International Trade in General Oligopolistic Equilibrium

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Overview

- Goal:
  - Integrate imperfect competition and trade
  - Combine insights of trade theory and I.O.
  - Bring real firms into trade theory
- Has all this not been done?
  - New trade theory revolution?
- Yes, but really two revolutions:
  1. Oligopoly in partial equilibrium
     - IIT (cross-hauling), strategic trade policy
  2. Monopolistic competition in GE: Firms atomistic
     - IIT (love of variety), MNCs, new economic geography
     - Heterogeneous firms, endogenous organizational form
- Unfinished part of the revolution:
  - Oligopoly in general equilibrium
  - Growing evidence that large firms matter for trade

[Mayer and Ottaviano (2008), Freund and Pierola (2015)]

Why Oligopoly in General Equilibrium?

- Why General Equilibrium?
  - Interaction between goods and factor markets
- Why oligopoly not competition (perfect or monopolistic)?
  - More realistic assumptions
    - Infinitely elastic supply of atomistic firms
    - No barriers to entry or exit
    - No strategic behaviour
  - New light on central questions in trade theory:
    - Trade patterns; Gains from trade; Trade policy and income distribution
  - Adding oligopoly to GE also allows new issues to be addressed:
    - Trade and wages debate: non-price interaction
    - Trade and competition; competitive advantage
    - Effects of trade on market structure: Cross-border mergers
    - Multi-product firms

Oligopoly in GE: Theoretical Challenges

- Problems with modelling oligopoly in general equilibrium:
  - Large firms have monopsony power
  - Large firms can influence GNP
    - Reaction functions badly behaved; equilibrium may not exist

      [Roberts and Sonnenschein (1977)]
  - Is profit maximization well defined? [Gabszewicz and Vial (1972)]
- Previous attempts to embed oligopoly in GE:
  - "Perceived" versus "actual" demand curves [Negishi (1961)]
  - Imperfect competition in goods and labour markets [Hart (1982)]
- Resolution: Firms large in their own market, but small in the economy
  - A continuum of oligopolistic sectors

    [Samuelson (1964), Dornbusch, Fischer, and Samuelson (1977)]
  - Firms take factor prices, GNP, and prices in other sectors as given
  - But: They have market power in their own sector
  - Labour market economy-wide and perfectly competitive

Related Work

- Related work:
  - Ruffin (2003)
  - Gabaix (2012), di Giovanni and Levchenko (2014)
  - Eaton, Kortum, and Sotelo (2013)
  - Edmond, Midrigan and Xu (2015)

Outline

Outline

Preferences: Additive Separability

- Additive separability:

$$U[\{x(z)\}] = \int_0^1 u[x(z)]dz, \qquad u'[x(z)] > 0, \qquad u''[x(z)] < 0$$

  - "Frisch" demand functions: [Browning, Deaton, and Irish (1985)]

$$p(z) = \lambda^{-1} u'[x(z)]$$

  - λ: Marginal utility of income
    - Taken as given by firms: "Perceived" demand function
    - Endogenous in GE: "Actual" demand function

Additive Separability plus Aggregation

- Consistent aggregation requires Gorman Polar Form preferences
- Additive separability plus Gorman Polar Form $\Leftrightarrow$ "Pollak" preferences
  [Pollak (1971)] ▸ Details
- Tractable special case: Continuum-quadratic preferences

$$u[x(z)] = ax(z) - \frac{1}{2}bx(z)^2$$

  - Demand functions are linear conditional on λ:

$$x(z) = \frac{1}{b}[a - \lambda p(z)]$$

  - Consistent aggregation over home and foreign representative consumers:

$$\overline{x}(z) \equiv x(z) + x^*(z) = \frac{1}{b}[\overline{a} - \overline{\lambda}p(z)] \qquad \overline{a} \equiv a + a^*, \quad \overline{\lambda} \equiv \lambda + \lambda^*$$

Measuring Welfare Change

- How to compare welfare in two different equilibria, A and B?
  - Two alternative but equivalent methods, corresponding to different normalizations of utility.

1. Cardinal/quantitative: Use the expenditure function

   [Dixit and Weller (1979)] ▸ Details

   - An equivalent variation type of money-metric welfare change:
   $$\Delta e^{AB} \equiv e(p^A, u^B) - e(p^A, u^A)$$
   - With CQ preferences:
   $$\Delta e^{AB} = (u^B - u^A)(\mu_2^{pA})^{1/2} \qquad \mu_2^p \equiv \int_0^1 p(z)^2 dz$$

2. Ordinal: Use the "Frisch indirect utility function"

   [Mrázová and Neary (2014)] ▸ Details

   - CQ utility depends on μ_2^p and marginal utility of income:
   $$U = -\lambda^2 \mu_2^p$$
   - In practice: Choose λ as numéraire; welfare is minus the second moment of prices

Specialization Patterns

- Cournot trade model: partial equilibrium

  Cournot vs. Bertrand [Neary and Tharakan (2013)]

  - Brander (1981), but with integrated rather than segmented markets.

- Given numbers of firms at home and abroad: n, n^*

- Perceived inverse demand curve:

$$p = a' - b'\overline{x}; \quad a' \equiv \frac{\overline{a}}{\lambda}, \quad b' \equiv \frac{b}{\lambda}, \quad \overline{x} = \overline{y} = ny + n^* y^*$$

- Firms in each country have identical costs: c, c^*

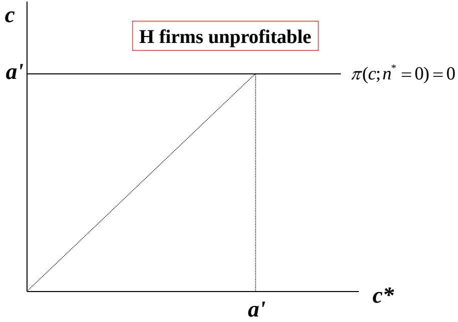
- Home sales with no foreign firms:

$$y(z) = \frac{a' - c}{b'(n+1)}; \quad y(z) > 0 \ \Rightarrow \ c < a'$$

- Home sales with active foreign firms:

$$y(z) = \frac{a' - (n^*+1)c + n^* c^*}{b'(n+n^*+1)}; \quad y(z) > 0 \ \Rightarrow \ c < \frac{a' + n^* c^*}{n^*+1}$$

Specialization Patterns



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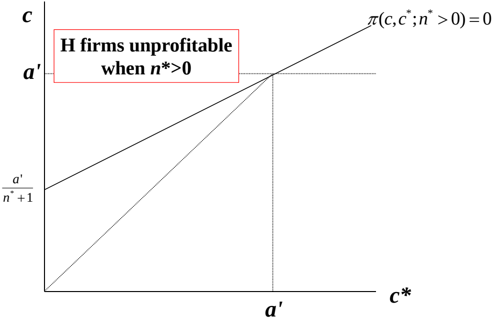

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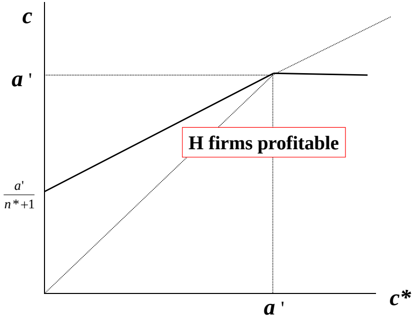

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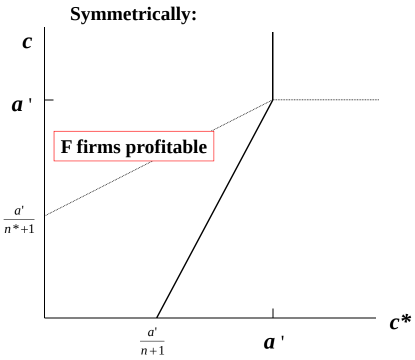

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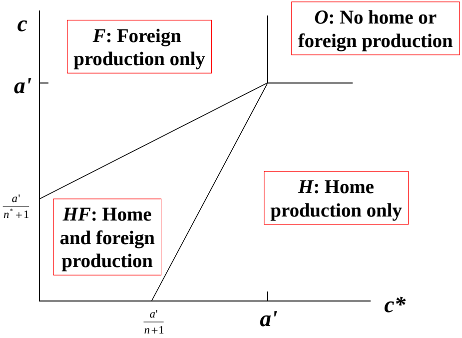
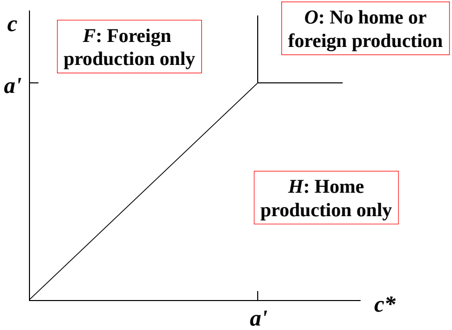


- Equilibrium Production Patterns for Arbitrary Home and Foreign Costs

Specialization Patterns



- Compare Perfect Competition: Cone of Diversification Vanishes

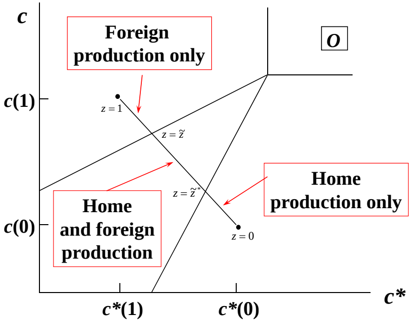
The Labour Market and Specialization Patterns

- Continuum of sectors, indexed by $z \in [0,1]$
- Ricardian cost structure:

$$c(z) = wa(z); \quad c^*(z) = w^*a^*(z)$$

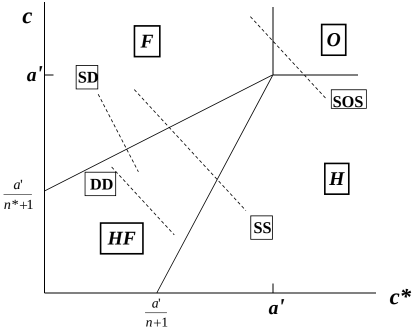
- Assume home more efficient in low-z sectors
  - Assumption: $y(z)$ decreasing, $y^*(z)$ increasing, in z
  - DFS: $a(z)/a^*(z)$ increasing in z
  - Special case: $a' > 0, a^{*\prime} < 0$
- Specialisation thresholds:
  - Perfect competition: $\tilde{z} : c(\tilde{z}) = c^*(\tilde{z})$
  - Here: 2 threshold sectors, $\tilde{z}$ and $\tilde{z}^*$, and 3 possible regimes:
    1. $z \in [0, \tilde{z}^*]$: Only home firms profitable
    2. $z \in [\tilde{z}^*, \tilde{z}]$: Both home and foreign firms profitable
    3. $z \in [\tilde{z}, 1]$: Only foreign firms profitable
  - Incomplete specialization in (2): Barriers to entry allow less efficient firms to survive Recall figure

Specialization Patterns



- Equilibrium Production Patterns for a Given Cost Distribution ▸ Formally

Specialization Patterns



- Illustrative Equilibrium Configurations

Outline

General Oligopolistic Equilibrium: Autarky

- Full employment:

$$L = \int_0^1 \alpha(z) n y(z) dz$$

- Firm output and price:

$$y(z) = \frac{a-\lambda w \alpha(z)}{b(n+1)} \qquad \lambda p(z) = \frac{a+\lambda w \alpha(z)}{n+1}$$

- Equilibrium wage: ▸ Details

$$w_a \equiv (\lambda w)\big|_a = \left[a\mu_1 - \frac{n+1}{n} bL\right] \frac{1}{\mu_2}$$

$$\mu_1 \equiv \int_0^1 \alpha(z) dz \qquad \mu_2 \equiv \int_0^1 \alpha(z)^2 dz$$

- Welfare: ▸ Details

$$U_a \equiv -(\lambda^2 \mu_2^p) = -\frac{a^2}{(n+1)^2} \frac{\sigma^2}{\mu_2} - \frac{(a\mu_1 - bL)^2}{\mu_2} \qquad \sigma^2 \equiv \mu_2 - \mu_1^2$$

  - Competition Effect: Welfare increasing in n
  - But: Only if sectors differ: $\sigma^2 > 0$ [Lerner (1933)]

Outline

Symmetric Free Trade: Wages

- Full employment:

$$L = \int_0^1 \alpha(z) n y(z) dz \qquad y(z) = \frac{a-(n+1)\lambda w \alpha(z) + n\lambda w \alpha^*(z)}{b(2n+1)}$$

- Equilibrium wage:

$$w_f \equiv (\lambda w)_f = \left[a\mu_1 - \frac{2n+1}{2n} bL\right] \frac{1}{\mu_2 + n\delta}$$

- Compare with autarky: $w_a = \left[a\mu_1 - \frac{n+1}{n} bL\right] \frac{1}{\mu_2}$

  1. Market Size Effect: $w_f > w_a$
  2. Competition Effect: $w_f < w_a$
  3. Comparative Advantage Effect: $w_f < w_a$
     - δ: International technological dissimilarity; i.e., comparative advantage

$$\delta \equiv \mu_2 - \int_0^1 \alpha(z) \alpha^*(z) dz$$

Gains from Trade

- Welfare in free trade:

$$U_f = -\frac{a^2}{(2n+1)^2}\frac{2\sigma^2-\delta}{2\mu_2-\delta} - (a\mu_1 - bL)^2\frac{2\mu_2-\delta}{2(\mu_2+n\delta)^2}$$

- Compare with autarky: $U_a = -\frac{a^2}{(n+1)^2}\frac{\sigma^2}{\mu_2} - \frac{(a\mu_1-bL)^2}{\mu_2}$
  - Zero in a featureless world: $\sigma^2 = \delta = 0$ [Lerner (1933)]
  - Strictly positive if $\delta = 0$ but some technological heterogeneity across sectors: $\sigma^2 > 0$ (competition effect)
    - i.e., pro-competitive gains even when no trade, and all sectors identical ex ante and ex post
    - Compare Brander (1981): Here, gains even when markets are integrated
  - Increasingly positive the greater is comparative advantage δ
    - All this, despite complete symmetry and incomplete specialisation

Winners and Losers from Trade

- Recall:
    - Market size effect tends to raise wage
    - Competition and comparative advantage effects tend to reduce it
    - Latter may dominate for large δ
- But: Aggregate welfare always rises
- Implication: Profits may increase because of comparative advantage
    - Contrary to partial equilibrium [Anderson-Donsimoni-Gabszewicz (1989)]
- Even stronger result: Share of wages in GDP is decreasing in δ

Volume of Trade

- Volume of Trade
  - Import volumes $m(z)$ are increasing in n
  - Import shares $m(z)/x(z)$ are increasing in n on average
  - So, oligopoly may explain the "missing trade" mystery

[Trefler (1995), Davis and Weinstein (2001), Ruffin (2003)]

Outline

Conclusion

- Model: General Oligopolistic Equilibrium [GOLE]
- Details:
  - Continuum-quadratic preferences
  - Cournot + Ricardo, or Brander + Samuelson
- Results, in contrast with perfect and monopolistic competition:
  - Production patterns more diverse, incomplete specialization
  - Gains from trade even if countries identical ex post and ex ante
  - Competition effects operate only if sectors heterogeneous
  - Profits may rise with free trade
  - Volume of trade is lower (missing trade)
- Extensions and Applications ...
- Broader implications:
  - For some questions, oligopoly richer than competition
  - (either perfect or monopolistic)

Thanks and Acknowledgements

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Measuring Welfare Change: Details

- $u^B > u^A \;\Leftrightarrow\; e(p, u^B) > e(p, u^A)$ for any fixed p Back to text
- In particular, for $p = p^A$: $u^B > u^A \;\Leftrightarrow\; e(p^A, u^B) > e(p^A, u^A)$
- So, money metric measure of welfare change: $\Delta e^{AB} = e(p^A, u^B) - e(p^A, u^A)$
- Relate this to equivalent variation: $EV_{AB} = e(p^A, u^B) - e(p^B, u^B)$
  - Subtract $I^B = e(p^B, u^B)$ from both sides: $\Leftrightarrow\; EV_{AB} > I^A - I^B$
  - EV: the amount that someone who currently has income I^A and prices p^A would be willing to pay in order to avoid a change such that the new price vector is p^B and her income is I^B.
  - Dixit and Weller (1979): "basic test for utility increase in going from A to B: the gain in consumer's surplus should exceed any loss in lump-sum income."
- With Gorman (GPF) preferences, $e(p, u) = f(p) + ug(p)$, this simplifies:

$$\Delta e^{AB} = (u^B - u^A)g(p^A)$$

CQ Preferences: The Frisch Indirect Utility Function

Back to text

- Utility: $U\left[\{x(z)\}\right] = \int_0^1 \left[ax(z) - \frac{1}{2}bx(z)^2\right] dz$
- Frisch demands: $\rightarrow \quad x(z) = \frac{1}{b}\left[a - \lambda p(z)\right]$
- Substitute back into U to get Frisch indirect utility function:

[Mrázová and Neary (2014)]

$$V^F\left[\lambda, \{p(z)\}\right] = \int_0^1 x(z)\left[a - \frac{1}{2}bx(z)\right] dz$$

$$= \frac{1}{2b}\int_0^1 \left[a - \lambda p(z)\right]\left[a + \lambda p(z)\right] dz = \frac{1}{2b}\int_0^1 \left[a^2 - \lambda^2 p(z)^2\right] dz$$

$$\rightarrow \quad V^F = \frac{1}{2b}\left(a^2 - \lambda^2 \mu_2^p\right) \qquad \mu_2^p \equiv \int_0^1 p(z)^2 dz$$

$$\rightarrow \quad \tilde{V}^F = -\lambda^2 \mu_2^p \quad \text{where:} \quad \tilde{V}^F \equiv 2bV^F - a^2$$

Pollak Preferences

Back to text

- Gorman Polar Form preferences
  - $e(p,u) = f(p) + ug(p)$, f and g linear homogeneous in p
  - "Quasi-homothetic": Linear Engel curves from $f(p)$
  - $f(p)$ is the price index of the reference indifference curve; $g(p)$ is the marginal price index
  - Consistent aggregation
- Additive separability plus Gorman Polar Form ⇔ "Pollak" preferences

$$u\left[x(z), z\right] =$$

Demand functions are "translated CES" conditional on λ:

$$x\left(z\right) =$$

CQ Preferences: The Expenditure Function

Back to text

- Solve for λ as a function of $\{p(z)\}$ and I:
  - Multiply demand function by $p(z)$, then integrate over all goods:

$$\int_0^1 p(z)\, x(z)\, dz = \frac{1}{b}\int_0^1 \left[ap(z) - \lambda p(z)^2\right] dz \quad \rightarrow \quad I = \frac{1}{b}\left(a\mu_1^p - \lambda\mu_2^p\right)$$

$$\rightarrow \quad \lambda = \frac{a\mu_1^p - bI}{\mu_2^p}$$

- Substitute into Frisch indirect utility function to get Marshallian:

$$V\left[I, \{p(z)\}\right] = \frac{1}{2b}\left[a^2 - \left(\frac{a\mu_1^p - bI}{\mu_2^p}\right)^2 \mu_2^p\right]$$

- Rewrite in Gorman Polar Form, $\tilde{V}\left[\{p(z)\}, I\right] = \frac{I - f(p)}{g(p)}$:

$$\rightarrow \quad \tilde{V}\left[\{p(z)\}, I\right] \equiv -\frac{1}{b}\left(a^2 - 2bV\right)^{1/2} = \frac{I - \frac{a}{b}\mu_1^p}{\left(\mu_2^p\right)^{1/2}}$$

- Invert to get expenditure function $e\left[\{p(z)\}, u\right] = f(p) + ug(p)$:

$$e\left[\{p(z)\}, u\right] = \frac{a}{b}\mu_1^p + \tilde{u}\left(\mu_2^p\right)^{1/2} \quad \text{where:} \quad \tilde{u} = -\frac{1}{b}\left[\left(a^2 - 2bu\right)\right]^{1/2}$$

Detailed Derivations: Autarky Wage

Back to text

- Full employment:

$$L = \int_0^1 \alpha(z) n y(z) dz \qquad y(z) = \frac{a - \lambda w \alpha(z)}{b(n+1)}$$

- Evaluate integral:

$$L = n \int_0^1 \alpha(z) \frac{a - \lambda w \alpha(z)}{b(n+1)} dz = \frac{n}{b(n+1)} \left[\int_0^1 \alpha(z) a - \lambda w \alpha(z) dz \right]$$

- Solve for equilibrium wage:

$$w_a \equiv (\lambda w)\big|_a = \left[a\mu_1 - \tfrac{n+1}{n} bL \right] \tfrac{1}{\mu_2}$$

$$\mu_1 \equiv \textstyle\int_0^1 \alpha(z) dz \qquad \mu_2 \equiv \textstyle\int_0^1 \alpha(z)^2 dz$$

Detailed Derivations: Autarky Welfare

- Price:

Back to text

$$\lambda p(z) = \frac{a + \lambda w \alpha(z)}{n+1}$$

- Welfare:

$$U_a \equiv -(\lambda^2 \mu_2^p) = -\frac{1}{(n+1)^2} \left(a^2 + 2an\mu_1 w_a + n^2 \mu_2 w_a^2\right)$$

$$= -\frac{a^2}{(n+1)^2} \frac{\sigma^2}{\mu_2} - \frac{(a\mu_1 - bL)^2}{\mu_2} \qquad \sigma^2 \equiv \mu_2 - \mu_1^2$$

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