

Gravity rules

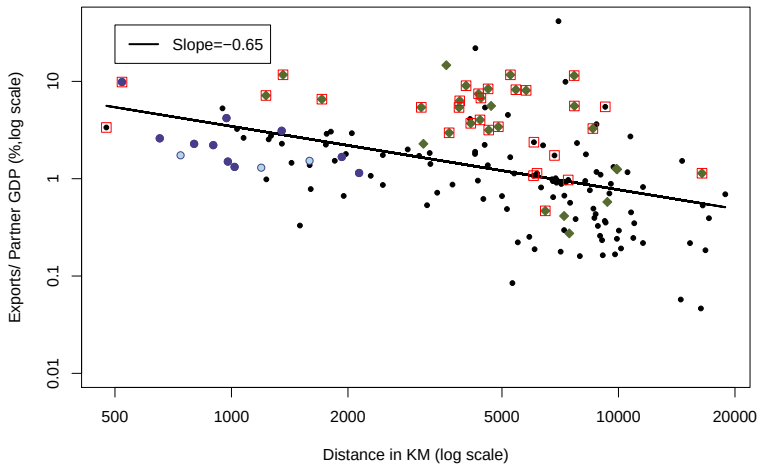
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PSE-U. Paris 1, CEPII, and CEPR.

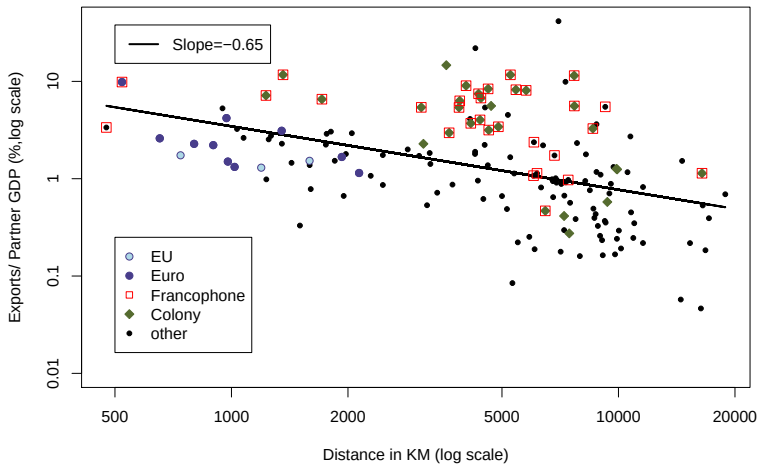
Motivation

- ▶ **Gravity rules** in all cases to date. Leamer & Levinshon (1995) argue that the gravity equation is one of the most stable relationship in economics.
- ▶ *The bad news*: “To amaze your friends with another important trade effect, develop a new proxy for trade costs and use a really big dataset; success is not guaranteed, but you’re likely to find significance (standard errors involve the inverse of the square root of number of observations) and you’ll have loads of fun in any case.”
- ▶ *The good news* is that we know why it works (much more than for Zipf’s law for instance): most trade models require gravity to work.

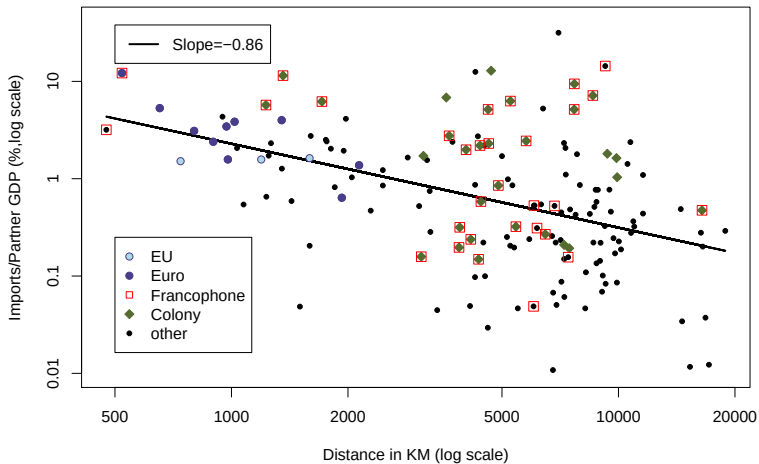
France's imports in 2000



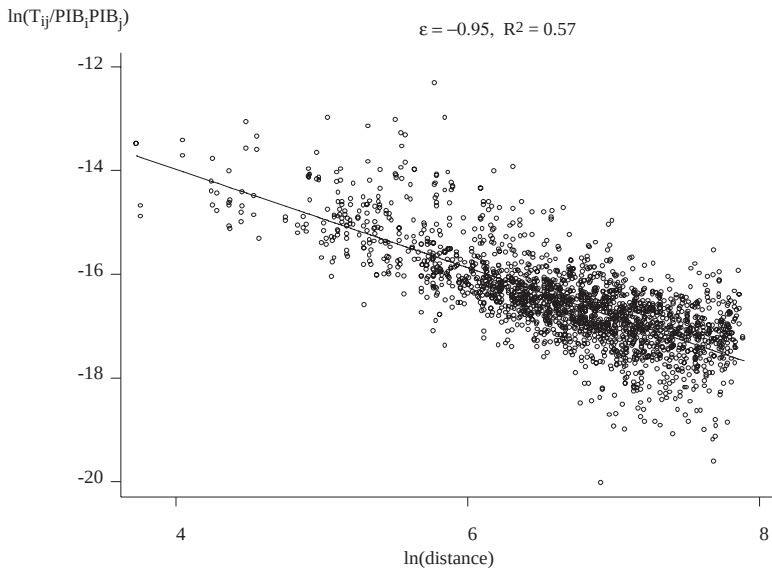
France's exports in 2000



France's imports in 2000



Trade within the USA in 1997



Theoretical foundations

- ▶ Mother gravity
- ▶ The two traditional versions: NPD-AvW and MC-DSK.
- ▶ The new derivations with heterogeneities (consumers, comparative advantage, firms).

Mother Gravity

Two important constraints in gravity equations. The first is **budget allocation** for the importer. The second is **market-clearing** for the exporter.

Budget allocation

- ▶ Let i be the exporter (or origin in the more general set-up that incorporates flows other than goods) and j be the importer (or destination).
- ▶ Let X_j represent the total “pie” to be allocated and Π_{ij} is the share of the pie allocated to country i . Then as an accounting identity we have

$$X_{ij} = \Pi_{ij} X_j, \tag{1}$$

where $\sum_i \Pi_{ij} = 1$ and $\sum_i X_{ij} = X_j$. In trade models X_j is total expenditure by the importing country.

Budget allocation

Critical step: show that Π_{ij} can be expressed in the following *multiplicatively separable form*:

$$\Pi_{ij} = \frac{A_i \phi_{ij}}{\Phi_j}. \quad (2)$$

- ▶ A_i represents “capabilities” of exporter i
- ▶ $0 \leq \phi_{ij} \leq 1$ represents the accessibility of the destination market to that particular exporter,
- ▶ Φ_j measures the set of opportunities of consumers in j or, equivalently, the degree of competition in that market.

Most specific trade models (if not all) yield such form.

Mother gravity

Consequently, bilateral trade has a multiplicative form:

$$X_{ij} = GS_i M_j \phi_{ij}. \quad (3)$$

- ▶ M_j encompasses all importer-specific factors,
- ▶ S_i comprises everything that is exporter-specific.
- ▶ G is just a constant (“gravitational constant” in analogies with physics). Does not depend on i or j , but varies over time → extent of “globalization.”
- ▶ At this point $G = 1$, $M_j = X_j / \Phi_j$ and $S_i = A_i$.
- ▶ With market-clearing, S_i will depend on A_i and also on all the ϕ_{ij} and M_j .

Market-clearing-1

A second accounting identity holds that the sum of i 's exports to all destinations—including i —equals the total value of i 's production, denoted as Q_i .

$$Q_i = \sum_j X_{ij} = A_i \sum_j \frac{\phi_{ij} X_j}{\Phi_j}. \quad (4)$$

- ▶ As with X_j , Q_i can be measured at the sectoral level.
- ▶ If B_i is i 's trade balance (or net exports), $Q_i \equiv X_i + B_i$. At the sectoral level we need to allow for $B_i \neq 0$. However, at the world level, we must have

$$Q \equiv \sum_i Q_i = \sum_j (X_j + B_j) = X + \sum_j B_j = X + 0.$$

Market-clearing-2

With data on both X_j and Q_i , market-clearing tells us something about A_i . To see this,

- ▶ define $s_j = X_j/X = X_j/Q$ as country j 's share of world expenditure (and production).
- ▶ define the following (**market potential or access**) term:

$$\Phi_i^* = \sum_h \frac{\phi_{ih} s_h}{\Phi_h}. \quad (5)$$

- ▶ market clearing, can be re-expressed as $Q_i = A_i Q \Phi_i^*$, at the sectoral level and implies:

$$A_i = \frac{Q_i}{Q \Phi_i^*}. \quad (6)$$

Market-clearing-3

- ▶ Since it is based entirely on adding-up conditions, $A_i = Q_i / (Q\Phi_i^*)$ **should be valid under all trade models.**
- ▶ A country that produces a lot (high Q_i), but is remote from world markets (low Φ_i^*), must have good capabilities (high A_i).
- ▶ At the aggregate level, $B_i = 0$ and $Q_i = X_i = Y_i \Rightarrow$ Stronger form of the market-clearing assumption used by Anderson and van-Wincoop (2003). Substituting $s_i = X_i/X = Y_i/Y$ into equation (2) and then into equation (1):

$$X_{ij} = \underbrace{\frac{1}{Y}}_G \underbrace{\frac{Y_i}{\Phi_i^*}}_{S_i} \underbrace{\frac{Y_j}{\Phi_j}}_{M_j} \phi_{ij}. \quad (7)$$

Market-clearing-4

- ▶ Many specific formulations imply:

$$\Phi_i = \sum_h A_h \phi_{hi}. \quad (8)$$

- ▶ Anderson and van Wincoop point out that if $\phi_{ij} = \phi_{ji}$, you can plug $A_h = Y_h / (Y \Phi_h^*)$ into (8) and obtain

$$\Phi_i = \sum_h \frac{\phi_{ih} S_h}{\Phi_h^*}$$

which combined with (5) has a solution where $\Phi_i = \Phi_i^* \forall i$, and all trade costs are symmetric. This in turn would imply $S_i = M_i$ in the mother gravity equation.

- ▶ Baldwin and Taglioni (2006) show that this solution is only valid in cross-section. More generally Φ_i and Φ_i^* are proportional, but the factor will vary over time as ϕ s and Y s vary.

Fixed effects estimation

Standard estimating procedure involves taking logs of equation (3), obtaining

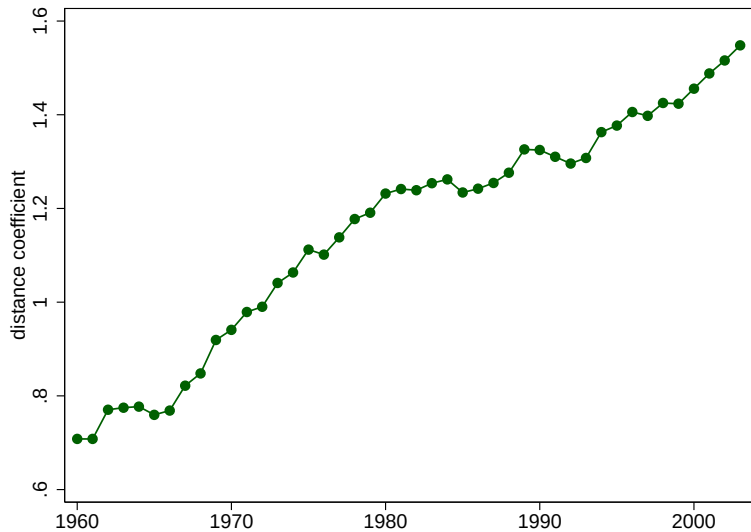
$$\ln X_{ij} = \ln G + \ln S_i + \ln M_j + \ln \phi_{ij}. \quad (9)$$

- ▶ Tradition = using log GDPs (and possibly other variables) as proxies for the $\ln S_i$ and $\ln M_j$: **Gold medal mistake**.
- ▶ Since Harrigan (1996) practice has been moving towards using fixed effects for these terms instead.
- ▶ Note that it does **not** involve strong structural assumptions on the underlying model. Only need something like mother gravity to estimate ϕ_{ij} consistently
- ▶ Furthermore, market-clearing does not affect the estimation procedure, since equations (3) and (7) yield the same estimable equation.
- ▶ Last, this is much simpler than NLLS.

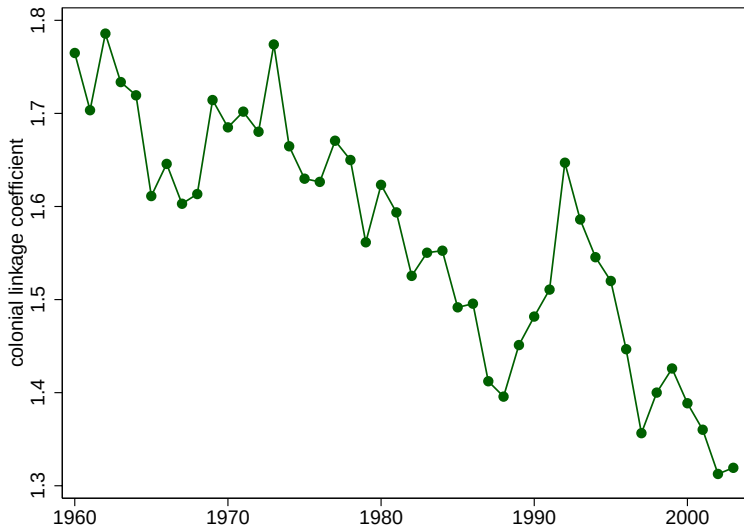
Cautions

- ▶ With panels, importer and exporter fixed effects should be time-varying as well.
- ▶ The same is true if the data pools over several industries.
- ▶ For panels of trade flows with a large number of years and/or industries, computational issues → other methods.
- ▶ If the precise model underlying fixed effects estimation does not matter for ϕ_{ij} coefficients, it does for S_i and M_j estimates.
- ▶ Silver medal mistake: averaging the reciprocal flows.
- ▶ Bronze medal mistake: deflating the flows. Gravity is an expenditure function allocating nominal GDP into nominal imports.

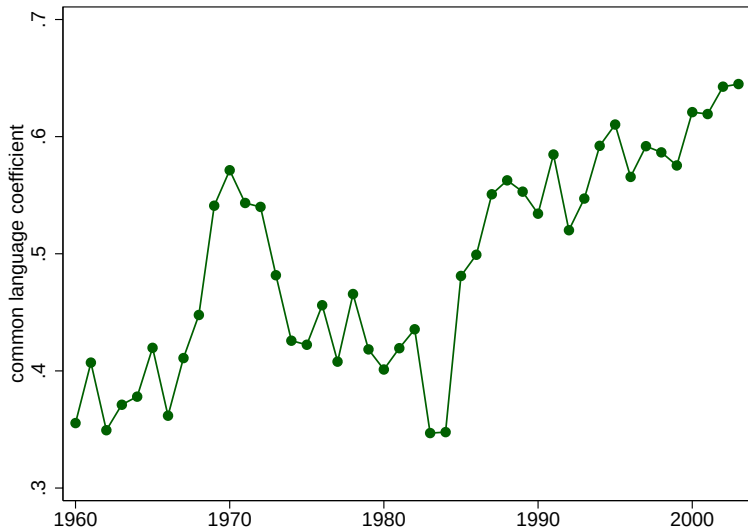
FE estimation of distance coefficient



FE estimation of colonial link coefficient



FE estimation of common language coefficient



Baby #1: NPD-AvW

Anderson (1979) / Anderson and van Wincoop (2003): As in Armington (1968), **each country is the unique source of each product**. Consumers in country j consume q_{ij} units of the product from country i . Utility exhibits CES with $\sigma > 1$, over all the national products:

$$U_j = \left(\sum_i (b_{ij} q_{ij})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}. \quad (10)$$

- ▶ b_{ij} can be interpreted as a bilateral quality shifter or preference parameter.
- ▶ Standard derivation of $X_{ij} = \frac{A_i \phi_{ij}}{\Phi_j} Y_j$ yields

$$A_i = (p_i/b_i)^{1-\sigma}, \quad \phi_{ij} = \tau_{ij}^{1-\sigma} \quad \Phi_j = \sum_h A_h \phi_{hj}. \quad (11)$$

Baby #2: MC-DSK

Dixit-Stiglitz-Krugman (DSK) assumptions yield gravity (first seem to be Bergstrand (1985)).

- ▶ Each country has N_i firms supplying one variety each to the world from a home-country production site.
- ▶ Utility is symmetric ($b_i = 1, \forall i$) and CES in terms of all $N = \sum_i N_i$ varieties available in the world.
- ▶ Standard derivation of $X_{ij} = \frac{A_i \phi_{ij}}{\Phi_j} Y_j$ yields

$$A_i = N_i p_i^{1-\sigma}, \quad \phi_{ij} = \tau_{ij}^{1-\sigma} \quad \Phi_j = \sum_h A_h \phi_{hj}. \quad (12)$$

Baby #2: MC-DSK

In a more general setting where utility is not symmetric and consumers perceive countries to have different associated qualities to their varieties as in equation (10), the terms become

$$A_i = N_i(p_i/b_i)^{1-\sigma}, \quad \phi_{ij} = \tau_{ij}^{1-\sigma} \quad \Phi_j = \sum_h A_h \phi_{hj}. \quad (13)$$

- ▶ Only apparent difference compared to the NPD model is the N_i term: monopolistic competition / perfect competition
- ▶ Note that prices are also different, because of different markups.

Alternatives to fixed effects-1

- ▶ One can use the multiplicative structure of the gravity model to get rid of trouble terms.
- ▶ Let us define $\lambda_{ij} \equiv b_{ij}^{\sigma-1}$
- ▶ Bilateral “relative” imports by country j from country i for a given industry/year, **odds specification** (Head and Mayer, 2000):

$$\frac{X_{ij}}{X_{jj}} = \left(\frac{n_i}{n_j} \right) \left(\frac{p_i}{p_j} \right)^{1-\sigma} \left(\frac{\phi_{ij}}{\phi_{jj}} \right) \left(\frac{\lambda_{ij}}{\lambda_{jj}} \right). \quad (14)$$

Alternatives to fixed effects-2

- ▶ Relative prices and numbers of varieties/firms are difficult to observe. **Friction specification** (Head and Ries, 2001):

$$\frac{X_{ij}X_{ji}}{X_{jj}X_{ii}} = \left(\frac{\phi_{ij}\phi_{ji}}{\phi_{jj}\phi_{ii}} \right) \left(\frac{\lambda_{ij}\lambda_{ji}}{\lambda_{jj}\lambda_{ii}} \right). \quad (15)$$

- ▶ Note that if $\phi_{ij} = \phi_{ji}$, $\lambda_{ij} = \lambda_{ji}$, and $\phi_{jj} = \phi_{ii} = \lambda_{jj} = \lambda_{ii} = 1$,

$$\phi_{ij}\lambda_{ij} = \sqrt{\frac{X_{ij}X_{ji}}{X_{jj}X_{ii}}}. \quad (16)$$

Alternatives to fixed effects-2

- ▶ Those manipulations can be done with any reference country (Martin et al. 2008):

$$\frac{X_{ij}}{X_{usj}} = \left(\frac{n_i}{n_{us}} \right) \left(\frac{p_i}{p_{us}} \right)^{1-\sigma} \left(\frac{\phi_{ij}}{\phi_{usj}} \right) \left(\frac{\lambda_{ij}}{\lambda_{usj}} \right).$$

- ▶ Also to get rid of exporter effects (Anderson and Marcouiller, 2002):

$$\frac{X_{usi}}{X_{usj}} = \left(\frac{\phi_{usi}}{\phi_{usj}} \right) \left(\frac{\lambda_{usi}}{\lambda_{usj}} \right) \left(\frac{\Phi_j}{\Phi_i} \right) \left(\frac{Y_i}{Y_j} \right).$$

Alternatives to fixed effects-3

Possible to get rid of... everything (Tetrads method), Romalis (2008), Hallak (2004), Head et al. (2008)

- ▶ Divide $X_{ij} = GS_i M_j \phi_{ij}$ by a reference importer k :

$$R_{i\{dk\}} = \frac{X_{ij}}{X_{ik}} = \frac{M_j \phi_{ij}}{M_k \phi_{ik}}.$$

- ▶ M_j/M_k problem $\implies$ pick a reference exporter ℓ :

$$R_{\ell\{jk\}} = \frac{X_{\ell d}}{X_{\ell k}} = \frac{M_j \phi_{\ell j}}{M_k \phi_{\ell k}}.$$

- ▶ Taking the ratio of ratios $\implies$ tetradic term

$$r_{\{i\ell\}\{jk\}} = \frac{R_{i\{jk\}}}{R_{\ell\{jk\}}} = \frac{X_{ij}/X_{ik}}{X_{\ell j}/X_{\ell k}} = \frac{\phi_{ij}/\phi_{ik}}{\phi_{\ell j}/\phi_{\ell k}}.$$

$$\ln r_{\{i\ell\}\{jk\}} = \ln \phi_{ij} - \ln \phi_{ik} - \ln \phi_{\ell j} + \ln \phi_{\ell k}.$$

Interpretation of coefficients

- ▶ Most important point is the OVB if one makes the gold medal mistake. Take AvW (2003):

$$X_{ij} = \frac{Y_i Y_j}{Y} \frac{\phi_{ij}}{\Phi_i \Phi_j}$$

- ▶ Bilateral trade is increasing in the “remoteness” of the pair $1/(\Phi_i \Phi_j)$. When omitted, all ϕ_{ij} variables that affect trade positively will tend to be biased downwards if they are negatively correlated with remoteness, and vice-versa.
- ▶ With $\phi_{ij} = \tau_{ij}^{1-\sigma}$ estimation of σ is possible if one has data on direct price shifters like tariffs or freight costs.

Hummels (2001), table 6

Table 6: Sensitivity to "pooling" level (OLS estimates)

All Goods

	# signif. (9 total)	1 digit mean coeff	price premium	# signif. (62 total)	2 digit mean coeff	price premium	# signif. (239 total)	3 digit mean coeff	price premium
CES	9	4.79		57	5.57		190	6.91	
DIST	4	-0.54	-0.04	35	-0.59	-0.07	109	-1.09	0.07
LANG	4	0.37	0.03	23	0.61	0.04	65	1.36	0.03
ADJ	4	0.25	0.03	16	0.43	0.02	46	-0.45	0.01
Residual			0.42			0.33			0.26

Manufactures: SITC 5-9

	# signif. (5 total)	1 digit mean coeff	price premium	# signif. (34 total)	2 digit mean coeff	price premium	# signif. (164 total)	3 digit mean coeff	price premium	# signif. (670 total)	4 digit mean coeff	price premium
CES	5	5.79		33	6.26		148	7.04		473	8.26	
DIST	4	-0.54	-0.07	31	-0.59	-0.11	96	-0.84	-0.09	217	-1.28	-0.05
LANG	4	0.37	0.05	19	0.55	0.05	58	0.78	0.04	130	1.21	0.03
ADJ	4	0.17	0.02	16	0.43	0.03	38	0.39	0.02	73	1.08	0.02
Residual			0.31			0.31			0.25			0.19

Mean coefficient calculated as average over all significant estimates in that set of regressions

Implied price premium calculated as average over all estimates in that set, with insignificant coefficients treated as zeros

Hummels (2001), table 6

where TAR and NTB represent the ad valorem rates of tariffs and nontariff barriers. We define NTB to comprise all barriers to export success other than tariffs, including transportation costs, home bias (h), and any government policies that favor domestically produced goods over imports. Other authors using different methodologies have estimated the overall border effect (John McCallum, 1995; John F. Helliwell, 1996; Shang-Jin Wei, 1996) but have not decomposed it into tariff and nontariff barrier components. Denoting industries with i and years with t , note that we observe TAR_{it} (see the Data Appendix) but must infer NTB_{it} as a residual. We assume that $(\sigma - 1)\ln(1 + NTB_{it})$ can be approximated as $(\sigma - 1)\ln(1 + NTB_t) + \varepsilon_{it}$. Substituting, we obtain a log linear regression equation:

$$(10) \ln(b_{it}) = (\sigma - 1)\ln(1 + \overline{NTB_t}) + (\sigma - 1)\ln(1 + TAR_{it}) + \varepsilon_{it}.$$

TABLE 1—DECOMPOSING CHANGES IN TRADE COSTS INTO TARIFF AND NONTARIFF EFFECTS

Method	OLS	Fixed effects	Average NTB (percent)	
			OLS	FE
Ln 1 + tariff	10.409 (1.916)	6.882 (1.532)		
Intercept (1990)	2.742 (0.139)	2.883 (0.070)	30.1	52.0
1991	-0.074 (0.159)	-0.082 (0.040)	29.2	50.2
1992	-0.123 (0.161)	-0.156 (0.044)	28.6	48.6
1993	-0.166 (0.164)	-0.240 (0.050)	28.1	48.6
1994	-0.212 (0.167)	-0.30 (0.056)	27.5	45.5
1995	-0.242 (0.169)	-0.335 (0.061)	27.1	44.8
N	615	615		
R^2	0.073	0.387		
RMSE	1.133	0.275		

Note: Standard errors are in parentheses. Dependent variable: Ln border effect: $\ln(b)$.

The trade impact of RTAs, GATT/WTO and CU.
Does the method matters?

Standard gravity for RTAs (Frankel et al. 95, JDE)

Table 2

Gravity model with western hemisphere broken into sub-regions (aggregate trade, 1965–1990) ^a

	1965	1970	1975	1980	1985	1990
GNP	0.63 ** (0.02)	0.64 ** (0.02)	0.72 ** (0.18)	0.74 ** (0.02)	0.53 ** (0.02)	0.75 ** (0.01)
GNP per capita	0.26 ** (0.02)	0.36 ** (0.02)	0.27 ** (0.02)	0.29 ** (0.02)	0.06 ** (0.02)	0.09 ** 0.02
Distance	-0.44 ** (0.04)	-0.53 ** (0.04)	-0.68 ** (0.05)	-0.56 ** (0.04)	-0.35 ** (0.05)	-0.56 ** (0.04)
Adjacency	0.62 ** (0.17)	0.58 ** (0.17)	0.45 * (0.19)	0.68 ** (0.18)	0.85 ** (0.20)	0.79 ** (0.16)
EAEC	1.40 ** (0.29)	1.71 ** (0.29)	0.86 ** (0.31)	0.78 ** (0.27)	-0.41 # (0.28)	0.63 ** (0.24)
APEC	0.61 ** (0.21)	0.76 ** (0.21)	0.97 ** (0.22)	1.49 ** (0.18)	1.58 ** (0.20)	1.32 ** (0.17)
EC	0.24 ** (0.17)	0.11 (0.17)	-0.06 (0.18)	0.21 (0.18)	1.51 ** (0.19)	0.49 ** (0.16)
EFTA	0.04 (0.30)	0.07 (0.30)	0.01 (0.32)	0.58 (0.32)	0.06 (0.36)	-0.05 (0.29)
NAFTA	-0.12 (0.63)	-0.41 (0.64)	-0.44 (0.70)	0.08 (0.71)	-0.58 (0.75)	0.05 (0.63)
MERCOSUR	-0.18 (0.46)	0.46 (0.46)	0.43 (0.50)	0.81 ** (0.51)	0.72 (0.55)	2.09 ** (0.46)
ANDEAN	-0.51 (0.39)	-0.13 (0.32)	1.15 ** (0.35)	1.11 ** (0.32)	-0.17 (0.59)	0.90 ** (0.29)
# Observations	1194	1274	1453	1708	1343	1573
SEE	1.07	1.08	1.18	1.20	1.28	1.08
Adjusted R ²	0.68	0.71	0.71	0.71	0.51	0.77

^a Standard errors are in parentheses.

** denotes significant at 1% level ($t \geq 2.576$);

The problems with gravity results for the EC

- ▶ The typical coefficient in 1990 = 0.5: two EC countries traded “only 65% more ($\exp(.5) = 1.65$).
- ▶ NAFTA insignificant / MERCOSUR and ANDEAN very large. Results are generally quite puzzling and counter-intuitive.

⇒ Is this coming from a problem in the methodology or does it mean that the EC did not have much of an effect?

Standard gravity for GATT/WTO (Rose, 04 AER)

Table 1: Benchmark Results

	Default	No Industrial Countries	Post '70	With Country Effects
Both in GATT/WTO	-.04 (.05)	-.21 (.07)	-.08 (.07)	.15 (.05)
One in GATT/WTO	-.06 (.05)	-.20 (.06)	-.09 (.07)	.05 (.04)
GSP	.86 (.03)	.04 (.10)	.84 (.03)	.70 (.03)
Log Distance	-1.12 (.02)	-1.23 (.03)	-1.22 (.02)	-1.31 (.02)
Log product Real GDP	.92 (.01)	.96 (.02)	.95 (.01)	.16 (.05)
Log product Real GDP p/c	.32 (.01)	.20 (.02)	.32 (.02)	.54 (.05)
Regional FTA	1.20 (.11)	1.50 (.15)	1.10 (.12)	.94 (.13)
Currency Union	1.12 (.12)	1.00 (.15)	1.23 (.15)	1.19 (.12)
Common Language	.31 (.04)	.10 (.06)	.35 (.04)	.27 (.04)
Land Border	.53 (.11)	.72 (.12)	.69 (.12)	.28 (.11)

Standard gravity for GATT/WTO (Rose, 04 AER)

Number Landlocked	-.27 (.03)	-.28 (.05)	-.31 (.03)	-1.54 (.32)
Number Islands	.04 (.04)	-.14 (.06)	.03 (.04)	-.87 (.19)
Log product Land Area	-.10 (.01)	-.17 (.01)	-.10 (.01)	.38 (.03)
Common Colonizer	.58 (.07)	.73 (.07)	.52 (.07)	.60 (.06)
Currently Colonized	1.08 (.23)		1.12 (.41)	.72 (.26)
Ever Colony	1.16 (.12)	-.42 (.57)	1.28 (.12)	1.27 (.11)
Common Country	-.02 (1.08)		-.32 (1.04)	.31 (.58)
Observations	234,597	114,615	183,328	234,597
R²	.65	.47	.65	.70
RMSE	1.98	2.36	2.10	1.82

Regressand: log real trade.

OLS with year effects (intercepts not reported).

Robust standard errors (clustering by country-pairs) in parentheses.

Odds results (Martin et al., 08 Restud)

Table 2: Impact of militarized interstate dispute on trade

Dependent Variables: Model:	ln imports		ln m_{ijt}/m_{iut}	
	(1)	(2)	(3)	(4)
ln GDP origin	0.959*** (0.006)	0.940*** (0.007)	1.001*** (0.007)	0.976*** (0.008)
ln GDP destination	0.847*** (0.006)	0.846*** (0.007)	- -	- -
ln distance	-1.008*** (0.017)	-0.991*** (0.019)	-1.188*** (0.018)	-1.158*** (0.019)
contiguity	0.452*** (0.075)	0.412*** (0.078)	0.663*** (0.066)	0.680*** (0.069)
similarity in language index	0.331*** (0.070)	0.301*** (0.074)	0.128** (0.062)	0.112* (0.065)
colonial link ever	1.121*** (0.088)	1.060*** (0.093)	0.302*** (0.061)	0.257*** (0.063)
common colonizer post 1945	0.568*** (0.058)	0.499*** (0.064)	0.545*** (0.063)	0.450*** (0.069)
preferential trade arrangement	0.545*** (0.049)	0.539*** (0.052)	0.441*** (0.049)	0.426*** (0.053)
number of gatt/wto members	0.204*** (0.021)	0.223*** (0.022)	0.337*** (0.034)	0.364*** (0.036)
one communist regime among partners	-0.399*** (0.032)	-0.422*** (0.034)	-0.720*** (0.045)	-0.767*** (0.045)

Odds results (Martin et al., 08 Restud)

bil. MID + 0 years	-0.245*** (0.059)	-0.244*** (0.044)	-0.485*** (0.036)	-0.434*** (0.032)
bil. MID + 1 years	-0.213*** (0.047)	-0.238*** (0.047)	-0.417*** (0.026)	-0.340*** (0.028)
bil. MID + 2 years	-0.224*** (0.040)	-0.199*** (0.040)	-0.373*** (0.028)	-0.287*** (0.030)
bil. MID + 3 years	-0.245*** (0.038)	-0.229*** (0.038)	-0.495*** (0.026)	-0.472*** (0.029)
bil. MID + 4 years	-0.162*** (0.041)	-0.139*** (0.045)	-0.329*** (0.026)	-0.327*** (0.028)
bil. MID + 5 years	-0.021 (0.034)	0.001 (0.036)	-0.196*** (0.030)	-0.323*** (0.034)
bil. MID + 6 years	-0.047 (0.031)	-0.018 (0.030)	-0.156*** (0.022)	-0.097*** (0.027)
bil. MID + 7 years	-0.024 (0.029)	-0.022 (0.032)	-0.193*** (0.026)	-0.138*** (0.026)
bil. MID + 8 years	-0.051** (0.025)	-0.067** (0.029)	-0.108*** (0.026)	-0.118*** (0.029)
bil. MID + 9 years	-0.023 (0.028)	-0.024 (0.029)	-0.082*** (0.023)	-0.046** (0.023)
bil. MID + 10 years	-0.045* (0.023)	-0.060** (0.027)	-0.164*** (0.023)	-0.133*** (0.026)
bil. MID + 11 years	-0.014 (0.026)	-0.025 (0.029)	-0.077*** (0.022)	-0.077*** (0.024)
...				
bil. MID - 1 years		-0.086** (0.041)		-0.285*** (0.030)
bil. MID - 2 years		-0.009 (0.042)		-0.214*** (0.028)
bil. MID - 3 years		0.011 (0.044)		-0.126*** (0.026)
bil. MID - 4 years		-0.033 (0.047)		-0.003 (0.024)
bil. MID - 5 years		-0.094 (0.059)		-0.105*** (0.033)
N	300323	244440	286179	231519
R ²	0.633	0.622	0.571	0.556

Standard gravity results for the CU (Rose, 00 EP)

	1970	1975	1980	1985	1990	Pooled
Currency Union γ	.87 (.43)	1.28 (.41)	1.09 (.26)	1.40 (.27)	1.51 (.27)	1.21 (.14)
Exchange Rate Volatility δ	-.062 (.012)	.001 (.008)	-.060 (.010)	-.028 (.005)	-.009 (.002)	-.017 (.002)
Output b_1	.77 (.02)	.81 (.01)	.81 (.01)	.80 (.01)	.83 (.01)	.80 (.01)
Output/Capita b_2	.65 (.03)	.66 (.03)	.61 (.02)	.66 (.02)	.73 (.02)	.66 (.01)
Distance b_3	-1.09 (.05)	-1.15 (.04)	-1.03 (.04)	-1.05 (.04)	-1.12 (.04)	-1.09 (.02)
Contiguity b_4	.48 (.21)	.36 (.19)	.73 (.18)	.52 (.18)	.63 (.18)	.53 (.08)
Language b_5	.56 (.10)	.36 (.10)	.28 (.09)	.36 (.08)	.50 (.08)	.40 (.04)
FTA b_6	.87 (.16)	1.02 (.21)	1.26 (.16)	1.21 (.17)	.67 (.14)	.99 (.08)
Same Nation b_7	1.02 (.74)	1.37 (.59)	1.12 (.38)	1.36 (.64)	.88 (.52)	1.29 (.26)
Same Coloniser b_8	.91 (.15)	.73 (.14)	.52 (.12)	.48 (.12)	.59 (.12)	.63 (.06)
Colonial Relationship b_9	2.52 (.23)	2.40 (.19)	2.28 (.14)	2.05 (.14)	1.75 (.15)	2.20 (.07)
Number of Observations	4052	4474	5092	5091	4239	22,948
R^2	.57	.59	.62	.65	.72	.63
RMSE	2.18	2.18	2.03	1.94	1.75	2.02

Note: OLS estimation; robust standard errors in parentheses.

Constant term (and year controls for pooled regression) not reported.

The CUs considered by Rose (2000)

Table 1: The Rose Garden, currency unions considered in Rose (2000)

Hub and Spoke arrangements		Multilateral currency unions	Misc.
✓ <u>Australia</u>	✓ <u>USA</u>	<u>CFA</u>	✓ <u>India</u>
Christmas Island	American Samoa	✓ Benin	✓ Bhutan
Cocos (Keeling) Islands	Guam	✓ Burkina Faso	✓ <u>Denmark</u>
Norfolk Island	✓ US Virgin Islands	✓ Cameroon	Faeroe Islands
✓ Kiribati	Puerto Rico	✓ Central African Republic	✓ Greenland
✓ Nauru	Northern Mariana Islands	✓ Chad	<u>Turkey</u>
✓ Tuvalu	✓ British Virgin Islands	Comoros	N. Cyprus
Tonga (pre '75)	✓ Turks & Caicos	✓ Congo	<u>Singapore</u>
✓ <u>France</u>	✓ Bahamas	✓ Cote d'Ivoire	Brunei
✓ French Guyana (OD)	Bermuda	Equatorial Guinea (post '84)	<u>Norway</u>
✓ French Polynesia	✓ Liberia	✓ Gabon	Svalbard
✓ Guadeloupe (OD)	Marshall Islands	Guinea-Bissau	<u>South Africa</u>
Martinique (OD)	Micronesia	✓ Mali (post '84)	Lesotho
Mayotte	Palau	✓ Niger	Namibia
✓ New Caledonia (OT)	✓ Panama	✓ Senegal	Swaziland
✓ Reunion (OD)	✓ Barbados	✓ Togo	<u>Switzerland</u>
Andorra	✓ Belize	<u>ECCA</u>	Liechtenstein
✓ St. Pierre & Miquelon	✓ <u>Britain</u>	✓ Anguilla	<u>Spain</u>
Wallis & Futuna Islands	✓ Falkland Islands	✓ Antigua and Barbuda	Andorra
Monaco	✓ Gibraltar	✓ Dominica	<u>Singapore</u>
✓ <u>New Zealand</u>	Guernsey	✓ Grenada	Brunei
✓ Cook Islands	Jersey	✓ Montserrat	<u>Italy</u>
✓ Niue	Isle of Man	✓ St. Kitts and Nevis	San Marino
Pitcairn Islands	✓ Saint Helena	✓ St. Lucia	Vatican
Tokelau	Scotland	✓ St. Vincent	<u>Morocco</u>
	✓ Ireland (pre '79)		Western Sahara

Notes: This lists all the pre-Eurozone currency unions and CU-like monetary arrangements from 1970 onwards. A 'check' sign indicates that the nation is included in the sample of Rose (2000).

Source: Rose (2000), appendix table A4 footnote 1.

The problems with gravity results for the CU

- ▶ The typical coefficient is way too large to be credible: two CU countries traded ($\exp(1.21) = 3.35$) times more.
- ▶ Can we extend those results for small very open economies to the eurozone?

Potential issues with both the RTA and CU dummies

The most important issues have all to do with endogeneity of the agreements / currency unions.

- ▶ **Specification:** the theory commands to put the relative price term, which is usually **omitted**.
- ▶ **Reverse causality:** it might be that RTAs/CUs are signed by country pairs that already trade a lot.
- ▶ **Omitted Variable Bias:** it might be that RTAs/CUs are signed by country pairs that have other characteristics that facilitate trade: trust, peaceful relationships, common legal origins...

FEs do not solve all endogeneity issues of RTAs and CUs.

First improvements

- ▶ Rose and van Wincoop (2001) introduce fixed effects in an extended (more years) dataset compared to Rose (2000).
- ▶ The trade multiplicative factor of CUs falls to around 2.
- ▶ Hence, a-theoretical estimates are severely biased upwards.
- ▶ How to control for OVB?
- ▶ A first way to control for omitted variables is to include a **dyadic fixed effect**.
- ▶ Will control for anything that does *not* vary over time and affects bilateral trade.

Results with dyadic FEs

- ▶ Glick and Rose (2002) introduce country-pair FEs and the coefficient drops to 0.65, meaning that CUs tend to increase bilateral trade by around 90%.
- ▶ Carrere (2006) and Baier and Bergstrand (2006) do the same for the RTA dummy and the results go the other way: from insignificant to around 0.7!

Might be because CUs are adopted by remote countries, and RTAs by central ones.

RTA impact with dyadic FEs (Baier and Bergstrand, 06 JIE)

Table 4
Panel gravity equations in levels using various specifications

Variable	(1) No fixed or time effects	(2) With time effects	(3) With bilateral fixed effects	(4) With time and bilateral fixed effects
$\ln \text{RGDP}_i$	0.95 (217.50)	0.97 (230.98)	0.71 (34.54)	1.27 (47.16)
$\ln \text{RGDP}_j$	0.94 (224.99)	0.97 (235.43)	0.58 (26.57)	1.22 (41.60)
$\ln \text{DIST}_{ij}$	−1.03 (−79.09)	−1.01 (−78.60)		
ADJ_{ij}	0.41 (8.23)	0.38 (7.28)		
LANG_{ij}	0.63 (19.06)	0.58 (17.73)		
FTA_{ij}	0.13 (3.73)	0.27 (7.19)	0.51 (10.74)	0.68 (14.27)
RMSE	1.9270	1.8601		
Overall R^2	0.6575	0.6809		
Within R^2			0.2036	0.2268
No. observations	47,081	47,081	47,081	47,081

t-statistics are in parentheses. The dependent variable is the (natural log of the) real bilateral trade flow from *i* to *j*. Coefficient estimates for various fixed/time effects are not reported for brevity.

Tetrad results (Head et al. 08)

Model :	(1)	(2)	(3)	(4)	(5)
ln Pop, origin	0.859 ^a (0.006)	0.235 ^a (0.047)			
ln Pop, dest	0.756 ^a (0.006)	0.923 ^a (0.040)			
ln GDP/Pop, origin	1.017 ^a (0.007)	0.669 ^a (0.015)			
ln GDP/Pop, dest	0.872 ^a (0.007)	0.611 ^a (0.014)			
ln Dist (avg)	-0.984 ^a (0.013)				
Shared Language	0.398 ^a (0.033)				
Colonial History	1.410 ^a (0.448)				
Shared Legal Origins	0.343 ^a (0.025)				
RTA	0.695 ^a (0.046)	0.630 ^a (0.032)	0.456 (0.022)	0.544 (0.029)	0.336 (0.023)
Both GATT	0.159 ^a (0.019)	0.161 ^a (0.016)	0.20 (0.029)	0.306 (0.031)	0.162 (0.029)
Currency union	0.770 ^a (0.134)	0.364 ^a (0.108)	0.462 (0.049)	0.163 (0.049)	0.105 (0.137)
Tetrads:			GBR,FRA	USA,DEU	CHE,CAN
Fixed Effects:	None	Dyads	Tetrads	Tetrads	Tetrads
N	521849	524820	562463	551883	528261
R ²	0.616	0.393	0.091	0.027	0.08
RMSE	1.894	1.242	1.459	1.508	1.57

Identification and remaining issues with dyadic FEs

- ▶ An important point for the CU result is that all changes are identified in **entries or exits**.
- ▶ It happens to be the case that there are **many more exits than entries**.
- ▶ What really matters more is entry: Nitsch finds that while the exits have a large trade drop / entries do NOT have a significant trade rise.
- ▶ Also **time-varying** omitted variables are more likely for exits (political trouble / large divergence in inflation rates...): The Irish example.

The real problem with endogeneity

Figure 4: UK's share of Irish trade, 1924-98 (Thom and Walsh 2002).



Is instrumentation of the EC/CU dummy possible?

- ▶ A valid IV would have to be a variable that **predicts CU or EC membership well, without a link to bilateral trade.**
- ▶ Geographical proximity, common language, common border, former colonial status and the smallness and poorness of the nation, have been shown to affect probability to sign RTA or CU.
- ▶ But all of those also affect trade.
- ▶ The current estimates using IV are very disappointing
- ▶ The way forward might be to use financial variables for CUs and political variables for RTAs/CUs.

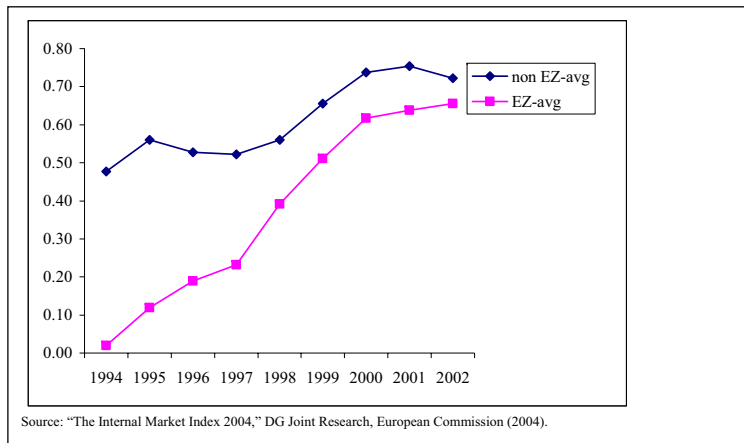
Results with matching

- ▶ Last issue is that the CU pairs are very unusual countries. They are very small, and nearby a large country with which they trade a lot.
- ▶ The “experiment” of the CU is by no way random.
- ▶ This causes a selection problem, since those countries that choose to abandon their own currencies are also very open.
- ▶ The solution to this issue is **matching**: Find for each country pair in the CU, the most proximate country pair that is not in a CU.
- ▶ Compares CU pairs with other small open economies, rather than with the universe of all countries.
- ▶ Results: CU augment trade by between 15 and 50%.
- ▶ In any case, it is crucial to be extremely cautious when interpreting this for the eurozone.

Results on the eurozone

- ▶ Micco, Stein and Ordoñez (2003) and Flam and Nordstrom implement the state of the art technology of gravity equation with the non-euro EU as a control group and find an order of magnitude of 6%-15%.
- ▶ The estimate is 28% with simple Rose-type gravity.
- ▶ No evidence of trade diversion.
- ▶ The story is not finished: delayed impact of euro devaluations / differences in implementation of Single Market measures.
- ▶ Key way forward will be to investigate firm-level data evidence: Richard Baldwin, Lionel Fontagné and others are working on this.

Internal Market Index evolution



Baldwin and Taglioni estimates: why does it matter (EU15 + OECD countries over 1992-2002)

Table 4: Gravity estimates with uni-directional nominal trade and GDPs.

	OLS	Time only	Pair & Time	Nation & Time	Importer, Exporter & Time	Time-varying Nation	Time-varying Nation and Pair
EZ11	0.17	0.13	0.09	0.24	0.26	0.34	-0.09
(Rose effect)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ly	0.81	0.81	0.57	0.65	0.70	0.98	0.94
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EU	0.14	0.14	0.06	0.20	0.21	0.22	0.04
	0.00	0.00	0.00	0.00	0.00	0.00	0.23
locked_o	-0.26	-0.25	5.17				
	0.00	0.00	0.00				
locked_d	-0.49	-0.49	-5.87				
	0.00	0.00	0.00				
ld	-0.86	-0.86		-0.93	-0.93	-0.93	
	0.00	0.00		0.00	0.00	0.00	
contig	0.17	0.17		0.11	0.11	0.11	
	0.00	0.00		0.02	0.01	0.02	
lang_off	0.68	0.67		0.53	0.53	0.53	
	0.00	0.00		0.00	0.00	0.00	
_cons	-15.50	-15.56	-7.23	-5.75	-8.18	-23.58	-30.77
	0.00	0.00	0.00	0.19	0.00	0.00	0.00
Observations	4837	4837	4837	4837	4837	4837	4837
R ²	0.88	0.88	0.99	0.91	0.93	0.91	0.99