Welfare Analysis: *Part I*

International Trade (PhD), Fall 2019

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General Setup

- Many countries: $i = 1, \ldots, N$
- Country i is endowed with L_i units of labor.
- Each country supplies a composite good produced with only labor.
- P_{ji} is the price index of the good supplied by country j to market i.

General Formula for Welfare Analysis

- The representative consumer's problem

$$V_i(Y_i, \mathbf{P}_i) \equiv \max_{\mathbf{Q}_i} U_i(Q_{1i}, ..., Q_{Ni})$$

$$\text{s.t.} \quad \sum_{j=1}^{N} P_{ji} Q_{ji} = Y_i$$

- Invoking envelope conditions $\Longrightarrow$ the change in Country i's welfare, $W_i \equiv V_i(.)$, in response to a policy change is given by

$$d \ln W_i = \frac{\partial \ln V_i(.)}{\partial \ln Y_i} \left\{ d \ln Y_i - \sum_{j=1}^{N} \lambda_{ji} d \ln P_{ji} \right\}$$

where $\lambda_{ji} \equiv P_{ji} Q_{ji} / Y_i$ is the share of expenditure on country j goods.

General Formula for Welfare Analysis

- Some policies (e.g., import tariffs, domestic subsidies) raise/exhaust revenue, in which case $d \ln Y_i \neq 0$.

- This lecture focuses on the reduction in *non-revenue-raising* iceberg trade costs: $d\boldsymbol{\tau} \equiv \{d\tau_{ji}\} \Longrightarrow d \ln Y_i = 0$ by choice of numeraire ($w_i = 1$).

- Assuming $\partial \ln V_i(.)/\partial \ln Y_i = 1$,[1] the change in welfare is given by

$$d \ln W_i = -\sum_{j=1}^{N} \lambda_{ji} d \ln P_{ji}$$

General Formula for Welfare Analysis

$$d \ln W_i = - \sum_{j=1}^{N} \lambda_{ji} d \ln P_{ji}$$

- The above formula is conceptually helpful, but difficult to implement.
- Suppose we want to quantify the gains from NAFTA for the US:
  - λ_{ji} is directly observable, but
  - inferring $d \ln P_{ji}$ from observed price changes is difficult, because
    1. prices are affected by non-NAFTA shocks.
    2. to construct P_{ji} we need adjust for changes in quality and variety.

Price Changes from the Lens of Trade Models

- In the class of models we considered, $P_{ji} = P_{ji}(\boldsymbol{w}, \boldsymbol{\tau})$.

- From the perspective of these models

$$d \ln P_{ji}(\boldsymbol{w}, \boldsymbol{\tau}) = \underbrace{\frac{\partial \ln P_{ji}(\boldsymbol{w}, \boldsymbol{\tau})}{\partial \ln \boldsymbol{\tau}} d\ln\boldsymbol{\tau}}_{\text{direct effect}} + \underbrace{\frac{\partial \ln P_{ji}(\boldsymbol{w}, \boldsymbol{\tau})}{\partial \ln \boldsymbol{w}} \frac{\partial \ln \boldsymbol{w}}{d \ln \boldsymbol{\tau}} d\ln\boldsymbol{\tau}}_{\text{GE wage effects}}$$

Welfare Gains with CES

- If we assume CES preferences, $\lambda_{ji}/\lambda_{ii} = \left(P_{ji}/P_{ii}\right)^{1-\sigma}$, then

$$d\ln P_{ji} = \frac{1}{1-\sigma}(d\ln\lambda_{ji} - d\ln\lambda_{ii}) + d\ln P_{ii}$$

- Plugging $d\ln P_{ji}$ back into the welfare formula yields

$$\begin{aligned} d\ln W_i &= -\sum_{j=1}^{N}\lambda_{ji}\left(\frac{1}{1-\sigma}(d\ln\lambda_{ji} - d\ln\lambda_{ii}) + d\ln P_{ii}\right) \\ &= \frac{1}{1-\sigma}d\ln\lambda_{ii} - d\ln P_{ii}, \end{aligned}$$

where the last line uses (i) $\sum_{j=1}^{N}\lambda_{ji} = 1$, and (ii) $\sum_{j=1}^{N}\lambda_{ji}\mathrm{d}\ln\lambda_{ji} = 0$.

Interpreting the Welfare Gains

- Decomposing the gains from trade liberalization (reduction in τ's):

$$d \ln W_i = \underbrace{\frac{1}{1-\sigma} d \ln \lambda_{ii}}_{\text{differentiated import varieties}} - \underbrace{d \ln P_{ii}}_{\text{efficeincy gains}}$$

- In all the models we covered, a country gains from importing differentiated goods from the rest of the world.

- In some models, trade liberalization makes the country more efficient.

Special Case: *The Armington Model*

– Price indexes in the Armington model:

$$P_{ji} = \tau_{ji} a_j w_j \implies d \ln P_{ii} = 0$$

– The gains from incremental trade liberalization:

$$d \ln W_i = \frac{1}{1-\sigma} d \ln \lambda_{ii}$$

– The gains from trade relative to autarky (indexed A; $\lambda_{ii}^A = 1$):

$$GT_i \equiv W_i / W_i^A = \lambda_{ii}^{\frac{1}{1-\sigma}}$$

Beyond Armington: *Price Indexes*

A general characterization of Price indexes in quantitative trade models

(Costinot and Rodriguez-Clare, 2014):

$$P_{ji} = \tau_{ji} w_j \times \left(\left(\frac{L_i}{f_{ji}} \right)^{\frac{\delta}{1-\sigma}} \frac{\tau_{ji} w_j}{P_i} \right)^{\eta} \times \left(\frac{L_j}{f_j^e} \right)^{\frac{\delta}{1-\sigma}} \times \xi_{ji}$$

- f_{ji}: fixed operating cost
- f_j^e: sunk entry cost
- ξ_{ji} is composed of structural parameters

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- Krugman: $\delta = 1$ and $\eta = 0$
- Eaton-Kortum $\delta = 0$ and $\eta = \left(\frac{\theta}{\sigma-1}\right)\left(1 + \frac{1-\sigma}{\theta}\right)$
- Melitz-Pareto $\delta = 1$ and $\eta = \left(\frac{\gamma}{\sigma-1}\right)\left(1 + \frac{1-\sigma}{\gamma}\right)$

Beyond Armington: *The Gains from Trade*

- Combining (i) the general formula for P_{ii} and (ii) $W_i = w_i/P_i = 1/P_i$
  $\Longrightarrow \mathrm{d}\ln P_{ii} = -\eta \mathrm{d}\ln P_i = -\eta \mathrm{d}\ln W_i$

- Plugging $\mathrm{d}\ln P_{ii} = -\eta \mathrm{d}\ln W_i$ back into the welfare formula implies:

$$\mathrm{d}\ln W_i \;=\; -\frac{1}{\epsilon}\mathrm{d}\ln \lambda_{ii}$$

where ϵ is the ***trade elasticity*** that is defined as

$$\epsilon \equiv -\frac{\partial \ln \frac{\lambda_{ji}}{\lambda_{ii}}}{\partial \ln \tau_{ji}} = -\frac{\partial \ln \frac{\lambda_{ji}}{\lambda_{ii}}}{\partial \ln \frac{P_{ji}}{P_{ii}}}\frac{\partial \ln \frac{P_{ji}}{P_{ii}}}{\partial \ln \tau_{ji}} = (\sigma - 1)(1+\eta)$$

Steps to Compute the Gains from Trade

- We can use data on trade shares, $\{\lambda_{ji}\}$, and trade costs, $\{\tau_{ji}\}$, to estimate ϵ (e.g., *Caliendo and Parro, 2014*).

- Using the estimated ϵ and the observed λ_{ii}, we can compute the gains from trade:

$$\mathrm{GT}_i = \lambda_{ii}^{-\frac{1}{\epsilon}}$$

- The above procedure delivers the same result if we adopt the Armington model or the Melitz-Pareto model.

- Our interpretation of ϵ will depend on our choice of model, but the computed gains will not!

Arkolakis, Costinot, Rodriguez-Clare (2012, AER)

ACR (2012)

- the first to note that different models imply the same gains from trade.
- a byproduct of this argument is that firm-level heterogeneity is inconsequential to the gains from trade.

Two Caveats:

- the unimportance of firm-heterogeneity is an artifact of the Pareto assumption (is it a reasonable assumption?).
- τ_{ji} is often unobservable; so ϵ is estimated using data on tariffs.
  - $\tilde{\epsilon} \equiv$ the elasticity of trade w.r.t. tariffs
  - with firm-heterogeneity, $\epsilon \neq \tilde{\epsilon}$
  - The choice of model determines how the estimated $\tilde{\epsilon}$ maps into ϵ.

Some Number Using Data from 2008 and $\epsilon = 5$

	λ_{ii}	% GT
Ireland	0.68	8%
Belgium	0.70	7.5%
Germany	0.80	4.5%
China	0.88	2.6%
U.S.	0.92	1.8%

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– Based on the above numbers ACR (2012) conclude that gains from trade are *small*.

The Gains from Trade: *Reduced-Form Evidence*

- Reduced-from evidence from Frankel & Romer (1999) indicate that

$$\ln \text{Real GDP}_i = 1.97 \underbrace{(1-\lambda_{ii})}_{\text{OPENNESS}} + \varepsilon_i$$

- If λ_{ii} is small, then $\ln \lambda_{ii} \approx -\frac{1}{2}(1-\lambda_{ii})$
- If we believe that $\epsilon \approx 5 \implies$ reduced-form evidence imply gains that are *20-times* larger than those predicted by quantitative trade models!

The Gains from Trade: *Reduced-Form Evidence*

- The gap between the gains predicted by quantitive trade models and the gains predicted by Frankel and Romer (1999) can be *partially* eliminated if we Account for
  - multiple industries (i.e., eliminate aggregation bias).
  - input-output linkages.
- However, even after adding all the above elements, the gap still persists!