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**Lerner meets Gravity**

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## Abstract

*ABSTRACT:* We examine the linkages between import policy and export performance, extending classic macroeconomic trade effects to more recent concepts from the modern literature on gravity models. We also examine these effects empirically with a panel of global and bilateral trade spanning 15 years. Our emphasis on the role of import policy (i.e. tariffs) of exporters as an explanation of trade volumes contrasts with the recent emphasis on importer policy in the gravity literature. It also reinforces the growing body of evidence on the importance of economic environmental (policy and infrastructure) conditions in explaining relative export performance.

*Keywords:* policy and aggregate exports, Lerner symmetry, gravity model  
*JEL categories:* F40, F68, F14,

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# Protection and Performance

*ABSTRACT:* We examine the linkages between import policy and export performance, extending classic macroeconomic trade effects to more recent concepts from the modern literature on gravity models. We also examine these effects empirically with a panel of global and bilateral trade spanning 15 years. Our emphasis on the role of import policy (i.e. tariffs) of exporters as an explanation of trade volumes contrasts with the recent emphasis on importer policy in the gravity literature. It also reinforces the growing body of evidence on the importance of economic environmental (policy and infrastructure) conditions in explaining relative export performance.

*Keywords:* import policy and exports, Lerner symmetry, gravity model

*JEL categories:* F10, F15, O19,

## 1 Introduction

In a 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. The intuition behind Lerner's proposition is that higher protection shifts home demand towards home goods, which makes less supply available for sale to export partners. The general equilibrium correspondence (or even an exact symmetric correspondence under appropriate conditions) between import policy (i.e. tariffs) and export policy now stands as a classic result of general equilibrium trade theory.<sup>1</sup> Despite this correspondence, the recent literature on policy and patterns of trade focuses on the policy of importers. This is especially true in the now voluminous literature on the gravity equation. In this literature, bilateral import protection affects trade directly, while the general level of protection of individual countries also plays a role. Indeed, general levels of

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<sup>1</sup>At the macroeconomic level this relationship has been well explored in the literature with alternative assumption sets. McKinnon (1966) extended the Lerner symmetry 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 et al 1992), to a three-sector model with non-tradables (Milner 1995, Chen and Devereux 1994). Other extensions have involved imperfect competition (Ray, 1975), bilateral tariffs (Gardner and Kimbrough, 1990), quantitative restrictions (Lopez and Panagariya, 1995) and the role of the trade balance (Blanchard, 2009). At the macroeconomic level, Lerner effects relate to the links between the real and financial sides of the economy.

import protection in third countries can also deflect trade to alternative markets. The critical point is the emphasis on policy in importing markets.

In contrast, in this paper we emphasize import protection by exporters. To do this, we bridge both the concepts of multilateral resistance from recent gravity literature to the macro concept of Lerner symmetry. Though largely ignored by the recent literature, we show that the role of policy in exporting markets in explaining general levels of trade should be comparable to policy in importing markets. In particular, we extend the classical, analytical mapping of aggregate, macroeconomic trade volume effects that follow from Lerner-type mechanisms to more recent concepts from the empirical trade literature linked to bilateral gravity models of trade. This is particularly relevant for the recent empirical literature on trade, policy, and trade cost estimation as specified using this class of models. In doing this, we provide an analytical extension of the underlying theory on Lerner mechanics at the level of aggregate trade volumes to include bilateral trade. We apply this framework to a panel of global and bilateral trade data spanning over 15 years. Consistent with the analytical results spelled out here, we find evidence at both the aggregate level, and also at the bilateral level, that the import policies implemented by exporters are a significant macroeconomic factor in explaining overall – and hence also bilateral – export performance. These results reinforce the growing body of recent evidence on the importance of economic environmental (policy and infrastructure) conditions in developing countries in explaining their relative export performance.

We have organized the paper as follows. In Section 2 we expand the relevant theory with extension to include both a dual representation of aggregate links between import and export values, and the linkage between aggregate Lerner effects and bilateral trade flows. This builds on on the Anderson and Neary (1992) balance of trade function. Section 3 provides our empirical analysis, highlighting the effects of import policy on export performance both at aggregate and bilateral level. We conclude in Section 4.

## 2 Import policy and exports

We start with a relatively general, duality-based representation of the aggregate links between import and export values, mapping trade volumes based on the trade

expenditure function of Neary and Schweinberger (1986). We also link import tariffs in exporting markets analytically to exports in the context of modern gravity model specifications which is closely linked to the concept of multilateral resistance as developed by Anderson and van Wincoop (2003) to include the impact of import policy on exports. This provides us with a set of estimating equations, both in aggregate and for bilateral gravity modeling of trade, augmented to incorporate not only standard gravity terms like trade policy in the destination market, but also aggregate trade protection in the source or export markets as a source of "multilateral export resistance" through general equilibrium Lerner effects.

## 2.1 Aggregate Trade

Assume 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 (Dixit and Norman, 1980). With identical homothetic preferences defined over goods  $X$ , so that welfare can be specified in terms of consumption of  $X$  as  $u = f(X)$ , we have

$$e(u, P) = \min_X \{P \cdot X \mid f(X) \geq u\} \quad (1)$$

In equation (1),  $u$  indexes final consumption (or identically national welfare), while  $P$  denotes the vector of internal prices. The expenditure function defines the minimum expenditure necessary, at prices  $P$ , to achieve national welfare  $u$  (or identically it measures national income from the expenditure side). For production, the revenue function defines the maximum value of national income given technology and resource constraints (or identically national income from the value added side). Taking  $a$  as a particular sub-set of unit input coefficients from the set of all possible unit input coefficients for endowments, we have

$$r = r(P, v) = \max_X \{P \cdot X \mid a \cdot X \leq v\} \quad (2)$$

In equation (2),  $r$  denotes the maximum value of national income achievable given the vector of factor endowments  $v$ . The economy-wide condition for equilibrium

requires that

$$Z = e - r \quad (3)$$

where  $Z = 0$  with balanced trade, and where under more general conditions it represents the value of the net trade balance. Starting from equation (3), known as the trade expenditure function (Neary and Schweinberger, 1986), a general equilibrium expression for the full matrix of net imports ( $z$ ) can then be defined by taking derivatives of equation (4), which gives us the trade offer function <sup>2</sup>:

$$Z_P = e_P - r_P \quad (4)$$

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  $u$ , it provides compensated net import demand. Evaluated in the context of the full general equilibrium system, it provides Marshallian net import demand. We can bifurcate the right hand side of equation (4) into gross imports and exports.

$$M = (e_P - r_P | p, \forall e_p - r_p > 0) \quad (5)$$

$$X = (r_P - e_P | p, \forall e_p - r_p < 0) \quad (6)$$

Using (5) and (6) we can then re-write equation (3):

$$Z = PM - PX = V^M - V^X \quad (7)$$

Equation (7) links the value of exports  $V^X$  to the value of imports  $V^M$  and  $Z$ . The relationship is quite general, though it involves both the value of exports and imports and net financial inflows  $Z$  so that systematic log variation in import and export values may or may not be directly proportional to each other. The closer  $Z$  is to zero, the closer the relationship should be to direct proportionality. This

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<sup>2</sup>We use the notation from (Dixit and Norman, 1980) in terms of expressing vectors and matrices of partial derivatives

relationship applies to the total value of imports and exports, and not to the underlying quantities involved. Values and quantities can move in opposite directions depending on price movements. In order to control for the role of the trade balance when mapping imports to exports, we will re-write equation (7) as follows:

$$\ln V^X = \ln V^M - \zeta \tag{8}$$

In equation (8), the term  $\zeta = \ln(V^X + Z) - \ln(V^X)$  allows for mapping of the value of exports and imports, corrected for the trade balance. Recall from equation (3) that  $Z$  is the current account deficit, or the mirror of the capital account. In equation (8) the term  $\zeta$  is another version of this deficit in logs, expressed as the log ratio of import to export values. Balanced trade implies that  $\zeta = 0$ . The term  $\zeta$  will allow for correction of the exporter capital account balance when we examine trade flows econometrically. The impact of tariffs on aggregate exports follows directly from our observation based on equation (7) about the linkage between aggregate import and export values. When comparing countries with different tariff regimes, as long as the value of imports is lower under higher import tariffs (i.e.  $Z_p < 0$ ), we expect to see a lower value for aggregate exports as well <sup>3</sup>.

## 2.2 Bilateral Trade

Although the literature on Lerner symmetry focuses on aggregate trade flows, it is actually highly relevant for bilateral trade flows as well. Indeed, 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. Therefore, in this sub-section (and the next) we extend our framework along bilateral lines.

We extend our basic theoretical framework above by introducing a CES-based aggregator for imports. This requires that we start subscripting exporter and importer countries. To avoid confusion, we will strictly use the following convention. We will subscript trade, with the first index indicating source, and the second indicating destination. So when country  $i$  is exporting, and its destination markets are indexed by  $j$ , then in terms of direction of flows,  $m_{i,j}$  means goods  $m$  flow  $i \rightarrow j$ .

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<sup>3</sup>Here we do not model endogenous changes in the net capital balance  $\zeta$ .



We define a composite of total imports  $M_i$  of country  $i$  as following from a representative CES aggregator for composite imports  $M_i$ .

$$M_i = \left[ \sum_k \alpha_k m_{k,i}^\rho \right]^{1/\rho} \quad 1 > \rho > 0 \quad (9)$$

In equation (9), the terms  $\alpha_k$  are the CES weights applied to imports indexed by source country  $k$ . 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 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 common to the Ethier (1982), Krugman (1980), and Melitz (2003) versions of trade under monopolistic competition.<sup>4</sup> In the case of monopolistic competition, the  $\alpha$  terms index available varieties by source. This means the estimation strategy employed in the recent gravity literature 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. From first order conditions for maximization of composite  $M_i$  subject to expenditure on imports  $E_{M,i}$  we can derive the following:

$$P_{M,i} = \left[ \sum_k \alpha_k^\sigma \omega_{k,i}^{1-\sigma} \right]^{1/(1-\sigma)} \quad (10)$$

where  $\omega_{k,i}$  are the border prices for imports from different markets indexed over  $k$  and flowing from  $k$  to  $i$ . 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  $\gamma$ :

$$\omega_{k,i} = \gamma_{k,i} \quad (11)$$

$$P_{M,i} = \left[ \sum_k \alpha_k^\sigma \gamma_{k,i}^{1-\sigma} \right]^{1/(1-\sigma)} \quad (12)$$

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<sup>4</sup>See for example: Feenstra, Markusen and Zeile (1991) ; Feenstra (1994) ; Francois and Roland-Holst (1997); Feenstra and Kee (2008); Francois and Woerz (2009).

As a final step to moving across the border we will assume there are also policy variables that raise the cost of imports, apart from any natural costs  $\gamma$  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, raising the price of delivered imports by the multiplier  $\tau_i$ . Following de Melo and Robinson (1989) we impose a specific functional form on the utility function underlying equation (1) by introducing a second CES aggregator specified over imports and domestic absorption  $D$ .<sup>5</sup> This second, upper-nest CES function is as follows:

$$u_i = A_i [\beta_{m,i} M_i^\rho + \beta_{d,i} D_i^\rho]^{1/\rho} \quad 1 > \rho > 0 \quad (13)$$

Recall from our discussion of equation(1) that the term  $u$  is a measure of real consumption (or real national income defined from the expenditure side). On the demand side, imports are related to relative prices (the real exchange rate) and total consumption. From our first order conditions for maximizing  $u$  at a given level of total expenditure expenditure  $e$ , the value of total import demand  $V^M$  can be shown, after some manipulation to equal:

$$V_i^M = u \left( \frac{\beta_{m,i}}{\tau_i} \right)^\sigma P_{M,i}^{1-\sigma} P_{u,i}^\sigma \quad (14)$$

where  $P_{u,i} = \partial e_i / \partial u_i$  is the CES-based composite price index for real consumption. Note that (14) can also be derived from the envelope theorem, by first taking the first derivative of the expenditure function with respect to  $P_{M,i}$ . Normalizing quantities (selecting  $A_i$  so that  $P_{u,i} = 1$ , and making substitutions), we then have the following:

$$V_i^M = u_i \left( \frac{\beta_{m,i}}{\tau_i} \right)^\sigma \left[ \sum_k \alpha_k^\sigma \gamma_{k,i}^{1-\sigma} \right] \quad (15)$$

This is a variation of the aggregate import demand function in de Melo and Robinson (1989). Taking logs, we arrive at a global estimating equation for aggregate imports,

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<sup>5</sup>This implies a CES-based expenditure function for (1). We keep 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.

corresponding to a specific form of equation (4) above.

$$\ln(V_i^M) = \ln(u_i) + \sigma \ln(\beta_{m,i}) + \ln\left(\sum_k \alpha_k^\sigma \gamma_{k,i}^{1-\sigma}\right) - \sigma\tau_i \quad (16)$$

Equation (16) defines the value of aggregate imports as a function of real consumption and a mix of natural and policy-related trade costs. We can map this into an estimating equation for the total value of exports by substitution through the Anderson and Neary (1992) balance of trade function. Starting with equation (8), and making a substitution into equation (16) we arrive at equation (17):

$$\ln(V_i^X) = \ln(u_i) + \sigma \ln(\beta_{m,i}) + \ln\left(\sum_k \alpha_k^\sigma \gamma_{k,i}^{1-\sigma}\right) - \sigma\tau_i - \zeta_i \quad (17)$$

Note that equation (17) points to the average tariff imposed in the market of the exporter as a determinant of aggregate exports that will carry over to bilateral export patterns. This is the mirror of the impact of general import protection imposed by importers on aggregate and bilateral trade stressed in the gravity literature (Anderson and van Wincoop, 2003). On the import side, aggregate tariffs are one determinant of what is referred to in the literature as *multilateral resistance* to imports. Aggregate exports, in this form, are a function of real consumption (GDP), natural trade barriers, and own tariffs in the exporter market. Turning to the role of country  $i$  as an exporter selling across the border and into market  $j$  we are also interested in the impact of its import policy on trade flow  $x_{i,j}$ . Taking equation (9) for a representative importer for a given set of world prices (recall we are working from first order conditions under equilibrium conditions and so will be assuming data represent equilibrium values in the cross-section), we can derive bilateral exports from the first order conditions for constrained optimization of the aggregate import equation (9).

$$x_{ij} = V_j^M \left(\frac{\alpha_i}{\tau_j \gamma_{i,j} P_i}\right)^\sigma P_{M_j}^{\sigma-1} \quad (18)$$

In equation (18) the composite import price term is defined by equation (12). Also, though we normalized export price  $P_i$  earlier for expositional purposes, we show it again here for the sake of completeness. This is a relatively standard bilateral

trade equation, specified in terms of the tariff of the importer  $\tau_j$ . We want to map the rate of protection in the export market  $\tau_i$  to bilateral exports, adding it to the estimating equation suggested by equation (18). We start by differentiating exports with respect to the import tariff, and manipulating the resulting expression to transform this into a function of the value of bilateral exports  $v_{ij}^x$  and export shares  $\theta_{ij}$  for the bilateral flows that make up the value of total exports  $V_i^X$  from country  $i$ . This is equation (19).

$$\hat{V}_i^X = -\sigma\hat{\tau}_i = \sum_j \theta_{ij} \hat{v}_{ij}^x \quad (19)$$

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

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

The last term in equation (19) is value-weighted deviations of individual changes from the average deviation in export values (in particular deviations in the impact of the tariff of the exporter given our aggregate import-export symmetry result above). 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 we have done in equation (20).

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

Because the last set of terms in brackets,  $\theta_{ik} \left( \hat{v}_{ik}^x - \hat{V}_i^X \right)$ , has an expected value of zero, we can write log deviations in the value of bilateral exports  $\hat{v}_{ij}^x$  in terms of the change in total value exports due to the import tariff, which in turn is linked to the tariff itself through the import price coefficient  $\sigma$ :

$$\hat{v}_{ij}^x |_{\hat{\tau} \neq 0} = -\sigma\hat{\tau}_i + \phi, \quad E(\phi) = 0 \quad (22)$$

Equation (22) states formally that the aggregate impact of an import tariff on bilateral exports can be captured by including the tariff as a right hand side variable.

### 2.3 The Standard CES model

The Anderson and van Wincoop (2003) framework has emerged as a standard reference point in the modern gravity literature. As such, in this sub-section we will map our general results to the specific structure of this class of models. Following Anderson and van Wincoop 2003, we can also re-arrange the demand expressions for a basic CES-based system to highlight the role of exporter protection. We first generalize equation (9) to include domestic absorption when defining a composite consumption good  $Q$ , inside a single CES nest.

$$Q_i = \left[ \sum_n \alpha_n g_{n,i}^\rho \right]^{1/\rho} \quad 1 > \rho > 0 \quad (23)$$

In equation (23),  $g$  denotes both domestic absorption and imports, and  $n$  includes all countries (and so indexes domestic purchases as well as imports). We again normalize prices to unity, and then define GDP as the quantity of the national good  $G_i$ . This implies the supply constraint

$$G_i = \sum_n g_{i,n} \quad (24)$$

From the properties of constrained optimization of consumption given equation (23), treating GDP as the income constraint, we then have

$$g_{i,j} = G_j P_{Q_j}^{\sigma-1} \left( \frac{\alpha_i}{\tau_j \gamma_{i,j}} \right)^\sigma \quad (25)$$

where in equation (25) the term  $P_{Q_j}$  denotes the CES price index for country  $j$  associated with equation (23). Combining equations (24) and (25), we have the following:

$$g_{i,j} = G_i - \sum_{n \neq j} g_{i,n} = G_i - \sum_{n \neq j} G_n P_{Q_n}^{\sigma-1} \left( \frac{\alpha_i}{\tau_n \gamma_{i,n}} \right)^\sigma \quad (26)$$

Manipulation then yields the following:

$$g_{i,j} = G_i \left( 1 - \sum_{n \neq j,i} G_n G_i^{-1} P_{Q_n}^{\sigma-1} \left( \frac{\alpha_i}{\tau_n \gamma_{i,n}} \right)^\sigma - P_{Q_i}^{\sigma-1} \alpha_i^\sigma \right) \quad (27)$$

If we substitute the functional specification of the CES price index in equation (27) we have the following.

$$g_{i,j} = G_i \alpha_i^\sigma \left( \alpha_i^{-\sigma} - \sum_{n \neq j,i} G_n G_i^{-1} P_{Q_n}^{\sigma-1} (\tau_n \gamma_{i,n})^{-\sigma} - \left( \sum_f \alpha_f^\sigma (\tau_i \gamma_{f,i})^{1-\sigma} \right)^{-1} \right) \quad (28)$$

From equation (28), we can see that viewed from the supply side, bilateral exports hinge on total available supply, third-country demand, but also the level of import protection applied by the exporter. This is because, to close Lerner's classic argument, higher protection shifts home demand towards home goods, which makes less supply available for sale to export partners. This is reflected, in equation (28), in the last term of the equation.<sup>6</sup>

### 3 Empirics

We next turn to an empirical analysis of the impact of import policy on export performance both at aggregate level and bilateral trade level.<sup>7</sup>

#### 3.1 Empirical methodology

##### 3.1.1 Aggregate Trade

In the section that follows, we start with versions of equations (17), (19) and (22). From equation (17), our estimating equation for total trade is defined below in equation (29):

$$\ln v_{it}^x = \beta_0 + \beta_1 \ln(\text{own } \tau_{it}) + \beta_2 \ln(\text{world } \tau_{it}) + \beta_3 \ln(\text{size}_{it}) + \beta_4 \zeta_{it} + \beta_5 \ln(\text{Wdistance}_{it}) + F_i + F_t + \varepsilon_{it} \quad (29)$$

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<sup>6</sup>technically in equation (28) we have also included the tariff applied to domestic absorption. This can be cleaned up by imposing the condition  $\gamma_{k,k} = \tau_k^{-1}$ .

<sup>7</sup>The recent empirical literature on the impact of tariffs on exports 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), and Manzur and Subramaniam (1995). More recently, in their empirical work on the role of the WTO in promoting trade, Subramaniam and Wei (2007) invoke own-liberalization in their econometric model of the evolution of bilateral trade. Our use of selection modeling is a break from the general approach followed in the literature.

Motivated by natural trade costs in equation (17), we have included the GDP-weighted distance from the world  $Wdistance$ . To represent the size of the economy (the term  $u$  in equation 17), we use both population and GDP. In addition to the exporter’s import tariff, *own*  $\tau$ , we also include third-country policy (another aspect of the trade cost environment) as the trade-weighted average tariff faced in export markets, represented by the variable *world*  $\tau$ . The term  $\zeta$  measures the role of the current account balance from equation (8).<sup>8</sup> Finally, we have also included exporter and time fixed effects in the regressions. We regress equation (29) using OLS.

### 3.1.2 Bilateral Trade

In specifying the underlying structure of equation (30) for the bilateral regressions, or identically the right hand side variables that make up  $v^x_{i,j}$ , we rely on equations (19), and (22) (and also on equation (28)). There are many paths that lead to the now standard functional relationship we use here. The first to propose a gravity equation for trade flows as an empirical specification for trade without theory was Tinbergen (1962). Anderson (1979) was the first to provide microfoundations based on the Armington assumption. Among the more recent literature, Anderson and van Wincoop (2003) elaborate on Anderson (1979) adding a practical way to estimate the gravity equation structurally.<sup>9</sup> A basic point of Anderson and van Wincoop (2003) is multilateral resistance. Not accounting for multilateral resistance terms in a gravity model can lead to biased parameter estimates. This can be addressed with country-level fixed effects, but one then loses scope for analysis of country-level factors. To get around this, a recent strategy involves Taylor approximations of the multilateral resistance terms to solve for the multilateral resistance terms (Baier and Bergstrand, 2009). This allows for estimation of the gravity equation, inclusive of country-level variables. In this paper we follow Baier and Bergstrand (2009) extended to accommodate our Lerner variable and time variation in the data.

Following the gravity literature we expect trade flows to be a function of

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<sup>8</sup>In particular, with some manipulation, one arrives at the term  $\zeta = \ln(V^X + Z) - \ln(V^X)$ . In theory, the coefficient on this term should be negative. However, our trade data are for merchandise only and we are missing export earnings linked to services exports. In addition, in official trade data, the world runs a substantial trade deficit with itself. This means that while we expect  $\zeta$  to carry some explanatory power and have a negative sign, this will be limited by these effects, implying a coefficient well below unity.

<sup>9</sup>Other important contributions to the gravity literature include Evenett and Keller (2002), Deardorff (1988).

importer and exporter income, as well as of determinants of bilateral trade costs, namely distance, tariffs, and whether countries speak the same language. Finally, pulling all this together yields the following estimating equation.

$$\begin{aligned} \ln v^x_{i,j,t} = & \alpha_0 + \alpha_1 \ln importerGDP_{j,t} + \alpha_2 \ln exporterGDP_{i,t} + \alpha_3 \ln distance_{i,j} + \\ & \alpha_4 commonlanguage_{i,j,t} + \alpha_5 \ln importer\tau_{i,j,t} + \alpha_6 \ln exporter\tau_{i,t} + \alpha_7 \zeta_{i,t} + u_{i,j,t} \end{aligned} \quad (30)$$

Equation (37) assesses the determinants of the value of bilateral trade.  $v^x_{i,j,t}$  is the value of country  $i$  exports to country  $j$  at time  $t$ .  $\ln importerGDP_{j,t}$  and  $\ln exporterGDP_{i,t}$  measure the market size of importers and exporters using GDP. Distance is well established in the gravity equation literature. (See for example Disdier and Head 2003, and Anderson and van Wincoop 2003.) The variable dummy *comlang\_ethno* captures if the traders of the two trading partners can speak the same language, or generally share the same linguistic heritage. For bilateral import protection, we use applied tariffs,  $\ln importer\tau_{i,j,t} = \ln(1 + \tau_{i,j,t})$ , where  $\tau_{i,j,t}$  indicates the tariff applied against exporter  $i$  by importer  $j$  in period  $t$ . The variable  $\ln exporter\tau_{i,t}$  measures the exporter country's own average import tariff rate vis-a-vis the rest of the world. The term  $\zeta$ , as in the aggregate regressions, measures the role of the current account balance from equation (8).

In order to include multilateral resistance terms, equation (37) is extended following Baier and Bergstrand (2009). Indexing importers by  $(j, k, h)$ , and exporters by  $(i, m, z)$ , equations (19) and (20) on page 80 of Baier and Bergstrand (2009) are reproduced as equations (31) and (32) below.

$$P_{it} = \sum_{m \neq i} \ln T_{imt} \frac{GDP_{mt}}{GDP_{wt}} - (0.5) \sum_h \sum_z \frac{GDP_{ht}}{GDP_{wt}} \frac{GDP_{zt}}{GDP_{wt}} \ln T_{hzt} \quad (31)$$

$$P_{jt} = \sum_{k \neq j} \ln T_{kjt} \frac{GDP_{kt}}{GDP_{wt}} - (0.5) \sum_h \sum_z \frac{GDP_{ht}}{GDP_{wt}} \frac{GDP_{zt}}{GDP_{wt}} \ln T_{hzt} \quad (32)$$

Here, we have modified the basic Baier and Bergstrand specification to include time indexing. In the case of bilateral tariffs  $\ln T_{ijt}$ , we can specify multilateral resistance



as in equation (33) below.

$$MRT_{ijt} = P_{it} + P_{jt} = \sum_{m \notin i} \ln T_{imt} \frac{GDP_{mt}}{GDP_{wt}} + \sum_{k \notin j} \ln T_{kjt} \frac{GDP_{kt}}{GDP_{wt}} - \sum_h \sum_z \frac{GDP_{ht}}{GDP_{wt}} \frac{GDP_{mt}}{GDP_{zt}} \ln T_{hzt} \quad (33)$$

We can easily extend equation (33) to the more general case of bilateral time varying variables  $G_{ijt}$  as in equation (34) and importer and exporter multilateral resistance term for the average tariff of exporters  $T_{export:jt}$  as in equation (35).

$$MRG_{ijt} = \sum_{m \notin i} \ln G_{imt} \frac{GDP_{mt}}{GDP_{wt}} + \sum_{k \notin j} \ln G_{kjt} \frac{GDP_{kt}}{GDP_{wt}} - \sum_{h=1}^N \sum_{z=1}^N \frac{GDP_{ht}}{GDP_{wt}} \frac{GDP_{mt}}{GDP_{zt}} \ln G_{hzt} \quad (34)$$

$$MR_{export:ijt} = \ln I_{it} \sum_{m \notin i} \frac{GDP_{mt}}{GDP_{wt}} + \sum_{k \notin j} \ln I_{kt} \frac{GDP_{kt}}{GDP_{wt}} - \sum_h \sum_z \frac{GDP_{ht}}{GDP_{wt}} \frac{GDP_{zt}}{GDP_{wt}} \ln I_{ht} \quad (35)$$

Our estimating equation augmented by the controls for multilateral resistance for all the variables proxying for transport costs:

$$\begin{aligned} \ln v^x_{i,j,t} = & \alpha_0 + \alpha_1 \ln importerGDP_{j,t} + \alpha_2 \ln exporterGDP_{i,t} + \alpha_3 \ln distance_{i,j} + \quad (37) \\ & \alpha_4 commonlanguage_{i,j,t} + \alpha_5 \ln importer\tau_{i,j,t} + \alpha_6 \ln exporter\tau_{i,t} + \alpha_7 \zeta_{i,t} + \\ & \alpha_8 MR \ln distance_{i,j,t} + \alpha_9 MR commonlanguage_{i,j,t} + \alpha_{10} MR \ln importer\tau_{i,j,t} \\ & \alpha_{11} MR \ln exporter\tau_{i,t} + u_{i,j,t} \end{aligned}$$

<sup>10</sup> where  $MR \ln distance_{i,j,t}$ ,  $MR commonlanguage_{i,j,t}$ , and  $MR \ln importer\tau_{i,j,t}$  have been constructed following (34),  $MR \ln exporter\tau_{i,t}$  has been constructed following (35). Also, following Baier and Bergstrand (2009), we impose constraints linking direct terms to MR terms in the estimating equation.<sup>11</sup>

In order to account for zero bilateral trade flows we employ a poisson estimator.<sup>12</sup> This implies that we do not take the log of the dependent variable in equation

<sup>10</sup>We also run the regression as a robustness check to smooth out imbalances with three years moving averages. The results are almost identical to those presented here.

<sup>11</sup> $\alpha_1 = 1, \alpha_2 = 1, \alpha_3 = \alpha_8, \alpha_4 = \alpha_9, \alpha_5 = \alpha_{10}, \alpha_6 = \alpha_{11}$ .

<sup>12</sup>When examining the global pattern of bilateral trade flows, one striking feature of the land-

(37). Santos and Tenreyro (2006) argue that gravity-type equations should be estimated in their multiplicative form and propose to use a Poisson estimation. Using this methodology is consistent in the presence of heteroskedasticity and provides a way to deal with zero values of the dependent variable.

## 3.2 Data

Our trade and tariff data spanning from 1988 to 2002 were obtained from the UN/World Bank WITS database system (World Integrated Trade Solution). The data in WITS come, primarily, from the UNCTAD TRAINS and COMTRADE systems and the World Trade Organization's integrated tariff database (IDB). The data on GDP were obtained from the World Bank's World Development Indicators Database. Geographic data, together with dummies for same language and colonial links, are taken from Clair et al (2004).<sup>13</sup> The distance data are calculated following the great circle formula, which uses latitudes and longitudes of the relevant capital cities. The countries included in the sample are listed in the annex.<sup>14</sup>

There are several country combinations for which trade data are 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.) However, we replace zero observations with missing observations in case a country did not report trade with any other country in a given year since in these cases the data are most probably missing from the database. 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 were missing we used mirrored export data if those were available (this represented only one-half of one percent of our observations).

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scape is that many country pairs do not trade. See Baldwin and Taglioni (2006) and Baldwin and Harrigan (2007). In our initial sample 42% of importer-exporter pairings had zero bilateral trade (in our final sample including observations only when tariffs were available the share of zeros was around 20% . 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.

<sup>13</sup><http://www.cepii.fr/anglaisgraph/bdd/distances.htm>

<sup>14</sup>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.

### 3.3 Results

#### 3.3.1 Aggregate trade

Estimation results for the aggregate export flows are reported in Table 1 where the dependent variable is export flows to the world. Results presented in Table 1 include time and country fixed effects. To test the Lerner-effect the average import tariffs of the exporting country were included in the regressions. Two different estimates are presented in Table 1. The difference between the two specification is that the first specification uses GDP of the exporter country as a proxy for the size of the economy while the specification presented in column 2 includes population as a proxy for size.

The results of both specifications indicate that the exporting country's own import tariffs have a negative effect on own exports. Thus based on our aggregate regression results we cannot reject that the exporting country's own import policy influences its export performance. Trade costs, such as distance, measured as a GDP weighted distance from the rest of the world, and the average import tariffs which are applied on the country's exports are both negatively influencing the value of total exports. The variable measuring current account deficit is also negative and significant as expected.

The second column presents results for a specification which uses population as a proxy for size instead of GDP. We estimate this alternative specification as a robustness check of the results presented in the first column as GDP of the exporting country is correlated with distance and also tariffs. The sign and significance of the variables do not change, however, the coefficient of distance and the tariff variables becomes somewhat higher with this specification.<sup>15</sup> Based on these results, the Lerner-effect cannot be rejected. Thus we find evidence that the exporting country's own import tariffs have a negative impact on its exports.

#### 3.3.2 Bilateral trade

Next we turn to bilateral trade flows. The first column in Table 2 presents results using poisson estimation including multilateral resistance terms and yearly fixed

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<sup>15</sup>The difference in the coefficients between the two specifications is due to the correlation of GDP of the exporting country with distance and tariffs.

effects. The results of the bilateral regressions are similar to those found at the aggregate level although the coefficients are somewhat different. Following Baier and Bergstrand (2009) the coefficients of the exporter and importer country's GDP is constrained to be one. All the variables have the expected sign and significance. The variable measuring the effects of current account deficit on exports and the coefficient of distance is negative and significant. The coefficient of the exporter country's own import tariff is close to what we found at the aggregate regression and also to the coefficient of the bilateral import tariffs. Both the bilateral tariff elasticity and the exporter country's own tariff coefficient is around -0.6. Thus these results support the existence of the Lerner-symmetry also for bilateral trade flows.

### 3.3.3 Robustness

A potential endogeneity problem can be present in our bilateral regression. There is a possibility of reverse causality in case bilateral exports would influence import policy and thus bilateral import tariffs.<sup>16</sup> To address this potential reverse causality we restrict our sample to non-preferential trade flows. The bilateral tariffs applicable in the case of non-preferential trade flows are the MFN (Most Favored Nation) tariffs which are not determined by country-pair trade relations but set equally for all partner countries thus reverse causality is unlikely. We also omit from the sample imputed missing values as a further robustness check.

The results for this reduced sample are presented in the second column in Table 2. This sample is smaller, includes only non-preferential trade. The results are similar to those using the full sample with the coefficient on the exporter's own tariffs being a slightly lower (-0.408 instead of -0.582). Nevertheless our results hold. Lerner effects are confirmed based on our results also at bilateral level.

## 4 Summary

In this paper we examine linkages between the trade policy (import protection) of exporting countries and their export performance, both at the aggregate and bilateral level. This involves analytical extension of the classic definition of ag-

<sup>16</sup>Reverse causality is unlikely to be a problem for the exporting country's own import tariffs as this variable is an aggregate tariff over all products and all import partners thus cannot be influenced by sectoral lobbies or other factors influencing trade policy.

gregate effects (linked to Lerner symmetry) to bilateral effects. This allows us to use a bilateral gravity model. We test the importance of the exporting country's import policy for its own export performance (the 'Lerner-effect' leading to export resistance) both with aggregate and bilateral trade flows. This is based on the theoretical framework developed in the paper. We find at both the aggregate level, and also at the bilateral level, that the trade policy of the exporting countries is a significant factor in explaining export performance. Indeed, given approximate symmetry as suggested by theory, the policy of exporters is as important, economically, as policy in import or destination markets. This reinforces the recent evidence on developing country's export performance. General conditions of trade openness in exporting markets matter empirically, for macroeconomic reasons, for the performance by that same country in export markets both in aggregate and bilaterally. This means that, when exploring multilateral or country specific determinants of trade in a gravity context, trade policies in exporting markets deserve place of importance next to trade policies in importing markets.

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Table 1: Lerner Effects at a Macro Level

	ln Exports	ln Exports
$\beta_1 : \ln(\text{own } \tau_{it})$	-0.361* (0.210)	-0.515** (0.215)
$\beta_2 : \ln(\text{world } \tau_{it})$	-2.957*** (0.415)	-3.239*** (0.424)
$\beta_3 : \ln(\text{gdp})$	0.896*** (0.0946)	
$\beta_3 : \ln(\text{population})$		0.499** (0.222)
$\beta_4 : \zeta$	-0.173*** (0.0198)	-0.170*** (0.0202)
$\beta_5 : \ln(\text{Wdistance}_{it})$	-0.462*** (0.149)	-1.323*** (0.146)
Constant	-6.692*** (1.381)	-9.609*** (1.379)
Observations	1095	1137
$R^2$	0.912	0.581
$F(\text{Pr} > 0)$	5.95(0.00)	5.98(0.00)
Number of observations	1095	1137

Standard errors in parentheses

Specification includes time and country fixed effects

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2: Poisson estimates for bilateral exports

	Full sample	Non-preferential trade with non-imputed tariffs
$\alpha_1 : \ln importerGDP\tau_{j,t}$	1 (0.000)	1 (0.000)
$\alpha_2 : \ln exporterGDP\tau_{i,t}$	1 (0.000)	1 (0.000)
$\alpha_3 : \ln(distance_{ij})$	-0.609*** (0.0187)	-0.500*** (0.0208)
$\alpha_4 : \ln(commonlanguage_{ij})$	1.041*** (0.0519)	0.717*** (0.0646)
$\alpha_5 : \ln importer\tau_{i,j,t}$	-0.627*** (0.0398)	-0.607*** (0.0479)
$\alpha_6 : \ln exporter\tau_{i,t}$	-0.582*** (0.0740)	-0.408*** (0.0435)
$\alpha_7 : \zeta_{i,t}$	-0.169*** (0.0144)	-0.208*** (0.0187)
Constant	11.66*** (0.117)	11.43*** (0.136)
Observations	106,561	82,625

Robust standard errors in parentheses

Regressions include annual fixed effects and multilateral resistance terms for all trade cost variables.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Annex Table A.1: Sample countries**

<b>reporter &amp; partner</b>		
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
	<b>partner only</b>	
Fiji	Sierra Leone	United Arab Emirates
Haiti		