Lecture 3: Gains from trade

Seminario Avanzado de Comercio

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References

- This lecture is based on Arkolakis, Costinot and Rodriguez-Clare (2012), ACR hereafter, and Costinot and Rodriguez-Clare (2014).
  - Please read introduction and sections I and II of ACR!

Preview: Variables to compute gains from trade

- Models with heterogeneous firms have changed the way we think about trade.
- Despite very different economic structure and micro-level behavior, many models deliver the same measure of the gains from trade ****IF**** they deliver the same two key variables:
  - the share of domestic expenditure λ
  - the trade elasticity ε: elasticity of trade to variable transport costs

Ex-ante vs. ex-post evaluations

- **Ex post welfare evaluation:** A class of models delivers a simple way to evaluate the impact on welfare W of various shocks (to population and transport costs):

$$\frac{W'}{W} = \left(\frac{\lambda'}{\lambda}\right)^{\frac{1}{\varepsilon}}$$

  where W and W' are welfare before and after the change.

- **Ex ante welfare evaluation**: when we do not require any information of the counterfactual equilibrium
  - Example: Computing the gains from trade!: easy to predict change in trade share under autarky... see next slide.

Gains from trade

- Focus on a specific shock to trade costs: autarky (transport costs go to ∞): then $\lambda = 1$
- Calculate GFT as change between autarky and current trade patterns: $\lambda_A = 1$ and observed λ_T under trade

$$\frac{W_T - W_A}{W_A} = \left(\frac{\lambda_T}{\lambda_A}\right)^{\frac{1}{\varepsilon}} - 1 = \lambda_T^{\frac{1}{\varepsilon}} - 1$$

using $\varepsilon = -5$ and taking the US in 2000 with import penetration of 7%

$$\frac{W_T - W_A}{W_A} = 0.93^{-\frac{1}{5}} - 1 \simeq 1.4\%$$

- It is tempting to use this simple formula and use it to calculate GFT in a variety of situations

Two very important caveats

- IMPORTANT: some people may use the formula in environments where ACR restrictions do not hold
  - there are some basic and reasonable models that do not satisfy the assumptions in ACR
  - that numerical example offered suggests GFT are small, but other (more realistic) models can deliver much larger GFT (we´ll see this)
- ACR themselves do NOT claim that all those models (which we are about to see) deliver the same GFT
  - to the extent that they deliver the same λ and have the same ε they have the same GFT
  - but in general different models will deliver different changes in λ

Basic result in the Armington model

- Armington model: the simplest quantitative trade model possible with differentiated products.
- Armington assumption: good i is differentiated by origin (country i), n countries
- Labor used one-to-one in production of good i
- Dixit Stiglitz preferences (CES) with price index:

$$P_j = \left[\sum_{i=1}^{n} (w_i \tau_{ij})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

where w_i is wage in country i, τ_{ij} is iceberg transportation cost between country i and country j.

- Value of imports from country i to country j

$$X_{ij} = \left(\frac{w_i \tau_{ij}}{P_j} \right)^{1-\sigma} Y_j \tag{1}$$

where total income $Y_j = \sum_{i=1}^{n} X_{ij}$

Armington case (cont.)

- Question: how is welfare in country j affected by shocks in transport costs and population in other countries? (τ_{jj} unaffected)
- Welfare W_j is real wage $\frac{Y_j}{P_j}$
- Choose country j labor as numeraire so that $L_j w_j = Y_j$ constant by assumption
- This implies $d \ln W_j = -d \ln P_j$
- Take logs of (1)

$$\ln X_{ij} = (1-\sigma)\left[\ln\left(w_i \tau_{ij}\right) - \ln P_j\right] + \ln Y_j$$

- and totally differentiate

$$d \ln X_{ij} = (1-\sigma)\left[d \ln\left(w_i \tau_{ij}\right) - d \ln P_j\right] + d \ln Y_j$$

Armington case (cont.)

- Since $d\ln Y_j = 0$ then

$$\begin{aligned}\frac{dX_{ij}}{X_{ij}} &= (1-\sigma)\left[d\ln\left(w_i\tau_{ij}\right) - d\ln P_j\right] \\ dX_{ij} &= (1-\sigma)\left[d\ln\left(w_i\tau_{ij}\right) - d\ln P_j\right] X_{ij}\end{aligned}$$

- Take the sum of both sides over all i

$$\begin{aligned}\sum_{i=1}^{n} dX_{ij} &= (1-\sigma)\sum_{i=1}^{n}\left[d\ln\left(w_i\tau_{ij}\right) - d\ln P_j\right] X_{ij} \\ 0 &= \sum_{i=1}^{n} X_{ij}\, d\ln\left(w_i\tau_{ij}\right) - Y_j\, d\ln P_j \\ d\ln P_j &= \sum_{i=1}^{n}\frac{X_{ij}}{Y_j}\, d\ln\left(w_i\tau_{ij}\right)\end{aligned}$$

Armington case (cont.)

- Therefore the change in welfare is a weighted average of changes in terms-of-trade (weights are import shares $\lambda_{ij} = \frac{X_{ij}}{Y_j}$):

$$d \ln W_j = -\sum_{i=1}^{n} \lambda_{ij} \left(d \ln w_i + d \ln \tau_{ij} \right)$$

- Using (1) again one can relate changes in terms-of-trade to changes in demand shares

$$d \ln \lambda_{ij} - d \ln \lambda_{jj} = (1 - \sigma) \left(d \ln w_i + d \ln \tau_{ij} \right)$$

- So we can rewrite the change in welfare:

$$d \ln W_j = \sum_{i=1}^{n} \lambda_{ij} \frac{\left(d \ln \lambda_{jj} - d \ln \lambda_{ij} \right)}{1 - \sigma}$$

- Since $\sum_{i=1}^{n} \lambda_{ij} d \ln \lambda_{ij} = \sum_{i=1}^{n} \lambda_{ij} \frac{d\lambda_{ij}}{\lambda_{ij}} = 0$

$$d \ln W_j = \frac{d \ln \lambda_{jj}}{1 - \sigma}$$

Armington case (cont.)

- To find the overall change in welfare one needs to integrate over all marginal changes between initial and final points

$$
\begin{aligned}
\int d \ln W_j &= \int \frac{d \ln \lambda_{jj}}{1-\sigma} \\
\left[\ln W_j\right]_{W}^{W'} &= \left[\ln \left(\lambda_{jj}\right)^{\frac{1}{1-\sigma}}\right]_{\lambda}^{\lambda'} \\
\frac{W'}{W} &= \left(\frac{\lambda'_{jj}}{\lambda_{jj}}\right)^{\frac{1}{1-\sigma}}
\end{aligned}
$$

- The larger the decrease in domestic share the larger the increase in welfare (for given σ)

General model

- ACR show that any model of trade that satisfies the following assumptions generates the same formula to measure welfare changes:
- 4 primitive assumptions
  - Dixit Stiglitz preferences
  - one factor of production
  - linear cost functions
  - perfect or monopolistic competition
- 3 macro-level restrictions: R1, R2 and R3
  - trade is balanced
  - aggregate profits are a constant share of aggregate revenues
  - import demand system is CES

Macro Level Restrictions

- R1 - Trade in goods is balanced

$$\sum_{i=1}^{n} X_{ij} = \sum_{i=1}^{n} X_{ji}$$

- R2 - Aggregate profits are a constant share of revenues
  - True in perfect competition (obviously) and with constant markup and homogeneous firms, otherwise not obvious

Macro Level Restrictions (cont.)

- R3- Import demand system is CES: define $\varepsilon_j^{ii'} = \partial \ln \left(X_{ij}/X_{jj} \right) / \partial \tau_{i'j}$

  $$\varepsilon_j^{ii'} = \varepsilon < 0 \text{ if } i = i' \text{and zero otherwise}$$

  Interpretation:

  - as t_{ij} changes X_{ij}/X_{jj} changes proportionally by the same amount
  - as $t_{i'j}$ changes X_{ij}/X_{jj} does not change: exports of A to B relative to B's domestic demand are not affected by changes in transport costs from C to B

Macro-Level Restrictions (cont.)

- More restrictive condition: Strong CES Import Demand System
- $R3'$: the IDS satisfies :

$$X_{ij} = \frac{\chi_{ij} N_i \left(w_i \tau_{ij}\right)^{\varepsilon} Y_j}{\sum_{i'=1}^{n} \chi_{i'j} N_{i'} \left(w_{i'} \tau_{i'j}\right)^{\varepsilon}}$$

where χ_{ij} is a constant and N_i is a mass of firms.

Ex-Post Welfare result

- Consider a shock that affects population and transport costs in other countries except for j
- **Proposition 1**: If R1-R3 conditions are met then change in welfare is:

$$\widehat{W}_j = \widehat{\lambda}_{jj}^{\frac{1}{\varepsilon}}$$

where $\widehat{W}_j = \frac{W_j'}{W_j'}$

- AGAIN NOTICE: if $\widehat{\lambda}_{jj}^{\frac{1}{\varepsilon}}$ is the same then models deliver same gains from trade, but generally not the case that different models deliver same change in λ
- This is an ex-post result: if you can observe the change in λ then you can measure change in welfare

Ex-Ante Welfare

- The authors have stronger result under $R3'$
- **Proposition 2**: if R1-R3' hold then for any change in variable trade costs $\hat{\tau}_{ij}$:

$$\widehat{W}_j = \hat{\lambda}_{jj}^{\frac{1}{\varepsilon}}$$

$$\hat{\lambda}_{jj} = \frac{1}{\sum_{i=1}^{n} \lambda_{ij} \left(\hat{w}_i \hat{\tau}_{ij}\right)^{\varepsilon}}$$

$$\hat{w}_i = \sum_{j'=1}^{n} \frac{\lambda_{ij'} \hat{w}_{j'} Y_{j'} \left(\hat{w}_i \hat{\tau}_{ij'}\right)}{Y_i \sum_{i'=1}^{n} \lambda_{i'j'} \left(\hat{w}_{i'} \hat{\tau}_{i'j'}\right)}$$

- This system of equations is an ex-ante evaluation!

When do R1-R3 hold for Melitz model?

- In the Melitz model R1-R3 hold if $g_i(\alpha_i)$ is Pareto: for $\alpha_i \in [0, \overline{\alpha}_i]$

$$g_i(\alpha_i) = \frac{\theta \alpha_i^{\theta-1}}{\overline{\alpha}_i^{\theta}}$$

- Elasticity of trade $\varepsilon = \theta$ here
- What about R3'?
  - Condition R3' satisfied only if export fixed cost paid in units of foreign labor

The magnitude of the gains from trade (GFT)

- You don't need unorthodox models to deliver larger GFT...
  - Models with multiple sectors can increase remarkably GFT
    - Additional gains from specialization due to comparative advantage
    - Equivalence of GFT between perfect competition and monopolistic competition no longer holds
  - Same if we allow trade of intermediate goods
    - Input-output loops amplify GFT
    - Again, equivalence of GFT between perfect competition and monopolistic competition does not hold

The magnitude of the gains from trade: Numbers (I)

Table 4.1 Welfare Gains from Trade

	G_j Expressed in Percentages Computed Using:						
	One Sector (12)	Multiple Sectors, No Intermediates (23)		Multiple Sectors, with Intermediates (29)			
		Perfect Competition	Monopolistic Competition	Perfect Competition (Data Alphas)	Perfect Competition	Monop. Comp. (Krugman)	Monop. Comp. (Melitz)
Country	**1**	**2**	**3**	**4**	**5**	**6**	**7**
AUS	2.3%	8.6%	3.7%	15.8%	15.7%	6.9%	6.8%
AUT	5.7%	30.3%	30.5%	49.5%	49.0%	57.6%	64.3%
BEL	7.5%	32.7%	32.4%	54.6%	54.2%	63.0%	70.9%
BRA	1.5%	3.7%	4.3%	6.3%	6.4%	9.7%	12.7%
CAN	3.8%	17.4%	15.3%	30.2%	29.5%	33.0%	39.8%
CHN	2.6%	4.0%	4.0%	11.5%	11.2%	28.0%	77.9%
CZE	6.0%	16.8%	21.2%	34.0%	37.2%	65.1%	86.7%
DEU	4.5%	12.7%	17.6%	21.3%	22.5%	41.4%	52.9%
DNK	5.8%	30.2%	24.8%	41.4%	45.0%	42.0%	44.8%
ESP	3.1%	9.0%	9.5%	18.3%	17.5%	24.4%	30.5%
FIN	4.4%	11.1%	10.5%	20.2%	20.3%	24.2%	28.0%
FRA	3.0%	9.4%	11.1%	17.2%	16.8%	25.8%	32.1%
GBR	3.2%	12.9%	11.7%	21.6%	22.4%	22.2%	23.5%
GRC	4.2%	16.3%	4.7%	23.7%	24.7%	6.8%	6.1%
HUN	8.1%	29.8%	31.3%	53.5%	55.3%	75.7%	91.0%
IDN	2.9%	5.5%	4.0%	13.1%	11.6%	11.2%	14.6%
IND	2.4%	4.6%	4.3%	9.2%	8.6%	9.5%	11.7%

The magnitude of the gains from trade: Numbers (II)

IRL	8.0%	23.5%	14.2%	37.1%	38.9%	28.1%	29.1%
ITA	2.9%	8.7%	9.2%	16.4%	16.2%	21.7%	26.5%
JPN	1.7%	1.4%	3.7%	4.6%	3.5%	20.7%	32.7%
KOR	4.3%	3.9%	8.6%	12.5%	11.4%	44.1%	70.2%
MEX	3.3%	11.1%	12.1%	18.4%	18.6%	24.3%	28.4%
NLD	6.2%	24.3%	23.1%	40.1%	39.8%	43.4%	47.6%
POL	4.4%	18.4%	19.7%	33.8%	34.5%	46.9%	57.0%
PRT	4.4%	23.8%	20.6%	35.9%	37.4%	36.7%	40.3%
ROM	4.5%	17.7%	12.7%	26.4%	29.2%	20.8%	20.7%
RUS	2.4%	18.0%	0.9%	35.9%	30.7%	−2.1%	−7.1%
SVK	7.6%	22.2%	23.6%	48.3%	50.5%	78.6%	96.4%
SVN	6.8%	39.6%	39.3%	57.8%	61.6%	71.3%	79.7%
SWE	5.1%	12.5%	14.5%	24.4%	23.6%	36.6%	45.8%
TUR	2.9%	11.9%	13.3%	20.0%	20.9%	26.4%	29.5%
TWN	6.1%	9.6%	9.9%	19.9%	19.4%	28.6%	37.8%
USA	1.8%	4.4%	3.8%	8.3%	8.0%	8.6%	10.3%
RoW	5.2%	15.2%	7.3%	33.3%	28.4%	18.1%	21.8%
Average	4.4%	15.3%	14.0%	26.9%	27.1%	32.3%	40.0%

Note: The numbers in parenthesis indicate the equation used for the computation. All data is from WIOD and trade elasticities are from Caliendo and Parro (2010). Perfect competition and monopolistic competition are obtained from the formulas using $\delta_s = 0$ for all s and $\delta_s = 1$ for all s, respectively. Results for the Krugman and Melitz models are obtained setting $\eta_s = 0$ for all s and setting $\eta_s = 0.65$ for all s, respectively.