BUSN 33946 & ECON 35101
International Macroeconomics and Trade

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Outline of today

- Course logistics
- Why trade is interesting
- Neoclassical model's assumptions
- Gains from trade and comparative advantage
- Empirical evidence from Japan

Logistics

- Mondays, 8:30–11:30 on Zoom, ten weeks (skip Nov 23)
- Jonathan Dingel
  - Email: jdingel@chicagobooth.edu
  - Zoom office hours: By appointment, please email
- Teaching assistant: Takashi Onoda (onoda@uchicago.edu)
- Course materials: github.com/jdingel/econ35101 and canvas.uchicago.edu

Also relevant: PhD trade working group, Wednesdays 11:00

Assessment

My goal is to introduce the fundamental concepts and tools of international trade and economic geography so that you can tackle relevant research questions

- Grades will be based on comprehension checks (15%), assignments (60%), and a final exam (25%).
- Comprehension checks should be easy if you do assigned readings
- Three types of assignments
  - Economics: Derive a theoretical result or survey an empirical literature.
  - Programming: Write a function that solves for equilibrium or estimates a parameter. (n.b. Julia)
  - Referee report: Assess a recent working paper.
- Let's discuss final-exam choices

Grab comprehension checks and assignments from GitHub. Submit your work via the Canvas site.

Topics

1. Gains from trade and comparative advantage
2. Deterministic Ricardian models
3. Probabilistic Ricardian models
4. Gravity and gains from trade
5. Multiple factors of production
6. Increasing returns and home-market effects
7. Heterogeneous firms
8. Models of agglomeration
9. Economic geography
10. Spatial sorting of skills and sectors

See my comments on "Linkages between international trade and urban economics"

Course sequence

- This course is one of three in the Trade & Growth field
- Ufuk Akcigit's Firm Dynamics and Economic Growth
- Felix Tintelnot's Topics in International Trade and Growth assumes you've masted the material from this class

Why trade is interesting

- International trade has long intellectual history (Smith, Ricardo) and is hot policy topic today (Brexit, Trump)
- Healthy balance of theory and empirics (c.f. theory-dominated from 1817 to 1990s) in which each informs the other
- International trade has tools and insights relevant for topics ranging from intracity commuting patterns to national TFP growth
- Trade economists sometimes have a data advantage because governments track cross-border transactions

Why are you interested in trade?

Trade's interplay between theory and empirics

Facts motivate theoretical work

- Observed intra-industry trade motivated "new trade theory" (e.g., Krugman 1980)
- Observed firm-level heterogeneity motivated "new new trade theory" (e.g., Melitz 2003)

Empirical evidence comes from wide range of methods

- Descriptive statistics and simple tests
- Quasi-natural experiments (rare, but see Japanese autarky, Suez Canal, the telegraph, etc)
- Estimated structural models
- Quantitative exercises employing calibrated models
- Applications employing sufficient statistics

Trade's interplay between theory and empirics

Even if not structural, empirical trade is typically theory-driven

- Famous mistakes in which empirical work didn't take theory seriously enough
- General-equilibrium predictions often differ from partial-equilibrium predictions

"How do you do general-equilibrium empirics?" will be one motif we repeatedly visit.

See Harrigan (2001) on "Do the Data Obey the Laws?"

- Long-running difficulties with what it means to "test" a trade model. Is there a clearly specified alternative hypothesis?
- Specifications haven't always isolated the distinct general-equilibrium prediction (relative to PE)

International trade theory

- Any GE model has preferences + technology + equilibrium
- International trade theory focuses on locations, such that preferences (rarely) and technology (typically) are location-specific
- Trade theory traditionally has "international" goods markets and "domestic" factor markets
- Consumers have preferences over goods; factors are employed to produce goods
- How does international integration affect the goods market, the factor market, and welfare?

Neoclassical trade models

- "Neoclassical trade models" are characterized by three key assumptions:
  - perfect competition
  - constant returns to scale
  - no distortions
- Can accommodate decreasing returns to scale (DRS) using "hidden" factors in fixed supply; IRS is "new trade theory"
- Given the generality of these assumptions, we won't obtain a wealth of results, but we can obtain two canonical insights:
  - gains from trade (Samuelson 1939)
  - law of comparative advantage (Deardorff 1980)

Neoclassical environment

- There are $n = 1, ..., N$ countries, each populated by $h = 1, ..., H_n$ households
- There are $g = 1, ..., G$ goods
  - Output vector in country n: $y^n \equiv (y_1^n, ..., y_G^n)$
  - Consumption vector of household h in country n: $c^{nh} \equiv \left(c_1^{nh}, ..., c_G^{nh}\right)$
  - Goods price vector in country n: $p^n \equiv (p_1^n, ..., p_G^n)$
- There are $f = 1, ..., F$ factors in fixed supply
  - The endowment vector in country n: $v^n \equiv (v_1^n, ..., v_F^n)$
  - The factor price vector in country n: $w^n \equiv (w_1^n, ..., w_F^n)$

Supply and the revenue function

Revenue function of country n is

$$r^n\left(p^n, v^n\right) = \max_{y^n}\left\{p^n \cdot y^n \middle| \left(y^n, v^n\right) \text{ feasible}\right\}$$

Lots of handy properties in a neoclassical environment (see Dixit & Norman 1980 p.31-36)

- Revenue function summarizes all relevant properties of technology
- Under perfect competition, y^n maximizes r^n
- Derivatives w.r.t. goods prices give supply curves

$$\nabla_p r^n\left(p^n, v^n\right) = y^n\left(p^n, v^n\right)$$

- Derivatives w.r.t endowments give inverse factor demand curves

$$\nabla_v r^n\left(p^n, v^n\right) = w^n\left(p^n, v^n\right)$$

Demand and the expenditure function

Expenditure function for household h in country n with utility function u^{nh} is defined as

$$e^{nh}\left(p^n, u^{nh}\right) = \min_{c^{nh}} \left\{ p^n \cdot c^{nh} |\ u^{nh}\left(c^{nh}\right) \geq u^{nh} \right\}$$

Familiar properties from consumer theory (see Dixit & Norman 1980 p.59-64)

- Optimization implies that $e^{nh}\left(p^n, u^{nh}\right) = p^n \cdot c^{nh}$ so

$$\nabla_p e^{nh}\left(p^n, u^{nh}\right) = c^{nh}\left(p^n, u^{nh}\right)$$

- $e^{nh}\left(p, u\right)$ is increasing in u

Gains from trade (representative household)

- The revealed-preference argument employs only the revenue and expenditure funtions
- Start with case of a single/representative household
- Drop the hn notation; use a to denote autarky vectors

Gains from trade (representative household)

Proposition

In a neoclassical trade model with one representative household per country, all households are (weakly) better off under free trade than autarky

Proof:

$$\begin{aligned} e\left(p, u^a\right) &\leq p \cdot c^a, && \text{by definition of the expenditure function} \\ &= p \cdot y^a, && \text{by market clearing under autarky} \\ &\leq r\left(p, v\right), && \text{by definition of the revenue function} \\ &= e\left(p, u\right), && \text{by budget and trade balance} \end{aligned}$$

Since expenditure is increasing in utility, we conclude that $u \geq u^a$.

- Weak inequalities to accommodate kinks in IC or PPF
- Demonstrating gains from trade relative to autarky does not compare trading equilibria
- Draw the two-good case

Gains from trade (lump-sum transfers)

- With multiple households, trade is likely to generate winners and losers but we can show the winners win more than the losers lose
- Formally, there exist feasible domestic lump-sum transfers that make every household better off under free trade than autarky
- Reintroduce the household superscript notation:
  - c^{ah} and c^h denote the vector of consumptions of household h under autarky and free trade
  - v^h denotes the vector of endowments of household h under autarky and free trade
  - u^{ah} and u^h denote the utility levels of household h under autarky and free trade
  - τ^h denotes the lump-sum transfer (in trade equilibrium) from government to household h (lump-sum tax if negative)

Gains from trade (lump-sum transfers)

Theorem

In a neoclassical trade model with multiple households per country, there exist domestic lump-sum transfers such that all households are (weakly) better off under free trade than autarky.

- Set transfers such that each household can still afford its autarky consumption bundle under free trade

$$\tau^h = (p - p^a) \cdot c^{ah} - (w - w^a) \cdot v^h$$

- These are feasible (government revenue is non-negative)

$$\begin{aligned}
-\sum\nolimits_h \tau^h &= (p^a - p) \cdot \sum\nolimits_h c^{ah} - (w^a - w) \cdot \sum\nolimits_h v^h, \text{ by definition of } \tau^h \\
&= (p^a - p) \cdot y^a - (w^a - w) \cdot v, \text{ market clearing under autarky} \\
&= -p \cdot y^a + w \cdot v, \text{ income equals expenditure under autarky} \\
&\geq -r(p, v) + w \cdot v, \text{ from definition of revenue function} \\
&= 0, \text{ income equals expenditure under free trade}
\end{aligned}$$

Gains from trade (commodity and factor taxation)

- Domestic lump-sum transfers are not typically feasible
- Let government set specific taxes on goods and factors so that, e.g., the price of good g is $p_g^{\text{consumer}} = p_g + \tau_g$
- Set $\tau_g = p_g^a - p_g$ and $\tau_f = w - w_f^a$ so household is indifferent
- Government revenue is positive (similar to above):

$$\begin{aligned} T &= \sum\nolimits_g \tau_g \sum\nolimits_h c_g^{ah} + \sum\nolimits_f \tau_f \sum\nolimits_h v_f^h \\ &= (p^a - p) \cdot \sum_h c^{ah} - (w^a - w) \cdot \sum_h v^h \geq 0 \end{aligned}$$

- Remember that you cannot just rebate the revenue, you need to change a consumer price to achieve the strict improvement (Kemp & Wan *JIE* 1986)
- There's probably a Pareto-improving direction of change in consumer prices in the neighborhood of the autarky price vector (Dixit & Norman *JIE* 1986)

Costinot and Werning (2018) consider more limited set of instruments

Introducing comparative advantage

- "Comparative advantage" – differences in autarkic relative marginal costs – is the basis for trade
- If autarkic relative prices are identical, then "zero trade" is a free-trade equilibrium allocation at those prices
- Theory of comparative advantage (2x2 case): If two countries engage in trade, each will export the good in which it has lower relative marginal cost prior to trade

Law of comparative advantage for free-trade equilibria

Theorem

In a neoclassical trade model with representative households with autarkic and free-trade prices p^{na} and p, $(p - p^{na}) \cdot t^n \geq 0$, where $t^n = y^n - c^n$ is the vector of country n's net exports.

Proof (Deardorff 1980, 1994):

$$
\begin{aligned}
p^{na} \cdot y^n &\leq r\left(p^{na}, v^n\right), && \text{by def of revenue function} \\
p^{na} \cdot c^n &\geq e\left(p^{na}, u^n\right), && \text{by def of expenditure function} \\
p^{na} \cdot t^n &\leq r\left(p^{na}, v^n\right) - e\left(p^{na}, u^n\right), && \text{by previous two inequalities} \\
e\left(p^{na}, u^n\right) &\geq e\left(p^{na}, u^{na}\right), && \text{since } u^n \geq u^{na} \text{ and } \frac{\partial e\left(p, u\right)}{\partial u} \geq 0 \\
p^{na} \cdot t^n &\leq r\left(p^{na}, v^n\right) - e\left(p^{na}, u^{na}\right), && \text{by previous two inequalities} \\
p^{na} \cdot t^n &\leq 0, && \text{since autarkic income equals autarkic expenditure} \\
p \cdot t^n &= 0, && \text{by balanced trade} \\
(p - p^{na}) \cdot t^n &\geq 0, && \text{by combining previous two expressions}
\end{aligned}
$$

Comments on general validity of law of CA

- $(p - p^{na}) \cdot t^n$ is a correlation result because covariance of two vectors is simply their inner product if one of the vectors (i.e., normalized $p - p^{na}$) sums to zero
- $(p - p^{na}) \cdot t^n$ depends on both autarky and free-trade prices
- Corollaries 3 and 4 of Deardorff (1980) state result in terms of only autarkic prices (requires world market-clearing assumption)
- Deardorff (1980) covers the case of costly trade, distinguishing consumer price p^q, producer price p^t, and world price p^w
- Core of the proof is that $p^{na} \cdot t^n \leq 0$: gains from trade mean that consumption is at most barely attainable under autarky ($p^a y^n \leq p^a c^n$)

Deardorff (1980) environment

Notation differs: country i, "natural trade" n, quantity Q

$$(Q^i, T^i) \in F^i \Rightarrow (Q^i + T^i, 0) \in F^i \quad \text{non-negative trade costs} \quad (1)$$

$$\text{local non-satiation} \quad (2)$$

$$(Q^{ai}, 0) \in F^i \quad \text{autarky eqlbm feasible} \quad (3)$$

$$p^{ai}Q^{ai} \geq p^{ai}Q \ \forall (Q, 0) \in F^i \quad \text{profit maximizing} \quad (4)$$

$$U^i(Q^{ai}) \geq U^i(Q) \ \forall Q : p^{ai}Q \leq p^{ai}Q^{ai} \quad \text{utility maximizing} \quad (5)$$

$$(Q^{ni}, T^{ni}) \in F^i \quad \text{trade eqlbm feasible} \quad (6)$$

$$p^{qi}Q^{ni} + p^{ti}T^{ni} \geq p^{qi}Q + p^{ti}T \ \forall (Q, T) \in F^i \quad \text{profit maximizing} \quad (7)$$

$$U^i(Q^{ni}) \geq U^i(Q) \ \forall Q : p^{qi}Q \leq p^{qi}Q^{ni} \quad \text{utility maximizing} \quad (8)$$

$$p^w T^{ni} = 0 \quad \text{balanced trade} \quad (9)$$

$$(p_g^w - p_g^{ti})T_g^{ni} \geq 0 \ \forall g \quad \text{"natural trade"} \quad (10)$$

$$\sum_i T^{ni} = 0 \quad \text{world market clears} \quad (11)$$

How should we take comparative advantage to data?

Canonical 2×2 insight we teach in principles classes isn't amenable to empirical investigation. Now we have a general formulation.

- Good news: "while the classical theory predicts only the direction and not the magnitude of trade, it nonetheless permits one to infer a negative infer a negative correlation between relative costs and net exports" (Deardorff 1980)
- Bad news: "relative antarky prices are not observable. Almost all countries have engaged in trade throughout history, so that there is no experience with autarky from which to draw data." (Deardorff 1984)
- Long-standing approach: Use model with observable primitives (technology and factor endowments) to infer autarkic prices. Joint test of CA and model.

Bernhofen and Brown: Sometimes we observe autarky

- Japan had "sudden and complete opening up to international trade in the 1860s" due to US military
- Bernhofen and Brown use this a natural experiment to test law of comparative advantage
- Key prediction is $p^{na} \cdot t^n \leq 0$, but we never simultaneously observe autarky prices p^a and trade-equilibrium net exports t^n
- "the comparison of autarky with free trade should be understood as a comparison between two alternative histories, not as a change that takes place over time" (Helpman and Krugman 1985)
- If preferences and technology in 1868-1875 (observed trade years) are same as those in 1858, hope that p^a from 1858 is valid measure of p^a for 1868-1875
- Test $p^{na} \cdot t^n \leq 0$ by computing $p^{a,1958} \cdot t^{n,1968}$ (roughly speaking)

Assumptions

- Read Section III of BB (2004) on the assumptions that this is a relevant and valid natural experiment
  1. Competitive economy in autarky
  2. Japanese are price takers in international markets
  3. Exports not subsidized
  4. PPF shifts from 1859 to 1968 not biased toward importables (if $\mathbf{p_2^a} = \mathbf{p_1^a} + \epsilon$, then $\epsilon \mathbf{T} \leq 0$ is sufficient for $\mathbf{p}_1^a \mathbf{T} \leq 0 \Rightarrow \mathbf{p}_2^a \mathbf{T} \leq 0$)
- What is the test of $p^{na} \cdot t^n \leq 0$?
  - Alternative hypothesis H_1: $p^{na} \cdot t^n > 0$
  - Alternative hypothesis H_2: $\Pr\left(p^{na} \cdot t^n \leq 0\right) = \frac{1}{2}$

Correlation of p^a and t in 1969

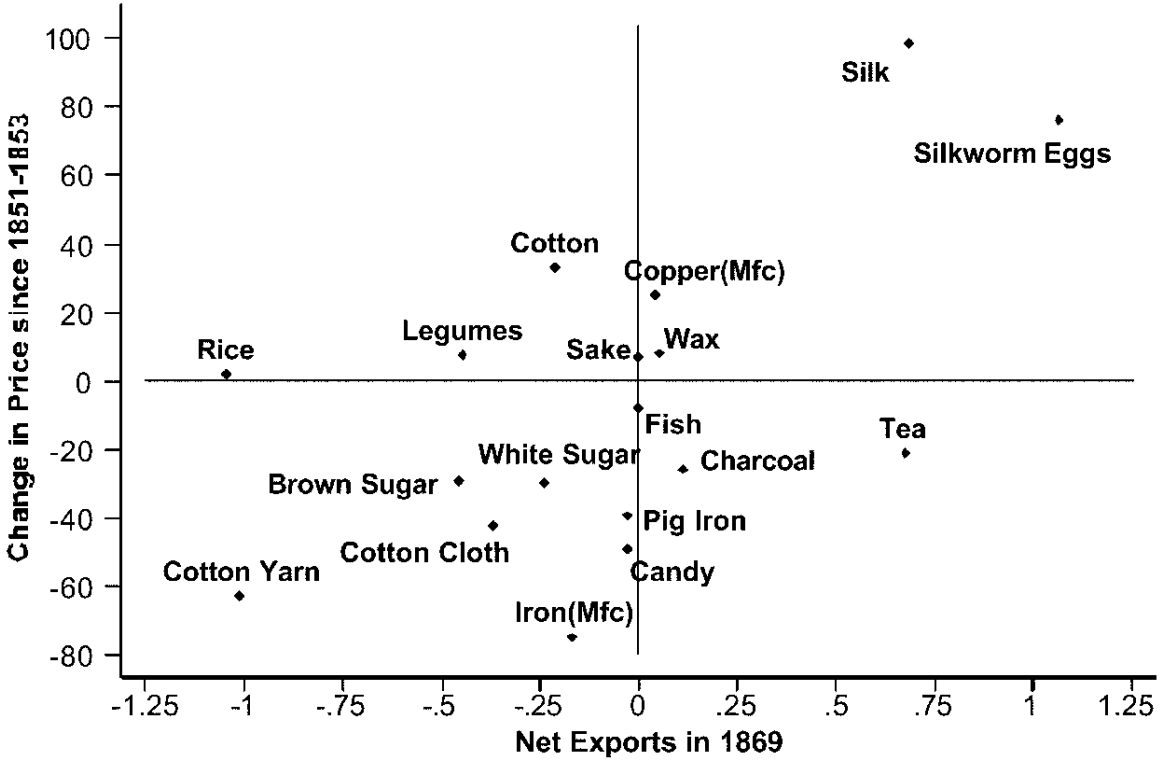

FIG. 4.—Net exports and price changes for 1869. Source: Japan Bureau of Revenue (1893) for trade data and Kinyu Kenkyukai (1937), Miyamoto (1963), Ono (1979), Yamazaki (1983), and Mitsui Bunko (1989) for price data.

Inner product of p^a and t, year by year

TABLE 2
APPROXIMATE INNER PRODUCT IN VARIOUS TEST YEARS (Millions of Ryō)

	YEAR OF NET EXPORT VECTOR							
COMPONENTS	1868	1869	1870	1871	1872	1873	1874	1875
1. Imports with observed autarky prices	−2.24	−4.12	−8.44	−7.00	−5.75	−5.88	−7.15	−7.98
2. Imports of woolen goods	−.98	−.82	−1.29	−1.56	−2.16	−2.50	−1.56	−2.33
3. Imports with approximated autarky prices (Shinbo index)	−1.10	−.95	−.70	−.85	−1.51	−2.08	−1.60	−2.65
4. Exports with observed autarky prices	4.07	3.40	4.04	5.16	4.99	4.08	5.08	4.80
5. Exports with approximated autarky prices (Shinbo index)	.09	.03	.07	.07	.15	.07	.11	.10
Total inner product (sum of rows 1–5)	**−.18**	**−2.47**	**−6.31**	**−4.17**	**−4.28**	**−6.31**	**−5.11**	**−8.06**

SOURCE.—For sources of price data, see Sec. IV*B* and n. 17. For rows 3 and 5, current silver yen values are converted to values of 1851–53 by deflating them with the price indices for exports and imports found in Shinbo (1978, table 5–10).

NOTE.—All values are expressed in terms of millions of ryō. The ryō equaled about $1.00 in 1873 and was equivalent to the yen when it was introduced in 1871. The estimates are of the approximation of the inner product ($\tilde{\mathbf{p}}_i^{a\prime}\mathbf{T}$) valued at autarky prices prevailing in 1851–53. An explanation of the assumptions underlying the approximation is contained in the text.

"The p-value is exactly 1/256, where 1/256 is the probability of obtaining eight heads in eight tosses with a balanced coin."

Comments on Bernhofen and Brown (2004)

- What is the autarky price of a good not produced in autarky?
- Plot of prices changes $p - p^a$ in Figure 4 okay if $p \cdot t = 0$ by balanced trade (check Figure 3)
- What is the power of this test in the absence of a competing theory?
- Computation of p-value assumes independence of observations
- Does $p^a \cdot t$ exhibit a trend?

Gains from trade (Bernhofen and Brown 2005)

How much did (the representative) Japanese consumer gain from opening to trade?

- Measure Slutsky compensation (income increase equivalent to consumption change) to consumers in autarky (1858)

$$\Delta W = p^a_{1858} c^t_{1858} - p^a_{1858} c^a_{1858}$$

[Aside: I didn't use BB's $e(p, c) = p \cdot c$ notation to avoid confusion with expenditure function $e(p, u)$]

- c^t_{1858} is consumption in the counterfactual trade equilibrium
- By WARP and GFT, c^t_{1858} was not affordable in 1858
- ΔW identifies how much more income would have been required to afford c^t_{1858}

GFT in terms of observables

$$
\begin{aligned}
\Delta W &= p^a_{1858} \cdot c^t_{1858} - p^a_{1858} \cdot c^a_{1858} \\
&= p^a_{1858} \cdot (c^t_{1858} - y^t_{1858}) + p^a_{1858} \cdot (y^t_{1858} - y^a_{1858}) \\
&= -p^a_{1858} \cdot t_{1858} - p^a_{1858} \cdot (y^a_{1858} - y^t_{1858}) \\
&\leq -p^a_{1858} \cdot t_{1858}
\end{aligned}
$$

- Inequality by property of revenue function (profit maximization)
- Deardorff-Dixit-Norman inner product is an upper bound on gains from trade (recall role of revealed preference in prior proof)
- Since t_{1858} is counterfactual, it is not observed
- BB (2005) assume counterfactual t_{1858} is observed t_{1868}

An upper bound on 1858 Japan's gains from trade

TABLE 2—CALCULATIONS OF THE PER CAPITA GAINS FROM TRADE
(*In gold ryō*)

	$p^a_{1850s}T_i$ (i = 1868 ... 1875)								$p^a_{1850s}\tilde{T}_{1850s}$
Group of goods	1868	1869	1870	1871	1872	1873	1874	1875	
(1) Goods with observed autarky prices	−0.05	0.03	0.16	0.08	−0.01	0.02	0.03	0.05	0.037
(2) Goods with estimated autarky prices	0.02	0.02	0.02	0.02	0.04	0.07	0.05	0.08	0.035
(3) Woolens and muskets	0.08	0.08	0.12	0.15	0.22	0.26	0.17	0.19	0.141
Gains per capita in ryō	0.05	0.13	0.30	0.25	0.24	0.34	0.26	0.32	0.219

Sources: Nakai (1989), Miyamoto (1963), Ono (1979), Kinyu Kenkyukai (1937), Yamazaki (1983), and Great Britain, *Consular Reports,* for the ports of Nagasaki and Kanagawa in 1859 and in 1860; von Scherzer (1872, p. 262) and Lühdorf (1857, pp. 141, 248–249) for price data. See the text for the estimate of the autarky valuation of imports of woolens and imports of muskets, and of goods without observed autarky prices. Crawcour and Yamamura (1970, Table A1) provide the exchange rate used to convert the inner product from momme into ryō.
Notes: The inner product is decomposed into three groups of commodities: the goods for which autarky prices are available from the existing historical sources; woolens; and goods with estimated autarky prices. $p^a_{1850s}\tilde{T}_{1850s}$ is the average of the annual estimates from 1868 through 1875 with the additional assumption that GDP per capita grew by an annual rate 0.4 percent from 1851–1853 to the test period.

- A "backcast" of GDP per capita says that 0.219 gold ryō is 5%–9% of 1851-1853 GDP
- BB contrast with Huber (1971) estimate of 65% increase in urban worker's real wages by late 1870s

In week 4, look at Bernhofen and Brown's "How our research relates to the new structural estimation trade literature"

Is this a small upper bound?

Missing mechanisms? (Double check the title of BB 2005)

- Frankel & Romer (1999): "there are many channels through which trade can affect income—notably specialization according to comparative advantage, exploitation of increasing returns from larger markets, exchange of ideas through communication and travel, and spread of technology through investment and exposure to new goods."
- Monopolistic competition puts new varieties, firm selection, and markups on the table
- A static model cannot predict dynamic gains

In a static world, 5% of GDP isn't small

Theory-free gains from trade?

- Ed Prescott: "People can quantify what gains there are from it [trade]. If you calibrate the models... most people want to get a big number, but a small number comes out."
- Can you measure GFT empirically without a model? Do "we know that periods of openness coincide with periods of strong economic growth and periods of protectionism coincide with recession"?
- Prescott says model needs additional mechanism to generate large "empirical" gains: technology diffusion, not just trade in goods
- Can you do theory-free empirics?

Frankel and Romer (1999)

Can trade explain income per capita in a cross-country regression?

- Frankel and Romer (1999) address endogeneity of trade by proposing an instrumental variable based on geography
- "Market access" is proximity to larger potential trading partners
- A big paper that reflects its era (e.g., Rodriguez and Rodrik Macro Annual critique has 4500+ cites!)

The method:

- Second stage: Regress GDP per capita on trade, controlling for country size
- First stage: Instrument for actual trade using "predicted trade" (akin to market potential)
- Zero stage: Predict bilateral trade flows using geography (and other countries' characteristics)

Frankel and Romer's "zero stage"

TABLE 1—THE BILATERAL TRADE EQUATION

	Variable	Interaction
Constant	−6.38	5.10
	(0.42)	(1.78)
Ln distance	−0.85	0.15
	(0.04)	(0.30)
Ln population	−0.24	−0.29
(country *i*)	(0.03)	(0.18)
Ln area	−0.12	−0.06
(country *i*)	(0.02)	(0.15)
Ln population	0.61	−0.14
(country *j*)	(0.03)	(0.18)
Ln area	−0.19	−0.07
(country *j*)	(0.02)	(0.15)
Landlocked	−0.36	0.33
	(0.08)	(0.33)
Sample size	3220	
R^2	0.36	
SE of regression	1.64	

Notes: The dependent variable is $\ln(\tau_{ij}/\text{GDP}_i)$. The first column reports the coefficient on the variable listed, and the second column reports the coefficient on the variable's interaction with the common-border dummy. Standard errors are in parentheses.

- Dependent variable is $\ln\left(\frac{\tau_{ij}}{GDP_i}\right)$, where τ_{ij} is sum of bilateral exports and imports
- This "gravity" equation is mis-specified by modern standards, as we'll learn in weeks 3 and 4
- How exogenous are these predictors? (And what do we require of a zero-stage regression?)

Frankel and Romer's first stage

TABLE 2—THE RELATION BETWEEN ACTUAL AND CONSTRUCTED OVERALL TRADE

	(1)	(2)	(3)
Constant	46.41	218.58	166.97
	(4.10)	(12.89)	(18.88)
Constructed trade share	0.99		0.45
	(0.10)		(0.12)
Ln population		−6.36	−4.72
		(2.09)	(2.06)
Ln area		−8.93	−6.45
		(1.70)	(1.77)
Sample size	150	150	150
R^2	0.38	0.48	0.52
SE of regression	36.33	33.49	32.19

Notes: The dependent variable is the actual trade share. Standard errors are in parentheses.

- Use zero-stage estimates to predict trade share $\hat{T}_i = \sum_{j \neq i} \exp(\hat{\alpha} X_{ij})$
- Use predicted trade share as instrument for trade share
- Correct first-stage standard errors for generated regressors

Frankel and Romer's second stage

TABLE 3—TRADE AND INCOME

	(1)	(2)	(3)	(4)
Estimation	OLS	IV	OLS	IV
Constant	7.40	4.96	6.95	1.62
	(0.66)	(2.20)	(1.12)	(3.85)
Trade share	0.85	1.97	0.82	2.96
	(0.25)	(0.99)	(0.32)	(1.49)
Ln population	0.12	0.19	0.21	0.35
	(0.06)	(0.09)	(0.10)	(0.15)
Ln area	−0.01	0.09	−0.05	0.20
	(0.06)	(0.10)	(0.08)	(0.19)
Sample size	150	150	98	98
R^2	0.09	0.09	0.11	0.09
SE of regression	1.00	1.06	1.04	1.27
First-stage F on excluded instrument		13.13		8.45

Notes: The dependent variable is log income per person in 1985. The 150-country sample includes all countries for which the data are available; the 98-country sample includes only the countries considered by Mankiw et al. (1992). Standard errors are in parentheses.

- Most expected OLS estimates to be upward biased
- But these IV estimates are much larger than OLS coefficients
- Led to a lot of discussion
- The paper itself contains important robustness checks/caveats:

"include countries' distance from the equator as a control variable. This variable may reflect the impact of climate, or it may be a proxy for omitted country characteristics that are correlated with latitude. With this approach, the IV estimate of trade and size's effects are virtually identical to the OLS estimate for the full sample, and only moderately larger than the OLS estimate for the 98-country sample."

Explaining Frankel and Romer's estimates

Why are the IV coefficients larger than OLS?

- IV isn't larger, check the standard errors (p.393)
- Weak instrument could exacerbate any small amount of endogeneity in the IV
- Measurement error: Physical shipments of goods don't capture all income-increasing interactions, so OLS suffers attentuation bias (p.393)
- LATE vs ATE

Cross-country regressions are less frequently run today as economists have come to understand the empirical challenges they face (e.g., Rodriguez and Rodrik, Bazzi and Clemens)

Interpreting Frankel and Romer's results

If valid, what do these parameter estimates mean?

- Rodriguez and Rodrik: "To the extent that trade restrictions represent policy responses to real or perceived market imperfections or, at the other extreme, are mechanisms for rent extraction, they will work differently from natural or geographical barriers to trade and other exogenous determinants."
- Estimates much larger than Bernhofen and Brown (2005) welfare consequence, but real GDP isn't same as welfare in an open economy
- In fact, measured GDP may fall even when trade liberalization raises welfare (Bajona, Gibson, Kehoe, and Ruhl 2010)

Wrapping up

- Two central concepts in international economics are generally valid in a neoclassical sense
- Trade theory can and should inform empirical investigations
- It's hard to come by exogenous variation in country-level trade (and even harder to find cases of autarky)
- Comparative advantage works in one empirical setting
- Welfare consequences of trade are subject to much greater debate
- Next week, we start studying models that make much stronger functional-form assumptions

Let's head to breakout rooms...