



Estimating Trade Flows: Trading Partners and Trading Volumes

Helpman, E., Melitz, M., and Rubinstein, Y. - QJE(2008)

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Conclusion



- ▶ Estimation of international trade flows has a long tradition
- ▶ Tinbergen (1962) pioneered the use of gravity equations in empirical specifications of bilateral trade flows
- ▶ The gravity equation has dominated empirical research in international trade henceforth
- ▶ Volume of trade between two countries is proportional to an index of their economic size, and the factor of proportionality depends on measures of trade resistance between them
- ▶ This approach has been supplemented with theoretical underpinnings and better estimation techniques. e.g. Anderson (1979), Helpman and Krugman (1985), Helpman (1987), Feenstra (2002), and Anderson and van Wincoop (2003)



- ▶ All the above-mentioned studies estimate the gravity equation on samples of countries that have only positive trade flows between them.
- ▶ By disregarding countries that do not trade with each other, these studies give up important information contained in the data, and they produce biased estimates as a result
- ▶ Moreover, standard specifications of the gravity equation impose symmetry that is inconsistent with the data and that too biases the estimates
- ▶ To correct these biases, the authors develop a theory that predicts positive as well as zero trade flows between countries and use the theory to derive estimation procedures that exploit the information contained in data sets of trading and nontrading countries alike.



Motivation

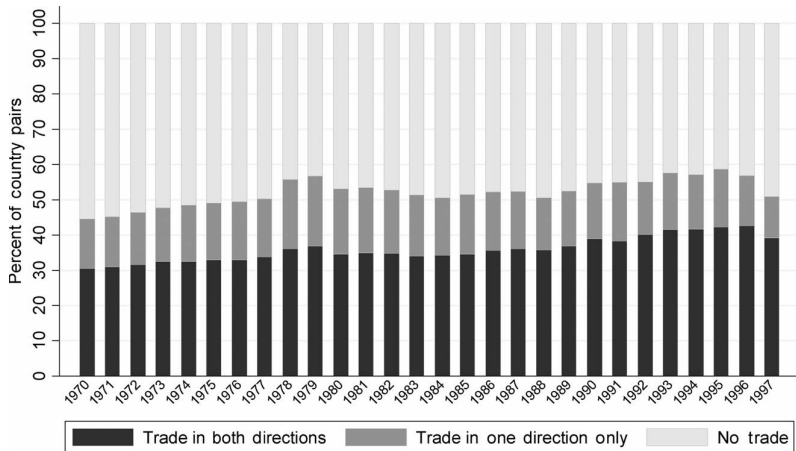
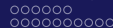


Figure: Distribution of Country Pairs Based on Direction of Trade



- ▶ A simple model of international trade with heterogeneous firms that predicts positive as well as zero trade flows across pairs of countries, and it allows the number of exporting firms to vary across destination countries
- ▶ The impact of trade frictions on trade flows can be decomposed into the intensive and extensive margins
- ▶ This model yields a generalized gravity equation that accounts for the self-selection of firms into export markets and their impact on trade volumes
- ▶ Two-stage estimation procedure that uses an equation for selection into trade partners in the first stage and a trade flow equation in the second
- ▶ Estimation: parametric, semiparametric, and nonparametric



The theoretical Model

- ▶ J countries $j = 1, 2, \dots, J$, and a continuum of products. Country j 's utility function is

$$u_j = \left[\int_{l \in B_j} x_j(l)^\alpha dl \right]^{1/\alpha}, 0 < \alpha < 1$$

$$(1) \quad x_j(l) = \frac{\check{p}_j(l)^{-\epsilon} Y_j}{P_j^{1-\epsilon}}, \epsilon = 1/(1 - \alpha)$$

$$(2) \quad P_j = \left[\int_{l \in B_j} \check{p}_j(l)^{1-\epsilon} dl \right]^{1/(1-\epsilon)}$$

- ▶ Country j has a measure N_j of firms each producing distinct product, $\sum N_j$ distinct products in the world economy



The theoretical Model

- ▶ $c_j a$ - Cost of producing 1 unit of output for country j firm
- ▶ c_j - country specific reflecting differences across countries in factor prices
- ▶ a - firm specific reflecting productivity differences across firms in the same country
- ▶ $1/a$ - represents the firm's productivity level.
- ▶ CDF: $G(a)$ with support $[a_L, a_H]$ describes the distribution of a across firms, where $a_H > a_L > 0$. This distribution function is the same in all countries
- ▶ Producer j bears two additional costs when it sells to country i , a fixed cost $c_j f_{ij}$, and a melting iceberg transport cost τ_{ij}
- ▶ $f_{ij} = 0$ for every j and $f_{ij} > 0$ for $i \neq j$, $\tau_{jj} = 1$ for every j and $\tau_{ij} > 1$ for $i \neq j$



The theoretical Model

- ▶ There is monopolistic competition in final products
- ▶ The standard mark up pricing equation for each producer is $p_j(l) = \tau_{ij} \frac{c_j a}{\alpha}$, with a smaller mark up associated with a larger elasticity of demand
- ▶ If country j producer of a product l sells to consumers in country i , price (in country i) and profits associated are

$$(3) \quad \check{p}_j(l) = \tau_{ij} \frac{c_j a}{\alpha}$$

$$\pi_{ij}(a) = (1 - \alpha) \left(\tau_{ij} \frac{c_j a}{\alpha P_i} \right)^{1-\epsilon} Y_i - c_j f_{ij}$$

- ▶ Evidently, these operating profits are positive for sales in the domestic market because $f_{jj} = 0$. Therefore, all N_j producers sell in country j



The theoretical Model

- ▶ But sales in country $i \neq j$ is profitable only if $a \leq a_{ij}$, where a_{ij} is defined by $\pi_{ij}(a_{ij}) = 0$, or

$$(4) \quad (1 - \alpha) \left(\frac{\tau_{ij} c_j a_{ij}}{\alpha P_i} \right)^{1-\epsilon} Y_i = c_j f_{ij}$$

- ▶ Thus only a fraction $G(a_{ij})$ of country j 's N_j firms export to country i
- ▶ The set B_i of products available in country i is smaller than the total products in the world economy
- ▶ It is possible for $G(a_{ij})$ to be zero i.e no firm from j finds it profitable to export to i when $a_{ij} \leq a_L$. These cases are explicitly considered as explaining zero bilateral trade volumes
- ▶ The case $a_{ij} \geq a_H$ means all firms of j export to i . But given pervasive evidence of existence of exporting and non exporting firms this case is disregarded.



The theoretical Model

- ▶ The Bilateral trade volumes can be characterized as follows.
Let

$$V_{ij} = \begin{cases} \int_{a_L}^{a_{ij}} a^{1-\epsilon} dG(a), & \text{for } a_{ij} \geq a_L \\ 0, & \text{otherwise.} \end{cases} \quad (5)$$

- ▶ The demand function (1) and the pricing equation (3) imply that the value of country i 's import from j is

$$(6) \quad M_{ij} = \left(\frac{c_j \tau_{ij}}{\alpha P_i} \right)^{1-\epsilon} Y_i N_j V_{ij}$$

- ▶ This bilateral trade volume equals zero when $a_{ij} \leq a_L$ because then $V_{ij} = 0$. Using the definition of V_{ij} and (2) we obtain

$$(7) \quad P_i^{1-\epsilon} = \sum_{j=1}^J \left(\frac{c_j \tau_{ij}}{\alpha} \right)^{1-\epsilon} N_j V_{ij}$$



The theoretical Model

- ▶ Equations (4) to (7) provide a mapping from Y_i , N_i , c_i , f_{ij} , τ_{ij} to the bilateral trade flows M_{ij}
- ▶ In the next section an estimation procedure that builds directly on equations (4) to (7), which allows for asymmetric bilateral trade flows, including zeros is developed.
- ▶ We begin by formulating a fully parametrized estimation procedure for this model, which delivers our benchmark results.
- ▶ We then progressively loosen these parametric restrictions and reestimate the model.
- ▶ In all cases, we obtain similar result that are consistent with the analysis of the baseline scenario



Empirical framework

- ▶ In the baseline scenario we assume that firm productivity $1/a$ Pareto distributed truncated to the support $[a_L, a_H]$
- ▶ Thus, $G(a) = (a^k - a_L^k) / (a_H^k - a_L^k)$, $k > (\epsilon - 1)$.
- ▶ As previously highlighted, $a_{ij} < a_L$ is possible for some $i - j$ pairs, inducing zero exports from j to i (i.e. $V_{ij} = 0$ and $M_{ij} = 0$)
- ▶ This framework also allows for asymmetric trade flows, $M_{ij} \neq M_{ji}$ including the scenario where trade is unidirectional, with $M_{ji} > 0$ and $M_{ij} = 0$, or $M_{ji} = 0$ and $M_{ij} > 0$
- ▶ Such unidirectional trading relationships are empirically common and can be predicted using our empirical method
- ▶ Moreover, asymmetric trade frictions are not necessary to induce such asymmetric trade flows when productivity is drawn from a truncated Pareto distribution



- ▶ The assumptions imply that V_{ij} can be expressed as (see(5))

$$V_{ij} = \frac{ka_L^{k-\epsilon+1}}{(k-\epsilon+1)(a_H^k - a_L^k)} W_{ij},$$

where

$$(8) \quad W_{ij} = \max \left\{ \left(\frac{a_{ij}}{a_L} \right)^{k-\epsilon+1} - 1, 0 \right\}$$

- ▶ Note that both V_{ij} and W_{ij} are monotonic functions of the proportion of exporters j to i , $G(a_{ij})$
- ▶ The export volume from j to i , can now be expressed in the log-linear form as

$$m_{ij} = (\epsilon-1) \ln \alpha - (\epsilon-1) \ln c_j + n_j + (\epsilon-1) p_i + y_i + (1-\epsilon) \ln \tau_{ij} + v_{ij},$$



Empirical framework

- ▶ τ_{ij} captures variable trade costs: costs that affect the volume of firm-level exports
- ▶ We assume that these costs are stochastic due to *i.i.d.* unmeasured trade frictions u_{ij} , which are country-pair specific. In particular let $\tau_{ij}^{\epsilon-1} \equiv D_{ij}^{\gamma} e^{-u_{ij}}$, where D_{ij} represents (symmetric) distance between i and j , and $u_{ij} \sim N(0, \sigma_u^2)$
- ▶ Then the equation of bilateral trade flows m_{ij} yields the estimating equation

$$(9) \quad m_{ij} = \beta_0 + \lambda_j + \chi_i - \gamma d_{ij} + \omega_{ij} + u_{ij},$$

where $\chi_i = (\epsilon - 1)p_i + y_i$ is a fixed effect of the importing country and $\lambda_j = (\epsilon - 1) \ln c_j + n_j$ is a fixed effect of the exporting country

- ▶ Equation (9) highlights several important differences with the gravity equation, as derived, for example, by Anderson and Wincoop(2003)



Empirical framework

- ▶ The most important difference being the addition of the new variable ω_{ij} a function of the cutoff a_{ij} , which controls for the fraction of firms (possibly zero) that export from j to i
- ▶ Otherwise coefficient γ can no longer be interpreted as the elasticity of a firm's trade *w.r.t.* distance (always modelled that way in literature that follows new trade Theory)
- ▶ Instead, the estimation of the standard gravity equation confounds the effects of trade barriers on firm-level trade with their effects on the proportion of exporting firms, which induces an upward bias in the estimated coefficient γ
- ▶ Another bias is introduced when country pairs with zero trade flows are excluded.
- ▶ This induces a positive correlation between the unobserved u_{ij} s and the trade barrier, d_{ij} s. Country pairs with large observed trade barriers (high d_{ij}) that trade with each other are likely to have low unobserved trade barriers (high u_{ij})



- ▶ The selection of firms into export markets is represented by W_{ij} determined by cut off a_{ij}
- ▶ Consider a latent variable Z_{ij} defined as

$$(10) \quad Z_{ij} = \frac{(1 - \alpha) \left(P_i \frac{\alpha}{c_j \tau_{ij}} \right)^{\epsilon-1} Y_i a_L^{1-\epsilon}}{c_j f_{ij}}$$

- ▶ So, positive exports are observed iff $Z_{ij} > 1$. And, W_{ij} is a monotonic function of Z_{ij} , i.e. $W_{ij} = Z_{ij}^{(\epsilon-1)/(\epsilon-1)} - 1$
- ▶ Like τ_{ij} , the fixed export costs are stochastic due to unmeasured trade frictions v_{ij} that are *iid* but correlated to the u_{ij} s
- ▶ let $f_{ij} = \exp(\phi_{EX,j} + \phi_{IM,i} + \kappa\phi_{ij} - v_{ij})$, where $v_{ij} \sim N(0, \sigma_v^2)$



Empirical framework

- ▶ $\phi_{IM,i}$ is a fixed trade barrier imposed by the importing country on all exporters, $\phi_{EX,j}$ is a measure of fixed export costs common across all export destinations, and ϕ_{ij} is an observed measure of any additional country-pair specific fixed trade costs

$$(11) \quad z_{ij} = \gamma_0 + \xi_j + \zeta_i - \gamma d_{ij} - \kappa \phi_{ij} + \eta_{ij}$$

where $\eta_{ij} = u_{ij} + v_{ij} \sim N(0, \sigma_u^2 + \sigma_v^2)$ is *i.i.d.*

- ▶ $\xi_j = -\epsilon \ln c_j + \phi_{EX,j}$ is an exporter fixed effect and $\zeta_i = (\epsilon - 1)p_i + y_i - \phi_{IM,i}$ is an importer fixed effect
- ▶ z_{ij} is unobserved, but we observe trade flows. $z_{ij} > 0$ if j exports to i , $z_{ij} = 0$ otherwise. Moreover, z_{ij} affects export volume
- ▶ define T_{ij} indicator variable = 1 if $z_{ij} > 0$ and let ρ_{ij} be the probability that j exports to i . Also divide (11) by $\sigma_{\eta^2} \equiv (\sigma_u^2 + \sigma_v^2)$



Empirical framework

- ▶ The Probit equation $\rho_{ij} = Pr(T_{ij} = 1 | \text{observed variables})$

$$(12) \quad \rho_{ij} = \Phi(\gamma_0^* + \xi_j^* + \zeta_i^* - \gamma^* d_{ij} - \kappa^* \phi_{ij})$$

Φ is the CDF of the unit Normal distribution

- ▶ Importantly, this selection equation has been derived from a firm-level decision, and it therefore does not contain the unobserved and endogenous variable W_{ij}
- ▶ The probit equation can be used to derive consistent estimates of W_{ij}
- ▶ let $\hat{\rho}_{ij}$ be the predicted probability, $\hat{z}_{ij}^* = \Phi^{-1}(\hat{\rho}_{ij})$ be the predicted value of the latent variable $z_{ij}^* = z_{ij}/\sigma_\eta$
- ▶ then a consistent estimate for W_{ij} can be obtained from

$$(13) \quad W_{ij} = \max \left\{ (Z_{ij}^*)^\delta - 1, 0 \right\}$$

where $\delta \equiv \sigma_\eta(k - \epsilon + 1)/(\epsilon - 1)$



Empirical framework

- ▶ Consistent estimation of (9) requires controls for both the endogenous number of exporters (via ω_{ij}) and the selection of country pairs into trading partners (which generates a correlation between the unobserved u_{ij} and the independent variables).
- ▶ We thus need estimates for $E[\omega_{ij}|., T_{ij} = 1]$ and $E[u_{ij}|., T_{ij} = 1]$. Both terms depend on $\bar{\eta}_{ij}^* \equiv E[\eta_{ij}^*|., T_{ij} = 1]$. Moreover, $E[u_{ij}|., T_{ij} = 1] = \text{corr}(u_{ij}, \eta_{ij})(\sigma_u/\sigma_\eta)\bar{\eta}_{ij}^*$.
- ▶ Since η_{ij}^* has a unit normal distribution, a consistent estimate $\hat{\eta}_{ij}^*$ is obtained from the inverse Mills ratio, $\hat{\eta}_{ij}^* = \phi(\hat{z}_{ij}^*)/\Phi(\hat{z}_{ij}^*)$
- ▶ thus, $\hat{z}_{ij}^* \equiv \hat{z}_{ij} + \hat{\eta}_{ij}^*$ is a consistent estimate for $E[z_{ij}|., T_{ij} = 1]$ and $\hat{\omega}_{ij}^* \equiv \ln \left\{ \exp[\delta(\hat{z}_{ij}^* + \hat{\eta}_{ij}^*)] - 1 \right\}$ is for $E[\omega_{ij}|., T_{ij} = 1]$
- ▶ (9) can now be estimated using the transformation



(14)

$$m_{ij} = \beta_0 + \lambda_j + \chi_i - \gamma d_{ij} + \ln \left\{ \exp[\delta(\hat{z}_{ij}^* + \hat{\eta}_{ij}^*)] - 1 \right\} + \beta_{u\eta} \hat{\eta}_{ij}^* + e_{ij}$$

- ▶ $\beta_{u\eta} \equiv \text{corr}(u_{ij}, \eta_{ij})(\sigma_u/\sigma_\eta)$ and e_{ij} is an *i.i.d.* error satisfying $E[e_{ij} | \cdot, T_{ij} = 1] = 0$.
- ▶ Because (14) is non linear in δ , NLS is used
- ▶ the use of $\hat{\eta}_{ij}^*$ to control for $E[u_{ij} | \cdot, T_{ij} = 1]$ is the standard Heckman(1979) correction for sample selection This addresses the biases generated by the unobserved country-pair level shocks u_{ij} and η_{ij}
- ▶ Used alone, the standard Heckman correction would only be valid in a world without firm-level heterogeneity
- ▶ Thus, all firms are identically affected by trade barriers and country characteristics and make the same export decisions or make export decisions that are uncorrelated with trade barriers





Empirical framework

- ▶ This misses the potentially important effect of trade barriers and country characteristics on the share of exporting firms.
- ▶ In a world with firm-level heterogeneity, a larger fraction of firms export to more attractive export destinations
- ▶ These biases are corrected by the additional control \hat{z}_{ij}^*
- ▶ So the theoretical framework delivers two equations, (11) and (14), which can be estimated in two stages.
- ▶ Note that the distributional assumptions on the joint normality of the unobserved trade costs and the Pareto distribution of firm-level productivity affect the functional form of the trade flow equation (14) via the functional form of the two additional controls for firm heterogeneity ($\hat{\omega}_{ij}^*$) and sample selection ($\hat{\eta}_{ij}^*$)



Traditional estimates

- ▶ Instead of constructing symmetric trade flows by combining exports and imports for each country pair, the authors use unidirectional trade value
- ▶ The Probit equation is also estimated
- ▶ The very same variables that impact export volumes from j to i also impact the probability that j exports to i
- ▶ The impact goes in the same direction except the effect of a common border: it raises the volume of trade but reduces the probability of trading
- ▶ Overall, this evidence strongly suggests that disregarding the selection equation of trading partners biases the estimates of the export equation.
- ▶ Nothing special about 1986



Traditional estimates

TABLE I
BENCHMARK GRAVITY AND SELECTION INTO TRADING RELATIONSHIPS

Variables	1986		1980s			
	m_{ij}	(Probit) T_{ij}	m_{ij}	(Probit) T_{ij}	m_{ij}	(Probit) T_{ij}
Distance	-1.176** (0.031)	-0.263** (0.012)	-1.201** (0.024)	-0.246** (0.008)	-1.200** (0.024)	-0.246** (0.008)
Land border	0.458** (0.147)	-0.148** (0.047)	0.366** (0.131)	-0.146** (0.032)	0.364** (0.131)	-0.146** (0.032)
Island	-0.391** (0.121)	-0.136** (0.032)	-0.381** (0.096)	-0.140** (0.022)	-0.378** (0.096)	-0.140** (0.022)
Landlock	-0.561** (0.188)	-0.072 (0.045)	-0.582** (0.148)	-0.087** (0.028)	-0.581** (0.147)	-0.087** (0.028)
Legal	0.486** (0.050)	0.038** (0.014)	0.406** (0.040)	0.029** (0.009)	0.407** (0.040)	0.028** (0.009)
Language	0.176** (0.061)	0.113** (0.016)	0.207** (0.047)	0.109** (0.011)	0.203** (0.047)	0.108** (0.011)
Colonial ties	1.299** (0.120)	0.128 (0.117)	1.321** (0.110)	0.114 (0.082)	1.326** (0.110)	0.116 (0.082)
Currency union	1.364** (0.255)	0.190** (0.052)	1.395** (0.187)	0.206** (0.026)	1.409** (0.187)	0.206** (0.026)
FTA	0.759** (0.222)	0.494** (0.020)	0.996** (0.213)	0.497** (0.018)	0.976** (0.214)	0.495** (0.018)
Religion	0.102 (0.096)	0.104** (0.025)	-0.018 (0.076)	0.099** (0.016)	-0.038 (0.077)	0.098** (0.016)
WTO (none)					-0.068 (0.058)	-0.056** (0.013)
WTO (both)					0.303** (0.042)	0.093** (0.013)
Observations	11,146	24,649	110,697	248,060	110,697	248,060
R ²	0.709	0.587	0.682	0.551	0.682	0.551

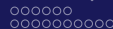
Notes. Exporter, importer, and year fixed effects. Marginal effects at sample means and pseudo R² reported for Probit. Robust standard errors (clustering by country pair).





Two stage estimation

- ▶ Let's turn to the second stage estimation of the trade flow equation (14)
- ▶ this requires a first-stage Probit selection equation (so we get $\hat{\rho}_{ij}$ and thus $\hat{\omega}_{ij}^*$ and $\hat{\eta}_{ij}^*$)
- ▶ To free the second stage estimates from the normality assumption for the unobserved trade costs, we need to select valid excluded variables for that second stage
- ▶ Also, distributional assumptions are further relaxed through the use of nonparametric methods
- ▶ The theoretical model suggests that trade barriers that affect fixed trade costs but do not affect variable (per-unit) trade costs satisfy this exclusion restriction
- ▶ country-level data on the regulation costs of firm entry, collected and analyzed by Djankov et al. (2002)



Two stage estimation

- ▶ Construct an indicator for high fixed-cost trading country pairs, consisting of country pairs in which both the importing and exporting countries have entry regulation measures above the cross-country median.
- ▶ One variable uses the sum of the number of days and procedures above the median (for both countries) whereas the other uses the sum of the relative costs above the median (again for both countries)
- ▶ By their nature, these measures affect firm-level fixed rather than variable costs of trade, i.e. do not depend on a firm's volume of exports to a particular country, and therefore satisfy the requisite exclusion restrictions
- ▶ By construction, these bilateral variables reflect regulation costs that should not depend on a firm's volume of exports to a particular country, and therefore satisfy the requisite exclusion restrictions



Two stage estimation

- ▶ But, no regulation cost data for 42 of 158 countries. 8 export to everyone, and Japan imports from everyone. Fixed exporter (importer for Japan) effects cannot be estimated, these observations had to be dropped
- ▶ Thus substantial decrease in no. of observations (more than halved)
- ▶ This led the authors to statistically test the validity of the exclusion restriction for additional bilateral trade barriers available for the full sample of countries (Religion)
- ▶ For now, the most relevant issue for our estimation purposes is that the additional cost variables have substantial explanatory power for the formation of trading relationships
- ▶ the two cost variables are economically and statistically significant
- ▶ We next estimate our fully parametrized trade flow equation (14) using NLS.



Two stage estimation

- ▶ We use the estimates of the Probit equation for the reduced sample to construct $\hat{z}_{ij}^* \equiv \hat{z}_{ij}^* + \hat{\eta}_{ij}^*$ and $\hat{\omega}_{ij}^* \equiv \ln \left\{ \exp[\delta(\hat{z}_{ij}^* + \hat{\eta}_{ij}^*)] - 1 \right\}$ for all country pairs with positive trade flows
- ▶ The standard errors are bootstrapped based on sampling (500 times) all available countries with replacement and using all the potential country pairs from that country sample.
- ▶ Both the nonlinear coefficient δ and $\hat{\omega}_{ij}^*$ and the linear coefficient for $\hat{\eta}_{ij}^*$ are precisely estimated.
- ▶ Substantial unmeasured heterogeneity biases: the measures of the effects of trade frictions in the benchmark gravity equation confound the true effect of these frictions with their indirect effect on the proportion of exporting firms
- ▶ higher trade volumes are not just the direct consequence of lower trade barriers.....



Two stage estimation

BASELINE RESULTS						
1986 reduced sample						
Variables	(Probit) T_{ij}	m_{ij}				Indicator variables
		Benchmark	NLS	Polynomial	50 bins	100 bins
Distance	-0.213** (0.016)	-1.167** (0.040)	-0.813** (0.049)	-0.847** (0.052)	-0.755** (0.070)	-0.789** (0.088)
Land border	-0.087 (0.072)	0.627** (0.165)	0.871** (0.170)	0.845** (0.166)	0.892** (0.170)	0.863** (0.170)
Island	-0.173* (0.078)	-0.553* (0.269)	-0.203 (0.290)	-0.218 (0.258)	-0.161 (0.259)	-0.197 (0.258)
Landlock	-0.053 (0.050)	-0.432* (0.189)	-0.347* (0.175)	-0.362+ (0.187)	-0.352+ (0.187)	-0.353+ (0.187)
Legal	0.049** (0.019)	0.535** (0.064)	0.431** (0.065)	0.434** (0.064)	0.407** (0.065)	0.418** (0.065)
Language	0.101** (0.021)	0.147+ (0.075)	-0.030 (0.087)	-0.017 (0.077)	-0.061 (0.079)	-0.036 (0.083)
Colonial ties	-0.009 (0.130)	0.909** (0.158)	0.847** (0.257)	0.848** (0.148)	0.853** (0.152)	0.838** (0.153)
Currency union	0.216** (0.038)	1.534** (0.334)	1.077** (0.360)	1.150** (0.333)	1.045** (0.337)	1.107** (0.346)
FTA	0.343** (0.009)	0.976** (0.247)	0.124 (0.227)	0.241 (0.197)	-0.141 (0.250)	0.065 (0.348)
Religion	0.141** (0.034)	0.281* (0.120)	0.120 (0.136)	0.139 (0.120)	0.073 (0.124)	0.100 (0.128)
Regulation costs	-0.108** (0.036)	-0.146 (0.100)				
R. costs (days & proc.)	-0.061* (0.031)	-0.216+ (0.124)				
δ (from \hat{u}_{ij}^*)			0.840** (0.043)			
$\hat{\eta}_{ij}^*$			0.240* (0.099)	0.882** (0.209)		
$\hat{\eta}_{ij}^*$				3.261** (0.540)		
$\hat{\eta}_{ij}^{*2}$				-0.712** (0.170)		
$\hat{\eta}_{ij}^{*3}$				0.060** (0.017)		
Observations	12,198	6,602	6,602	6,602	6,602	6,602
R^2	0.573	0.693		0.701	0.704	0.706



Two stage estimation

- ▶ they also represent a greater proportion of exporters to a particular destination
- ▶ Now, progressively relax the parameterization assumptions that determined the functional forms.
- ▶ First, relax the assumption governing the distribution of firm heterogeneity, and hence the form of the control function $\hat{\omega}_{ij}^*(\delta)$ and \hat{z}_{ij}^* in the trade flow equation (14).
- ▶ Thus, drop Pareto assumption for $G(\cdot)$ and revert to the general specification for V_{ij} in (5)
- ▶ Using (4) and 10, $v \equiv v(z_{ij})$ is now any arbitrary (increasing) function of z_{ij}
- ▶ we then directly control for $E[V_{ij} | \cdot, T_{ij} = 1]$ using $v(\hat{z}_{ij}^*)$ which is approximated by a polynomial in \hat{z}_{ij}^* . This replaces $\hat{\omega}_{ij}^* \equiv \ln \left\{ \exp[\delta(\hat{z}_{ij}^* + \hat{\eta}_{ij}^*)] - 1 \right\}$ in (14)



Two stage estimation

- ▶ As the nonlinearity induced by $\hat{\omega}_{ij}^*$ is eliminated, we now estimate the second stage using OLS
- ▶ We thus see, the Pareto distribution does not appear to unduly constrain the baseline specification
- ▶ We further relax the joint normality assumption for the unobserved trade costs, and hence the Mills ratio functional form for the selection correction.
- ▶ In the the first we now can use any cumulative distribution function instead of the normal distribution. Logit and t-distributions with various low degrees of freedom produce predicted probabilities strikingly similar $\hat{\rho}_{ij}$
- ▶ For this reason, we no longer use the normality assumption to recover the \hat{z}_{ij}^* and $\hat{\eta}_{ij}^*$. Instead we work directly with the predicted probabilities $\hat{\rho}_{ij}$.



Two stage estimation

- ▶ In order to approximate as flexibly as possible an arbitrary functional form of the $\hat{\rho}_{ij}$ s, a large set of indicator variables are used
- ▶ We partition the obtained $\hat{\rho}_{ij}$ s into a number of bins with equal observations and assign an indicator variable to every bin
- ▶ Then replace the $\hat{\omega}_{ij}^*$ and $\hat{\eta}_{ij}^*$ controls from the NLS estimation or the \hat{z}_{ij}^* and $\hat{\eta}_{ij}^*$ controls from the polynomial estimation with this set of indicator variables.
- ▶ Results with 50 and 100 bins are reported. And these results are virtually unchanged when switching to a Logit or t-distribution in the first stage
- ▶ Evidently, all three estimation methods yield very similar results



Decomposing the bias

Variables	1986 full sample			
	Benchmark	NLS	Firm heterogeneity	Heckman selection
Distance	-1.176** (0.031)	-0.798** (0.039)	-0.769** (0.038)	-1.214** (0.031)
Land border	0.458** (0.147)	0.834** (0.132)	0.855** (0.142)	0.436** (0.149)
Island	-0.391** (0.121)	-0.169 (0.120)	-0.164 (0.118)	-0.425** (0.120)
Landlock	-0.561** (0.188)	-0.447** (0.172)	-0.433* (0.187)	-0.565** (0.187)
Legal	0.486** (0.050)	0.387** (0.048)	0.381** (0.049)	0.488** (0.050)
Language	0.176** (0.061)	0.023 (0.062)	0.023 (0.060)	0.223** (0.061)
Colonial ties	1.299** (0.120)	1.001** (0.204)	0.979** (0.119)	1.311** (0.123)
Currency union	1.364** (0.255)	1.023** (0.273)	0.996** (0.260)	1.391** (0.257)
FTA	0.759** (0.222)	0.380* (0.182)	0.314+ (0.168)	0.737** (0.235)
Religion	0.102 (0.096)			
δ (from \hat{w}_{ij}^*)		0.871** (0.028)		
$\hat{\eta}_{ij}^*$		0.372** (0.069)		0.265** (0.070)
\hat{z}_{ij}^*			0.892** (0.051)	
Observations	11,146	11,146	11,146	11,146
R ²	0.709		0.716	0.710

Notes. m_{ij} is dependent variable throughout. Exporter and importer fixed effects. Religion is excluded variable in all second stage specifications. Bootstrapped standard errors for NLS; robust standard errors (clustering by country pair) elsewhere.



Asymmetric Trade Relationships

- ▶ The model predicts asymmetric trade flows between countries.
- ▶ Do these predicted asymmetries have explanatory power for the direction of trade flows and net bilateral trade balances?
- ▶ We look at the OLS regression of $T_{ij} - T_{ji}$ on $\hat{\rho}_{ij} - \hat{\rho}_{ji}$ based on Probit results of 1986. $T_{ij} - T_{ji}$ can take the values $-1, 0, 1$ depending on the direction of trade.
- ▶ The magnitude of the $\hat{\rho}_{ij} - \hat{\rho}_{ji}$ measures the models prediction for an asymmetric trading relationship, while its sign predicts the direction of the asymmetry.
- ▶ Next, regress net bilateral trade $m_{ij} - m_{ji}$ (percentage difference between exports and imports). The regressor captures differences in proportion of exporting firms
- ▶ Again, we find that this single regressor (using either specification) is a strong predictor of net bilateral trade



Asymmetric Trade Relationships

ASYMMETRIES

Variable	1986 full sample			
	$T_{ij} - T_{ji}$	$m_{ij} - m_{ji}$		
		NLS	Polynomial	
$\hat{\rho}_{ij} - \hat{\rho}_{ji}$	0.999** (0.0169)			
$\hat{w}_{ij}^* - \hat{w}_{ji}^*$		1.187** (0.042)	1.251** (0.266)	
$\hat{v}(\hat{z}_{ij}^*) - \hat{v}(\hat{z}_{ji}^*)$				1.012** (0.035) 0.703** (0.143)
Country fixed effects	No	No	Yes	No Yes
Observations	12,246	4,517	4,517	4,517 4,517
R^2	0.219	0.153	0.324	0.157 0.325

**Significant at 1%.



SUMMARY STATISTICS OF THE TRADE ELASTICITY RESPONSE ACROSS COUNTRY PAIRS

Country pairs group	Number of country pairs	Nonlinear least squares				Polynomial approximation			
		Mean	S. D.	Min	Max	Mean	S. D.	Min	Max
NN	342	1.292	0.034	1.283	1.642	1.290	0.107	1.141	2.222
NS	4,626	1.404	0.152	1.283	2.949	1.526	0.386	1.141	2.895
SS	6,178	1.698	0.303	1.283	3.777	2.130	0.443	1.141	2.995
Overall	11,146	1.563	0.289	1.283	3.777	1.854	0.517	1.141	2.995



- ▶ Empirical explanations of international trade flows have a long tradition
- ▶ The gravity equation with various measures of trade resistance plays a key role in this literature.
- ▶ This paper develops an estimation procedure that corrects certain biases embodied in the standard gravity estimation of trade flows
- ▶ The approach is driven by theoretical as well as econometric considerations.
- ▶ Possible extension is to use firm level data to compare the results
- ▶ The regulation costs might still be related to variable costs