Chaney, Thomas (2008) "Distorted Gravity: The Intensive and Extensive Margins of International Trade." *American Economic Review*, 98:4, 1707-1721

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- Krugman: When trade barriers change the set of exporters does not change (the *extensive* margin), only the quantity they export changes (the *intensive* margin)
- Melitz: Set of exporters is endogenous with free entry
- The **main goals**:
  1. Identify and explain the extensive margin of trade
  2. What happens with the elasticity of trade flows w.r.t. to trade barriers
- Multiple, asymmetric countries with asymmetric trade barriers + a general equilibrium solution

$$Exports_{AB} = Constant \times \frac{GDP_A \times GDP_B}{(Trade\ barriers_{AB})^{\sigma}}$$

- With identical firms (Krugman) or models with a representative firm (Anderson and van Wincoop): Higher elasticity of substitution (σ) means higher influence of trade barriers on exports
- Now: Extending the Melitz model yields the opposite conclusion $\rightarrow$ the sensitivity of exports w.r.t. trade barriers is inversely related to σ

- Introduction of firm heterogeneity and fixed costs of trading
- Intensive margin and extensive margin
- The elasticity of substitution has the opposite effect as in Krugman

$$Exports_{AB} = Constant \times \frac{GDP_A \times GDP_B}{(Trade\ barriers_{AB})^{\epsilon(\sigma)}}, \quad \text{with } \epsilon'(\sigma) < 0$$

Setup

- N asymmetric countries but with same technology; differ in L_n and w_n and trade barriers
- Only production factor is labor (L)
- Every country produces a single homogeneous (Good 0) which is freely traded; One unit of labor needed to produces w_n units and the price is fixed to one
- So this good is a proxy for productivity, as the wage w_n is pinned down by its production

Consumer utility

$$(1) \qquad U \equiv q_0^{\mu_0} \prod_{h=1}^{H} \left(\int_{\Omega_h} q_h(\omega)^{(\sigma_h - 1)/\sigma_h} d\omega \right)^{[\sigma_h/(\sigma_h - 1)]\mu_h}$$

$$\mu_0 + \sum_{h=1}^{H} \mu_h = 1, \ \sigma_h > 1$$

- H sectors are comprised of a continuum of differentiated goods
- Set Ω determined in equilibrium

Trade barriers and firm productivity

- Good 0 is freely traded
- Two sorts of trade barriers: Variable and **fixed**
- Variable take the "iceberg" form; fixed in units of numeraire
- As in Melitz: Draw a productivity φ from a Pareto distribution over $[1, +\infty)$

$$P(\tilde{\varphi}_h < \varphi) = G_h(\varphi) = 1 - \varphi^{-\gamma_h} \quad (2)$$

  with $\gamma_h > (\sigma_h - 1)$
- Shape parameter γ_h determines spread within each sector

Firms: costs and price setting

$$c_{ij}^{h}(q) = \frac{w_i \tau_{ij}^{h}}{\varphi} q + f_{ij}^{h} \quad (3)$$

- Fixed costs → increasing returns to scale
- Firms are price setters
- Remember: Demand is isoelastic; optimal price is a constant mark-up over unit costs

$$p_{ij}^{h}(\varphi) = \frac{\sigma_h}{\sigma_h - 1} \times \frac{w_i \tau_{ij}^{h}}{\varphi} \quad (4)$$

Additional notes

- Mass of potential entrants is proportional to $w_n L_n$
- Important: no free entry, firms earn a net profit which has to be redistributed
- Who gets it? Every worker owns w_n shares of a global fund that collects all profits

Demand and exports

- Total income of workers Y_j = Labor income $w_j L_j$ + dividends $\pi * w_j L_j$ from global fund
- Exports:

$$(5) \qquad x_{ij}^h(\varphi) = p_{ij}^h(\varphi) q_{ij}^h(\varphi) = \mu_h Y_j \left(\frac{p_{ij}^h(\varphi)}{P_j^h} \right)^{1-\sigma_h}$$

- Note that for an individual firms, exports depend on σ

Price index and dividends

$$(6) \quad P_j^h = \left(\sum_{k=1}^{N} w_k L_k \int_{\bar{\varphi}_{kj}^h}^{\infty} \left(\frac{\sigma_h}{\sigma_h - 1} \frac{w_k \tau_{kj}^h}{\varphi} \right)^{1-\sigma_h} dG_h(\varphi) \right)^{\frac{1}{(1-\sigma_h)}}$$

$$(7) \quad \pi = \frac{\sum_{h=1}^{H} \sum_{k,l=1}^{N} w_k L_k \left(\int_{\bar{\varphi}_{kj}^h}^{\infty} \pi_{kj}^h(\varphi) dG_h(\varphi) \right)}{\sum_{n=1}^{N} w_n L_n}$$

Global equilibrium

- Firms choose which markets to they enter
- Decision to enter a market depends on competition (which in turn depends on which firms enter)
- Consumer, given prices, choose consumption
- Consider only a static equilibrium

Productivity threshold

- Remember: Fixed costs of exporting $\rightarrow$ Firms need to compensate
- Threshold equal to zero profits condition:

$$\pi^h_{kl}(\varphi) = (p^h_{kl}(\varphi) - c^h_{kl}(\varphi))q^h_{kl}(\varphi) - f^h_{kl} = 0$$

$$\bar{\varphi}_{ij} = \lambda_1 \left(\frac{f_{ij}}{Y_j}\right)^{(1/(\sigma-1))} \frac{w_i \tau_{ij}}{P_j} \tag{8}$$

Equilibrium price index

$$P_j = \lambda_2 \times Y_j^{1/\gamma - 1/(\sigma-1)} \times \Theta_j \quad (9)$$

- Depends on country characteristics (simplifying assumptions: Wages + no. of potential entrants exogenous)
- Also the set of exporters engaged in trade with country j depend only on country j's characteristics
- Θ is the "remoteness" of a country

$$\Theta_j^{-\gamma} \equiv \sum_{k=1}^{N} (Y_k/Y) \times (w_k \tau_{kj})^{-\gamma} \times f_{kj}^{-[\gamma/(\sigma-1)-1]}$$

Equilibrium exports, thresholds and profits

$$x_{ij}(\varphi) = \begin{cases} \lambda_3 \times \left(\frac{Y_j}{Y}\right)^{(\sigma-1)/\gamma} \times \left(\frac{\Theta_j}{w_i \tau_{ij}}\right)^{\sigma-1} \times \varphi^{\sigma-1}, & \text{if} \varphi \geq \bar{\varphi}_{ij} \\ 0, & \text{otherwise} \end{cases}$$

$$\bar{\varphi} = \lambda_4 \times \left(\frac{Y}{Y_j}\right)^{1/\gamma} \times \left(\frac{w_i \tau_{ij}}{\Theta_j}\right) \times f_{ij}^{1/(\sigma-1)}$$

$$\pi = \lambda_5(\sigma_h, \mu_h, \gamma_h)$$

$$Y_i = (1 + \lambda_5) \times w_i L_i$$

Equilibrium exports, thresholds and profits

- Note: These are functions of fundamentals only: L, w, f, τ + remoteness factor Θ
- From before we know that exports of any ind. firm depend on transportation costs with $\sigma - 1$ (traditional trade model)
- But on the aggregate, it will look different

Aggregate trade

$$X_{ij}^h = \mu_h \times \frac{Y_i \times Y_j}{Y} \times \left(\frac{w_i \tau_{ij}^h}{\Theta_j^h} \right)^{-\gamma_h} \times (f_{ij}^h)^{-[\gamma/(\sigma_h - 1) - 1]} \tag{10}$$

- The gravity structure is distorted by firm heterogeneity
- First: The elasticity to trade barriers is now larger than without heterogeneity and in aggregate larger than for any individual firm (since $\gamma_h > \sigma - 1$)
- A reduction in variable costs leads to more exports of any given exporter + the **new entry** of previously only domestic producers in the export market

Aggregate trade

$$X_{ij}^h = \mu_h \times \frac{Y_i \times Y_j}{Y} \times \left(\frac{w_i \tau_{ij}^h}{\Theta_j^h} \right)^{-\gamma_h} \times (f_{ij}^h)^{-[\gamma/(\sigma_h - 1) - 1]}$$

- Second: Elasticity to trade barriers depends on firm heterogeneity
- Third: Elasticity of variable cost to σ is zero (as in Eaton and Kortum). Fixed costs depend negatively on σ!

Elasticities

- Elasticity of substitution magnifies the effect of the intensive margin, but dampens the effect of the extensive margin
- Now we want to show that the dampening dominates

$$\text{if } \zeta \equiv -\frac{d \ln X_{ij}}{d \ln \tau_{ij}} \text{ and } \xi \equiv -\frac{d \ln X_{ij}}{d \ln f_{ij}}, \text{ then } \frac{\partial \zeta}{\partial \sigma} = 0 \text{ and } \frac{\partial \xi}{\partial \sigma} < 0$$

Elasticity derivation

- Differentiate aggregate exports (and distinguish intensive and extensive margin)

$$
\begin{aligned}
dX_{ij} &= \left(w_i L_i \int_{\bar{\varphi}_{ij}}^{\infty} \frac{\partial x_{ij}(\varphi)}{\partial \tau_{ij}} \right) d\tau_{ij} - \left(w_i L_i x(\bar{\varphi}_{ij}) G'(\bar{\varphi}_{ij}) \times \frac{\partial \bar{\varphi}_{ij}}{\partial \tau_{ij}} \right) d\tau_{ij} \\
&+ \underbrace{\left(w_i L_i \int_{\bar{\varphi}_{ij}}^{\infty} \frac{\partial x_{ij}(\varphi)}{\partial \tau_{ij}} \right)}_{\text{Intensive margin}} df_{ij} - \underbrace{\left(w_i L_i x(\bar{\varphi}_{ij}) G'(\bar{\varphi}_{ij}) \times \frac{\partial \bar{\varphi}_{ij}}{\partial \tau_{ij}} \right)}_{\text{Extensive margin}} df_{ij}
\end{aligned}
$$

Elasticity - variable trade costs

$$\zeta \equiv -\frac{d \ln X_{ij}}{d \ln \tau_{ij}} = \underbrace{(\sigma - 1)}_{\substack{\text{Intensive margin} \\ \text{Elasticity}}} + \underbrace{(\gamma - (\sigma - 1))}_{\substack{\text{Extensive margin} \\ \text{Elasticity}}} = \gamma$$

$$\frac{\partial \zeta}{\partial \sigma} = 0$$

- Intensive marging responds like in Krugman
- The extensive margin, on the other hand, is less sensitive as σ increases (new entrants can only capture a small market share, negligibile)

Elasticity - fixed trade costs

$$\xi \equiv -\frac{d \ln X_{ij}}{d \ln f_{ij}} = \underbrace{0}_{\substack{\text{Intensive margin} \\ \text{Elasticity}}} + \underbrace{\frac{\gamma}{\sigma - 1} - 1}_{\substack{\text{Extensive margin} \\ \text{Elasticity}}} = \frac{\gamma}{\sigma - 1} - 1$$

$$\frac{\partial \xi}{\partial \sigma} < 0$$

- Does not change behaviour of incumbents (they have already decided to enter)

Results

- Firm heterogeneity and fixed trade costs create the, in reality observed, extensive margin of trade
- Intensive margin is more sensitive to trade barriers the higher σ
- Extensive margin is less sensitive
- Elasticity of trade flows w.r.t. to trade barriers is larger
- It is not equal to σ, but negatively related to it

Results

- Different sectors have different dependence on intensive and extensive margins (due to product differentiation)
- Yet, the solution is specific to the assumption of a Pareto distribution of productivity shocks
- Pareto distribution, monopolistic competition and the assumed utility function allow predictions about firm sizes (high $\sigma \rightarrow$ large difference in sizes)

Empirics

- Empirical implications are testable (in fact, Rauch (1999) found empirical results as implied by this model)
- Koenig (2006) found empirical evidence for French firms that the importance of different sectors to intensive and extensive margins differ

Extensions

- Firms only use labor; technology does not differ between countries
- No investment, no savings, profits just redistributed
- Effects of trade policies like infant-industries or import substitution?
- Number of potential exporters proportional to $w_n L_n$
- Adjustment dynamics? How long does it take to reach the steady state after a shock?