PhD Topics in Macroeconomics

Lecture 16: heterogeneous firms and trade, part four

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This lecture

Trade frictions in Ricardian models with heterogeneous firms

1- Dornbusch, Fischer, Samuelson (1977) standard 2-country model

2- Eaton and Kortum (2002) probabilistic multi-country formulation

3- Gravity, inferring trade costs, quantitative experiments

Dornbusch, Fischer, Samuelson (1977)

- Two countries, $i = 1, 2$
- Continuum of goods $\omega \in [0, 1]$
- Labor productivities $a_i(\omega)$
- Wages w_i, inelastic labor supplies L_i
- Symmetric variable trade cost $\tau \geq 1$

Pattern of comparative advantage

- Let $A(\omega)$ denote relative productivity

$$A(\omega) := \frac{a_1(\omega)}{a_2(\omega)}, \qquad A'(\omega) < 0$$

  ordering ω by diminishing country 1 comparative advantage

- Country 1 consumer buys good ω from $i = 1$ producer if and only if

$$p_{11}(\omega) = \frac{w_1}{a_1(\omega)} \leq \frac{\tau w_2}{a_2(\omega)} = p_{21}(\omega)$$

- Country 2 consumer buys good ω from $i = 2$ producer if and only if

$$p_{12}(\omega) = \frac{\tau w_1}{a_1(\omega)} \geq \frac{w_2}{a_2(\omega)} = p_{22}(\omega)$$

Pattern of comparative advantage

- Hence country 1 produces all ω such that

$$\frac{w_1}{w_2} \leq \tau A(\omega) \quad \Leftrightarrow \quad \omega \leq \overline{\omega} := A^{-1}\Big(\frac{1}{\tau}\frac{w_1}{w_2}\Big)$$

- And country 2 produces all ω such that

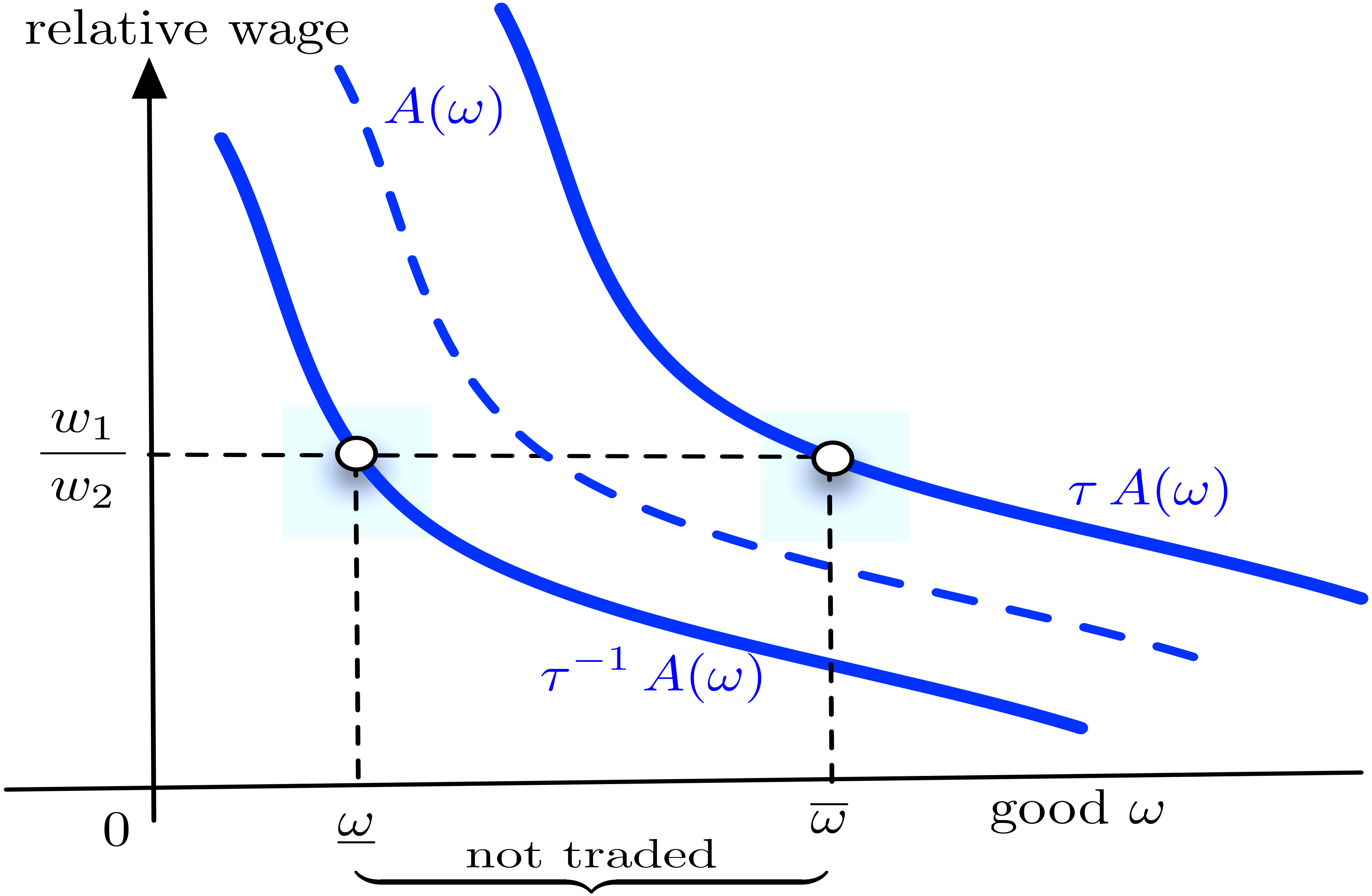
$$\frac{w_1}{w_2} \geq \tau^{-1} A(\omega) \quad \Leftrightarrow \quad \omega \geq \underline{\omega} := A^{-1}\Big(\tau\frac{w_1}{w_2}\Big)$$

- **Partition structure:**

$\omega \in [0, \underline{\omega})$ produced only in country 1, exported to 2
$\omega \in [\underline{\omega}, \overline{\omega}]$ produced in both, *not traded*
$\omega \in (\overline{\omega}, 1]$ produced only in country 2, exported to 1

- To close model need to determine relative wage w_1/w_2 and equilibrium thresholds $\underline{\omega}, \overline{\omega}$. If $\tau = 1$, then $\underline{\omega} = \overline{\omega}$ and all traded

Pattern of comparative advantage



Preferences

- Representative consumer in each country, identical preferences

$$\log C_i = \int_0^1 b(\omega) \log c_i(\omega)\, d\omega, \qquad \int_0^1 b(\omega)\, d\omega = 1$$

  with budget constraint

$$\int_0^1 p(\omega) c_i(\omega)\, d\omega \leq Y_i = w_i L_i$$

- Given constant expenditure shares $b(\omega)$, demand simply

$$c_i(\omega) = b(\omega) \frac{Y_i}{p(\omega)}$$

- Let $B(\omega)$ denote *cumulative expenditure share*

$$B(\omega) := \int_0^\omega b(\omega')\, d\omega'$$

Equilibrium

- Country 1 exports $\omega \in [0, \underline{\omega})$, so value of country 1 exports to 2

$$\int_0^{\underline{\omega}} p(\omega)c_2(\omega)\,d\omega = \int_0^{\underline{\omega}} b(\omega)Y_2\,d\omega = B(\underline{\omega})w_2L_2$$

- Country 1 imports $\omega \in (\overline{\omega}, 1]$, so value of country 1 imports from 2

$$\int_{\overline{\omega}}^1 p(\omega)c_1(\omega)\,d\omega = \int_{\overline{\omega}}^1 b(\omega)Y_1\,d\omega = (1 - B(\overline{\omega}))w_1L_1$$

- Trade balanced when

$$(1 - B(\overline{\omega}))w_1L_1 = B(\underline{\omega})w_2L_2$$

Equivalently, relative wage must satisfy

$$\frac{w_1}{w_2} = \frac{B(\underline{\omega})}{1 - B(\overline{\omega})}\frac{L_2}{L_1}$$

Frictionless trade

- Suppose $\tau = 1$. Then $\underline{\omega} = \overline{\omega} =: \omega^*$

- Two equations in two unknowns, w_1/w_2 and cutoff ω^*, specifically

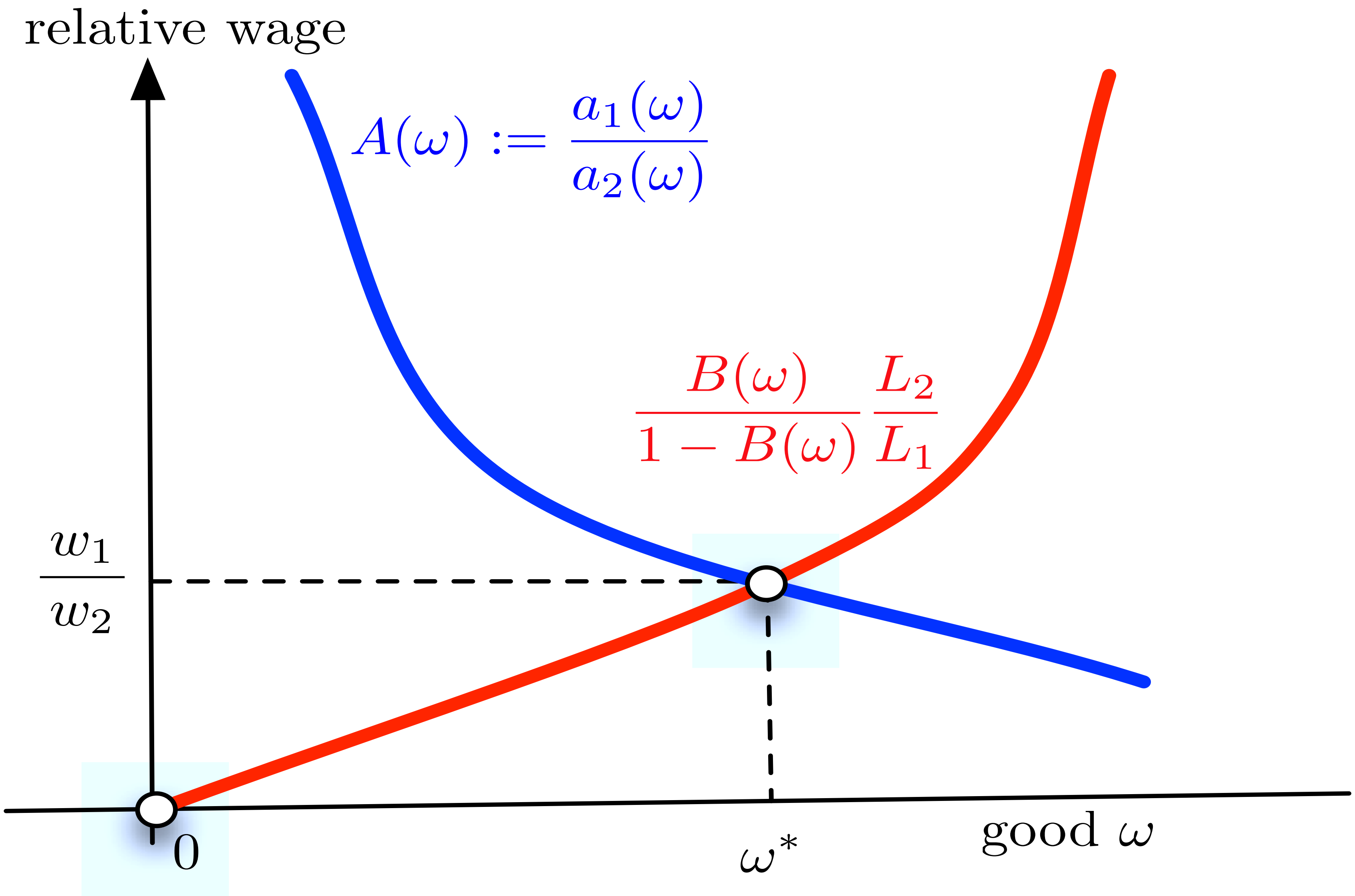
$$\frac{w_1}{w_2} = A(\omega^*)$$

and trade balance condition

$$\frac{w_1}{w_2} = \frac{B(\omega^*)}{1 - B(\omega^*)} \frac{L_2}{L_1}$$

- If range of goods produced by country 1 increases, relative wage w_1/w_2 rises to maintain trade balance (otherwise trade surplus)

Frictionless trade



Frictional trade

- More generally we have two cutoffs

$$\overline{\omega} = A^{-1}\left(\frac{1}{\tau}\,\frac{w_1}{w_2}\right)$$

$$\underline{\omega} = A^{-1}\left(\tau\,\frac{w_1}{w_2}\right)$$

with balanced trade requiring

$$\frac{w_1}{w_2} = \frac{B(\underline{\omega})}{1-B(\overline{\omega})}\frac{L_2}{L_1}$$

- Gives equilibrium relative wage and hence equilibrium cutoffs etc

$$\tau\,,\;B(\cdot)\,,\;\frac{L_2}{L_1} \qquad \mapsto \qquad \frac{w_1}{w_2}\,,\;\overline{\omega}\,,\;\underline{\omega}$$

Eaton/Kortum (2002)

- Many asymmetric countries, asymmetric trade costs
- Perfect competition (similar with Bertrand cf., BEJK 2003)
- Fréchet distribution for productivity, gives lots of tractability

Preferences

- Countries $i = 1, \ldots, N$
- Continuum of goods $\omega \in [0, 1]$
- Representative consumer in each country, identical CES preferences

$$C = \left(\int_0^1 c(\omega)^{\frac{\sigma-1}{\sigma}} \, d\omega \right)^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 0$$

with budget constraint in country i

$$\int_0^1 p_i(\omega) c_i(\omega) \, d\omega \leq P_i C_i =: X_i \qquad (= Y_i = w_i L_i)$$

- Standard price index

$$P_i = \left(\int_0^1 p_i(\omega)^{1-\sigma} \, d\omega \right)^{\frac{1}{1-\sigma}}$$

Technology

- Marginal cost of producing ω in country i is

$$\frac{w_i}{a_i(\omega)}$$

  where $a_i(\omega)$ is good-specific productivity

- Variable trade costs $\tau_{ij} \geq 1$ to ship from country i to j.

  Need not be symmetric but satisfy 'triangle inequality' $\tau_{ij} \leq \tau_{ik}\tau_{kj}$

Pricing

- Price that consumers in j *would pay <u>if</u> they bought from* i

$$p_{ij}(\omega) = \frac{\tau_{ij} w_i}{a_i(\omega)}$$

- With perfect competition, price consumers in j *actually pay* is

$$p_j^*(\omega) := \min_i \Big[p_{ij}(\omega) \Big]$$

Productivity draws

- For each $\omega \in [0, 1]$, country i efficiency $a_i(\omega)$ is IID draw from

$$F_i(a) := \text{Prob}[a_i \leq a]$$

- Distribution $F_i(a)$ is *Fréchet*, written

$$F_i(a) = e^{-T_i a^{-\xi}}, \qquad T_i > 0, \quad \xi > 1$$

T_i country-specific location parameter, governs *absolute advantage*
ξ common shape parameter, governs *comparative advantage*

- Approximately Pareto in the tails

$$F_i(a) = 1 - T_i a^{-\xi} + o(a^{-\xi})$$

which is Pareto for a large (that is, $a^{-\xi} \approx 0$). Again need $\xi > \sigma - 1$ for some key moments to be well-defined

Prices

- Let $G_{ij}(p)$ be the probability that the price at which country i can supply j is $\leq$ some fixed p,

$$G_{ij}(p) := \text{Prob}[p_{ij} \leq p]$$

- Since country i presents j with prices $p_{ij}(\omega) = \tau_{ij} w_i / a_i(\omega)$, this event is equivalent to

$$a_i(\omega) \geq \frac{\tau_{ij} w_i}{p}$$

so that

$$G_{ij}(p) = \text{Prob}\left[a_i \geq \frac{\tau_{ij} w_i}{p}\right] = 1 - F_i\left(\frac{\tau_{ij} w_i}{p}\right)$$

- Since $F_i(a)$ is Fréchet, we then have

$$G_{ij}(p) = 1 - \exp(-T_i(\tau_{ij} w_i)^{-\xi} p^{\xi}) = 1 - \exp(-\Phi_{ij} p^{\xi})$$

(i.e., a *Weibull* distribution, with shape ξ and scale $\Phi_{ij}^{-1/\xi}$)

Prices

- Let $G_j(p)$ denote the distribution of prices that consumers in j actually pay (the distribution of the lowest price)

$$
\begin{aligned}
G_j(p) := \text{Prob}[p_j^* \leq p] &= \text{Prob}\left[\min_i [p_{ij}] \leq p\right] \\
&= 1 - \text{Prob}\left[\min_i [p_{ij}] \geq p\right] \\
&= 1 - \text{Prob}\left[\{p_{1j} \geq p\}, \ldots, \{p_{Nj} \geq p\}\right] \\
&= 1 - \prod_{i=1}^{N} \Big(1 - G_{ij}(p)\Big) \\
&= 1 - \prod_{i=1}^{N} \exp(-\Phi_{ij} p^{\xi})
\end{aligned}
$$

- That is, $G_j(p)$ is another Weibull distribution

$$
G_j(p) = 1 - \exp(-\Phi_j p^{\xi}), \qquad \Phi_j := \sum_{i=1}^{N} \Phi_{ij} = \sum_{i=1}^{N} T_i (\tau_{ij} w_i)^{-\xi}
$$

$$\Phi_j := \sum_{i=1}^{N} T_i(\tau_{ij} w_i)^{-\xi}$$

- Summary statistic for how trade costs govern prices

- Trade enlarges each country's effective technology

- **Free trade**: $\tau_{ij} = 1$ for all i, j, then $\Phi_j = \Phi$ for all j. Law of one price holds (price distribution same in all countries)

- **Autarky**: $\tau_{jj} = 1$ and $\tau_{ij} = \infty$ for all $i \neq j$, then $\Phi_j = T_j w_j^{-\xi}$ independent of other countries

Probability i supplies j

- Let $\pi_{ij}(p)$ denote probability that i supplies j at price $p_{ij} = p$

- Let π_{ij} denote unconditional probability that i supplies j (that is, i provides j with lowest price for a given good)

- If $p_{ij} =$ some fixed p, then probability i supplies j *at that p* is equivalent to probability $p_{kj} \geq p$ for all $k \neq i$, so

$$\pi_{ij}(p) = \text{Prob}\Big[p \leq \min_{k \neq i}[p_{kj}]\Big] = \prod_{k \neq i}^{N} \Big(1 - G_{kj}(p)\Big) = \exp(-\Phi_j^{\neg i} p^{\xi})$$

where

$$\Phi_j^{\neg i} := \Phi_j - \Phi_{ij}$$

- Then

$$\pi_{ij} = \text{Prob}\Big[p_{ij} \leq \min_{k \neq i}[p_{kj}]\Big] = \int_0^{\infty} \pi_{ij}(p)\, dG_{ij}(p)$$

Probability i supplies j

- Which we can calculate as follows

$$
\begin{aligned}
\pi_{ij} &= \int_0^\infty \pi_{ij}(p)\, dG_{ij}(p) \\
&= \int_0^\infty \exp(-\Phi_j^{\neg i} p^\xi)\, dG_{ij}(p) \\
&= \int_0^\infty \exp(-\Phi_j^{\neg i} p^\xi)\, \Phi_{ij} \xi p^{\xi-1} \exp(-\Phi_{ij} p^\xi)\, dp \\
&= \Phi_{ij} \int_0^\infty \exp(-(\Phi_j^{\neg i} + \Phi_{ij}) p^\xi)\, \xi p^{\xi-1}\, dp \\
&= \frac{\Phi_{ij}}{\Phi_j} \int_0^\infty \exp(-\Phi_j p^\xi)\, \Phi_j \xi p^{\xi-1}\, dp \\
&= \frac{\Phi_{ij}}{\Phi_j} \int_0^\infty dG_j(p)
\end{aligned}
$$

Probability i supplies j

- Hence

$$\pi_{ij} = \frac{\Phi_{ij}}{\Phi_j} = \frac{T_i(\tau_{ij} w_i)^{-\xi}}{\sum_{i=1}^{N} T_i(\tau_{ij} w_i)^{-\xi}}$$

- This is the probability i supplies j with any randomly chosen ω

- It is also the fraction of $\omega \in [0, 1]$ that are supplied from i to j

Conditioning on the source does not matter

- Recall $G_j(p)$ is distribution of prices consumers in j actually pay

- Let $G_j(p \,|\, s)$ denote distribution of prices of goods j buys from any fixed source country s

$$G_j(p \,|\, s) := \text{Prob}\left[p_{sj} \leq p \,\middle|\, p_{sj} \leq \min_{k \neq s}[p_{kj}]\right]$$

- Amazingly, we find that

$$G_j(p \,|\, s) = G_j(p) \qquad \text{independent of the source } s$$

Conditioning on the source does not matter

- To show this, first observe that

$$
\begin{aligned}
G_j(p \,|\, s) :=\; & \mathrm{Prob}\Big[p_{sj} \le p \,\Big|\, p_{sj} \le \min_{k \neq s}[p_{kj}]\Big] \\
&= \frac{\mathrm{Prob}\Big[p_{sj} \le p\,,\, p_{sj} \le \min_{k \neq s}[p_{kj}]\Big]}{\mathrm{Prob}\Big[p_{sj} \le \min_{k \neq s}[p_{kj}]\Big]} \\
&= \frac{\mathrm{Prob}\Big[p_{sj} \le p\,,\, p_{sj} \le \min_{k \neq s}[p_{kj}]\Big]}{\pi_{sj}} \\
&= \frac{1}{\pi_{sj}} \int_0^p \mathrm{Prob}\Big[p' \le \min_{k \neq s}[p_{kj}]\Big]\, dG_{sj}(p') \\
&= \frac{1}{\pi_{sj}} \int_0^p \pi_{sj}(p')\, dG_{sj}(p')
\end{aligned}
$$

Conditioning on the source does not matter

- Now calculating as before

$$
\begin{aligned}
G_j(p \mid s) &= \frac{1}{\pi_{sj}} \int_0^p \pi_{sj}(p')\, dG_{sj}(p') \\
&= \frac{1}{\pi_{sj}} \int_0^p \exp(-\Phi_j^{\neg s} p'^{\xi})\, dG_{sj}(p') \\
&= \frac{1}{\pi_{sj}} \int_0^p \exp(-\Phi_j^{\neg s} p'^{\xi})\, \Phi_{sj} \xi p'^{\xi-1} \exp(-\Phi_{sj} p'^{\xi})\, dp' \\
&= \frac{1}{\pi_{sj}} \left(\frac{\Phi_{sj}}{\Phi_j} \int_0^p dG_j(p') \right) \\
&= \int_0^p dG_j(p') \\
&= G_j(p) \qquad \text{independent of } s!
\end{aligned}
$$

Discussion

- All adjustment is on the extensive margin (range of goods)
- Country with lower τ_{ij}, lower w_i, or higher T_i sells a *broader range of goods* but average price is the same
- That is, the range of goods expands until distribution of *i's prices in j* is same as the general price distribution in j
- Also turns out to imply that share of spending on imports from i is just the probability π_{ij}

Expenditure share on imports from i

- Let Ω_{ij} denote the set of goods j imports from i

$$\Omega_{ij} := \{\, \omega \in [0,1] \,:\, p_{ij}(\omega) = p_j^*(\omega)\,\}$$

- Let X_{ij} denote spending on imports from i

$$\begin{aligned}
X_{ij} :=& \int_{\Omega_{ij}} p_{ij}(\omega) c_j(\omega)\, d\omega \\
=& \int_{\Omega_{ij}} p_j^*(\omega) c_j(\omega)\, d\omega \\
=& \int_{\Omega_{ij}} \left(\frac{p_j^*}{P_j}\right)^{1-\sigma} X_j\, d\omega, \qquad X_j = P_j C_j \\
=& P_j^{\sigma-1} X_j \int_{\Omega_{ij}} p_j^{*1-\sigma}\, d\omega
\end{aligned}$$

- But conditioning on source does not matter

Expenditure share on imports from i

- That is

$$\begin{aligned}\int_{\Omega_{ij}} p_j^{*1-\sigma}\, d\omega &= \mathbb{E}[\, p_j^{*1-\sigma} \,|\, \omega \in \Omega_{ij}\,] \, \text{Prob}[\, \omega \in \Omega_{ij}\,] \\ &= \mathbb{E}[\, p_j^{*1-\sigma}\,] \, \text{Prob}[\, \omega \in \Omega_{ij}\,] \\ &= P_j^{1-\sigma} \pi_{ij}\end{aligned}$$

- So we have

$$X_{ij} = P_j^{\sigma-1} X_j \int_{\Omega_{ij}} p_j^{*1-\sigma}\, d\omega = P_j^{\sigma-1} X_j P_j^{1-\sigma} \pi_{ij}$$

or

$$\frac{X_{ij}}{X_j} = \pi_{ij} = \frac{\Phi_{ij}}{\Phi_j} = \frac{T_i(\tau_{ij} w_i)^{-\xi}}{\sum_{i=1}^N T_i(\tau_{ij} w_i)^{-\xi}}$$

Price index

- Price index in country j with distribution of prices $G_j(p)$ given by

$$P_j^{1-\sigma} = \int_0^\infty p^{1-\sigma}\, dG_j(p)$$
$$= \int_0^\infty p^{1-\sigma}\, \Phi_j \xi p^{\xi-1} \exp(-\Phi_j p^\xi)\, dp$$

- Now do change of variables. Let $x = \Phi_j p^\xi$, so $dx = \Phi_j \xi p^{\xi-1}\, dp$ and $p^{1-\sigma} = (x/\Phi_j)^{(1-\sigma)/\xi}$ giving

$$P_j^{1-\sigma} = \int_0^\infty (x/\Phi_j)^{(1-\sigma)/\xi} \exp(-x) dx$$

so that we have the solution

$$P_j = \gamma \Phi_j^{-1/\xi}, \qquad \gamma := \left[\Gamma\left(1 + \frac{1-\sigma}{\xi}\right)\right]^{1/(1-\sigma)}$$

where $\Gamma(z) := \int_0^\infty x^{z-1} e^{-x}\, dx$ is the *gamma function*
(note we need $\xi > \sigma - 1$ for this price index to be meaningful)

Gravity

- Let X_i denote total sales by *source country i*

$$X_i := \sum_{k=1}^{N} X_{ik} = \sum_{k=1}^{N} \frac{\Phi_{ik}}{\Phi_k} X_k = \sum_{k=1}^{N} \frac{T_i(\tau_{ik} w_i)^{-\xi}}{\Phi_k} X_k$$

- Pulling out the terms common to i

$$X_i = T_i w_i^{-\xi} \sum_{k=1}^{N} \frac{\tau_{ik}^{-\xi}}{\Phi_k} X_k$$

- Hence we can write bilateral trade flows between i and j as

$$X_{ij} = \frac{\Phi_{ij}}{\Phi_j} X_j = \frac{T_i(\tau_{ij} w_i)^{-\xi}}{\Phi_j} X_j = \frac{(\tau_{ij}^{-\xi}/\Phi_j)}{\sum_{k=1}^{N} (\tau_{kj}^{-\xi}/\Phi_k) X_k} X_i X_j$$

Gravity

- So again we have a gravity equation of the form

$$X_{ij} = \frac{\rho_{ij}^{-\varepsilon}}{\sum_{k=1}^{N} \alpha_k \rho_{kj}^{-\varepsilon}} \frac{X_i X_j}{X}, \qquad \alpha_k := \frac{X_k}{X}$$

with *trade friction* $\rho_{ij} := \tau_{ij} \Phi_j^{1/\xi}$ and *trade elasticity* $\varepsilon = \xi$

- Or in terms of the price index $P_j = \gamma \Phi_j^{-1/\xi}$,

$$X_{ij} = \frac{(\tau_{ij}/P_j)^{-\xi}}{\sum_{k=1}^{N} \alpha_k (\tau_{kj}/P_k)^{-\xi}} \frac{X_i X_j}{X}$$

- Trade barriers τ_{ij} deflated by P_j. Stiff competition in j decreases P_j and hence decreases i sales to j

- Weak comparative advantage (high ξ) increases trade elasticity, i.e., relative productivity similar, few outliers to lock down trade flows

Trade, geography, and prices

- Consider normalized share of country i in country j

$$S_{ij} := \frac{X_{ij}/X_j}{X_{ii}/X_i} = \tau_{ij}^{-\xi}\frac{\Phi_i}{\Phi_j} = \left(\tau_{ij}\frac{P_i}{P_j}\right)^{-\xi}$$

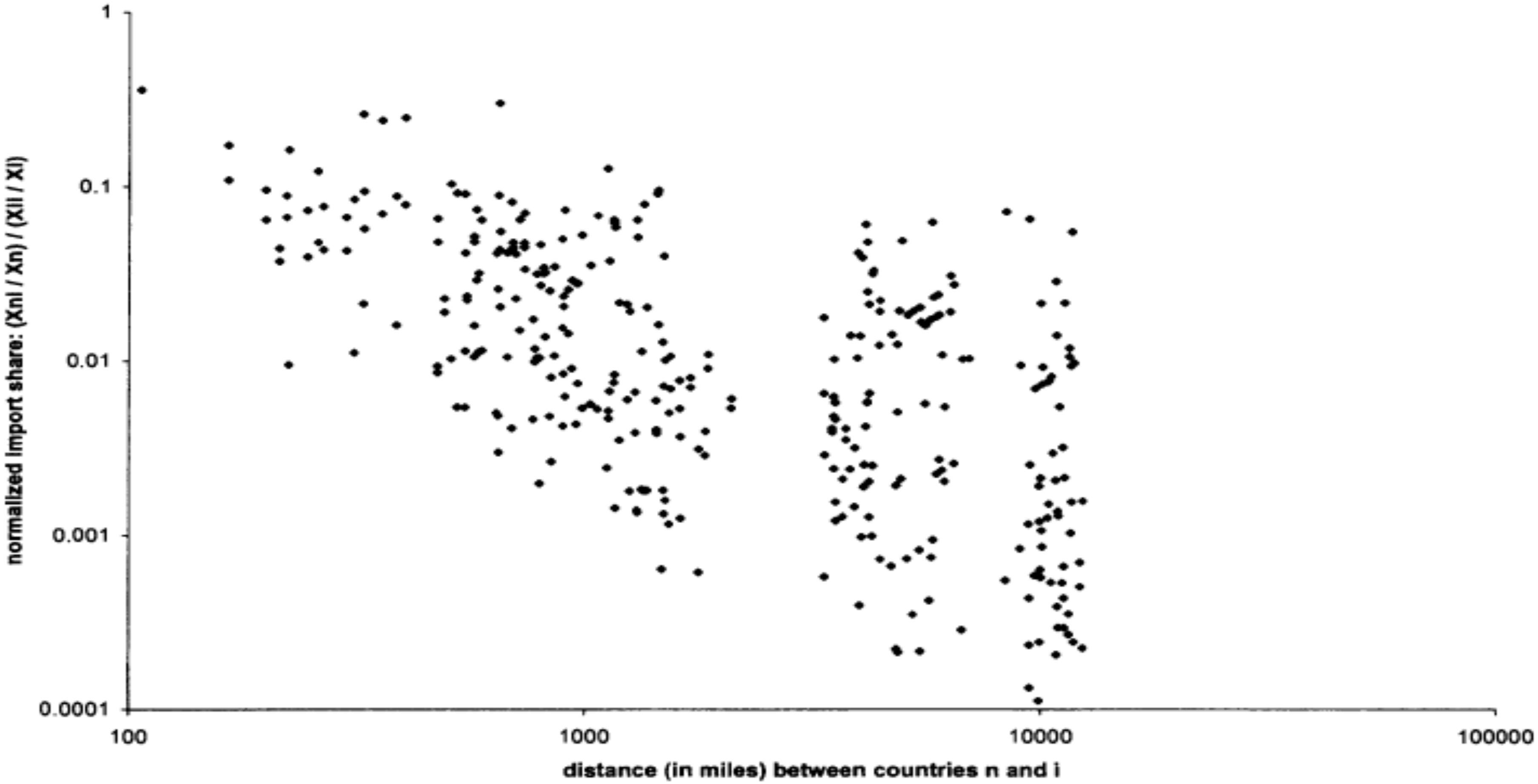
(normalized by share in home market)

- Normalized share S_{ij} declines if P_i/P_j increases or if τ_{ij} increases. A 'CES import demand system' with elasticity ξ

- Triangle inequality, $\tau_{ij} \leq \tau_{ik}\tau_{kj}$ implies $P_j \leq \tau_{ij}P_i$ so $S_{ij} \leq 1$

- Frictionless world, $\tau_{ij} = 1$ implies $P_j = P_i$ so that $S_{ij} = 1$

Trade and geography



Normalized share S_{ij} and distance between i, j for bilateral pairs of OECD countries.

Trade and geography

- S_{ij} well less than one, never exceed 0.2

- Scatter does not use information on relative price levels P_i/P_j

- Confounds geographic barriers and comparative advantage

  Inverse correlation could be strong geographic barriers overcoming strong comparative advantage (low ξ) or mild geographic barriers overcoming mild comparative advantage (high ξ)

$\Rightarrow$ Need to estimate ξ

Estimating ξ: main idea

- Main idea

$$\log S_{ij} = -\xi \log\left(\tau_{ij}\frac{P_i}{P_j}\right)$$

- Estimate ξ as slope coefficient in regression

- But to do this, need measures of trade costs τ_{ij}

Inferring trade costs τ_{ij}

- No-arbitrage implies trade costs

$$\frac{p_j^*(\omega)}{p_i^*(\omega)} \leq \tau_{ij}$$

with equality if j imports good ω from i

- If j imports from i, then should have

$$\max_{\omega}\left[\frac{p_j^*(\omega)}{p_i^*(\omega)}\right] = \tau_{ij}$$

- Eaton/Kortum implement this using retail prices for 50 manufactured products

Inferring trade costs τ_{ij}

- Calculate

$$D_{ij} := \frac{\text{max2}_\omega \left[r_{ij}(\omega) \right]}{\text{mean}_\omega \left[r_{ij}(\omega) \right]}, \qquad r_{ij}(\omega) := \log \left(\frac{p_j^*(\omega)}{p_i^*(\omega)} \right)$$

- Set

$$D_{ij} \approx \log \left(\tau_{ij} \frac{P_i}{P_j} \right)$$

- Run regression

$$\log S_{ij} = -\xi D_{ij}$$

Note $\exp(D_{ij})$ is price index in j if everything imported from i relative to actual price index in j

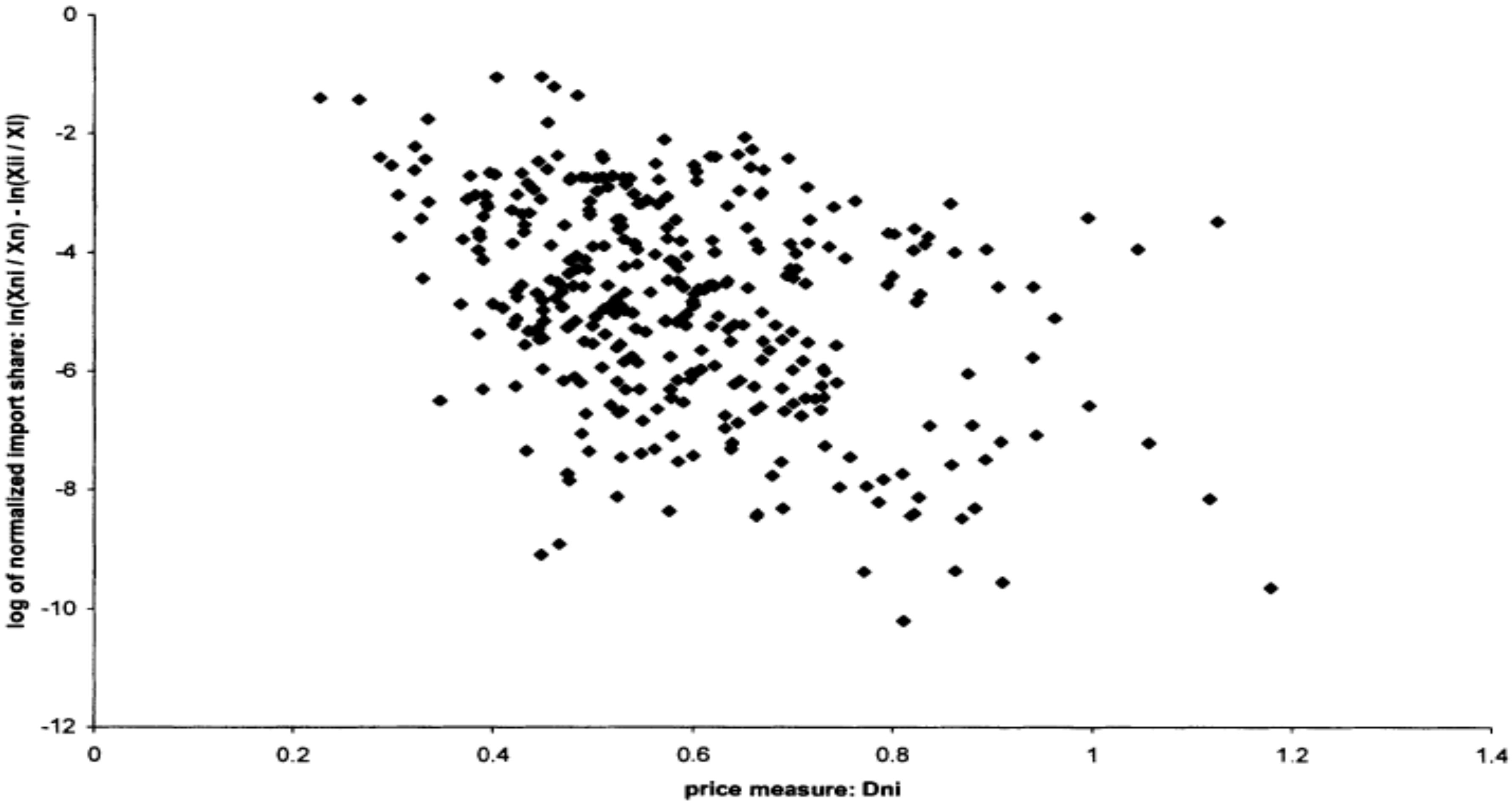
D_{ij}

PRICE MEASURE STATISTICS

Country	Foreign Sources		Foreign Destinations	
	Minimum	Maximum	Minimum	Maximum
Australia (AL)	NE (1.44)	PO (2.25)	BE (1.41)	US (2.03)
Austria (AS)	SW (1.39)	NZ (2.16)	UK (1.47)	JP (1.97)
Belgium (BE)	GE (1.25)	JP (2.02)	GE (1.35)	SW (1.77)
Canada (CA)	US (1.58)	NZ (2.57)	AS (1.57)	US (2.14)
Denmark (DK)	FI (1.36)	PO (2.21)	NE (1.48)	US (2.41)
Finland (FI)	SW (1.38)	PO (2.61)	DK (1.36)	US (2.87)
France (FR)	GE (1.33)	NZ (2.42)	BE (1.40)	JP (2.40)
Germany (GE)	BE (1.35)	NZ (2.28)	BE (1.25)	US (2.22)
Greece (GR)	SP (1.61)	NZ (2.71)	NE (1.48)	US (2.27)
Italy (IT)	FR (1.45)	NZ (2.19)	AS (1.46)	JP (2.10)
Japan (JP)	BE (1.62)	PO (3.25)	AL (1.72)	US (3.08)
Netherlands (NE)	GE (1.30)	NZ (2.17)	DK (1.39)	NZ (2.01)
New Zealand (NZ)	CA (1.60)	PO (2.08)	AL (1.64)	GR (2.71)
Norway (NO)	FI (1.45)	JP (2.84)	SW (1.36)	US (2.31)
Portugal (PO)	BE (1.49)	JP (2.56)	SP (1.59)	JP (3.25)
Spain (SP)	BE (1.39)	JP (2.47)	NO (1.51)	JP (3.05)
Sweden (SW)	NO (1.36)	US (2.70)	FI (1.38)	US (2.01)
United Kingdom (UK)	NE (1.46)	JP (2.37)	FR (1.52)	NZ (2.04)
United States (US)	FR (1.57)	JP (3.08)	CA (1.58)	SW (2.70)

Notes: The price measure D_{ni} is defined in equation (13). For destination country n, the minimum Foreign Source is $\min_{i \neq n} \exp D_{ni}$. For source country i, the minimum Foreign Destination is $\min_{n \neq i} \exp D_{ni}$.

Trade and prices



Correlation ≈ -0.4, regression coefficient implies $\xi \approx 8$.

Welfare gains: benchmark vs. autarky

The Gains from Trade: Raising Geographic Barriers

	Percentage Change from Baseline to Autarky					
	Mobile Labor			Immobile Labor		
Country	Welfare	Mfg. Prices	Mfg. Labor	Welfare	Mfg. Prices	Mfg. Wages
Australia	−1.5	11.1	48.7	−3.0	65.6	54.5
Austria	−3.2	24.1	3.9	−3.3	28.6	4.5
Belgium	−10.3	76.0	2.8	−10.3	79.2	3.2
Canada	−6.5	48.4	6.6	−6.6	55.9	7.6
Denmark	−5.5	40.5	16.3	−5.6	59.1	18.6
Finland	−2.4	18.1	8.5	−2.5	27.9	9.7
France	−2.5	18.2	8.6	−2.5	28.0	9.8
Germany	−1.7	12.8	−38.7	−3.1	−33.6	−46.3
Greece	−3.2	24.1	84.9	−7.3	117.5	93.4
Italy	−1.7	12.7	7.3	−1.7	21.1	8.4
Japan	−0.2	1.6	−8.6	−0.3	−8.4	−10.0
Netherlands	−8.7	64.2	18.4	−8.9	85.2	21.0
New Zealand	−2.9	21.2	36.8	−3.8	62.7	41.4
Norway	−4.3	32.1	41.1	−5.4	78.3	46.2
Portugal	−3.4	25.3	25.1	−3.9	53.8	28.4
Spain	−1.4	10.4	19.8	−1.7	32.9	22.5
Sweden	−3.2	23.6	−3.7	−3.2	19.3	−4.3
United Kingdom	−2.6	19.2	−6.0	−2.6	12.3	−6.9
United States	−0.8	6.3	8.1	−0.9	15.5	9.3

Welfare gains: benchmark vs. $\tau_{ij} = 1$

THE GAINS FROM TRADE: LOWERING GEOGRAPHIC BARRIERS

	Percentage Changes in the Case of Mobile Labor					
	Baseline to Zero Gravity			Baseline to Doubled Trade		
Country	Welfare	Mfg. Prices	Mfg. Labor	Welfare	Mfg. Prices	Mfg. Labor
Australia	21.1	−156.7	153.2	2.3	−17.1	−16.8
Austria	21.6	−160.3	141.5	2.8	−20.9	41.1
Belgium	18.5	−137.2	69.6	2.5	−18.6	68.8
Canada	18.7	−139.0	11.4	1.9	−14.3	3.9
Denmark	20.7	−153.9	156.9	2.9	−21.5	72.6
Finland	21.7	−160.7	172.1	2.8	−20.9	44.3
France	18.7	−138.3	−7.0	2.3	−16.8	15.5
Germany	17.3	−128.7	−50.4	1.9	−14.3	12.9
Greece	24.1	−178.6	256.5	3.3	−24.8	29.6
Italy	18.9	−140.3	6.8	2.2	−16.1	5.7
Japan	16.6	−123.5	−59.8	0.9	−6.7	−24.4
Netherlands	18.5	−137.6	67.3	2.5	−18.5	65.6
New Zealand	22.2	−164.4	301.4	2.8	−20.5	50.2
Norway	21.7	−161.0	195.2	3.1	−22.9	69.3
Portugal	22.3	−165.3	237.4	3.1	−22.8	67.3
Spain	20.9	−155.0	77.5	2.4	−18.0	−4.4
Sweden	20.0	−148.3	118.8	2.7	−19.7	55.4
United Kingdom	18.2	−134.8	3.3	2.2	−16.4	28.5
United States	16.1	−119.1	−105.1	1.2	−9.0	−26.2

Next

- Aggregate gains from trade, part one

- Gains from trade in standard trade models

    ◇ Arkolakis, Costinot and Rodríguez-Clare (2012): New trade models, same old gains? *American Economic Review*.

    ◇ Costinot and Rodríguez-Clare. (2014): Trade theory with numbers: Quantifying the consequences of globalization, *Handbook of International Economics*.