Session 1: Measuring Trade Costs using Inverse Gravity

Ben Shepherd

Principal, Developing Trade Consultants Ltd.

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Outline

Introduction

- Thus far, we've focused on estimating the parameters of the gravity model using econometric techniques.
- This approach gives us:
  - Estimated elasticities of trade with respect to particular factors we are interested in.
  - The ability to test whether different types of trade respond more or less strongly to particular factors.
  - Some simple ways of analyzing trade propensities (using zero-corrected gravity models).

Introduction

- But gravity is not only a bed of roses.
  - There is never any guarantee that we have included all relevant trade cost variables in the model. The risk of omitted variables bias is ever-present.
  - Gravity with policy variables is data intensive, and thus difficult to do over extended time periods and across a wide range of (rich and poor) countries.
  - Elasticity estimates are always subject to uncertainty. When they are strongly correlated–as with trade facilitation policies–the uncertainty can be very large. Estimates can be difficult to interpret and use.
- It would be nice to have a complementary way of looking at the data...

Outline

The Inverse Gravity Model

- In a series of papers, Dennis Novy and co-authors have developed just such a methodology. Since it is derived by (essentially) flipping the gravity model on its head, it is sometimes referred to as the "inverse gravity model" (or, more unkindly, the "levity" model–hat tip to Peter Neary).
- They develop a general measure of international trade costs–i.e., the cost of moving goods between countries i and j relative to the cost of selling goods domestically.
- Their measure is an index of average trade costs between two countries, based on trade costs in both directions ($i \rightarrow j$ and $j \rightarrow i$). It can easily be converted to an ad valorem tariff equivalent.

The Inverse Gravity Model

Advantages of the inverse gravity model

- It is theoretically rigorous, with micro-foundations from a number of common gravity models, including “gravity with gravitas”.
- It has relatively limited data requirements.
- It relies largely on theory and numerical decompositions. The basic implementation does not require any econometrics at all!

The Inverse Gravity Model

Disadvantages of the inverse gravity model

- The data upon which the trade cost index is based are subject to noise (measurement error). So the index itself is subject to some degree of uncertainty, just like traditional gravity model estimates.
- A simple version of the model can be implemented using widely available data. But the preferred version requires data that can be difficult to obtain in many poorer countries.
- To answer policy questions, we still need to resort to econometrics to examine the determinants of trade costs.

Outline

Where does Inverse Gravity Come From?

1. Start with the AvW model.
2. Solve it for the product of the multilateral resistance terms.
3. Combine the gravity models for x_{ij} and x_{ji}, then substitute from 2.
4. Solve for trade costs, take the geometric average, and calculate the trade costs index τ_{ij}.

The Trade Costs Index

- All the algebra and re-arranging gives:

$$\tau_{ij} = \left(\frac{t_{ij} t_{ji}}{t_{ii} t_{jj}} \right)^{\frac{1}{2}} = \left(\frac{x_{ii} x_{jj}}{x_{ij} x_{ji}} \right)^{\frac{1}{2(\sigma-1)}}$$

- τ_{ij} is the geometric average of international trade costs for $i \rightarrow j$ and $j \rightarrow i$.
- x_{ij} and x_{ji} are exports in each direction.
- x_{ii} and x_{jj} are domestic production in each country.
- σ is the intra-sectoral elasticity of substitution.

Ad Valorem Trade Costs

- We can easily use τ_{ij} to calculate an ad valorem equivalent of bilateral trade costs, τ_{ij}^{AV}:

$$\tau_{ij}^{AV} = \tau_{ij} - 1 = \left(\frac{x_{ii} x_{jj}}{x_{ij} x_{ji}} \right)^{\frac{1}{2(\sigma-1)}} - 1$$

- Note that once we have the data for all the variables in the formula, we can simply calculate (not estimate) it.

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Data Requirements

- Exports in each direction (x_{ij} and x_{ji}) are just standard trade data, and easy to get.
- Domestic production (x_{ii} and x_{jj}) is harder to get. Note that it is not value added.
  - National accounts data.
  - Convert industry classifications to trade classifications.
  - Try to deal with the (frequent) inconsistencies between trade and production data, even in rich countries.

Data Requirements

- An alternative (more approximate) version of the trade costs formula (Novy, 2007) is:

$$\tau_{ij}^{AV} = 1 - \left(\frac{x_{ij} x_{ji}}{(y_i - X_i)(y_j - X_j) s^2} \right)^{\frac{1}{2(\sigma-1)}}$$

- y_i and y_j are GDP in each country.
- X_i and X_j are total exports from each country, i.e. summed across all trading partners.
- s is the share of tradables in GDP. A reasonable assumption is $s = 0.8$.

Data Requirements

- The elasticity of substitution (σ) could be plugged in for different countries and sectors using data from Broda and Weinstein (2006, QJE).
- In practice, though, we generally just make an assumption.
  - $\sigma = 8$ is a rough average from previous work.
  - $\sigma = 11$ seems like a decent benchmark, as it implies a 10% markup in the monopolistic competition model underlying most gravity models.
- The choice of σ is important for calculating τ_{ij}^{AV}: a higher σ means more homogeneous goods, means more price sensitive consumers, means lower inferred trade costs.
- The choice of σ matters much less for comparing τ_{ij} across countries or through time, i.e. using it as an index number.

Outline

Determinants of Trade Costs

- Inverse gravity gives us an omnibus measure of trade costs.
- How can we use that measure to look at the impacts of different policy factors on trade costs?
- Now we are back to a regression problem: τ_{ij}^{AV} is the dependent variable, and we can use distance, tariffs, trade facilitation, and all the other gravity variables to try and account for cross-country and through-time variation in trade costs.

Outline

The Long Term: Novy et al. (2008, AER)

FIGURE 1A. TRADE COST INDICES, 1870–1913 (1870 = 100)

The Long Term: Novy et al. (2008, AER)

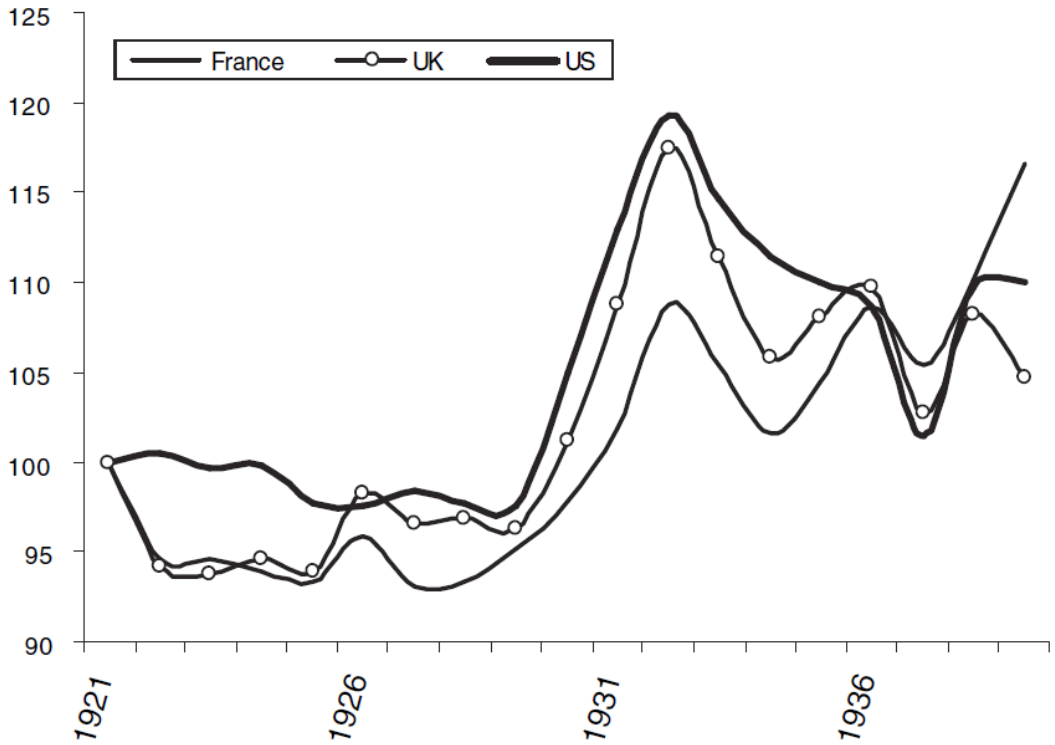


FIGURE 1B. TRADE COST INDICES, 1921–1939 (1921 = 100)

The Long Term: Novy et al. (2008, AER)

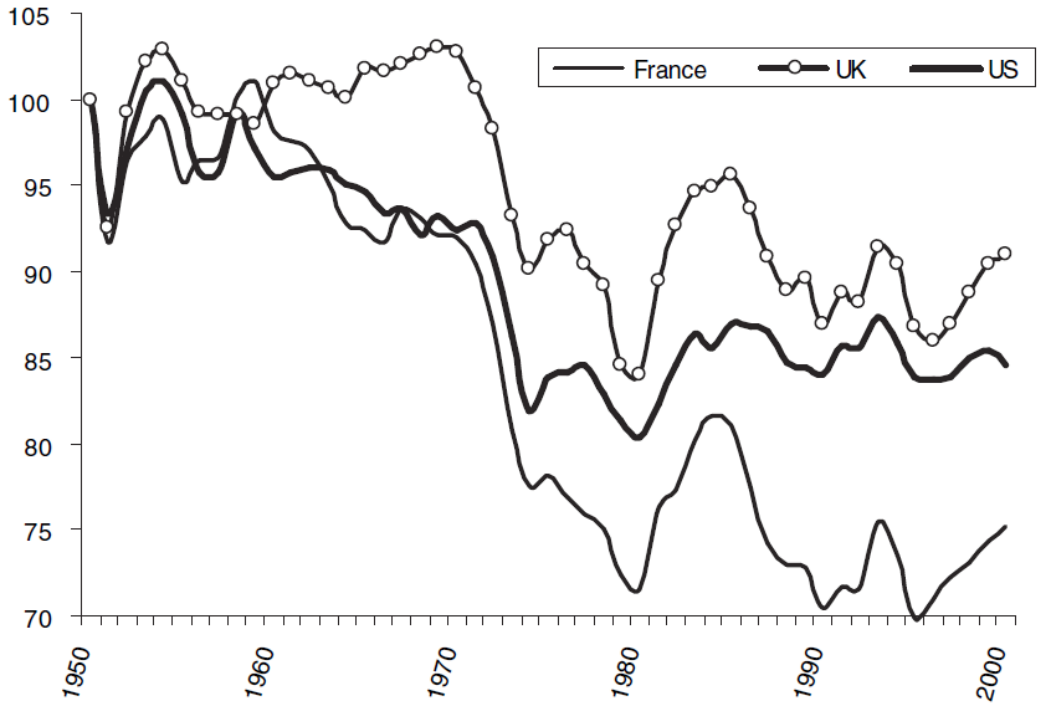


FIGURE 1C. TRADE COST INDICES, 1950–2000 (1950 = 100).

Outline

Determinants of Trade Costs: Novy & Chen (2008)

Dependent Variable: $\log\left(\tau_{ij}^{AV}\right)$

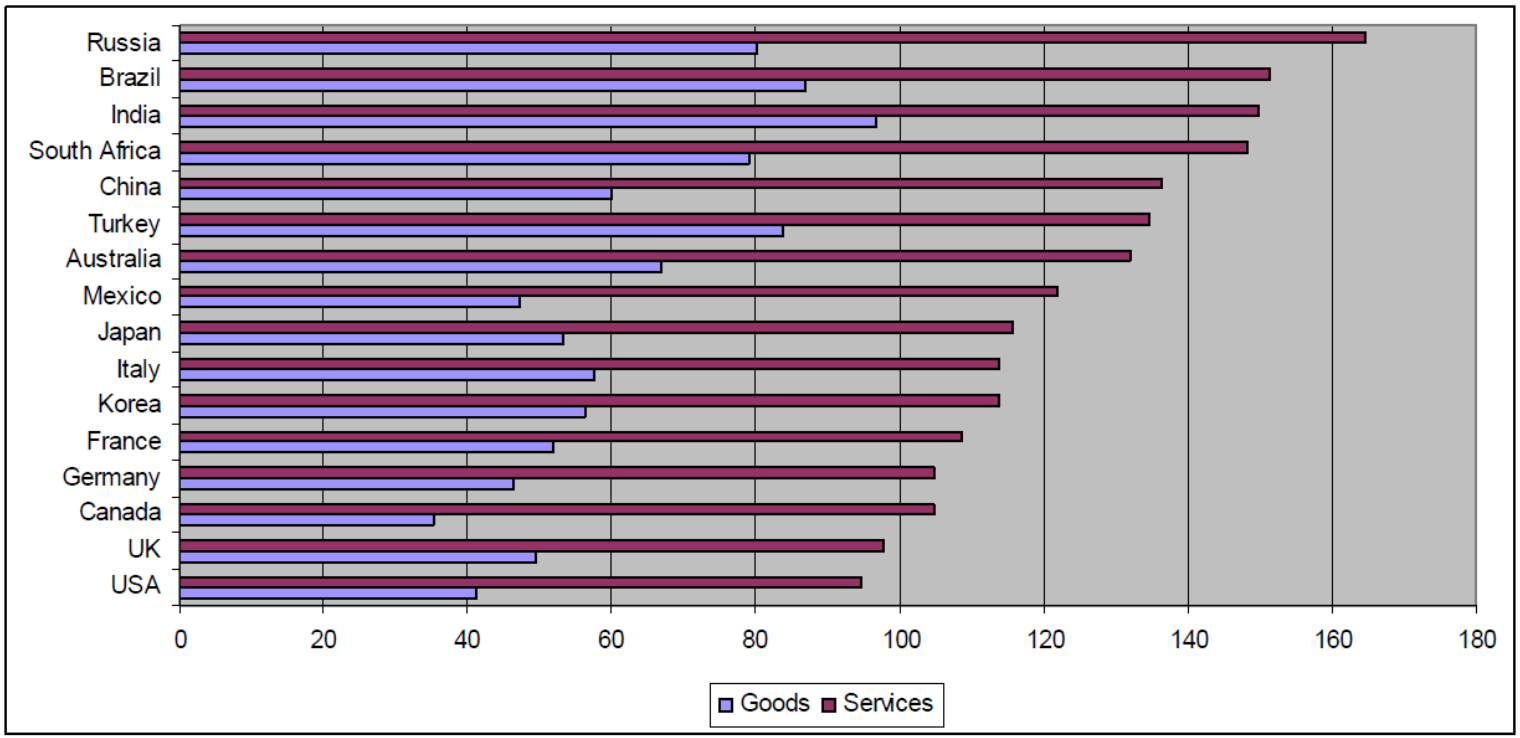
Table 3: The Determinants of EU Trade Integration

	(1)	(2)	(3)	(4)	(5)	(6)
Geography/Transport Costs						
$\ln D_{ij}$	0.583^{a} (28.378)	0.515^{a} (23.296)	0.530^{a} (24.799)	0.483^{a} (21.420)	0.495^{a} (22.074)	0.506^{a} (22.806)
$\ln(D_{ii} \times D_{jj})$	-0.930^{a} (-11.973)	-0.945^{a} (-11.381)	-0.990^{a} (-12.247)	-0.923^{a} (-11.323)	-0.928^{a} (-11.672)	-0.969^{a} (-12.354)
Adj_{ij}	-0.063^{a} (-2.810)	-0.051^{b} (-2.218)	-0.044^{c} (-1.939)	-0.068^{a} (-2.917)	-0.061^{a} (-2.625)	-0.055^{b} (-2.428)
$Lang_{ij}$	-0.201^{a} (-4.854)	-0.355^{a} (-8.109)	-0.353^{a} (-7.995)	-0.363^{a} (-8.186)	-0.369^{a} (-8.432)	-0.368^{a} (-8.331)
$\ln cfob_{t}^{k}$	0.030^{a} (5.464)	0.030^{a} (6.152)	0.031^{a} (6.294)	0.030^{a} (6.146)	0.015^{a} (3.291)	0.016^{a} (3.400)
$\ln wv_{t}^{k}$	0.719^{a} (5.973)	0.631^{a} (6.414)	0.642^{a} (6.459)	0.648^{a} (6.698)	0.664^{a} (6.833)	0.673^{a} (6.854)
Policy Variables						
FI, AT_{ij}	–	0.199^{a} (11.215)	0.187^{a} (10.666)	0.233^{a} (12.376)	0.228^{a} (12.331)	0.220^{a} (11.851)
$noEURO_{ij,t}$	–	0.042^{a} (3.108)	0.032^{b} (2.388)	0.040^{a} (2.906)	0.036^{a} (2.704)	0.027^{b} (2.072)
$Schengen_{ij,t}$	–	-0.137^{a} (-5.443)	-0.118^{a} (-4.774)	-0.135^{a} (-4.914)	-0.132^{a} (-4.954)	-0.113^{a} (-4.302)
$\ln TBT_{ij}^{k}$	–	0.142^{a} (2.822)	–	0.146^{a} (2.721)	0.131^{b} (2.434)	–
TBT^{k}	–	–	0.057^{b} (2.156)	–	–	0.056^{b} (1.967)
$\ln Proc_{ij,t}^{k}$	–	-0.573^{c} (-1.886)	-0.528^{c} (-1.738)	-0.963^{a} (-2.729)	-0.917^{b} (-2.564)	-0.892^{b} (-2.495)
$\ln VAT_{ij}^{k}$	–	-2.282^{a}	-2.290^{a}	-2.259^{a}	-1.910^{a}	-1.931^{a}

Outline

G-20 Goods and Services: Miroudot & Shepherd (2009)

Figure 2: Trade costs in goods and services, 2000 (ad valorem equivalent).



G-20 Goods and Services: Miroudot & Shepherd (2009)

Figure 4: Changes in trade costs facing goods producers and service providers, 2000-2005 (ad valorem equivalent).

Summary

- The inverse gravity model provides a simple way of computing an all-inclusive measure of trade costs across countries and through time.
- The trade costs measure is micro-founded: it is derived by, approximately, flipping the AvW model on its head. It can be derived in a similar way from a number of other popular trade models.
- A trade costs index and its ad valorem equivalent can be calculated quickly, and with minimal data requirements.

Summary

- Trade costs calculated using inverse gravity are sensitive to the assumed value of the intra-sectoral elasticity of substitution. But this is much less of an issue when looking at changes through time.
- Econometrics still rears its (ugly?) head: if we want to know more about the determinants of trade costs, not just their level and changes, then we need all the usual policy data, and we will have to obtain coefficient estimates in the usual way.
- On balance: an extremely useful tool for policy work, and a nice complement to traditional gravity modeling.