# Graduate Trade (II): ECON 8433

Sergey Nigai
University of Colorado Boulder
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# Plan

| Week | Topic |
| --- | --- |
| Week 1 | Introduction to Structural Gravity Equation |
| Week 2 | Calibration and Estimation |
| Week 3 | Mapping Models to the Data |
| Week 4 | Designing Counterfactual Experiments in General Equilibrium |
| Week 5 | Presentations (I) and Catch-up |
| Week 6 | Heterogeneous Firms (I) |
| Week 7 | Heterogeneous Firms (II) |
| Week 8 | Ricardian Models |
| Week 9 | Multi-Sector Models |
| Week 10 | Global Value Chains |
| Week 11 | Presentations (II) and Catch-up |
| Week 12 | Extensions: Demand Side |
| Week 13 | Extensions: Supply Side |
| Week 14 | Extensions: Migration and Geography |
| Week 15 | Presentations (III) and Catch-up |

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# One-sector models

So far, we have focused on one-sector models of international trade:

- Anderson and van Wincoop (2003)
- Eaton and Kortum (2002)
- Melitz (2003)

Under certain parametric assumptions about technology:

- The models are isomorphic
- The welfare gains from trade can be measured as $G_j = \lambda_{jj}^{-\frac{1}{\epsilon}}$

# One-sector models

- Isomorphic one-sector models generally predict that the welfare gains from trade relative to autarky are moderate at best
- For example, according to Arkolakis, Costinot and Rodriguez-Clare (2012), in " ... the United States for the year 2000, the import penetration ratio was 7 percent, which implies $\lambda = 0.93$. ... Applying the previous formula ... implies gains from trade ranging from 0.7 to 1.4 percent".

What are the reasons behind these arguably negligible welfare gains?

- Caliendo and Parro (2014) and Ossa (2015) argue that the main driver behind the results above is the assumption of a single sector.
- Input-output linkages across sectors magnify the welfare gains from trade and account for the rich patterns of national and international supply chains.

# Multi-sector models

- Multi-sector and multi-country models of trade are on the frontier of quantitative trade models
- We will spend the next 4 classes:
  - Understanding the set-up
  - Calibrating/estimating parameters of the model
  - Conducting counterfactual experiments
- Today: Understanding the set-up and data prep.
- Wednesday: Calibration & first part of the solution

# Multi-sector model

The set-up mostly follows Caliendo and Parro (2014):

- There are $S$ countries in the world, each endowed with $L_i$ unit of labor
- There are $J$ sectors. Labor is mobile across sectors within each country but not across countries. What does it imply?
- Markets are perfectly competitive as in EK (2002)
- Countries differ in productivity levels in every sector as in EK (2002)
- There are input-output linkages such that the output of one sectors is used as inputs in all other sectors
- There are (potentially) two types of trade barriers: iceberg trade costs and tariffs

# Consumption

The utility function has two tiers. The upper-tier is a Cobb-Douglas aggregate:

$$U(C_i) = \prod_j (Q_i^j)^{\alpha_i^j} \text{ such that } \sum_j \alpha_i^j = 1$$

Consumers maximize this utility function given their income $I_i$ which includes labor income, transfers from other countries, and (potentially) rebates from tariff revenues.

Each $(Q_i^j)$ is a CES-type aggregate which is defined as:

$$Q_i^j = \left( \int r_n^j(\omega^j)^{1-1/\sigma^j} d\omega^j \right)^{\sigma^j/(\sigma^j-1)}$$

# Production

Within each sector, production is as in EK (2002). The cost function is defined as:

$$c_i^j = \Gamma_i^j w_i^{\gamma_i^j} \prod_k (P_i^k)^{\eta_i^{k,j}},$$

where

- $\Gamma_i^j$ is a constant
- $w_i$ is wage in country $i$
- $\gamma_i^j$ is the value-added parameter
- $\eta_i^{k,j}$ is the share of materials in sector $k$ used in the production in sector $j$ such that $\sum_k \eta_i^{k,j} = 1 - \gamma_i^j$.

Note that a change in the price of output of any sector affects the costs in all other sectors via $\eta_i^{k,j}$!

# International Trade and Prices

Within each sector, production is as in EK (2002), which means that the price of a variety $\omega^j$ in country $i$ is:

$$p_i^j(\omega^j) = \min_n \left\{ \frac{c_n^j \tau_{ni}^j}{z_n^j(\omega_n^j)} \right\}$$

As in EK (2002), assume that $z_n^j$ is drawn from a country-sector-specific Frechet distribution with the location parameter $\lambda_i^j$ and dispersion parameter $\omega^j$. Then the price of the CES composite can be defined as:

$$P_i^j = A^j \left( \sum_n \lambda_n^j (c_n^j \tau_{ni}^j)^{-\theta^j} \right)^{-\frac{1}{\theta^j}},$$

where $A^j$ is a constant.

# International Trade and Prices

We can also derive the trade shares for each sector $j$ as:

$$\pi_{in}^{j} = \frac{\lambda_i^j (c_i^j \tau_{in}^j)^{-\theta^j}}{\sum_\ell \lambda_\ell^j (c_\ell^j \tau_{\ell n}^j)^{-\theta^j}}$$

In nominal terms, the trade flow from $i$ to $n$ in sector $j$ is:

$$X_{in}^j = \pi_{in}^j Y_n^j,$$

where $Y_n^j$ is $n$'s total expenditure on goods produced in sector $j$.

# Total expenditure

Total expenditure includes intermediate and final demand:

$$Y_i^j = \sum_k \eta_i^{j,k} \sum_n \pi_{in}^k Y_n^k + \alpha_i^j I_i,$$

where $I_i = L_i w_i + D_i$. Here $D_i$ is the exogenous trade deficit (defined as total imports net of total exports). The trade balance condition is:

$$\sum_j \sum_n \pi_{ni}^j Y_i^j - D_i = \sum_j \sum_n \pi_{in}^j Y_n^j$$

# Calibration

- In general, it would be challenging to estimate all primitives of a multi-country, multi-industry model of trade
- Instead, it has become a convention to use the hat algebra approach. Recall the following identity for an arbitrary variable $a$:

  $$\widehat{a} = \frac{a'}{a},$$

  where $a'$ is a counterfactual value of $a$
- We will rewrite the model in *hat* terms

# Calibration

$$\widehat{c}_i^j = \widehat{w}_i^{\gamma_i^j} \prod_k (\widehat{P}_i^k)^{\eta_i^{k,j}} \tag{1}$$

$$\widehat{P}_i^j = \left( \sum_n \pi_{ni} (\widehat{c}_n^j \widehat{\tau}_{ni}^j)^{-\theta^j} \right)^{-\frac{1}{\theta^j}} \tag{2}$$

$$\pi_{in}^{j'} = \pi_{in}^j \left( \frac{\widehat{c}_i^j \widehat{\tau}_{in}^j}{\widehat{P}_n^j} \right)^{-\theta^j} \tag{3}$$

$$Y_i^{j'} = \sum_k \eta_i^{j,k} \sum_n \pi_{in}^{k'} Y_n^{k'} + \alpha_i^j I_i' \tag{4}$$

$$I_i' = (L_i w_i) \widehat{w}_i + D_i \tag{5}$$

$$D_i = \sum_j \sum_n \pi_{ni}^{j'} Y_i^{j'} - \sum_j \sum_n \pi_{in}^{j'} Y_n^{j'} \tag{6}$$