
Ricardo Lives On

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Samuel Kortum
Yale University

Collaboration

- Jonathan Eaton and I met at Boston University when I arrived as an assistant professor in 1991
- We've been working together ever since
- Our collaboration was built on *comparative advantage*
 - Eaton: general-equilibrium reasoning, international economics
 - Kortum: probabilistic reasoning, technological change
 - these differences faded, but we learned to listen to each other

Trade in Ideas

- We began with the issues in Eaton's Lecture, innovation and international diffusion of new technology
- We arrived at a probabilistic formulation for the labour $a_i(j)$ needed by a country i to produce a good j

$$\Pr[a_i(j) \geq a] = e^{-T_i a^\theta}$$

More on that later ... the point is we ignored trade in goods

Trade in Goods

- One day we asked: What's the probability that country i is the cheapest source of a good j ? (given wages $\{w_k\}$)
- That moment at the chalk board is a vivid memory
... the answer got our attention!

$$\Pr[\arg \min_k \{a_k(j)w_k\} = i] = \frac{T_i w_i^{-\theta}}{\sum_k T_k w_k^{-\theta}}$$

Why Ricardo?

- As we processed this result we came to appreciate its intimate link to Ricardo's Trade Theory
 - allowing for many goods and any number of countries
 - crucial for quantitative applications
- Since it's the 201st birthday of his work, let's see what Ricardo wrote, and what was left to fill in

Ricardo on Wages

The labour of 100 Englishmen cannot be given for that of 80 Englishmen, but the produce of 100 Englishmen may be given for the produce of the labor of 80 Portuguese, 60 Russians, or 120 East Indians.

Ricardo (1817, page 141)

Translate: vector of relative wages

$$w = \left(1, \frac{100}{80}, \frac{100}{60}, \frac{100}{120} \right)$$

Ricardo's Example

	Relative	Labour Requirements	
	Wage	Cloth	Wine
England	1	100	120
Portugal	100/80	90	80
Russia	100/60		
East India	100/120		

Labor-requirement columns aren't proportional

- indicates comparative advantage
- England's cheaper for cloth and Portugal for wine
- countries specialize in producing a single good

Expanding Ricardo's Example

	Relative	Labour Requirements		
	Wage	Cloth	Wine	Aircraft ...
England	1	100	120	$a_1(3) \dots$
Portugal	100/80	90	80	$a_2(3) \dots$
Russia	100/60	$a_3(1)$	$a_3(2)$	$a_3(3) \dots$
East India	100/120	$a_4(1)$	$a_4(2)$	$a_4(3) \dots$
China	w_5	$a_5(1)$	$a_5(2)$	$a_5(3) \dots$
•	•	•	•	•
•	•	•	•	•
•	•	•	•	•

Challenge

- Expanding Ricardo this way kills the parsimony
- It becomes a morass of numbers, countless a's
- And the solution is a bunch of knife edges
 - due to the tendency for specialization

Probability to the Rescue

- Return to our probability distribution

$$\Pr[a_i(j) \geq a] = e^{-T_i a^\theta}$$

- Higher T_i means (typically) lower labour requirements for country i to produce anything: *absolute advantage*!
- Lower θ means more variability in labour requirements (columns less parallel): *comparative advantage*!
- Whose comparative advantage? As if random

Why that Distribution?

- Innovation leads to an *extreme value distribution*, as breakthroughs are prized and failures discarded
- Such distributions take only three forms
- We chose the one that's scale free
 - scope for comparative advantage remains intact as countries grow

What Did We Get?

- Our formulation keeps Ricardo's concept of comparative advantage front and center
- Also smooths out the sharp edges in high dimensions
- The probability that country n purchases a particular good from country i (incorporating iceberg trade costs d_{ni})

$$\pi_{ni} = \frac{T_i (w_i d_{ni})^{-\theta}}{\sum_k T_k (w_k d_{nk})^{-\theta}}$$

What Does it Deliver?

- With many goods, the π_{ni} 's become trade shares, the fraction of country n 's spending directed to goods produced in i
- This framework can match data on trade flows between any number of countries
- ... connecting the Gravity Model of bilateral trade to the equilibrium foundations of classical Ricardian Trade Theory

It Turned out to be Versatile

1. **Firms and Imperfect Competition:** our work with Andrew Bernard and Brad Jensen
2. **Trade and Productivity:** Arnaud Costinot, Dave Donaldson, and Ivana Komunjer
3. **Trade and FDI:** Natalia Ramondo and Andrés Rodríguez-Clare; Felix Tintelnot
4. **Tariffs and NAFTA:** Lorenzo Caliendo and Fernando Parro
5. **Railroads in an Agrarian Economy:** Donaldson; Donaldson and Richard Hornbeck
6. **Trade and Labor Markets:** Caliendo, Maximiliano Dvorkin, and Parro
7. **Supply chains:** Pol Antràs and Alonso de Gortari; Antràs, Teresa Fort, and Tintelnot
8. **Economic Geography of a City:** Gabriel Ahlfedlt, Stephen Redding, Daniel Sturm, and Nikolaus Wolf; Stephan Heblich, Redding and Sturm
9. **Heckscher-Ohlin Factors:** Ariel Burstein and Jonathan Vogel; Serge Shiker
10. **Transport Networks:** Treb Allen and Costas Arkolakis
11. **Firm-to-Firm Networks:** our work with Francis Kramarz ...

What Next?

- Most basic to this talk and to Jonathan's
- Fully integrate trade in goods with trade in ideas
- That's our holy grail