International Trade: Lecture 6

Empirics of Comparative Advantage

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Testing the Ricardian Model

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- But very little has been done to confront its predictions with the data
- Challenge (i): autarky productivities and prices are unobserved
- If we assume productivities are fixed, we can "infer" autarky prices as function of technology and tastes
- Is that trivial?
- Challenge (ii): for a long time, the Ricardian model was purely bilateral
  (changes with Eaton-Kortum, but that we do not cover it)

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- Question: can the most important mechanism be right?

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- With 2 countries in the world (UK an USA) then each country will:
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- With 2 countries in the world (UK an USA) then each country will:
  “export those goods for which the ratio of its output per worker to that of the other country exceeds the ratio of its money wage rate to that of the other country.”
- lots relative labor productivities (US:UK) against relative exports to the entire world (US:UK)
  - 2×2 Ricardian intuition suggests that this should be upward-sloping.
  - Nothing about how much a country will export.

MacDougall's chart

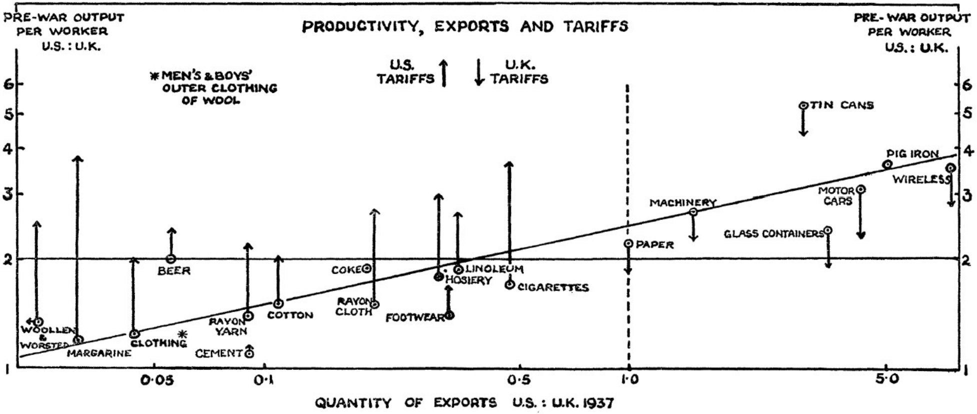

Fig. 1.

Figure: Source: MacDougall (1951)

...then replicated other times

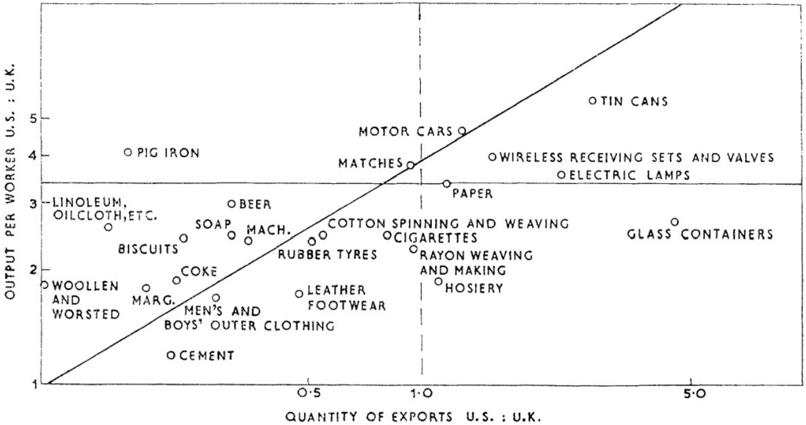

Fig. 1. Scatter diagram of American and British ratios of output per worker and quantity of exports, 1950.

Figure: Source: Stern (1962)

Tying the model to the data

- Question: which country has a comparative advantage in good g if $\frac{w_H}{w_F} \leq \frac{a_{F,g}}{a_{H,g}}$?

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- Production only if cheaper to produce domestically than to import goods, i.e.:

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- Countries are expected to export goods in which they have high productivity (low unit labor requirements)

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- Golub and Hsieh (2000) take this approach to test the Ricardian theory
- Recall we are expanding from the bilateral Ricardian model, so we are comparing two countries: i and j.
- Then we could run the following regressions to test predictions:

$$
\begin{aligned}
\ln\left(\frac{X_i^k}{X_j^k}\right) &= \alpha_1 + \beta_1 \ln\left(\frac{a_j^k}{a_i^k}\right) + \varepsilon_1^k \\
\ln\left(\frac{X_{i\to j}^k}{X_{j\to i}^k}\right) &= \alpha_2 + \beta_2 \ln\left(\frac{a_j^k}{a_i^k}\right) + \varepsilon_2^k
\end{aligned}
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where X_i^k are total exports of good k in country i; and $X_{i\to j}^k$ are bilateral exports from i to j.

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- In which does it differ importantly from the theory?
- The intuition of the Ricardian model suggests that $\beta_1 > 0$ and $\beta_2 > 0$.
  (countries should export goods they are most productive in)
- But we are extrapolating from a 2x2 model to multicountry data; no obvious way to interpret the results.
  (model predicts *full specialization*)

Results are consistent with the Ricardian intuition

Table 2. Relative Exports[a] and Relative Productivity[b], for 39 Manufacturing Sectors

		Unadjusted		ICP PPP		ICOP PPP	
	Period	β_{jk}	R^2	β_{jk}	R^2	β_{jk}	R^2
US–Japan	84–90	0.33	0.22	0.31	0.20	0.30	0.18
		(3.03)[c]		(2.96)[c]		(2.80)[c]	
US–Germany	77–91	0.18	0.08	0.15	0.07	0.15	0.05
		(4.28)[c]		(3.55)[c]		(3.80)[c]	
US–UK	79–91	0.09	0.03	0.07	0.02	0.23	0.12
		(2.78)[c]		(2.45)[c]		(4.48)[c]	
US–France	78–91	–0.19	0.03	–0.24	0.06	0.09	0.03
		(–3.50)[d]		(–3.92)[d]		(1.96)[c]	
US–Italy	78–91	0.36	0.09	0.37	0.13	—	—
		(5.48)[c]		(6.25)[c]			
US–Canada	72–90	0.21	0.01	0.27	0.04	—	—
		(5.29)[c]		(6.26)[c]			
US–Australia	81–91	0.16	0.04	0.31	0.10	—	—
		(2.27)[c]		(3.52)[c]			

Note: $\log(X_{ij}/X_{ik}) = \alpha_{jk_1} + \beta_{jk_1}\log(a_{ik}/a_{ij})_{-1} + \varepsilon_{ijk_1}$ estimated by seemingly unrelated regressions. *t*-statistics in parentheses, calculated from heteroskedasticity-consistent (White) standard errors.
[a] Log of US divided by other country exports.
[b] Log of US relative to other productivity.
[c] The coefficient is significant at 1% level with the correct sign.
[d] The coefficient is significant at 1% level with incorrect sign.

Figure: Source: Golub and Hsieh (2000)

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Table 4. Bilateral Trade Balances[a] *and Relative Productivity*[b], *for 21 Manufacturing Sectors*

		Unadjusted		ICP PPP		ICOP PPP	
	Period	b_{jk}	R^2	b_{jk}	R^2	b_{jk}	R^2
US–Japan	84–91	0.14	0.09	0.20	0.10	0.43	0.25
		(2.07)[c]		(2.68)[c]		(2.99)[c]	
US–Germany	77–90	0.46	0.06	0.83	0.11	0.07	0.05
		(8.71)[c]		(17.03)[c]		(1.32)	
US–UK	79–90	–0.08	0.03	–0.02	0.02	–0.01	0.02
		(–2.93)[d]		(–1.41)		(–.06)	
US–France	78–90	–0.21	0.02	0.02	0.02	0.05	0.02
		(–7.97)[d]		(0.52)		(2.70)[c]	
US–Italy	79–89	0.26	0.11	0.25	0.01	—	—
		(7.11)[c]		(7.55)[c]			
US–Canada	72–89	0.41	0.02	0.73	0.01	—	—
		(37.44)[c]		(77.15)[c]			
US–Australia	81–91	0.72	0.05	0.89	0.10	—	—
		(5.75)[c]		(7.13)[c]			
US–Korea	72–90	–0.64	0.02	–0.12	0.02	0.93	0.18
		(–11.17)[d]		(–6.71)[d]		(36.88)[c]	
US–Mexico	80–90	0.46	0.14	0.31	0.10	0.56	0.18
		(6.12)[c]		(4.21)[c]		(7.50)[c]	

Note: $\log(X_{ijk}/M_{ijk}) = \alpha_{jk_3} + \beta_{jk_3}\log(a_{ik}/a_{ij})_{-1} + \varepsilon_{ijk_3}$ estimated by seemingly unrelated regressions. *t*-statistics in parentheses, based on heteroskedasticity-consistent (White) standard errors.

[a] Log of the ratio of bilateral exports to bilateral imports.

[b] Log of US relative to other productivity.

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  - PPP exchange rates used instead
  - Think of this as “Big Mac index”

Big Mac Index

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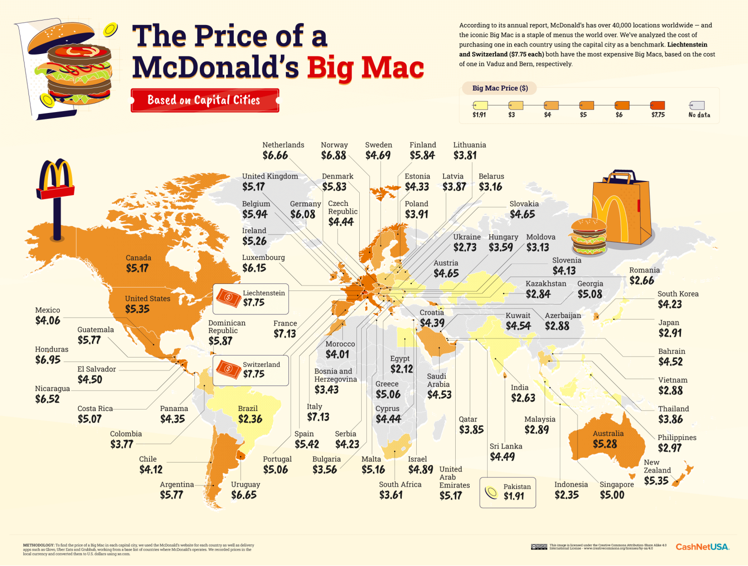
- If a Big Macs could be teleported to the point of sale, they would be produced in the place where they are cheapest
- Why do prices differ
  - Labor is not mobile across countries
  - Other factors of production (rent) are immobile
  - You cannot ship a burger long distance

Big Mac Index



Balassa Samuelson Effect

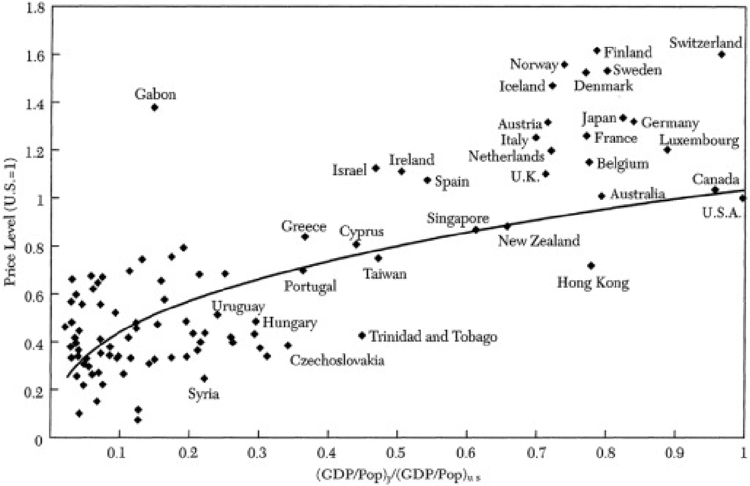


Figure: Balassa Samuelson Effect: Goods and Services are more expensive in richer countries (Rogoff, 1996)

Purchasing Power Parity

- Prices are sistematically higher in richer countries:
  - Nontradables reflect domestic wages and technology
  - Service economy (largely nontradable) more important

- World Bank's International Comparison Program collects data on prices for many goods across countries to create benchmarks

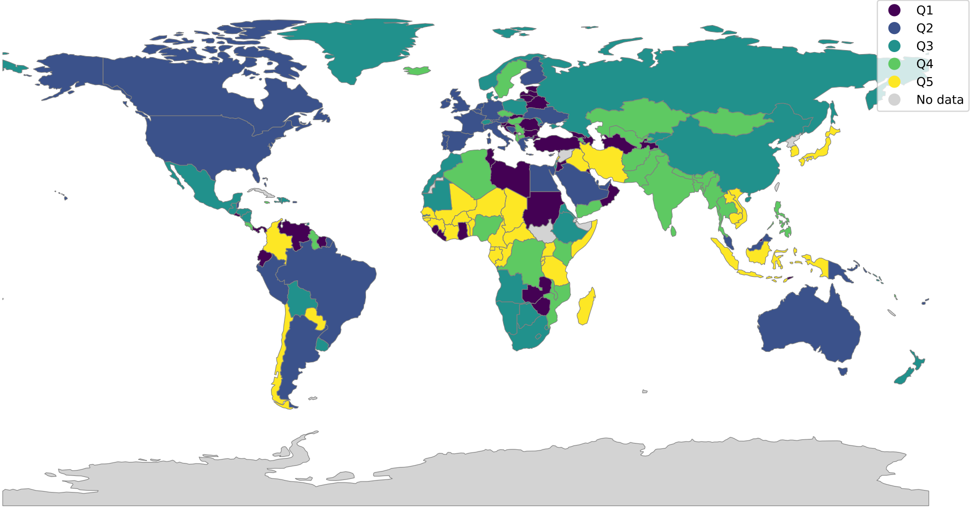
- Output: How much is a dollar worth in each country (US is the benchmark)

- When comparing productivities and incomes, economists often adjust for overall price levels

- Intuition:
  - Inflation adjustment corrects for price differences across time (e.g., 1960 USD vs 2025 USD)
  - PPP adjustment corrects for price differences across space (same USD buys more goods and services in Brazil vs US)

Differences in prices across the world

PPP Conversion Factor Quintiles (2000)



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  - Only modern papers that came out after Eaton Kortum (2002) were able to do that

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- There are two main problems with all of the papers we have seen so far
- First, none of them rely on a true multi-country model to know what to test
  - Only modern papers that came out after Eaton Kortum (2002) were able to do that
- Second, they do not deal with the selection effect:
  - Don't observe the productivity of goods that a country does not produce
  - Only observe productivity of goods productive enough to be produced

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$$\tilde{a}_i^k \equiv \frac{1}{N_G} \sum_g a_i^k(g) \qquad \text{for } g \leq G$$

- In general $\tilde{a}_i^k \leq \bar{a}_i^k$, since these are by definition the most productive products

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- They show, under some assumptions, we can map unobserved productivities to observed productivities

- Specifically, they show:

$$\underbrace{\frac{\tilde{a}_i^k}{\tilde{a}_j^k}}_{\text{observed}} = \underbrace{\frac{\bar{a}_i^k}{\bar{a}_j^k}}_{\text{unobserved}} \times \underbrace{\left(\frac{1 - \text{Import Share}_i^k}{1 - \text{Import Share}_j^k}\right)^{\theta}}_{\text{observed}}$$

Intuition: more open economies (higher import shares) are able to avoid using their low productivity for some goods by importing these varieties.

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$$\ln\left(\frac{X_{i\to j}^{k}}{1-\text{Import Share}_{i}^{k}}\right)=\delta_{ij}+\delta_{i}^{k}-\theta\ln\tilde{a}_{i}^{k}+\varepsilon_{ij}^{k}$$

where:

- $X_{i\to j}^{k}$ are exports from *i* to *j* in industry *k*
- $\tilde{a}_{i}^{k}$ is the observed unit labor requirement
- $\delta_{ij},\delta_{i}^{k}$ are bilateral and industry-source specific coefficients, that adjust for differences in pair-relationship (say, former colony) and industry characteristics (say, manufacturing vs services)

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  - They have written a multi-country multi-sector Ricardian model and derived predictions;
  - They found a way to overcome the selection issue of non-observed productivities

- They estimate the following equation:

$$\ln\left(\frac{X^k_{i\to j}}{1-\text{Import Share}^k_i}\right) = \delta_{ij} + \delta^k_i - \theta \ln \tilde{a}^k_i + \varepsilon^k_{ij}$$

  where:
  - $X^k_{i\to j}$ are exports from *i* to *j* in industry *k*
  - $\tilde{a}^k_i$ is the observed unit labor requirement
  - δ_{ij}, δ^k_i are bilateral and industry-source specific coefficients, that adjust for differences in pair-relationship (say, former colony) and industry characteristics (say, manufacturing vs services)

- We expect $\theta > 0$

Results are consistent with the Ricardian predictions

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 × importer fixed effects	YES	YES	YES	YES
Industry × importer fixed effects	YES	YES	YES	YES
Observations	5652	5652	5576	5576
R^2	0·856	0·844	0·747	0·460

Notes: Regressions estimating equation (18) 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 IPR). "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. ***Statistically significant different from zero at the 1% level.

Figure: Source: Costinot, Donaldson and Komunjer (2012)

Results are consistent with the Ricardian predictions

TABLE 4
Cross-sectional results—alternative productivity measures

Dependent variable in all regressions: corrected exports				
	(1)	(2)	(3)	(4)
log(productivity based on producer prices)	6·534*** (0·708)			
log(productivity based on producer prices, dual TFP measure)		6·704*** (0·874)		
log(productivity based on real gross output per worker)			2·725*** (0·234)	
log(productivity based on real gross output, primal TFP measure)				4·316*** (0·504)
Observations	5576	5576	5576	4541
R^2	0·747	0·587	0·839	0·835

Notes: Regressions are based on estimating equation (18) using data from 21 countries and 13 manufacturing sectors (listed in Table 1) in 1997. All regressions estimated use the log of 1997 R&D expenditure as an instrument for the productivity measure and with exporter-times-importer and industry-times-importer fixed effects included. "Corrected exports" is the value of bilateral 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 IPR). "Productivity based on producer prices" is the inverse of the average producer price in an exporter–industry. "Productivity based on producer prices, dual TFP measure" is the inverse of the average producer price divided by an income share-weighted composite of producer input prices (wages, capital rental rates, and intermediate inputs), as defined in footnote 24. "Productivity based on real gross output per worker" is a nominal measure of gross output, deflated by average gross output producer price indices. "Productivity based on real gross output, primal TFP measure" is the nominal value of gross output deflated by a producer gross output price index, divided by an income share-weighted composite of input values deflated by input price indices, as defined in footnote 26. Data sources and construction are described in full in Section 4.1. Heteroskedasticity-robust standard errors are reported in parentheses. ***Statistically significantly different from zero at the 1% level.

Figure: Source: Costinot, Donaldson and Komunjer (2012)

Takeaways

- We walked through the empirics of comparative advantage
- For the last 75 years, early and recent tests have confirmed important Ricardian intuitions
- More rigorous tests only happened surprisingly late
- Good example of theory + empirics being interdependent
- It was hard to reliably test the theory while it was underdeveloped