14.581 International Trade
Class notes on 4/10/2013

1 Goodness of Fit of Gravity Equations

- Lai and Trefler (2002, unpublished) discuss (among other things) the fit of the gravity equation.
- Using the notation in Anderson and van Wincoop (2004), but study imports \((M)\) into \(i\) from \(j\) rather than exports:

\[
M_{ij}^k = \frac{E_k^i Y_j^k}{Y_k^i} \left( \frac{\tau_{ij}^k}{P_i^k \Pi_j^k} \right)^{1-\epsilon_k}
\]

- \(E_i^k\) and \(Y_j^k\) are price indices (that of course depend on \(E, M\) and \(\tau\)).

\[
M_{ij}^k = \frac{E_k^i Y_j^k}{Y_k^i} \left( \frac{\tau_{ij}^k}{P_i^k \Pi_j^k} \right)^{1-\epsilon_k}
\]

- Lai and Trefler (2002) discuss the fit of this equation, and then divide up the fit into 3 parts (mapping to their notation):

1. \(Q_j^k \equiv Y_j^k\). Fit from this, they argue, is uninteresting due to the “data identity” that \(\sum_i M_{ij}^k = Y_j^k\).
2. \(s_i^k \equiv E_i^k\). Fit from this, they argue, is somewhat interesting as it’s due to homothetic preferences. But not that interesting.
3. \(\Phi_{ij}^k \equiv \left( \frac{\tau_{ij}^k}{P_i^k \Pi_j^k} \right)^{1-\epsilon_k}\). This, they argue, is the interesting bit of the gravity equation. It includes the partial-equilibrium effect of trade costs \(\tau_{ij}^k\), as well as all general equilibrium effects (in \(P_i^k\) and \(\Pi_j^k\)).

1.1 Lai and Trefler (2002)

- Other notes on their estimation procedure:

  - They use 3-digit manufacturing industries (28 industries), every 5 years from 1972-1992, 14 importers (OECD) and 36 exporters. (Big constraint is data on tariffs.)
  - They estimate trade costs \(\tau_{ij}^k\) as equal to tariffs.

- The notes are based on lecture slides with inclusion of important insights emphasized during the class.
They estimate one parameter $e^k$ per industry $k$.
They also allow for unrestricted taste-shifters by country (fixed over time).
Note that the term $\Phi_{ij}^k$ is highly non-linear in parameters.

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<table>
<thead>
<tr>
<th>$\ln(s_{it})$</th>
<th>$\ln(M_{it})$</th>
<th>$\ln(\Phi_{ij}^k Q_{jt})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$ All</td>
<td>.78</td>
<td>.06</td>
</tr>
<tr>
<td>Rich</td>
<td>.83</td>
<td>.05</td>
</tr>
<tr>
<td>Poor</td>
<td>.77</td>
<td>.00</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>$\ln(M_{it})$</th>
<th>$\ln(\Phi_{ij}^k)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$ All</td>
<td>.06</td>
</tr>
<tr>
<td>Rich</td>
<td>.05</td>
</tr>
<tr>
<td>Poor</td>
<td>.00</td>
</tr>
</tbody>
</table>

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Courtesy of Daniel Trefler and Huiwen Lai. Used with permission.
\[ \ln\left( \frac{M_{ijt}}{\Phi_{ijt}} \right) \]

\[ \ln\left( \frac{M_{ijt}}{s_{ijt}Q_{ijt}} \right) \]

\[ R^2 \text{ All} = .16 \]
Rich = .09
Poor = .06

\[ R^2 \text{ All} = .21 \]
Rich = .05
Poor = .30

\[ R^2 \text{ All} = .02 \]
Rich = .00
Poor = .05

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2 Measuring Trade Costs: What do we mean by ‘trade costs’?

- The sum total of all of the costs that impede trade from origin to destination.

- This includes:
  - Tariffs and non-tariff barriers (quotas etc).
  - Transportation costs.
  - Administrative hurdles.
– Corruption.
– Contractual frictions.
– The need to secure trade finance (working capital while goods in transit).

• NB: There is no reason that these ‘trade costs’ occur only on international trade.
  – This point widens the

2.1 Why care about trade costs?
• They enter many modern models of trade, so empirical implementations of these models need an empirical metric for trade costs.
• There are clear features of the international trade data that seem hard (but not impossible) to square with a frictionless world.
• As famously argued by Obstfeld and Rogoff (Brookings, 2000), trade costs may explain ‘the six big puzzles of international macro’.
• Trade costs clearly matter for welfare calculations.
• Trade costs could be endogenous and driven by the market structure of the trading sector; this would affect the distribution of gains from trade. (A monopolist on transportation could extract all of the gains from trade.)

2.2 Are Trade Costs ‘Large’?
• There is considerable debate (still unresolved) about this question.
  • Arguments in favor:
    – Trade falls very dramatically with distance (see Figures).
    – Clearly haircuts are not very tradable but a song on iTunes is. Everything else is in between.
    – Contractual frictions of sale at a distance (Avner Grief’s ‘Fundamental Problem of Exchange’) seem potentially severe.
    – One often hears the argument that a fundamental problem in developing countries is their ‘sclerotic infrastructure’ (ie ports, roads, etc). Economist article on traveling with a truck driver in Cameroon.
  • Arguments against:
    – Inter- and intra-national shipping rates aren’t that high: in March 2010 (even at relatively high gas prices) a California-Boston refrigerated truck journey cost around $5,000. Fill this with grapes and they will sell at retail for around $100,000.
– Tariffs are not that big (nowadays).
– Repeated games and reputations/brand names get around any high stakes contractual issues.

• Surprisingly little hard evidence has been brought to bear on these issues.

*Leamer: A Review of Thomas L Friedman’s The World is Flat* 111
Figure 1 from Crozet, M., and Koenig, P. "Structural Gravity Equations with Intensive and Extensive Margins." Canadian Journal of Economics/Revue canadienne d'économique 43 (2010): 41–62. © John Wiley And Sons Inc. All rights reserved. This content is excluded from our Creative Commons license. For more information, see http://ocw.mit.edu/fairuse.
3 Direct Measurement of Trade Costs

- The simplest way to measure TCs is to just go out there and measure them directly.
- Many components of TCs are probably measurable. But many aren’t.
- Still, this sort of descriptive evidence is extremely valuable for getting a sense of things.
- Examples of creative sources of this sort of evidence:
  - Hummels (JEP, 2007) survey on transportation.
  - Anderson and van Wincoop (JEL, 2004) survey on trade costs.
  - Limao and Venables on shipping.
  - Olken on bribes and trucking in Indonesia.
3.1 Direct Measures: Hummels (2007)

![Figure 1: Worldwide Air Revenue per Ton-Kilometer](image1)

![Figure 2: Air Transport Price Indices](image2)


Note: 2007 base on base group.

Announced growth rates for 1973-86 of盯着 price per kg (in year 2000 dollars): All routes 2.67; North Atlantic 1.99; Mid Atlantic 3.02; South Atlantic 2.85; North and Mid Pacific -3.28; South Pacific -3.07; North to Central America 3.02; North and Central America to South America 2.39; Europe to Middle East 6.26; Europe and Middle East to Africa 1.84; Europe/ Middle East/Africa to Asia/Pacific 1.15; Local Asia/Pacific 0.63; Local North America 1.00; Local Europe 1.01; Local South America 2.59; Local Middle East 1.52; Local Africa 0.85.

Announced growth rates for 1988-99 of盯着 price per kg (in year 2000 dollars): All routes 0.95; North Atlantic 1.65; Mid Atlantic -3.22; South Atlantic 1.20; North and Mid Pacific -3.18; South Pacific -0.86; North to Central America -0.27; North and Central America to South America 2.26; Europe to Middle East 3.03; Europe and Middle East to Africa 3.18; Europe/Middle East/Africa to Asia/Pacific -2.74; Local Asia/Pacific -1.15; Local North America 1.29; Local Europe 0.50; Local Central America 1.37; Local South America -2.72; Local Middle East -1.46; Local Africa -3.13.

Courtesy of David Hummels and the American Economic Association. Used with permission.
Figure 3
Tramp Price Index
(with U.S. GDP deflator and with commodity price deflator)


Note: Tramp prices deflated by a U.S. GDP deflator and tramp prices deflated by commodity price deflator.

Figure 4
Liner Price Index
(with German GDP deflator and with German traded goods price deflator)


Note: Liner prices deflated by a German GDP deflator and liner prices deflated by a German traded-goods price deflator.

Courtesy of David Hummels and the American Economic Association. Used with permission.


- They begin with descriptive, ‘direct’ evidence on:
  - Tariffs—but this is surprisingly hard. (It is very surprising how hard it is to get good data on the state of the world’s tariffs.)
- NTBs—much harder to find data. And then there are theoretical issues such as whether quotas are binding.
- Transportation costs (mostly now summarized in Hummels (2007)).
- Wholesale and retail distribution costs (which clearly affect both international and intranational trade).

### Table 1. Small Countries with High Shares of Tariffs—1980

<table>
<thead>
<tr>
<th>Country</th>
<th>tariff share</th>
<th>TNY tariff share</th>
<th>FYI tariff share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1.2</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>Australia</td>
<td>1.5</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Belgium</td>
<td>1.1</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Canada</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Chile</td>
<td>1.5</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Colombia</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Denmark</td>
<td>1.1</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Germany</td>
<td>1.4</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Greece</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Hungary</td>
<td>1.4</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Iceland</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Ireland</td>
<td>1.4</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Italy</td>
<td>1.5</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Japan</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Korea</td>
<td>1.4</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1.5</td>
<td>1.4</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Notes: The data are from UNCTAD’s TRAINS database (Hummels and Anderson 2005). TNY = trade-weighted national yen. FYI = trade-weighted U.S. dollar. A “*” indicates that with distortions the figures are invalid.

Courtesy of James E. Anderson and Eric van Wincoop. Used with permission.
TABLE 5  
TARIFF REPRESSION OF U.S. FTA QUOTAS, 1985 AND 2000 (Percent)  

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Textiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broadwoven fabric mills</td>
<td>8.5</td>
<td>9.5</td>
<td>14.4</td>
<td>13.3</td>
<td>21.8</td>
<td>16.0</td>
<td>0.48</td>
</tr>
<tr>
<td>Narrow fabric mills</td>
<td>3.4</td>
<td>3.3</td>
<td>6.9</td>
<td>6.7</td>
<td>10.0</td>
<td>6.0</td>
<td>0.02</td>
</tr>
<tr>
<td>Yarn mills and textile finishing</td>
<td>3.1</td>
<td>3.1</td>
<td>10.9</td>
<td>9.3</td>
<td>11.0</td>
<td>9.6</td>
<td>0.09</td>
</tr>
<tr>
<td>Thread mills</td>
<td>4.8</td>
<td>2.2</td>
<td>9.5</td>
<td>3.8</td>
<td>13.8</td>
<td>6.0</td>
<td>0.08</td>
</tr>
<tr>
<td>Knit goods</td>
<td>2.6</td>
<td>0.3</td>
<td>7.8</td>
<td>8.7</td>
<td>11.6</td>
<td>8.2</td>
<td>0.31</td>
</tr>
<tr>
<td>Knit and textile shawls, none</td>
<td>1.0</td>
<td>0.1</td>
<td>4.7</td>
<td>6.2</td>
<td>9.3</td>
<td>6.9</td>
<td>0.09</td>
</tr>
<tr>
<td>Linen and flax fabric goods</td>
<td>3.5</td>
<td>3.0</td>
<td>12.4</td>
<td>12.3</td>
<td>17.7</td>
<td>9.0</td>
<td>0.06</td>
</tr>
<tr>
<td>Coated fabrics, not elsewhere</td>
<td>3.0</td>
<td>3.0</td>
<td>9.4</td>
<td>6.6</td>
<td>7.6</td>
<td>5.0</td>
<td>0.03</td>
</tr>
<tr>
<td>Rayon and fabric</td>
<td>2.2</td>
<td>2.8</td>
<td>5.3</td>
<td>6.8</td>
<td>6.8</td>
<td>6.8</td>
<td>0.08</td>
</tr>
<tr>
<td>Cotone and hemp</td>
<td>3.1</td>
<td>3.2</td>
<td>6.2</td>
<td>6.6</td>
<td>6.9</td>
<td>6.9</td>
<td>0.05</td>
</tr>
<tr>
<td>Nonwovens (fabric)</td>
<td>0.1</td>
<td>0.2</td>
<td>10.6</td>
<td>9.5</td>
<td>9.7</td>
<td>9.4</td>
<td>0.09</td>
</tr>
<tr>
<td>Apparel and textile products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women’s and men’s, except scarves</td>
<td>3.0</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handkerchief, none</td>
<td>0.8</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knit goods, fabric</td>
<td>9.0</td>
<td>6.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wool and related products</td>
<td>3.0</td>
<td>3.2</td>
<td>6.4</td>
<td>6.8</td>
<td>9.4</td>
<td>6.8</td>
<td>0.08</td>
</tr>
<tr>
<td>Lace and embroidery</td>
<td>8.5</td>
<td>7.5</td>
<td>8.9</td>
<td>9.1</td>
<td>13.7</td>
<td>9.0</td>
<td>0.07</td>
</tr>
<tr>
<td>Embroidered textile products, none</td>
<td>9.2</td>
<td>6.0</td>
<td>5.3</td>
<td>4.8</td>
<td>5.4</td>
<td>4.7</td>
<td>0.07</td>
</tr>
<tr>
<td>Lace and embroidery</td>
<td>8.5</td>
<td>7.4</td>
<td>12.8</td>
<td>10.6</td>
<td>21.2</td>
<td>14.0</td>
<td>0.28</td>
</tr>
<tr>
<td>Women’s hosiery and petticoats</td>
<td>0.8</td>
<td>1.1</td>
<td>9.5</td>
<td>9.7</td>
<td>9.8</td>
<td>9.7</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Notes: The table indicates “simple” and “TW” indicates “trade-weighted.” Tariff repression for U.S. exports from Hong Kong were estimated on the basis of average weights. Hong Kong quota prices paid by buyers, using information from International Business and Economic Research Corporation. The countries do not always quote rights in public auctions; export prices were enforced. Hong Kong export prices, with adjustments for differences in labor costs and productivity, form one of the counterpart countries, are denoted in UNCTAD (1995) Table 6. The new CEP results are reported from Duesterblatt and Strem (1998) Table 1.8). Notes UNCTAD 1993, 1995. Tariff averages, trade-weighted tariff averages and U.S. import percentages are calculated using data from the UNCTAD TRAINS dataset. SIC to HS concordance factor the U.S. Census Bureau is used.

TABLE 6  
DISTRIBUTION MARGINS FOR HOUSEHOLD CONSUMPTION AND CAPITAL GOODS  

<table>
<thead>
<tr>
<th>Select</th>
<th>Aus</th>
<th>Bel</th>
<th>Can</th>
<th>Cor</th>
<th>Eta</th>
<th>Jap</th>
<th>Net</th>
<th>UK</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Categories</td>
<td>95</td>
<td>90</td>
<td>90</td>
<td>93</td>
<td>92</td>
<td>95</td>
<td>90</td>
<td>90</td>
<td>92</td>
</tr>
<tr>
<td>Rice</td>
<td>1.239</td>
<td>1.237</td>
<td>1.987</td>
<td>1.423</td>
<td>1.549</td>
<td>1.335</td>
<td>1.434</td>
<td>1.511</td>
<td>1.435</td>
</tr>
<tr>
<td>Frozen, frozen beef</td>
<td>1.485</td>
<td>1.626</td>
<td>1.544</td>
<td>1.423</td>
<td>1.605</td>
<td>1.681</td>
<td>1.640</td>
<td>1.390</td>
<td>1.534</td>
</tr>
<tr>
<td>Beer</td>
<td>1.185</td>
<td>1.435</td>
<td>1.213</td>
<td>1.423</td>
<td>1.240</td>
<td>1.710</td>
<td>1.573</td>
<td>2.210</td>
<td>1.960</td>
</tr>
<tr>
<td>Cigarettes</td>
<td>1.191</td>
<td>1.133</td>
<td>1.505</td>
<td>1.423</td>
<td>1.240</td>
<td>1.598</td>
<td>1.230</td>
<td>1.129</td>
<td>1.582</td>
</tr>
<tr>
<td>Ladies’ clothing</td>
<td>1.385</td>
<td>1.845</td>
<td>1.866</td>
<td>2.039</td>
<td>1.562</td>
<td>2.295</td>
<td>1.855</td>
<td>2.005</td>
<td>2.159</td>
</tr>
<tr>
<td>Refrigerators, freezers</td>
<td>1.236</td>
<td>1.586</td>
<td>1.744</td>
<td>1.826</td>
<td>1.783</td>
<td>1.638</td>
<td>1.601</td>
<td>2.080</td>
<td>1.682</td>
</tr>
<tr>
<td>Passenger vehicles</td>
<td>1.595</td>
<td>1.196</td>
<td>1.227</td>
<td>1.374</td>
<td>1.457</td>
<td>1.760</td>
<td>1.247</td>
<td>1.216</td>
<td>1.200</td>
</tr>
<tr>
<td>Books</td>
<td>1.882</td>
<td>1.452</td>
<td>1.294</td>
<td>2.039</td>
<td>1.778</td>
<td>1.665</td>
<td>1.690</td>
<td>1.625</td>
<td>1.751</td>
</tr>
<tr>
<td>Office, data proc. mach.</td>
<td>1.715</td>
<td>1.072</td>
<td>1.035</td>
<td>1.153</td>
<td>1.660</td>
<td>1.389</td>
<td>1.217</td>
<td>1.040</td>
<td>1.226</td>
</tr>
<tr>
<td>Electronic equip., etc</td>
<td>1.715</td>
<td>1.080</td>
<td>1.198</td>
<td>1.189</td>
<td>1.576</td>
<td>1.432</td>
<td>1.224</td>
<td>1.080</td>
<td>1.139</td>
</tr>
<tr>
<td>Simple Average (125 categories)</td>
<td>1.574</td>
<td>1.420</td>
<td>1.571</td>
<td>1.335</td>
<td>1.577</td>
<td>1.703</td>
<td>1.502</td>
<td>1.562</td>
<td>1.681</td>
</tr>
</tbody>
</table>

Notes: The table is reproduced from Bradford and Lawrence, “Pay the Price: The Cost of Fragmented International Markets”, Institute of International Economics, forthcoming (2003). Margins represent the ratio of purchaser prices to producer price. Margins data on capital goods are not available for the Netherlands, so an average of the four European countries’ margins is used.

Courtesy of James E. Anderson and Eric van Wincoop. Used with permission.
### List of Procedures

1. Secure letter of credit
2. Obtain and load containers
3. Assemble and process export documents
4. Preshipment inspection and clearance
5. Prepare transit clearance
6. Inland transportation to border
7. Arrange transport; waiting for pickup and loading on local carriage
8. Wait at border crossing
9. Transportation from border to port
10. Terminal handling activities
11. Pay export duties, taxes, or tariffs
12. Waiting for loading container on vessel
13. Customs inspection and clearance
14. Technical control, health, quarantine
15. Pass customs inspection and clearance
16. Pass technical control, health, quarantine
17. Pass terminal clearance

### Descriptive Statistics by Geographic Region Required Time for Exports

<table>
<thead>
<tr>
<th>Region</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Number of Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa and Middle East</td>
<td>41.83</td>
<td>20.41</td>
<td>10</td>
<td>116</td>
<td>35</td>
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<td>Total Sample</td>
<td>30.40</td>
<td>19.13</td>
<td>5</td>
<td>116</td>
<td>98</td>
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</table>

Note: Seven countries belong to more than one regional agreement.

Source: Data on time delays were collected by the doing business team of the World Bank/IFC. They are available at www.doingbusiness.org.
<table>
<thead>
<tr>
<th>Table 1: Summary Statistics</th>
<th>Both Roads (1)</th>
<th>Meulaboh Road (2)</th>
<th>Banda Aceh Road (3)</th>
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<tr>
<td>Total expenditures during trip (rupiah)</td>
<td>2,901,345</td>
<td>2,592,087</td>
<td>2,863,637</td>
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<tr>
<td>Bribe, extortion, and protection payments</td>
<td>361,323</td>
<td>361,323</td>
<td>361,323</td>
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<tr>
<td>Payments at checkpoints</td>
<td>131,876</td>
<td>201,671</td>
<td>47,905</td>
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<td>Payments at weigh stations</td>
<td>131,404</td>
<td>152,131</td>
<td>106,468</td>
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<tr>
<td>Convoy fees</td>
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<td>132,131</td>
<td>106,468</td>
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<td>Coupons/protection fees</td>
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<td>Fuel</td>
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<td>Salary for truck driver and assistant</td>
<td>275,058</td>
<td>325,514</td>
<td>214,353</td>
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<tr>
<td>Loading and unloading of cargo</td>
<td>131,876</td>
<td>201,671</td>
<td>47,905</td>
</tr>
<tr>
<td>Food, lodging, etc.</td>
<td>148,872</td>
<td>124,649</td>
<td>178,016</td>
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<tr>
<td>Other</td>
<td>140,791</td>
<td>161,471</td>
<td>116,308</td>
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<td>Average payment at checkpoint</td>
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<td>4,421</td>
</tr>
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<td>Number of checkpoints</td>
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<td>11</td>
</tr>
<tr>
<td>Number of trips</td>
<td>282</td>
<td>154</td>
<td>128</td>
</tr>
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</table>

Note.—Standard deviations are in parentheses. Summary statistics include only those trips for which salary information was available. All figures are in October 2006 rupiah (US$1.00 = Rp. 9,200).
4 Measuring Trade Costs from Trade Flows

- Descriptive statistics can only get us so far. No one ever writes down the full extent of costs of trading and doing business afar.
  - For example, in the realm of transportation-related trade costs: the full transportation-related cost is not just the freight rate (which Hummels (2007) presents evidence on) but also the time cost of goods in transit, etc.
- The most commonly-employed method (by far) for measuring the full extent of trade costs is the gravity equation.
  - This is a particular way of inferring trade costs from trade flows.
  - Implicitly, we are comparing the amount of trade we see in the real world to the amount we’d expect to see in a frictionless world; the ‘difference’—under this logic—is trade costs.
  - Gravity models put a lot of structure on the model in order to (very transparently and easily) back out trade costs as a residual.
4.1 Estimating $\tau_{ij}^k$ from the Gravity Equation: ‘Residual Approach’

- One natural approach would be to use the above structure to back out what trade costs $\tau_{ij}^k$ must be. Let’s call this the ‘residual approach’.

- Head and Ries (2001) propose a way to do this:
  - Suppose that intra-national trade is free: $\tau_{ii}^k = 1$. This can be thought of as a normalization of all trade costs (eg assume that AvW (2004)’s ‘distributional retail/wholesale costs’ apply equally to domestic goods and international goods (after the latter arrive at the port).
  - And suppose that inter-national trade is symmetric: $\tau_{ij}^k = \tau_{ji}^k$.
  - Then we have the ‘phi-ness’ of trade:
    \begin{equation}
    \phi_{ij}^k \equiv (\tau_{ij}^k)^{1-\varepsilon^k} = \frac{X_{ij}^k X_{ji}^k}{X_{ii}^k X_{jj}^k}
    \end{equation}

- There are some drawbacks of this approach:
  - We have to be able to measure internal trade, $X_{ii}^k$. (You can do this if you observe gross output or final expenditure in each $i$ and $k$, and re-exporting doesn’t get misclassified into the wrong sector.)
  - We have to know $\varepsilon$. (But of course when we’re inferring prices from quantities it seems impossible to proceed without an estimate of supply/demand elasticities, i.e. the trade elasticity $\varepsilon$.)
4.1.1 Estimating $\tau_{ij}^k$ from the Gravity Equation: ‘Determinants Approach’

- A more common approach to measuring $\tau_{ij}^k$ is to give up on measuring the full $\tau$, and instead parameterize $\tau$ as a function of observables.

- The most famous implementation of this is to model TCs as a function of distance ($D_{ij}$):
  - $\tau_{ij}^k = \beta D_{ij}^\rho$.
  - So we give up on measuring the full set of $\tau_{ij}^k$'s, and instead estimate just the elasticity of TCs with respect to distance, $\rho$.
  - How do we know that trade costs fall like this in distance? Eaton and Kortum (2002) use a spline estimator.

- But equally, one can imagine including a whole host of $m$ ‘determinants’ $z(m)$ of trade costs:
  - $\tau_{ij}^k = \Pi_m(z(m)_{ij}^k)^{\rho_m}$.

- This functional form doesn’t really have any microfoundations (that I know of).
  - But this functional form certainly makes the estimation of $\rho_m$ in a gravity equation very straightforward.
4.2 Anderson and van Wincoop (AER, 2003)

- An important message about how one actually estimates the gravity equation was made by AvW (2003).
- Suppose you are estimating the general gravity model:
  \[
  \ln X_{ij}^k(\tau, E) = A_{ij}^k(\tau, E) + B_{ij}^k(\tau, E) + \epsilon^k \ln \tau_{ij}^k + \nu_{ij}^k. \tag{2}
  \]
- You assume \( \tau_{ij}^k = \beta D_{ij}^k \) and try to estimate \( \rho^k \).
  - Aside: Note that you can’t actually estimate \( \rho^k \) here! All you can estimate is \( \delta^k \equiv \epsilon^k \rho^k \). But with outside information on \( \epsilon^k \) (in some models it is the CES parameter, which maybe we can estimate from another study) you can back out \( \epsilon^k \).
- You are estimating the general gravity model:
  \[
  \ln X_{ij}^k(\tau, E) = A_{ij}^k(\tau, E) + B_{ij}^k(\tau, E) + \epsilon^k \ln \tau_{ij}^k + \nu_{ij}^k. \tag{3}
  \]
  - Note how \( A_{ij}^k \) and \( B_{ij}^k \) (which are equal to \( Y_{ij}^k(\Pi_{ij}^k)^{\epsilon^k-1} \) and \( E_{ij}^k(P_{ij}^k)^{\epsilon^k-1} \) respectively in the AvW (2004) system) depend on \( \tau_{ij}^k \) too.
  - Even in an endowment economy where \( Y_{ij}^k \) and \( E_{ij}^k \) are exogenous this is a problem. The problem is the \( P_{ij}^k \) and \( \Pi_{ij}^k \) terms.
  - These terms are the price index, which is very hard to get data on.
  - So a naive regression of \( X_{ij}^k \) on \( E_{ij}^k \), \( Y_{ij}^k \) and \( \tau_{ij}^k \) is usually performed (this is AvW’s ‘traditional gravity’) instead.
  - AvW (2003) pointed out that this is wrong. The estimate of \( \rho \) will be biased by OVB (we’ve omitted the \( P_{ij}^k \) and \( \Pi_{ij}^k \) terms and they are correlated with \( \tau_{ij}^k \)).
- How to solve this problem?
  - AvW (2003) propose non-linear least squares:
    * The functions \( (\Pi_{ij}^k)^{1-\epsilon^k} \equiv \sum_j \left( \frac{\tau_{ij}^k}{\tau_{ij}^k} \right)^{1-\epsilon^k} \frac{E_{ij}^k}{Y_{ij}^k} \) and \( (P_{ij}^k)^{1-\epsilon^k} \equiv \sum_i \left( \frac{\tau_{ij}^k}{\tau_{ij}^k} \right)^{1-\epsilon^k} \frac{Y_{ij}^k}{\sum_{i} Y_{ij}^k} \) are known.
    * These are non-linear functions of the parameter of interest (\( \rho \)), but NLS can solve that.
  - A simpler approach (first in Harrigan (1996)) is usually pursued instead though:
    * The terms \( A_{ij}^k(\tau, E) \) and \( B_{ij}^k(\tau, E) \) can be partialled out using \( \alpha_i^k \) and \( \alpha_j^k \) fixed effects.
* Note that (ie avoid what Baldwin and Taglioni call the ‘gold medal mistake’) if you’re doing this regression on panel data, we need separate fixed effects $\alpha_i^k$ and $\alpha_j^k$ in each year $t$.

- This was an important general point about estimating gravity equations
  - And it is a nice example of general equilibrium empirical thinking.

- But AvW (2003) applied their method to revisit McCallum (AER, 1995)’s famous argument that there was a huge ‘border’ effect within North America:
  - This is an additional premium on crossing the border, controlling for distance.
  - Ontario appears to want to trade far more with Alberta (miles away) than New York (close, but over a border).

- The problem is that, as AvW (2003) showed, McCallum (1995) didn’t control for the endogenous terms $A_i^k(\tau, E)$ and $B_j^k(\tau, E)$.

---

4.2.1 Other elements of Trade Costs

- Many determinants of TCs have been investigated in the literature.

- AvW (2004) summarize these:
  - Tariffs, NTBs, etc.
  - Transportation costs (directly measured). Roads, ports. (Feyrer (2009) on Suez Canal had this feature).
  - Currency policies.
  - Being a member of the WTO.
  - Language barriers, colonial ties.
  - Information barriers. (Rauch and Trindade (2002)).
  - Contracting costs and insecurity (Evans (2001), Anderson and Marcoulier (2002)).
  - US CIA-sponsored coups. (Easterly, Nunn and Sayananth (2010)).

- Aggregating these trade costs together into one representative number is not trivial (assuming the costs differ across goods).
  - Anderson and Neary (2005) have outlined how to solve this problem (conditional on a given theory of trade).

---

**Table 2—Estimation Results**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Two-country model</th>
<th>Multicountry model</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(1 - \sigma)p$</td>
<td>-0.79 (0.03)</td>
<td>-0.82 (0.03)</td>
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<tr>
<td>$(1 - \sigma)\ln b_{US,CA}$</td>
<td>-1.65 (0.08)</td>
<td>-1.59 (0.08)</td>
</tr>
<tr>
<td>$(1 - \sigma)\ln b_{US,ROW}$</td>
<td>-1.68 (0.07)</td>
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<td>$(1 - \sigma)\ln b_{CA,ROW}$</td>
<td>-2.31 (0.08)</td>
<td></td>
</tr>
<tr>
<td>$(1 - \sigma)\ln b_{ROW,ROW}$</td>
<td>-1.66 (0.06)</td>
<td></td>
</tr>
</tbody>
</table>

**Average error terms:**

- US–US: 0.06
- CA–CA: -0.17
- US–CA: -0.05

**Notes:** The table reports parameter estimates from the two-country model and the multicountry model. Robust standard errors are in parentheses. The table also reports average error terms for interstate, interprovincial, and state–province trade.

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4.3 A Concern About Identification

- The above methodology identified tau (or its determinants) only by assuming trade separability. This seems potentially worrying.

- In particular, there is a set of taste or technology shocks that can rationalize any trade cost vector you want.
  
  - Eg if we allowed each country $i$ to have its own taste for varieties of $k$ that come from country $j$ (this would be a ‘demand shock’ shifter in the utility function for $i$, $a_{ij}^k$) then this would mean everywhere we see $\tau_{ij}^k$ above should really be $\tau_{ij}^k a_{ij}^k$
  
  - In general $a_{ij}^k$ might just be noise with respect to determining $\tau_{ij}^k$. But if $a_{ij}^k$ is spatially correlated, as $\tau_{ij}^k$ is (when, for example, we are projecting $\tau$ on distance), then the estimation of $\tau$ would be biased.

- To take an example from the Crozet and Koenigs (2009) maps, do Alsaciens trade more with Germany (relative to how the rest of France trades with Germany) because:
  
  - They have low trade costs (proximity) for getting to Germany?
  
  - They have tastes for similar goods?
  
  - There is no barrier to factor mobility here. German barbers might even cut hair in France.
  
  - Integrated supply chains choose to locate near each other.
Ellison, Glaeser and Kerr (AER, 2009) look at this ‘co-agglomeration’ in the US.

Hummels and Hilberry (EER, 2008) look at this on US trade data by checking whether imports of a zipcode’s goos are correlated with the upstream input demands of that zipcode’s industry-mix.

Rossi-Hansberg (AER, 2005) models this on a spatial continuum where a border is just a line in space.

Yi (JPE, 2003) looks at this. And Yi (AER, 2010) argues that this explains much of the ‘border effect’ that remains even in AvW (2003).
4.4 Puzzling Findings from Gravity Equations

- Trade costs seem very large.
- The decay with respect to distance seems particularly dramatic.
- The distance coefficient has not been dying.
- One sees a distance and a ‘border’ effect on eBay too:
  - Hortascu, Martinez-Jerez and Douglas (AEJ 2009).
4.4.1 The exaggerated death of distance?

4.5 Consequences of Supply Chains for Estimating Trade Costs via Gravity

- We now discuss some of the consequences of international fragmentation for the study of trade flows.

1. Yi (JPE 2003): The possibility of international fragmentation raises the trade-to-tariff elasticity.


4.6 Yi (2003)

- Yi (2003) motivates his paper with 2 puzzles:

  1. The trade flow-to-tariff elasticity in the data is way higher than what standard models predict.
  2. The trade flow-to-tariff elasticity in the data appears to have become much higher, non-linearly, around the 1980s. Why?

- Yi (2003) formulates and calibrates a 2-country DFS (1977)-style model with and without ‘vertical specialization’ (ie intermediate inputs are required for production, and these are tradable).
  - The model without VS fails to match puzzles 1 or 2.
– The calibrated model with VS gets much closer.
– Intuition for puzzle 1: if goods are crossing borders $N$ times then it is not the tariff $(1 + \tau)$ that matters, but of course $(1 + \tau)^N$ instead.
– Intuition for puzzle 2: if tariffs are very high then countries won’t trade inputs at all. So the elasticity will be initially low (as if $N = 1$) and then suddenly higher (as if $N > 1$).

4.6.1 Simplified Version of Model

• Production takes 3 stages:
  1. $y_1^i(z) = A_1^i(z)l_1^i(z)$ with $i = H, F$. Inputs produced.
  2. $y_2^i(z) = x_1^i(z)^\theta [A_2^i(x)l_2^i(z)]^{1-\theta}$ with $i = H, F$. Sector uses inputs to produce final goods. Inputs $x_1$ are the output of sector 1.
  3. $Y = \exp \left[ \int_0^1 \ln [x_2(z)] \, dz \right]$. Final (non-tradable) consumption good is Cobb-Douglas aggregate of Stage 2 goods.

• If VS is occurring (ie $\tau$ is sufficiently low) then let $z_l$ be the cut-off that makes a Stage 3 firm indifferent between using a “HH” and a “HF” upstream organization of production.
  – This requires that: $\frac{w_H}{w_F} = (1 + \tau)^{(1+\theta)/(1-\theta)} A_2^H(z_l)/A_2^F(z_l)$.
  – Differentiating and assuming that the relative wage doesn’t change much:

$$1 - z_l = \frac{1 + \theta}{1 - \theta} \left[ \frac{z_l}{(1 - z_l)\eta A_2} \right] 1 + \tau$$
• However, if VS is not occurring (ie \( \tau \) is high) then:
  
  – This requires \( \frac{\partial H}{\partial \tau} = (1 + \tau)A_2^H(z_l)/A_2^F(z_l) \).
  
  – So the equivalent derivative is:
    \[
    1 - z_l = \left[ \frac{z_l}{(1 - z_l)\eta A_2} \right] 1 + \tau
    \]

• For \( \theta < 1 \) (eg \( \theta = \frac{2}{3} \)) the multiplier in the VS can be quite big (eg 5).

![Graph: Export share of GDP vs Tariffs]

Fig. 10.—Narrow case: vertical model vs. one-stage model

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4.7 Yi (AER, 2010)

• Yi (2010) points out that the Yi (2003) VS argument also has implications for cross-sectional variation in the trade elasticities
  
  – Recall that estimates of the gravity equation (eg Anderson and van Wincoop, 2003) within the US and Canada find that there appears to be a significant additional trade cost involved in crossing the US-Canada border. The tariff equivalent of this border effect is much bigger than US-Canada tariffs.
  
  – This is called the ‘border effect’ or the ‘home bias of trade’ puzzle.

• Yi (2010) argues that if production can be fragmented internationally then the (gravity equation-) estimated border-crossing trade cost will be higher than the true border-crossing trade cost.
– This is because (in such a model) the true trade flow-to-border cost elasticity will be larger than that in a standard model (without multi-stage production).

4.7.1 Results

• Yi (2010) uses data on tariffs, NTBs, freight rates and wholesale distribution costs to claim that the ‘true’ Canada-US border trade costs are 14.8%.

• He then simulates (a calibrated version of) his model based on this ‘true’ border cost.

• He then compares the border dummy coefficient in 2 regressions:
  – A gravity regression based on his model’s predicted trade data.
  – And the gravity regression based on actual trade data.

• The coefficient on the model regression is about 2/3 of the data regression. A trade cost of 26.1% would be needed for the coefficients to match.
  – By contrast, a standard Eaton and Kortum (2002) model equivalent (without multi-stage production) would give much smaller coherence between model and data.