Trade and Macroeconomics

Lectures 1-2: Quantitative Trade Models and Applications

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The Global Economy

- economic globalization:
  - international integration of commodity, capital and labor markets
  - phenomenon of unprecedented size
- 1960-2010, volume of trade (import+export)/GDP:
  - $0.26 \longrightarrow 0.90$ (GER)
  - $0.08 \longrightarrow 0.57$ (Spain)
  - $0.22 \longrightarrow 0.57$ (UK)
  - $0.08 \longrightarrow 0.29$ (US)
  - $0.04 \longrightarrow 0.92$ (Korea)
  - $0.11 \longrightarrow 0.77$ (China)
- why trade and macroeconomics?
  - global recessions
  - global imbalances
  - technological/policy externalities between countries
  - tension between political and economic integration

Main Drivers of Globalization: Policies

- political stimulus to cooperation and integration after WWII
- fall of communism
- dismantling of man-made barriers:
  - expansion of the European Union
  - NAFTA (1994)
  - Mercosur (1991-94)
  - ASEAN FTA (1992-2003)
  - China's accession to the WTO (2001)
- average import tariff fell from 14% in 1952 to 3.03% in 2010
- yet, these are not the main drivers of the recent globalization boom

Main Drivers of Globalization: Technology

- technological innovations:
  - faster and cheaper transportation
- Levinson (2008):
  - the introduction of the container in 1955 made shipping cheap, and by doing so changed the shape of the world economy
- other examples:
  - railroad costs declined from 0.18$ per ton-mile in 1890 to 0.02$ in 2000
  - air transport costs dropped by 92% between 1955 and 2004
- yet, these are not the main drivers of the next wave of globalization

Trading Technology: Yesterday and Tomorrow

- containers changed shipping...

- ...the Information and Communication Technology is changing the nature of trade

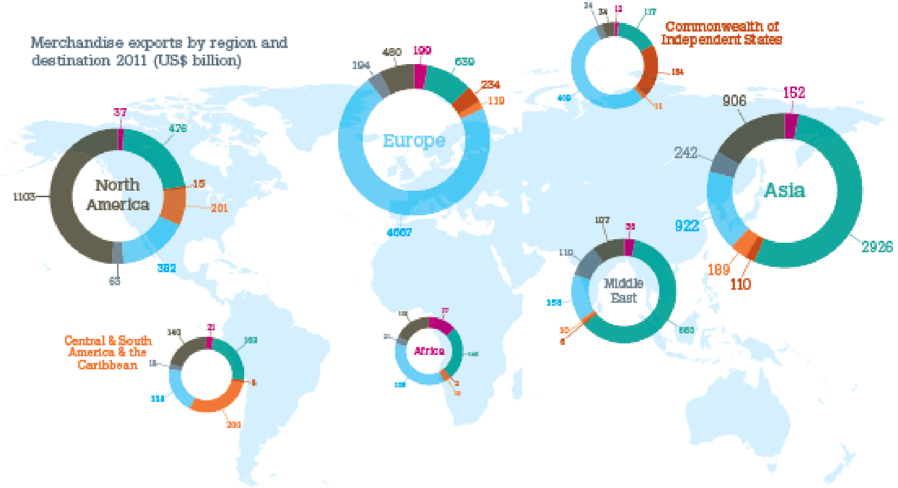
The ICT Revolution

- the cost of international calls:
  - in 2005 was 1/10th of the cost in 1955 (Germany)
- cost of transmitting a bit over an optical network:
  - decreases by half every nine months (Butter's law)
- number of internet users:
  - around 20 million in 1994
  - more than 2,000 million in 2010
- ICT revolution led to the reorganization of production around the world
  - global supply chains
  - vertical specialization
  - offshoring

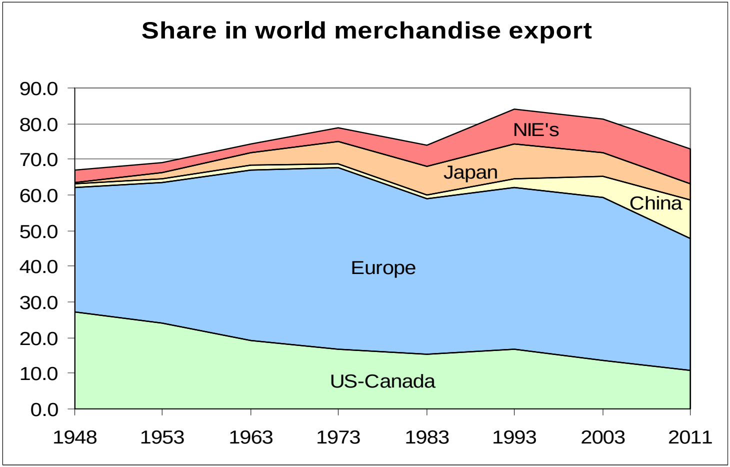
Basic Facts about Trade Flows

- structure of trade:
  - North-North trade $\simeq 52\%$
  - North-South trade $\simeq 33\%$
  - South-South trade $\simeq 15\%$
- most of North-North trade is Intra-Industry Trade (IIT):
  - simultaneous import and export of similar products
- North-South trade is the fastest growing component of world trade
- the volume of trade (Export/GDP) varies with income:
  - 24% in low income countries
  - 37% in middle income countries
  - 42% in high income countries

Global Trade Flows: a Snapshot

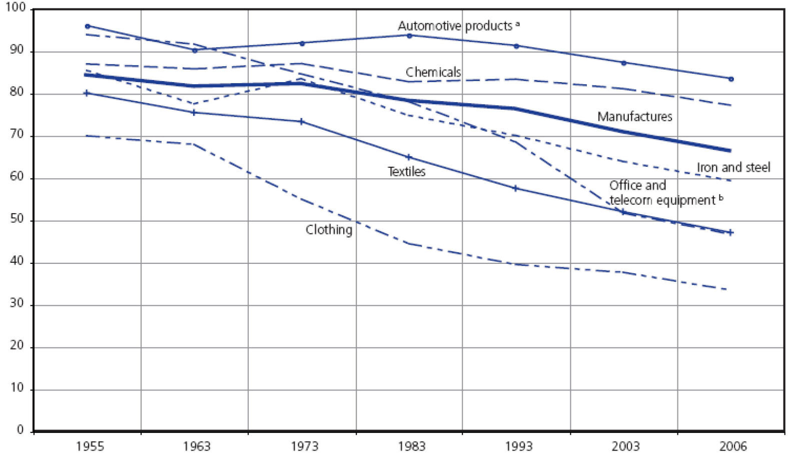


Who Are the Main Exporters?



What Do Advanced Countries Export?

Chart 2
Share of industrial countries in world manufactures exports by product group, 1955-2006
(Percentage)



Goods, Firms and Trade

- merchandise accounts for 70% of export (services 30%)
- not all goods are traded
  - main traded products: computers, cars, chemicals, clothing, intermediates, fuels and mining
  - agriculture accounted for 40% of trade in 1950, since 1995 it is less than 10% and falling
- not all firms export
  - share of exporters among manufacturing firms:
    - ★ US (2002) $\rightarrow$ 18%
    - ★ Norway (2003) $\rightarrow$ 39.2%
    - ★ France (1986) $\rightarrow$ 17.4%
    - ★ Japan (2000) $\rightarrow$ 20%
    - ★ Chile (1999) $\rightarrow$ 20.9
  - only the most productive firms export

A Brief History of Trade Theory

- Adam Smith (1776)
  - benefit of specialization - absolute advantage
- David Ricardo (1817)
  - (technological) Comparative Advantage (CA)
- Eli Heckscher- Bertil Ohlin (1919-1933)
  - factor proportions
- multi-good synthesis of CA models
  - Ricardian CA: Dornbusch, Fischer & Samuelson (1977)
  - HO CA: Dornbusch, Fischer & Samuelson (1980)
- New Trade Theory: Krugman (1979), Lancaster (1979)
  - IIT between similar countries
  - imperfect competition, IRS and (symmetric) firms
- recent emphasis: *intra*-sectoral trade + technology differences
  - Eaton & Kortum (2002) → quantitative Ricardian model
  - firm heterogeneity: Melitz (2003), Bernard, Jensen, Eaton & Kortum (2003), Eaton, Kortum & Kramarz (2011)

Road Map

- review of basic Ricardian models $\longrightarrow$ go quantitative:
  - modeling technology differences
  - estimating the model to explain trade flows
  - quantify the GFT
- two "macro" applications:
  - global imbalances
  - trade volumes during the great recession
- production offshoring
  - welfare consequences (application: the rise of China)
- trade, offshoring and labor market outcomes
  - wage inequality (skill premia, residual inequality)
  - unemployment in the global economy
- policy making in an interdependent world
  - policy externalities due to globalization
  - effects of globalization on political organization

A Workhorse Ricardian Model

- the idea that technology matters for trade goes back to Ricardo (1817)
- a modern synthesis:
  - Ricardian model by Dornbusch, Fischer & Samuelson (1977)
- reason for trade:
  - exogenous differences in technology across countries
- 2 countries:
  - home and foreign(*)
- one factor of production, labor, in fixed supply (L and L^*)
- continuum $[0, 1]$ of goods
- perfect competition

Technology

- country- and good-specific unit labor requirements:
  - $a(z)$ and $a^*(z)$ = workers required to produce 1 unit of good z
- relative home productivity

$$A(z) \equiv \frac{a^*(z)}{a(z)}$$

  - rank all goods so that $A(z)$ is decreasing in z
  - assume that $A(z)$ is a continuous function of z
- price = marginal cost:

$$p(z) = a(z)\,w \quad \text{and} \quad p^*(z) = a^*(z)\,w^*$$

  - w and w^* are wages
- good z will be produced in the home country iff:

$$p(z) < p^*(z) \quad \Longleftrightarrow \quad A(z) > \frac{w}{w^*} \equiv \omega$$

Specialization

- draw the condition for home production in the space (ω, z)

$$\omega < A(z)$$

- given ω, there is a good $\bar{z}$ such that $\omega = A(\bar{z})$
  - goods with $z < \bar{z}$ are produced in home
  - goods with $z > \bar{z}$ are produced in foreign
- determinants of comparative advantage:
  - technology and wages
- yet, wages are endogenous:
  - how do we solve for ω? look at the demand side

Preferences

- assumptions:
  - identical preferences
  - constant expenditure shares:

$$\begin{aligned} \theta(z) &= \text{share of income spent on all goods } i \in [0, z] \\ \theta(\bar{z}) &= \text{share of income spent on home goods} \end{aligned}$$

- value of home import = value of foreign imports:

$$wL\left[1 - \theta(\bar{z})\right] = w^* L^* \theta(\bar{z})$$

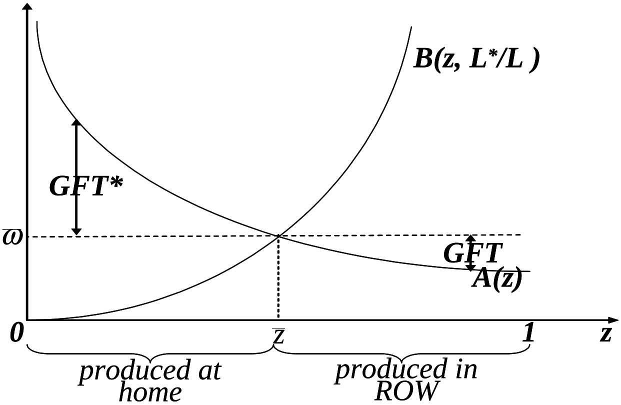
  - rearrange:

$$\omega = \frac{L^*}{L} \cdot \frac{\theta(\bar{z})}{1 - \theta(\bar{z})} = B\left(\bar{z}, \frac{L^*}{L}\right)$$

  - upward sloping relationship in the space $(\omega, \bar{z})$
    - the more is produced at home, the higher the demand for home labor and thus home wages

Equilibrium

$$\bar{\omega} = A\left(\bar{z}\right) \quad \text{and} \quad \bar{\omega} = B\left(\bar{z}, L^{*}/L\right)$$



Gains from Trade: Proof

- compute the domestic real wage, $w/p(z)$, under autarky:

$$\frac{w}{p(z)} = \frac{w}{a(z)\,w} = \frac{1}{a(z)} \quad \forall z$$

- in free trade:
  - for goods produced at home, $z < \bar{z}$:

$$\frac{w}{p(z)} = \frac{w}{a(z)\,w} = \frac{1}{a(z)}$$

  - for imported goods, $z > \bar{z}$:

$$\frac{w}{p(z)} = \frac{w}{a^*(z)\,w^*} > \frac{1}{a(z)}$$

    because the condition for foreign production is $a(z)\,w > a^*(z)\,w^*$
- same for Foreign:
  - positive GFT, irrespective of the level of productivity

DFS: Comments

- the model can be used to study the effects on welfare and specialization of:
  - changes in country size and migration
  - technological progress
- key lesson:
  - GFT are always positive, even if a country has an inferior technology
- some limitations:
  - does not generalize easily to more than two countries (Jones 1961, Wilson 1980)
  - little role for geography and barriers to trade
  - hard to take to the data
  - where do differences in technology come from?
- next step:
  - develop a version suitable for quantitative analysis

Eaton & Kortum (2002, 2012): Key Ideas

- Eaton & Kortum (EK, 2002, 2012):
  - generalize DFS to $N > 2$ countries
  - add bilateral trade barriers (geography)
- how? taking a probabilistic approach to technology
  - in each country productivity across goods is drawn from a given distribution
  - cross-country differences are summarized by the parameters of the distribution
- model predicts bilateral trade flows as function of:
  1. average technology in each country (absolute advantage)
  2. technology heterogeneity (comparative advantage)
  3. bilateral geographical barriers
  4. country size

EK (2002, 2012): Applications

- using structural predictions:
  - model parameters can be estimated using bilateral trade and wage data
- the estimated model is used to perform exercises such as computing:
  - actual gains from trade
  - welfare effect of moving to free trade
  - welfare effect of technology improvements in one country
- state-of-the-art quantitative model:
  - can be extended to incorporate more determinants of comparative advantage (such as differences in endowments)
  - can be used for policy analysis
  - predictions can be used for testing

Simplified Model: Markets and Prices

- all markets are competitive
  - prices = marginal cost
- price of good j produced in country o sold in country n:

$$p_{n,o}(j) = MC = a_o(j)\, w_o d_{o,n}$$

where:

  - w_o = wage in country o (origin)
  - $a_o(j)$ = unit labor req. of country o in good j
  - $d_{o,n}$ = (iceberg) cost of distance between o and n
- shopping around:
  - price actually paid = lowest across all sources

$$p_n(j) = \min_o \{p_{n,o}(j)\}$$

Technology

- $a_o(j)$ is the realization of iid draws from a Frechet distribution:

$$\Pr\left[a_o(j) \leq a\right] = 1 - e^{-(A_o a)^\theta}$$

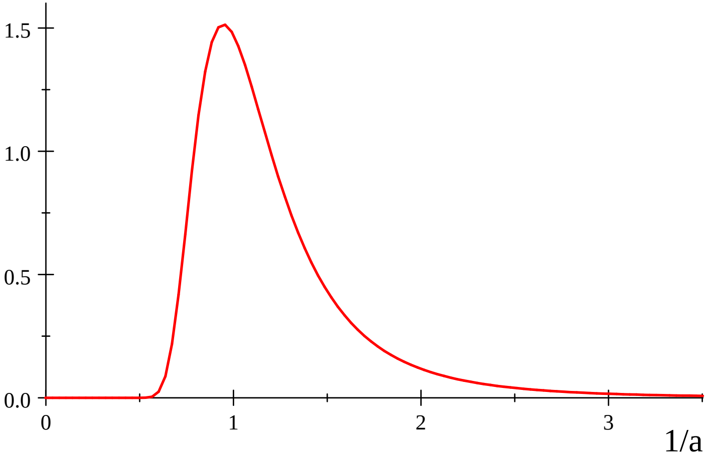
  - or:

$$a_o(j) = \frac{x_j^{1/\theta}}{A_o} \quad \text{where} \quad x_j \sim \exp(1)$$

- key parameters
  - $A_o > 0$, country-specific, governs the mean
    - ★ high $A_o \rightarrow$ higher probability to draw a low $a_o(j) \rightarrow$ better technology
  - $\theta > 1$, assumed equal across countries, governs the dispersion
    - ★ high $\theta \rightarrow$ less variability
- given θ, technology is entirely summarized by the set of A_o

Frechet: an Example

- distribution of productivity $(1/a_o(j))$ $A_o = 1$, $\theta = 4$



Probability Density Function

Distribution of Prices

- distribution of price *offers* from country o to n:
  - $\Pr\left[p_{n,o}(j) \leq p\right] = \Pr\left[a_o\left(j\right) \leq \frac{p}{w_o d_{o,n}}\right] = 1 - e^{-\left(A_{n,o} p\right)^{\theta}}$
  - $A_{n,o} \equiv A_o / \left(w_o d_{o,n}\right)$
- distribution of prices *paid* in n:
  - $\Pr\left[p_n(j) \geq p\right]$ = (joint) probability that prices from all sources are above p

$$\Pr\left[p_n(j) \geq p\right] = \prod_{o=1}^{N}\left[e^{-\left(A_{n,o} p\right)^{\theta}}\right] = e^{-\left(\bar{A}_n p\right)^{\theta}}$$

    - ★ with $\bar{A}_n \equiv \left[\sum_{o=1}^{N}\left(A_{n,o}\right)^{\theta}\right]^{1/\theta}$
  - realized prices in country n are $\sim$ Frechet with parameter $\bar{A}_n$
    1. prices are high if all w_o, $d_{o,n}$ are high and A_o low (low $\bar{A}_n$)
    2. if $d_{o,n} = 1\ \forall o, n \longrightarrow$ same prices everywhere (LOP)
    3. otherwise, more remote countries have higher prices
    4. prices fall with the number of countries

Export Probability

- probability that o exports good j to n:

$$\Pr\left[p_{n,o}(j) \leq \min\left\{p_{n,s}(j); s \neq o\right\}\right]$$

  - (joint) probability that all other prices are higher than $p_{n,o}(j)$
- *average* probability that o exports *any* good to n:

$$\pi_{n,o} = \left(\frac{A_{n,o}}{\bar{A}_n}\right)^{\theta} = \frac{\left[A_o / \left(w_o d_{o,n}\right)\right]^{\theta}}{\sum_{o=1}^{N}\left[A_o / \left(w_o d_{o,n}\right)\right]^{\theta}}$$

  - think of $A_{n,o}$ as country o "competitiveness" in market n
    - depends on **technology**, **wages**, **distance**
  - probability that o is the cheapest supplier:
    - ratio of country o "competitiveness" to the sum of all
- by LLN $\pi_{n,o}$ is also the fraction of goods that n buys from o
  - pins down the volume of bilateral trade

Properties of Distributions

- $\pi_{n,o}$ is derived using the properties of distributions
- recall:
$$[a_o(j)A_o]^\theta = x \sim \exp(1)$$
- useful properties of exponential distributions
  1. if $x \sim \exp(\lambda)$ and $k > 0$:
  $$kx \sim \exp\left(\frac{\lambda}{k}\right)$$
  2. if $x \sim \exp(\lambda)$, $y \sim \exp(\mu)$, x and y are independent:
  $$z = \min(x, y) \sim \exp(\lambda + \mu)$$
  $$\Pr[x \leq y] = \frac{\lambda}{\lambda + \mu}$$

Closing the Model

- we need to solve for wages
- demand:
  - a simple case is as DFS with symmetric preferences across goods
- impose market clearing by country (income = expenditure):

$$w_o L_o = \sum_{n=1}^{N} \pi_{n,o} w_n L_n$$

  - the wage adjusts so that a country can sell all its output
- large system of nonlinear equations
  - numeric solutions

Estimating the Model

- share of imports from o relative to domestic consumption:

$$\frac{\pi_{n,o}}{\pi_{n,n}} = \left(\frac{A_{n,o}}{A_{n,n}}\right)^{\theta} = \left(\frac{A_o}{A_n}\frac{1}{d_{o,n}}\frac{w_n}{w_o}\right)^{\theta}$$

  - in logs:

$$\ln\frac{\pi_{n,o}}{\pi_{n,n}} = -\theta \ln d_{o,n} + \theta \ln\left(A_o w_o^{-1}\right) - \theta \ln\left(A_n w_n^{-1}\right)$$

- the LHS is constructed from bilateral trade data
- $d_{o,n}$ is proxied by:
  - distance + dummies for common language, common border, being part of same trade area
- $\theta \ln\left(A_o w_o^{-1}\right)$ can be identified from source-country fixed effects
  - using wage data and the estimated θ, the A_o can be retrieved

Counterfactuals

- some alternative estimation strategies are possible
- moreover, the model in the paper is more general:
  1. more general preferences
  2. second input: intermediate goods (can be imported)
- model is estimated with data for $N = 19$ OECD countries
  - extended to other samples in recent papers
- the calibrated model can be used to simulate alternative scenarios and compute:
  - welfare effect of moving to autarky (realized GFT)
  - welfare effect of moving to free trade (potential GFT)
  - welfare effect of technology improvements in one country

Trade Volumes and Distance

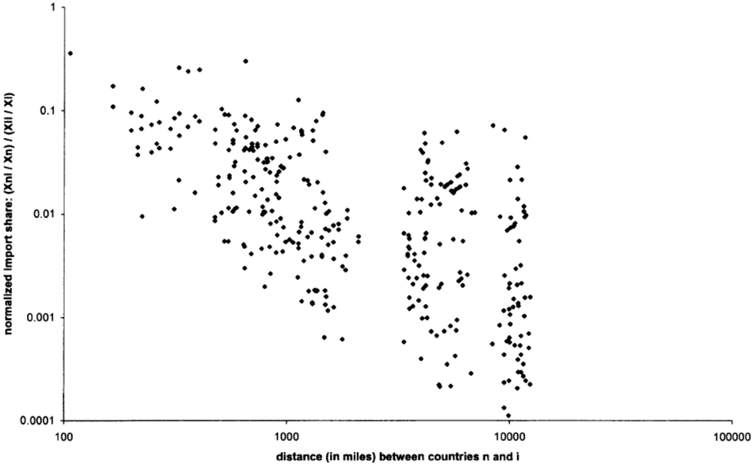


FIGURE 1.—Trade and geography.

Technology Differences

TABLE VI

STATES OF TECHNOLOGY

Country	Estimated Source-country Competitiveness	Implied States of Technology $\theta = 8.28$	$\theta = 3.60$	$\theta = 12.86$
Australia	0.19	0.27	0.36	0.20
Austria	−1.16	0.26	0.30	0.23
Belgium	−3.34	0.24	0.22	0.26
Canada	0.41	0.46	0.47	0.46
Denmark	−1.75	0.35	0.32	0.38
Finland	−0.52	0.45	0.41	0.50
France	1.28	0.64	0.60	0.69
Germany	2.35	0.81	0.75	0.86
Greece	−2.81	0.07	0.14	0.04
Italy	1.78	0.50	0.57	0.45
Japan	4.20	0.89	0.97	0.81
Netherlands	−2.19	0.30	0.28	0.32
New Zealand	−1.20	0.12	0.22	0.07
Norway	−1.35	0.43	0.37	0.50
Portugal	−1.57	0.04	0.13	0.01
Spain	0.30	0.21	0.33	0.14
Sweden	0.01	0.51	0.47	0.57
United Kingdom	1.37	0.49	0.53	0.44
United States	3.98	1.00	1.00	1.00

Notes: The estimates of source-country competitiveness are the same as those shown in Table III. For an estimated parameter $\widehat{S}_i$, the implied state of technology is $T_i = (e^{\widehat{S}_i} w_i^{\theta})^{\beta}$. States of technology are normalized relative to the U.S. value.

Estimated Gains from Trade

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

Notes: All percentage changes are calculated as $100\ln(x'/x)$ where x' is the outcome under autarky ($d_{ni} \to \infty$ for $n \neq i$) and x is the outcome in the baseline.

Potential Gains from Trade

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

Notes: All percentage changes are calculated as $100\ln(x'/x)$ where x' is the outcome under lower geographic barriers and x is the outcome in the baseline.

Trade and Technology Spillovers

THE BENEFITS OF FOREIGN TECHNOLOGY

	Welfare Consequences of Improved Technology			
	Higher U.S. State of Technology		Higher German State of Technology	
Country	Mobile Labor	Immobile Labor	Mobile Labor	Immobile Labor
Australia	27.1	14.9	12.3	4.4
Austria	9.3	2.9	61.8	5.4
Belgium	13.2	3.0	50.7	4.8
Canada	87.4	19.9	9.3	1.3
Denmark	12.2	6.2	62.5	7.1
Finland	11.3	4.3	37.5	3.0
France	10.1	4.2	39.2	3.0
Germany	9.7	−11.6	100.0	100.0
Greece	14.0	18.3	38.9	8.0
Italy	9.7	3.9	38.4	3.0
Japan	6.6	−0.8	5.9	−0.2
Netherlands	12.8	6.8	63.5	8.3
New Zealand	33.8	13.5	15.6	3.9
Norway	13.2	11.7	43.8	6.1
Portugal	14.3	8.6	39.6	4.7
Spain	9.6	7.0	27.3	3.3
Sweden	12.8	1.1	42.7	2.3
United Kingdom	14.6	0.5	38.3	1.6
United States	100.0	100.0	9.7	1.4

Notes: All numbers are expressed relative to the percentage welfare gain in the country whose technology expands. Based on a counterfactual 20 per cent increase in the state of technology for either the United States or Germany.

EK (2002) and the Gains from Trade: Caveat

- utility (real wage) in EK(2002) can be expressed as:

$$U_n = cA_n \left(\pi_{n,n}\right)^{-1/\theta}$$

  - where c is a constant
- GFT fully summarized by two statistics
  - the share of non-imported goods ($\pi_{n,n}$)
  - the elasticity of trade to distance θ
  - Arkolakis, Costinot & Rodriguez-Clare (2012) show this is true in Armington, Krugman (1980), Melitz (2003)
- for most countries, these GFT are modest
- yet, this formula depends crucially on the assumed distribution:
  - θ allows us to extrapolate the (unobserved) cost of producing domestically the imported goods
  - moreover, estimating θ may be difficult (macro estimates $>$ micro, Simonovska & Waugh 2014)

Costinot, Donaldson & Komunjer (2012), Chor (2010)

- extend the model to study trade *patterns* across *sectors*
  - instead of trade *volumes* across *countries*
- new assumptions:
  1. many sectors (k-index)
     - ★ within each sector $[0, 1]$ continuum of symmetric differentiated varieties
  2. technology:
     - ★ a deterministic component A_n^k (*country* and *industry* specific)
     - ★ plus a random component $a_o^k(j)$ variety-specific $\longrightarrow$ generates within-sector dispersion

Testable Ricardian Predictions

- normalized import share in sector k from country o :

$$\frac{x_{n,o}^k}{x_{n,n}^k} = \left(\frac{A_o^k}{A_n^k} \frac{1}{d_{o,n}^k} \frac{w_n}{w_o} \right)^\theta$$

- if trade costs satisfy $d_{o,n}^k = d_{o,n} \cdot d_n^k$
  - for any two origins o and o^*

$$\frac{A_o^1}{A_{o^*}^1} \leq ... \leq \frac{A_o^K}{A_{o^*}^K} \Longleftrightarrow \frac{x_{n,o}^1}{x_{n,o^*}^1} \leq ... \leq \frac{x_{n,o}^K}{x_{n,o^*}^K}$$

  - country o exports relatively more than country o^* in industries in which it is relatively more productive

- empirical foundation for testing the Ricardian model across industries and countries

Testing the Ricardian Model

Table 3: Cross-Sectional Results - Baseline

Dependent variable:	log (corrected exports)	log (exports)	log (corrected exports)	log (exports)
	(1)	(2)	(3)	(4)
log (productivity based on producer prices)	1.123***	1.361***	6.534***	11.10***
	(0.0994)	(0.103)	(0.708)	(0.981)
Estimation method	OLS	OLS	IV	IV
Exporter x Importer fixed effects	YES	YES	YES	YES
Industry x Importer fixed effects	YES	YES	YES	YES
Observations	5,652	5,652	5,576	5,576
R-squared	0.856	0.844	0.747	0.460

Notes: Regressions estimating equation (17) using data from 21 countries and 13 manufacturing sectors (listed in Table 1) in 1997. 'Exports' is the value of bilateral exports from the exporting country to the importing country in a given industry. 'Corrected exports' is 'exports' divided by the share of the exporting country's total expenditure in the given industry that is sourced domestically (equal to one minus the country and industry's import penetration ratio). 'Productivity based on producer prices' is the inverse of the average producer price in an exporter-industry. Columns 3 and 4 use the log of 1997 R&D expenditure as an instrument for productivity. Data sources and construction are described in full in Section 4.1. Heteroskedasticity-robust standard errors are reported in parentheses. *** indicates statistically significantly different from zero at the 1% level.

Macro Application 1: Global Imbalances

- current account (in 2011):
  - net exports + net transfers + net factor income (interest & dividends)

Country	CA in US$ bill.	CA as % GDP
Algeria	19.697	9.955
Argentina	-0.299	-0.067
Australia	-33.522	-2.254
Austria	8.147	1.947
Brazil	-52.48	-2.105
Canada	-48.906	-2.812
Chile	-3.222	-1.297
China	201.72	2.764
Colombia	-9.978	-3.046
Denmark	22.178	6.68
Egypt	-6.088	-2.583
Finland	-3.124	-1.186
France	-54.169	-1.95
Germany	203.929	5.653
Greece	-29.353	-9.808
Hong Kong	12.908	5.297
India	-62.756	-3.435
Ireland	2.484	1.123
Israel	1.907	0.783
Italy	-71.67	-3.26

Country	CA in US$ bill.	CA as % GDP
Japan	119.304	2.034
Korea	26.505	2.375
Kuwait	70.8	43.98
Mexico	-11.073	-0.96
Netherlands	70.901	8.46
Norway	70.289	14.48
Pakistan	0.214	0.102
Peru	-3.341	-1.885
Portugal	-15.339	-6.449
Russia	98.834	5.341
Singapore	56.989	21.932
Spain	-52.174	-3.526
Sweden	37.73	6.927
Switzerland	69.538	10.524
Thailand	11.87	3.434
Turkey	-77.141	-9.962
United Kingdom	-46.578	-1.916
United States	-465.928	-3.091
Uruguay	-1.442	-3.087
Venezuela	27.205	8.597

Global Imbalances

- key questions:
  - what are the real effects of global imbalances?
  - what are the wage implications of eliminating them?
- assume China (*) makes a transfer T to the US:
  - recall
$$\omega = A(z) \quad \text{and} \quad \omega = B\left(z, \frac{L^*}{L}\right)$$
  - technology, $A(z)$, is unchanged
  - $B(z, L^*/L)$ is unchanged too, because China and US spend the transfer in the same way:
$$T = \overbrace{(1-\theta)(wL+T)}^{\text{US import}} - \overbrace{\theta(w^*L^*-T)}^{\text{US export}} \rightarrow \omega = \frac{L^*}{L}\frac{\theta(z)}{1-\theta(z)}$$
  - result: no effect on ω and z

Global Imbalances with Non-Traded Goods

- different results with a home bias in consumption (non-traded goods)
  - assume that a fraction $k < 1$ of income is spent on traded goods
  - transfer must be in tradeables
  - trade imbalance condition:

$$T = \overbrace{(1-\theta)\,k\,(wL+T)}^{\text{US import}} - \overbrace{\theta k\,(w^{*}L^{*}-T)}^{\text{US export}}$$

  - normalizing $w^{*} = 1$ and rearranging:

$$wL = \frac{1-k}{k\,(1-\theta)}T + \frac{\theta}{1-\theta}L^{*}$$

- a transfer increases home demand for labor and its relative wage
  - due to home bias, the location of demand matters
  - with a higher w home specializes in fewer sectors

Quantification: Global Imbalances with Non-Traded Goods

- Dekle, Eaton & Kortum (2007):
  - use a 42-country quantitative Ricardian model
  - compute the wage adjustment of eliminating trade imbalances:

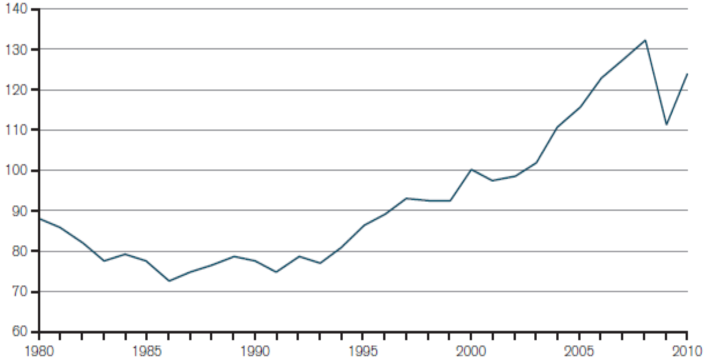
TABLE 3—CONSEQUENCES OF CURRENT ACCOUNT BALANCE

	Implied change in		
	Wage	Real wage	Welfare
China/Hong Kong	1.025	1.001	1.043
Germany	1.031	1.002	1.042
Japan	1.037	1.001	1.039
United States	0.932	0.995	0.941

  - less than +4% in China, Germany, or Japan (surplus countries)
  - 7% decline in US
  - real wages change much less
- Dekle, Eaton & Kortum (2008):
  - larger wage adjustments if factor mobility between sectors is lower

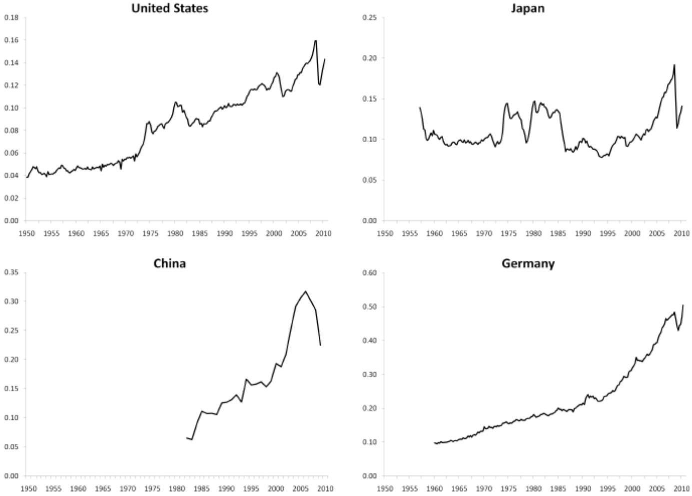
Macro Application 2: Trade Over The Great Recession

- Export/GDP



  - global trade fell 30 percent relative to GDP during the Great Recession of 2008-2009

Export/GDP: Selected Countries



Explaining the Trade Collapse

- proposed explanations:
  - resurge of protectionism
  - constraints to trade credit (following the financial crisis)
  - fall in productivity
  - demand effects:
    - ★ shift in demand away from manufactures and durables
    - ★ durables are traded more than non-durables
- Eaton, Kortum, Neiman & Romalis (2011):
  - use a quantitative model of trade to decompose the fall in trade/GDP
    - ★ the decline in demand explains 80% (64% due to durables)
  - different findings with data from the Great Depression
    - ★ dramatic increase in US trade frictions in early 1930s

The Model and the Shocks

- key ingredients
  - 22 countries (75% of world trade) + 1 ROW
  - data on input-output structure, production and exports
  - 3 macro sectors, $j \in \{N, D, S\}$:
    - nondurable, durables, services
- four types of shocks:
  1. shocks to sector j's share in the final spending of country i
     - e.g., consumers putting off buying cars or firms postponing investment
  2. shocks to the frictions in exporting goods of type j from i to n
     - e.g., tariff increases, "Buy America" provision, lack of trade credit
  3. shocks to country i's productivity in sector j
  4. changes in country i's trade deficits

The Role of Trade Frictions

- recall:

$$\frac{x_{n,o}}{x_{n,n}} = \frac{\pi_{n,o}}{\pi_{n,n}} = \left(\frac{A_o}{A_n} \frac{1}{d_{o,n}} \frac{w_n}{w_o} \right)^{\theta}$$

- Head-Ries Index:

$$\frac{x_{n,o}}{x_{n,n}} \cdot \frac{x_{o,n}}{x_{o,o}} = \left(d_{o,n} \cdot d_{n,o} \right)^{-\theta}$$

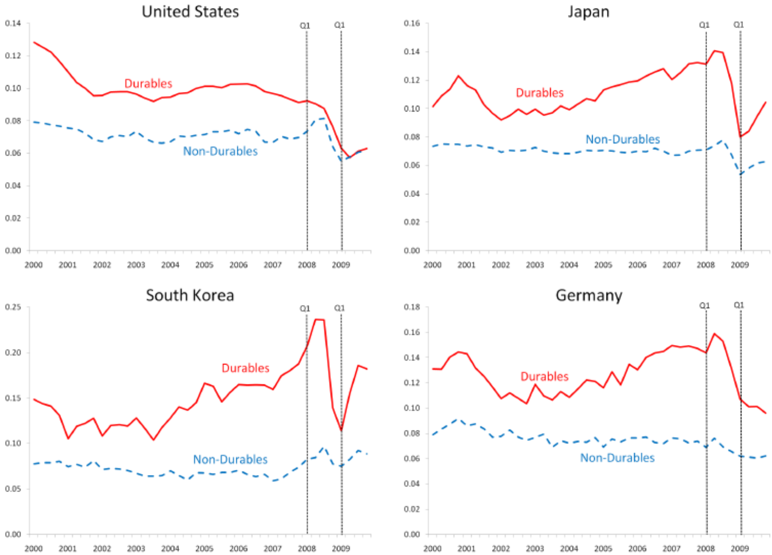
  - extracts (inversely) the pure trade friction component of the gravity equation
  - holds in more general models consistent with gravity
  - easily computed with bilateral trade data

- if trade frictions increase $\rightarrow$ the index should fall

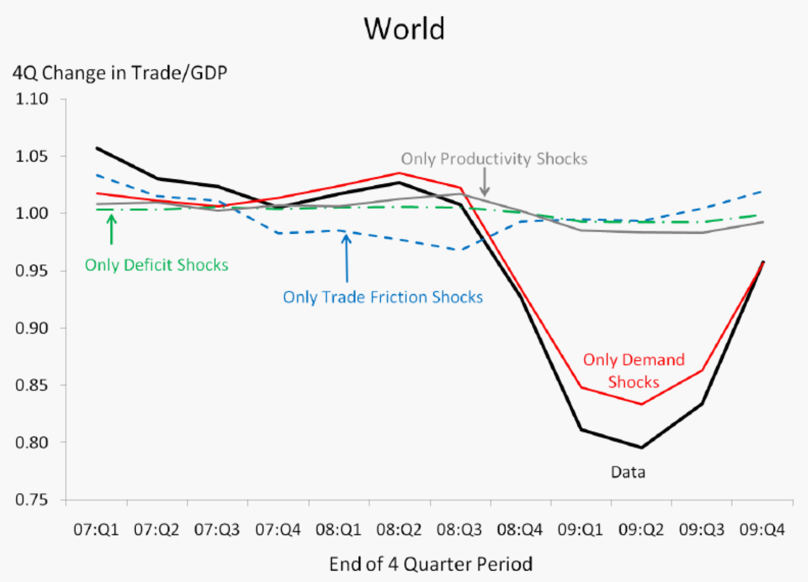
Head-Ries Indexes

- no clear fall of the HR index during the Great Recession

Shares of Manufacturing in Final Demand



Trade and the Global Recession: Results



Further Readings

- Bernard, Eaton, Jensen & Kortum (2003):
  - add firm heterogeneity and imperfect competition
  - the model explains why only the most productive firms export
- Alvarez & Lucas (2007):
  - more technical results, better solution algorithm
- Fieler (2011):
  - extend calibration to LDCs, add non-homothetic preferences
- Caliendo & Parro (2012):
  - welfare effect of NAFTA
- Levchenko & Zhang (2013):
  - evolution of comparative advantage over time

What Did We Learn?

- technological heterogeneity is at the core of Ricardian models:
  - modeling productivity as random draws $\longrightarrow$ summarize technological heterogeneity with the parameters of a probability distribution
  - useful to build tractable multi-country models
- productivity is an important determinant of trade flows
- trade flows can be used to estimate the state of technology across countries (and sectors)
- some lessons from quantitative Ricardian models:
  - realized GFT may be small, but large potential gains yet to be realized
  - country interdependence is strongly mediated by distance
- macro applications
  - trade is pro-cyclical
  - rebalancing $\longrightarrow$ wage reductions in deficit countries