1 Law of Comparative Advantage

1.1 Basic Idea

- In Lecture 1 we used a revealed preference argument to establish the existence of gains from trade
- We now demonstrate how the same argument can be used to make positive predictions about the pattern of trade
- **Principle of comparative advantage:**
  Comparative advantage—meaning differences in relative autarky prices—is the basis for trade
- Why? If two countries have the same autarky prices, then after opening up to trade, the autarky prices remain equilibrium prices. So there will be no trade....
- **The law of comparative advantage (in words):**
  Countries tend to export goods in which they have a CA, i.e. lower relative autarky prices compared to other countries

1.2 Dixit-Norman-Deardorff (1980)

- Let \( t^n = \left(y_1^n - \sum c_1^n, y_G^n - \sum c_G^n\right) \) denote net exports in country \( n \)
- Let \( u^n \) and \( u^n \) denote the utility level of the representative household in country \( n \) under autarky and free trade
- Let \( p^n \) denote the vector of autarky prices in country \( n \)
- Without loss of generality, normalize prices such that:
  \[
  \sum p_g = \sum p_g^n = 1
  \]
- **Notations:**

\[
\begin{align*}
\text{cor}(x, y) &= \frac{\text{cov}(x, y)}{\sqrt{\text{var}(x) \text{var}(y)}} \\
\text{cov}(x, y) &= \sum_{i=1}^{n} (x_i - \overline{x})(y_i - \overline{y}) \\
\overline{x} &= \frac{1}{n} \sum_{i=1}^{n} x_i
\end{align*}
\]

\(^1\)The notes are based on lecture slides with inclusion of important insights emphasized during the class.
• Recall from Lecture 1:

• **Proposition 4** In a neoclassical trade model, if there is a representative household in country $n$, then $\text{cor}(p - p^o, t^o) \geq 0$

## 2 Testing for Comparative Advantage

• Principle of CA is a fundamental theoretical idea in Economics, yet testing it is hard. Why?
  
  – Problem 1: ‘Principle’ version is too weak to test in real world (where more than 2 countries or goods).
  – Problem 2: Latent variable problem: ‘Law’ version is statement about *trading* behavior but is based on *autarky* prices!
  – Problem 3: Periods of autarky rarely observed.

• How to proceed? Two routes:
  
  1. Put a small amount of structure on the problem, as in Proposition 4. Avoids Problem 1. Downside: Problems 2 and 3 remain, and test lacks power. We will discuss this approach next.
  2. Put a large amount of structure on the problem: model determinants of autarky prices and substitute this model in. This is hard to do, but can in principal avoid Problems 1-3. Downside: tests become joint test of CA and structure. Much of the rest of this course can be thought of as attempts to do this.

• Recall Proposition 4:
  
  – If $p^o$ is the vector of prices that prevail in an economy under autarky,
  
  – And $t$ is the vector of net exports by this *same economy* in any trading equilibrium,
  
  – Then $p^o.t \leq 0$.

• Comments from empirical perspective:
  
  – It is impossible to observe $p^o$ and $t$ at the same time (ie ‘Problem 2’ can never be overcome).
  
  – This is a very weak prediction. (Compare with coin toss model.)
  
  – But remarkably, $p^o$ (if you observe it) is a sufficient statistic for all of the supply and demand features of the economy. (Chetty 2009 ARE discusses advantages of settings like this in which ‘sufficient statistics’ exist. Though here dimensions of statistics may be quite high...)

2
2.1 Bernhofen and Brown (JPE, 2004)

- Bernhofen and Brown (JPE, 2004) exploit the (nearly) closed economy of Japan in 1858, and its subsequent opening up to trade in 1859, as a natural experiment to test for Law of CA.
  - Rare example of a closed economy, so $p^a$ is (almost) observed. This overcomes ‘Problem 3’.

- Further attractive features of this setting:
  - Relatively simple economy
  - Subsequent opening up was plausibly exogenous to economic change in Japan (non-autarky was forced upon Japan by USA).

2.2 Japan Opening Up

![The Development of Japan's External Trade, 1860–85](Image by MIT OpenCourseWare)

2.2.1 Empirical Methodology

- Suppose 1858 is autarky and 1859 is not.

- BB (2004) effectively observe $p_{1858}$ and $t_{1859}$.
  - Though in practice they use years prior to 1858 for $p_{1858}$ and years post-1859 for $t_{1859}$, to allow for adjustment.
• They compute \( p_{1858}.t_{1859} \) and check whether it’s negative.

• Before seeing the answer, what might we be worried about if this is meant to be a test of the Law of Comparative Advantage?

2.2.2 Assumptions Required by BB (2004) Approach

1. Perfect competition under autarky

2. Japan price taker on international markets ⇒ there still is perfect competition in 1859

3. No export subsidies ⇒ no pattern of trade reversals

4. To overcome ‘Problem 2’: Observed autarky prices under autarky (ie \( p_{1858} \)) are same as what post-1858 Japan’s autarky prices would have been if it were in autarky. (That is, the theory really calls for us to compute \( p_{1859}.t_{1859} \), where \( p_{1859} \) is the counterfactual price of Japan’s 1859 economy if it were in autarky.)

• (Put another way: Japan’s underlying technology and tastes haven’t changed around 1858.)

• BB (2004) point out that if the unobserved 1859 autarky price \( (p_{a,1859}) \) is equal to \( p_{1858} \) plus an error term \( (\varepsilon) \) then the only real worry is comparative advantage.

![Net Exports and Price Changes for 1869](Image by MIT OpenCourseWare)

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.
2.2.3 Results

<table>
<thead>
<tr>
<th>Components</th>
<th>1868</th>
<th>1869</th>
<th>1870</th>
<th>1871</th>
<th>1872</th>
<th>1873</th>
<th>1874</th>
<th>1875</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Imports with observed autarky prices</td>
<td>-2.24</td>
<td>-4.12</td>
<td>-8.44</td>
<td>-7.00</td>
<td>-5.75</td>
<td>-5.88</td>
<td>-7.15</td>
<td>-7.98</td>
</tr>
<tr>
<td>(2) Imports of woolen goods</td>
<td>-0.98</td>
<td>-0.82</td>
<td>-1.29</td>
<td>-1.56</td>
<td>-2.16</td>
<td>-2.50</td>
<td>-1.56</td>
<td>-2.33</td>
</tr>
<tr>
<td>(3) Imports with approximated autarky prices</td>
<td>-1.10</td>
<td>-0.95</td>
<td>-0.70</td>
<td>-0.85</td>
<td>-1.51</td>
<td>-2.08</td>
<td>-1.60</td>
<td>-2.65</td>
</tr>
<tr>
<td>(4) Exports with observed autarky prices</td>
<td>4.07</td>
<td>3.40</td>
<td>4.04</td>
<td>5.16</td>
<td>4.99</td>
<td>4.08</td>
<td>5.08</td>
<td>4.80</td>
</tr>
<tr>
<td>(5) Exports with approximated autarky prices</td>
<td>0.09</td>
<td>0.03</td>
<td>0.07</td>
<td>0.07</td>
<td>0.15</td>
<td>0.07</td>
<td>0.11</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Note: All values are expressed in terms of millions of ryō. The ryō equaled about $1.00 in 1873 and was equivalent to the yen when it was introduced in 1871. The estimates are of the approximation of the inner product ($p^aT$) valued at autarky prices prevailing in 1851-53.

2.2.4 Comments

- Theory says nothing about which goods are ‘up’ and which are ‘down’ in Figure 3, only that the scatter plot should be upward-sloping.

- Low power test. Harrigan (2003): “I think I can speak for many economists who have taught this theory with great fervor when I say ‘thank goodness’.”

- Why is $p^a.t$ growing in magnitude over time?

3 How Large Are the Gains from Trade?

- Many approaches to this question.

- Today we will discuss some recent answers employing a ‘reduced-form’ approach:
  - Bernhofen and Brown (AER, 2005)
  - Frankel and Romer (AER, 1999)
  - Feyrer (2009a, 2009b)

- Many other approaches in the literature will come up throughout the course (estimating GT is of fundamental interest throughout).
3.1 Bernhofen and Brown (2005)

- Measure gains (to a representative Japan consumer) of Japan’s opening up in 1858

- Consider Slutsky compensation to consumers in (autarkic) 1858:

\[ \Delta W = e(p_{1858}, c^f_{1858}) - e(p_{1858}, c^a_{1858}) \]

- Here, \( c^f_{1858} \) is the counterfactual consumption of Japan in 1858 if it were open to trade.
  
  - Of course, by WARP, \( c^f_{1858} \) was not affordable in 1858 or else it would have been chosen.
  
  - \( \Delta W \) measures the amount of income that would have made counterfactual \( c^f_{1858} \) affordable.

3.1.1 Towards an Observable Expression

- Rearrange this to get something observable (let \( y \) be output):

\[
\begin{align*}
\Delta W &= e(p_{1858}, c^f_{1858}) - e(p_{1858}, c^a_{1858}) \\
&= p^a_{1858}c^f_{1858} - p^a_{1858}c^a_{1858} \\
&= p^a_{1858}(c^f_{1858} - y^f_{1858}) + p^a_{1858}(y^f_{1858} - y^a_{1858}) \\
&= -p^a_{1858}t_{1858} - p^a_{1858}(y^a_{1858} - y^f_{1858}) \\
&\leq -p^a_{1858}t_{1858}
\end{align*}
\]

- Here, the last line follows from profit maximization.

- Note that \( t_{1858} \) is counterfactual too. (1858 was autarky!)

- Under the assumption that \( t_{1858} = t_{1859} \), the DDN CA statistic puts an upper-bound on GT. Not super surprising: \( p^a_{1858}t_{1858} \leq 0 \) because of GT in Proposition 4...
3.1.2 Results

3.1.3 Interpretation

• “Small” (upper-bound) effects in BB (2005) surprising to some

• What potential gains/losses from trade are not being counted in BB (2005) calculation?

• A partial list often mentioned in the literature:
  
  – Selection of more productive domestic firms
  – New goods available (for consumption and production)
  – Pro-competitive effects of openness to trade.
  – ‘Dynamic effects’ of openness to trade (typically defined as something, like innovation or learning, that moves the PPF).
  – Institutional change driven by openness to trade.

• Some more pedestrian answers:

  – A few percentage points of GDP is nothing to spit at (small relative to what?)
  – GT depend on how much you trade (and Japan may trade much more in the future than in 1859)

3.2 Frankel and Romer (1999)

• Extremely influential paper (one of AER’s most highly cited articles in recent decades).

• FR (1999) takes a huge question (‘Does trade cause growth?’) and answers it with more attention to the endogenous nature of trade than previous work.
Key idea: FR instrument for a country’s trade (really, its ‘openness’) by using a measure of distance: how far that country is from large (ie rich) potential trade partners.

3.2.1 FR (1999): First-Stage (Part I)

• First-stage regression has two parts.
  • First is based on well-known gravity equation.
    - We will have much to say about these in a few weeks.
    - Key idea: bilateral trade flows fall with bilateral trade costs (and variables like bilateral distance, and whether two countries share a border, appear to be correlated with trade costs).

• Gravity equation estimated is the following (NB: this isn’t really conventional by modern standards):

\[
\ln\left(\frac{X_{ij} + M_{ij}}{GDP_i}\right) = a_0 + a_1 \ln D_{ij} + a_2 N_i + a_3 N_j + a_4 B_{ij} + e_{ij}
\]

• Where \((X_{ij} + M_{ij})\) is exports plus imports between country \(i\) and \(j\), \(D_{ij}\) is distance, \(N\) is population and \(B_{ij}\) is a shared border dummy. FR (1999) also control for each country’s area, landlocked status, as well as interactions between these variables and \(B_{ij}\).

<table>
<thead>
<tr>
<th>The Bilateral Trade Equation</th>
<th>Variable</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-6.38 (-0.42)</td>
<td>5.10 (1.78)</td>
</tr>
<tr>
<td>Ln distance</td>
<td>-0.85 (0.04)</td>
<td>0.15 (0.30)</td>
</tr>
<tr>
<td>Ln population (country i)</td>
<td>-0.24 (0.03)</td>
<td>-0.29 (0.18)</td>
</tr>
<tr>
<td>Ln area (country i)</td>
<td>-0.12 (0.02)</td>
<td>-0.06 (0.15)</td>
</tr>
<tr>
<td>Ln population (country j)</td>
<td>0.61 (0.03)</td>
<td>-0.14 (0.18)</td>
</tr>
<tr>
<td>Ln area (country j)</td>
<td>-0.19 (0.02)</td>
<td>-0.07 (0.15)</td>
</tr>
<tr>
<td>Landlocked</td>
<td>-0.36 (0.08)</td>
<td>0.33 (0.33)</td>
</tr>
</tbody>
</table>

Sample size 3220

\(R^2\) 0.36

SE of regression 1.64

Notes: The dependent variable is \(\ln(\frac{t_{ij}}{GDP_i})\). 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.
3.2.2 FR (1999): First-Stage (Part II)

- Now FR (1999) aggregate the previously estimated gravity regression over all of country $i$’s imports from all of its bilateral partners, $j$:

$$\hat{T}_i = \sum_{i \neq j} e^{\hat{X}_{ij}}$$

- This constructed variable $\hat{T}_i$ is then used as an instrument for how much a country is actually trading (which they, somewhat confusingly, denote by $T_i$).

- That is, the real first-stage regression is to regress $T_i$ (exports plus imports over GDP) on $\hat{T}_i$ and population and area.

### The Relation between Actual and Constructed Overall Trade

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>46.41(4.10)</td>
<td>218.58(12.89)</td>
<td>166.97(18.88)</td>
</tr>
<tr>
<td>Constructed trade share</td>
<td>0.99(0.10)</td>
<td>-</td>
<td>0.45(0.12)</td>
</tr>
<tr>
<td>Ln population</td>
<td>-</td>
<td>-6.36(2.09)</td>
<td>-4.72(2.06)</td>
</tr>
<tr>
<td>Ln area</td>
<td>-</td>
<td>-8.93(1.70)</td>
<td>-6.45(1.77)</td>
</tr>
<tr>
<td>Sample size</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.38</td>
<td>0.48</td>
<td>0.52</td>
</tr>
<tr>
<td>SE of regression</td>
<td>36.33</td>
<td>33.49</td>
<td>32.19</td>
</tr>
</tbody>
</table>

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

3.2.3 FR (1999): The Second-Stage

- Now, finally, FR (1999) run the regression of interest—‘Does trade cause growth?’:

$$\ln \frac{Y_i}{N_i} = a + bT_i + c_1N_i + c_2A_i + u_i$$

- Here, $\frac{Y_i}{N_i}$ is GDP per capita and $A_i$ is area.

- FR run this regression using both OLS and IV.
  - The IV for $T_i$ is $\hat{T}_i$. 

Image by MIT OpenCourseWare.
3.3 Why does trade increase GDP per capita?

- These are big effects, that surprised many people. Possible explanations:
  - The IV results are still biased upwards. (A small amount of endogeneity in an IV gets exaggerated by the IV method.) Countries that are close to big countries are rich not just because of trade, but because of spatially correlated true determinants of prosperity (eg,
– ‘Openness’ is proxying for lots of true treatment effects of proximity to neighbors: multinational firms, technology transfer, knowledge spillovers, migration, political spillovers. Not just ‘Trade’.

– The dynamic effects of ‘openness’ accumulated over a long period of time, are larger than the static one-off effects of opening up to trade.

• Effects are many orders of magnitude higher than BB 2005 results. But not clear how to compare them:
  – BB focus on consumption/welfare. FR focus on production.
  – We would expect measured GDP to fall in Japan between 1858 and 1859 (Why?)

• It’s very surprising that the IV coefficients are larger than the OLS coefficients. Possible explanations:
  – Weak instrument. (But the F-stat on the first stage is reasonably high.)
  – OLS is not biased after all.
  – Sampling variation: OLS and IV coefficients not statistically distinguishable from one another.
  – Measurement error. (“Trade is an [imperfect] proxy for the many ways in which interactions between countries raise income—specialization, spread of ideas, and so on.”)
  – Heterogeneous treatment effects—IV only gets at the LATE, which might be high.

3.4 Follow-on Work from FR (1999)

• Because of importance of question, and surprising findings, FR (1999) generated a lot of controversy and follow-on work.

• Rodrik and Rodriguez (2000) were most critical.

• Fundamental message (that has now also been confirmed for many cross-country studies, in all fields) is that these regressions are not that robust.
  – Inclusion of various controls can change the results a great deal.
  – Different measures of ‘openness’ yield quite different results.

• RR (2000) also critical of the identification assumption behind FR (1999)’s IV.
• Lots of work used micro-data and trade liberalization episodes to go beyond the cross-country comparisons in FR (1999):
  
  – Do individual firms (or industries) become more productive when they open to trade?
  – Eg: Trefler (2004), Pavcnik (2002), Tybout (various years).
  – We will review this literature later in the course.
  – But note that we’re drifting away from theoretical arguments establishing GT in a neoclassical world

• In two recent papers, James Feyrer has revamped interest in the cross-country approach by using panel data and an IV based on a time-varying component of ‘distance’.


3.4.1 Feyrer (2009) Paper 1

• Uses panel of country-level GDP and trade data from 1960-1995

• Exploits fact that marginal cost of shipping via air fell faster over this period than marginal cost of shipping via sea.

• This will make trade costs (or ‘distance’) fall over time. And importantly, trade costs between country pairs will be affected very differently by this:

  – Germany-Japan sea distance is 12,000 miles, but only 5,000 air miles. (‘Treatment’)
  – Germany-USA sea and air distances are basically the same. (‘Control’)

• Feyrer uses this variation to get a time-varying instrument for trade openness, and then pursues a FR 1999 approach.
Figure 1: Air Freight Share of US Trade Value (excluding North America)


Figure 3: The Change in Elasticity of Trade with Respect to Sea and Air Distance over Time

source: Coefficients from regression table 9 column 2. Each point represents the coefficient on (sea or air) distance over a 5 year interval. Estimates are from a gravity model with country fixed effects. Error bars represent plus or minus two standard errors for each coefficient.

Courtesy of James Feyrer. Used with permission.
3.4.2 Feyrer (2009) Paper 2


- Perhaps, therefore, omitted variable bias was not as big an issue as previously thought.

- But a fundamental question of interpretation remains:
  - Is ‘openness’ capturing channels related purely to the trade of goods, or is it possible that this variable is (also) proxying for other elements of international interaction (FDI, migration, knowledge flows) made cheaper by the rise of air travel?

- Feyrer (2009) Paper 2 exploits the closing and re-opening of the Suez Canal between 1967 and 1975 to dig deeper:
  - (Unstated) logic: No one is doing FDI or migration by sea during this period, so only thing a change in sea distance can affect is trade.
  - Short-run shock.
  - Can trace the timing of the impact.
  - Very nice feature that it turns off and on: Should expect symmetric results from static trade models, but asymmetric results if driven purely by (eg) spread of knowledge.
Figure 1: Average bilateral trade residuals grouped by Suez Distance Increase

Source: IMF direction of trade database, author’s calculations.
The vertical lines mark the closing and reopening of the Canal in 1967 and 1975.
Residuals from a regression with country pair and year dummies.

<table>
<thead>
<tr>
<th>Trade Versus Sea Distance with the Closure of Suez 67-75</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pairwise ln (trade)</strong></td>
</tr>
<tr>
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</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>In (sea dist)</td>
</tr>
<tr>
<td>In (sea dist) (67)</td>
</tr>
<tr>
<td>In (sea dist) (74)</td>
</tr>
<tr>
<td>Test 67 == 74 (p-value)</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Pairs</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>R-squared</td>
</tr>
<tr>
<td>Balanced Panel</td>
</tr>
<tr>
<td>Omit Transition</td>
</tr>
</tbody>
</table>

**p<0.01, * p<0.05, +p<0.1 Regressions include country pair and year dummies. Standard errors clustered by country pair. Years 1967-1969 and 1975-1977 are the transition periods.
3.5 Conclusion

- CA seems to hold, in one place where tested.
- GT appear to vary considerably across estimates.
  - But GT are hard to measure. There are aspects of welfare (e.g.

Source: World Development Indicators, author’s calculations.
change in the number of varieties available) that are not captured in the studies we’ve seen above, but which might be important (or not!).

– Also very hard to get exogenous change in ability to trade.

4 Areas for future research

• Are there other ways (or places) in which to test CA?

• Can we find more natural experiments that affect regions’ abilities to trade, to shed more light on the size of GT?

• More work is needed on quantifying empirically (ideally as non-parametrically as possible) the different mechanisms behind GT

• Are there ways to formalize the connection (or lack thereof) between reduced-form estimates of GT (that we saw today) and GT predicted by commonly-used models of trade (that we will see later)?

• How well do the measures that statistical agencies use to measure economic welfare correspond with the concepts of welfare in the models we have seen? See Burstein and Cravino (2011) for a discussion.