary	Panama
Benin	Indonesia	Peru
Bangladesh	India	Philippines
Bulgaria	Ireland	Papua New Guinea
Bahamas, The	Iran, Islamic Rep.	Poland
Bolivia	Iceland	Portugal
Brazil	Israel	Paraguay
Barbados	Italy	Romania
Botswana	Jamaica	Russian Federation
Central African Republic	Jordan	Rwanda
Chile	Japan	Senegal
Cote d'Ivoire	Kenya	Singapore
Cameroon	Korea, Rep.	El Salvador
Congo, Rep.	Kuwait	Slovak Republic
Colombia	Sri Lanka	Slovenia
Costa Rica	Lithuania	South Africa
Cyprus	Latvia	Sweden
Czech Republic	Luxembourg	Syrian Arab Republic
Germany	Morocco	Chad
Dominican Republic	Madagascar	Togo
Algeria	Mexico	Thailand
Ecuador	Mali	Trinidad and Tobago
Egypt, Arab Rep.	Malta	Tunisia
Spain	Mauritius	Turkey
Estonia	Malawi	Tanzania
Finland	Malaysia	Uganda
Gabon	Namibia	Ukraine
Ghana	Nicaragua	Venezuela
Guatemala	Norway	Zambia
		Zimbabwe
	partner only	
Fiji	Sierra Leone	United Arab Emirates
Haiti		