# International Economics I

## Increasing Returns to Scale (The Krugman Model)

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# Introduction

- In the early neoclassical frameworks, there is trade when there is **comparative advantage**.
  - Trade exists because countries are different.
  - e.g. differences in technology or factor endowments...
- Very useful to explain inter-industry and trade between "North" and "South.
- However, in the data:
  - most of trade is between countries that are very similar (developed countries)
  - tons of **Intra-industry** trade.

# Introduction

- To account for these empirical regularities we must have additional reasons to trade $\Rightarrow$ **Increasing returns to scale (IRS)**!
  - Access to international markets allows to increase production and decrease costs.
- Many economists already recognized this idea but they could not formalize it well $\Rightarrow$ increasing returns to scale does not mix well with perfect competition.
- The development of formal models of monopolistic competition in the 70's (Dixit and Stiglitz, 1977 among others) help them to study IRS more rigorously.
- Led to the development of the **New Trade Theory**.

# Introduction

- The **New Trade Theory** was developed by Krugman, Helpman, Grossman among others in the late 70's and early 80's.
  - Paul Krugman received the Nobel Prize in 2008 for this theory.
- The NTT relies on increase returns to scale at the firm level (combined with monopolistic competition).
  - Some goods are only viable in large scale (because of large fixed costs).
  - Requires specialization to take advantage of large-scale production.
- It allow us to consider:
  - Intra-industry trade (each country imports and exports different varieties of the same good).
  - Trade between similar contries (e.g., North-North).

# Introduction

## Modeling Increasing Returns to Scale

- **External Economies of Scale** $\Rightarrow$ Decreasing in cost depends on the size of the industry (because specialized supplies, workers, etc) $\rightarrow$ many small firms.

- **Internal Economies of Scale** $\Rightarrow$ Decreasing in cost depends on the size of the firm $\rightarrow$ few large firms producing differentiated products.
  - e.g. Amazon has a large fixed cost and is only able to sell its product if it serves a large market.

# IRS and Differentiated Goods: Intuition

- Consider differentiated goods within a sector:
  - e.g., iPhone and Galaxy S are 2 varieties perceived as imperfect substitutes
- Internal economies of scale imply:
  - Each variety is cheaper if production is concentrated in one large firm
  - Apple is located in one country (US) and Samsung possibly in another (Korea)
- In both countries, some prefer Apple and some Samsung
- Trade allows both varieties to be sold in both countries
- Gains:
  - Americans (Koreans) preferring Samsung (Apple) are happier.
  - "competition" with foreign variety reduces the price of both.

# Introduction

- IRS and differentiated good: new gains from trade!
- with trade we have:
  - (i) More "varieties" to choose.
  - (ii) Larger markets (i.e. more countries to sell) reduce costs.
  - (iii) Pro-competitive gains: more competition (from abroad) reduces prices if firms have some monopolistic power.
- We will study a model based on Krugman (1980, 1979) to understand these new gains from trade.

# Outline

1. Increasing Returns and Monopolistic Competition
2. Open Economy
3. Pro-Competitive GFT
4. Empirical Evidence

# Increasing Returns: A Problem

- Assume production requires:
  - fixed input of $F$ units of labor (building a plant or designing a product)
  - variable input of $\beta$ units of labor per unit of output
  - total cost of producing $q$ units:

$$TC(q) = (F + \beta q)\, w$$

    - ⋆ $w$ = wage; $Fw$ = fixed cost; $\beta w$ = marginal cost ($MC$)
  - take wage as the numeraire ($w = 1$)
    - ⋆ average production cost decreasing in $q$

$$AC = F/q + \beta$$

- Perfect competition requires price = MC: $p = \beta$
  - Profits: $\pi(q) = pq - F - \beta q = \beta q - F - \beta q = -F$
  - Firms selling at $MC$ make losses $\Rightarrow$ no firm wants to produce.

# Non-competitive Market

If not competitive, what market structure?

- **Monopoly**: aggressive hypothesis, only realistic in very specific markets.
- **Oligopoly**: interesting, but it involves complicated modeling strategic interactions between firms (How? Game theory?).
  - e.g. Coca-cola vs Pepsi: one makes the decision considering the other.
- **Monopolistic competition**:
  - Monopoly pricing: firms choose price given demand curve.
  - Each firm produces a individual variety of the same good: they have market power over that variety.
  - No strategic interactions (many firms): although demand for every variety depends on all prices, each individual firm is atomistic and ignore the decision of the others.

# Differentiated Goods + Monopolistic Competition

- assume $n$ firms in the economy (we can also interpret as a "sector").
- each firm produces a different variety of the same good
  - varieties are imperfect substitutes
    - ⋆ consumers are willing to pay more to have them all
  - each firm has market power over its variety (monopoly)
- each firm chooses price to maximize profit
  - taking the demand for its variety as given (as in monopoly)
  - without considering the effect of its price on market conditions (as in perfect competition)

# Preferences and Demand

- consider a country with $L$ agents (work & consume)
- consumers draw utility from the $n$ varieties

$$U = \sum_{i=1}^{n} c_i^{\alpha} \quad \alpha \in (0,1)$$

  - love of variety: consumers are happier the more varieties they have
    - ⋆ assume consumption of each variety $c_i = c = C/n$ (equal shares of total consumption)
    - ⋆ then $U = n\,(C/n)^{\alpha} = C^{\alpha} n^{1-\alpha}$, increasing in $n$ since $\alpha \in (0,1)$
- individual demand of each variety $i$ is the solution to

$$\max_{c_i} \sum_{i=1}^{n} c_i^{\alpha}$$
$$\text{s.t. } w \geq \sum_{i=1}^{n} p_i c_i$$

  - $w$ = income, $p_i$ = price of $i$

# The Model: Demand

- to obtain demand, set the Lagrangean

$$\mathcal{L} = \sum_{i=1}^{n} c_i^{\alpha} - \lambda \left( \sum_{i=1}^{n} p_i c_i - w \right)$$

  - the f.o.c. for $c_i$ requires that for all $i$

$$\alpha c_i^{\alpha-1} = \lambda p_i$$

  - demand of variety $i$ relative to $j$ is

$$\frac{c_i}{c_j} = \left( \frac{p_i}{p_j} \right)^{-\frac{1}{1-\alpha}}$$

  - demand for each variety $i$ is

$$c_i = \frac{w}{P} \left( \frac{P}{p_i} \right)^{\frac{1}{1-\alpha}}$$

    - ⋆ $P = \left[ \sum_{i=1}^{n} p_i^{-\alpha/(1-\alpha)} \right]^{-(1-\alpha)/\alpha}$ is the price index (note: $P$ decreasing in $n$)

# The Model: Demand

- demand for each variety $i$ is

$$c_i = \frac{w}{P}\left(\frac{P}{p_i}\right)^{\frac{1}{1-\alpha}}$$

  - is increasing in the real wage $\uparrow w/P \Rightarrow \uparrow c_i$.
  - decreasing in its price: $\downarrow p_i \Rightarrow \uparrow c_i$
  - increasing in the price index: $\uparrow P \Rightarrow \uparrow c_i$. Intuitively, if the price of "other" varieties increase you substitute for the variety $i$.
- What is the price index? Think about the price weighted average of the consumption implied by the utility function.
  - $P = \left[\sum_{i=1}^{n} p_i^{-\alpha/(1-\alpha)}\right]^{-(1-\alpha)/\alpha}$
  - $\uparrow n \Rightarrow \downarrow P \Rightarrow \downarrow c_i$: more goods, the consumers "split" demand between them.

# The Model: Demand

- the price-elasticy of demand is

$$\epsilon_p = \frac{\%\Delta c_i}{\%\Delta p_i} = -\frac{\partial \ln c_i}{\partial \ln p_i} = \frac{1}{1-\alpha}$$

  $\epsilon_p$ is increasing in $\alpha$
- the elasticity of substitution between any two varieties is

$$\epsilon_{ij} = \frac{\%\Delta \left(c_i/c_j\right)}{\%\Delta \left(p_i/p_j\right)} = -\frac{\partial \ln \left(c_i/c_j\right)}{\partial \ln \left(p_i/p_j\right)} = \frac{1}{1-\alpha}$$

  $\epsilon_{ij}$ is increasing in $\alpha$
- we interpret $\alpha$ as the substitutability between varieties
- if $\uparrow \alpha \Rightarrow \uparrow \epsilon_{ij}$: you are willing to substitute more between varieties.

# The Model: Firms and Prices

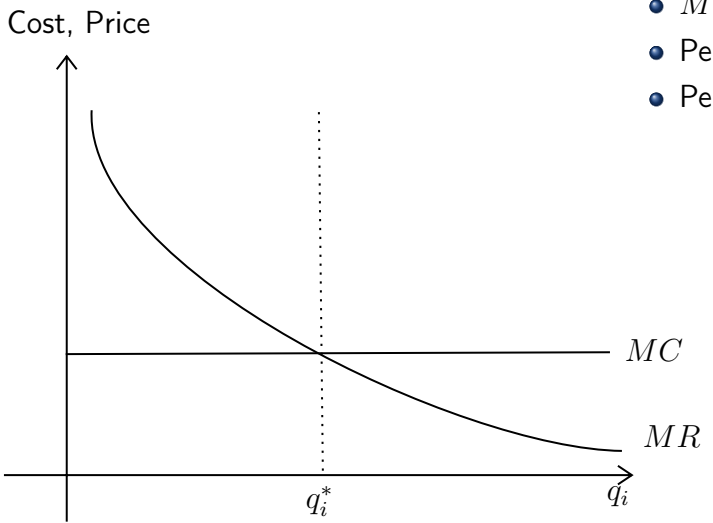
- All firms have the same technology (i.e. fixed cost $F$ and marginal cost $\beta$).
- They have monopoly over one variety.
- Firm producing variety $i$ chooses its quantity (or alternatively its price) so as to
  - maximize profit $\pi_i$, given aggregate demand for their variety $q_i = Lc_i$ and $w = 1$.

$$\max_{q_i} \left[\pi_i = p_i q_i - (F + \beta q_i)\, w\right]$$
$$\text{s.t. } q_i = (P/p_i)^{1/(1-\alpha)}\, L/P \Leftrightarrow p_i = (L/q_i)^{(1-\alpha)}\, P^{\alpha}$$

  - Monopoly $\Rightarrow$ it does not matter if we maximize over price or quantity.
- The f.o.c. requires that Mg. Revenue = Mg. cost:

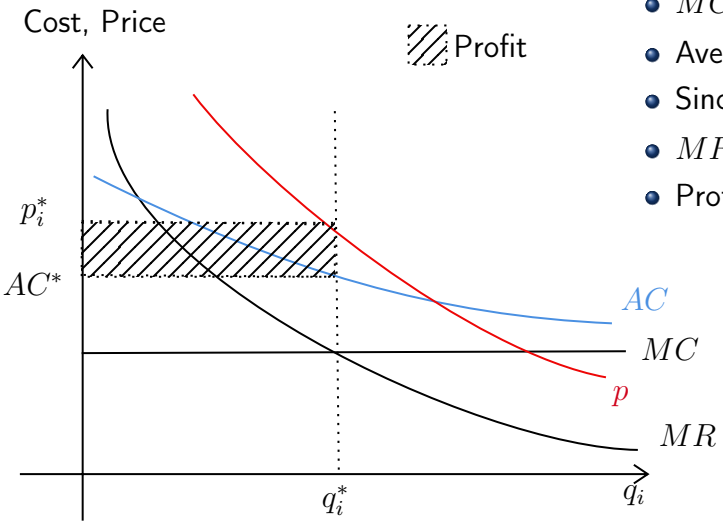
$$\text{Mg R.} = p_i + \frac{\partial p_i}{\partial q_i} q_i = \beta = \text{Mg. C.}$$

# Monopolistic Competition




- $MC = \beta$ and $MR = p_i + \frac{\partial p_i}{\partial q_i} q_i$.
- Perfect competition: $MR = p$!
- Perfect competition: $MR$ is flat!

# Monopolistic Competition




- $MC = \beta$ and $MR = p_i + \frac{\partial p_i}{\partial q_i} q_i$.
- Average cost = $AC = F/q + \beta$.
- Since, $\frac{\partial p_i}{\partial q_i} < 0$,
- $MR(q) < p(q)$.
- Profit: $\pi = p \times q - AC(q) \times q$

# The Model: Firms and Prices

- differentiate $p_i$ with respect to $q_i$ and using the aggregate demand to obtain

$$p_i + \frac{\partial p_i}{\partial q_i} q_i = p_i - (1-\alpha) \underbrace{\left(\frac{L}{q_i}\right)^{(1-\alpha)} P^{\alpha}}_{=p_i} = \beta$$

$$\Rightarrow p_i - (1-\alpha) p_i = \beta$$

hence

$$p_i = \frac{\beta}{\alpha} \qquad \text{and} \qquad q_i = \left(\frac{P\alpha}{\beta}\right)^{1/(1-\alpha)} \frac{L}{P}$$

# Monopolistic Competition Pricing and Scale

- $p_i$ equals perfect-competition price * mark-up

$$p_i = \underbrace{\beta}_{\text{marginal cost}} \times \underbrace{\frac{1}{\alpha}}_{\text{mark-up}} > \beta$$

  - higher elasticity of substitution ($\alpha \uparrow$):
    - ⋆ firms have less market power
    - ⋆ firms can charge lower mark-up $\rightarrow$ lower price ($\alpha \uparrow \rightarrow p \downarrow$)
- same technology (same $\beta$) + isoelastic demand (constant elasticity, same $\alpha$) implies
  - same price ($p_i = p$)
  - same scale ($q_i = q = (P/p)^{1/(1-\alpha)} L/P$)

# Monopolistic Competition: Free Entry

- all firms have the same scale and prices, hence substituting $q$ and $p$ in profits

$$\pi = pq - F - \beta q = A\beta^{-\frac{\alpha}{1-\alpha}} - F$$

  with $A \equiv (1-\alpha)L\left(\alpha P\right)^{\alpha/(1-\alpha)}$
  - profit decreasing in marginal and fixed cost $\beta$ and $F$
  - profit increasing in mkt size $L$ and price index $P$
- re-write profit as

$$\pi = \left(\frac{\beta}{\alpha} - \beta\right) q - F = 0$$

- new firms (i.e., varieties) enter the sector as long as $\pi > 0$
- in equilibrium, entry drives profit to zero, $\pi = 0 \rightarrow$ obtain scale of production $q$

$$q = \frac{\alpha}{1-\alpha}\frac{F}{\beta}$$

# Equilibrium Varieties

- to obtain the equilibrium number of varieties, $n$, impose labor market clearing:
  - supply $= L$ workers
  - demand= workers needed in overall production (fixed+variable)

$$L = (F + \beta q)\, n = F\left(1 + \frac{\alpha}{1-\alpha}\right) n$$

- hence

$$n = \frac{L}{F}\,(1-\alpha)$$

  - larger economies produce more varieties ($L \uparrow \rightarrow n \uparrow$)
  - the higher the fixed cost the fewer varieties ($F \uparrow \rightarrow n \downarrow$)
  - the higher the elasticity of substitution the fewer varieties ($\alpha \uparrow \rightarrow n \downarrow$)

# Equilibrium: Summary

- Optimality conditions of consumers and firms:

$$c_i = \frac{w}{P}\left(\frac{P}{p_i}\right)^{\frac{1}{1-\alpha}} = c \qquad \text{and} \qquad p_i = \frac{\beta}{\alpha} = p$$

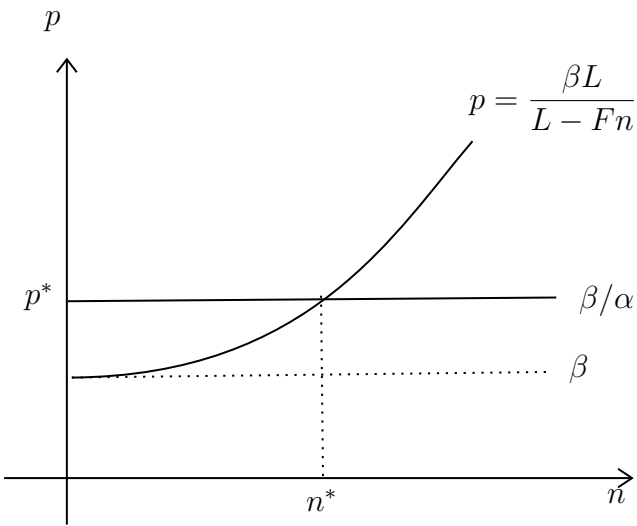
- Free entry ($\pi = 0$):

$$(p-\beta)q - F = 0 \Rightarrow q = \frac{\alpha}{1-\alpha}\frac{F}{\beta}$$

- Goods and labor market clearing:

$$q_i = q = L \times c_i \qquad \text{and} \qquad L = n(F + \beta q)$$

# Equilibrium




- Combining $L = n(F + \beta q)$ with $(p - \beta)q = F$:
  $\rightarrow p = \beta L/(L - Fn)$
- There are other ways to express eq., Krugman (1979) plots $p$ on $c$.

# Outline

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# Equilibrium in Open Economy

- Consider 2 countries:
  - same technology ($F$, $\beta$) and preferences ($\alpha$)
    - all firms charge the same price ($p = p^*$)
    - and produce the same quantities ($q = q^*$)
  - possibly different country size ($L \neq L^*$)
    - different number of varieties

$$n = \frac{L}{F}(1-\alpha) \neq \frac{L^*}{F}(1-\alpha) = n^*$$

- In the usual neoclassical model: no comparative advantage $\Rightarrow$ no reasons for trade!
- Where are the gains for trade?

# Gains From Trade

- Note that utility is increasing in $n$:

$$U = \sum_{i=1}^{n} c_i^{\alpha} = \sum_{i=1}^{n} \left(\frac{q}{L}\right)^{\alpha} = n\left(\frac{q}{L}\right)^{\alpha}$$

- where we used the fact that

$$q_i = q = c_i L \Rightarrow c_i = \left(\frac{q}{L}\right)$$

- when we open to trade the variety $i$ is consumed in both countries (firm has to produce to serve both countries $\Rightarrow$ large scale!)

$$q_i = q = c_i(L + L^*) \Rightarrow c_i = \left(\frac{q}{L + L^*}\right)$$

- number of available variety increases: $n + n^*$

# Gains From Trade

- consumers in both countries can consume more varieties $(n + n^*)$
  - utility in autarky and free trade

$$U_A = n\left(\frac{q}{L}\right)^{\alpha} \quad \text{and} \quad U_{FT} = (n + n^*)\left(\frac{q}{L + L^*}\right)^{\alpha}$$

  - GFT: utility is higher under free trade

$$\frac{U_{FT}}{U_A} = \frac{n + n^*}{n}\left(\frac{L}{L + L^*}\right)^{\alpha} = \left(\frac{L + L^*}{L}\right)^{1-\alpha} > 1$$

- new type of GFT: gains from variety
  - gains are lower if varieties are better substitutes $(\alpha \uparrow \rightarrow U_{FT}/U_A \downarrow)$
  - gains are higher for smaller countries
    - ⋆ if $L^* > L \rightarrow \ (L + L^*)/L > (L + L^*)/L^*$

# Pattern of Trade

- each country exports its varieties and imports the foreign ones

$$X = \frac{L^*}{L^* + L} nq \quad \text{and} \quad M = \frac{L}{L^* + L} n^* q$$

  - $nq$: quantity produced at home; $L^*/(L^* + L)$: demand by foreign.
  - $n^*q$: quantity produced by foreign; $L/(L^* + L)$: demand by home.
- all firms in both countries are exporters
- trade is intra-industry trade
  - export and import same good (different varieties)

# Outline

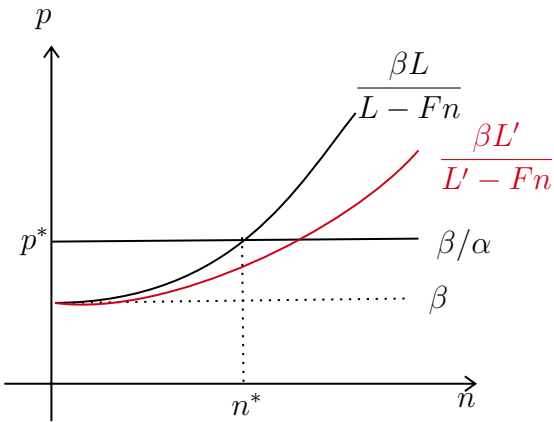
# Extension: Pro-Competitive GFT

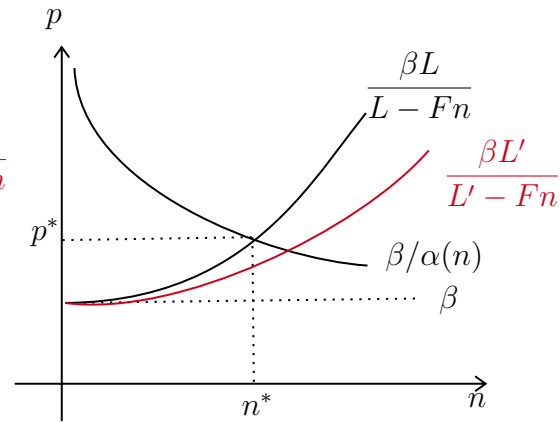
- Another possible gain: More firms in the market decrease market power of monopolistics.
- $\uparrow n$ decreases mark-up $\downarrow 1/\alpha$
- assume that $\alpha$ is increasing in $n$: $\alpha(n) \Rightarrow$ changes in $n$ affect prices! $p = \beta/\alpha(n)$
  - smartphones become better substitutes as more varieties enter the market (e.g., HTC, Motorola, Nokia, Sony etc.)
  - monopoly power erodes as $n$ increases
  - mark-ups and prices fall: $n \uparrow \rightarrow \alpha \uparrow \rightarrow p \downarrow$
  - profits fall $\rightarrow$ less entry

# Extension: Pro-Competitive GFT

- Effects of trade (an increase in $L$):
  - varieties increase by less: $n_{FT} < n_A$, $n^*_{FT} < n^*_A$
  - less gains from variety
  - but prices fall and we are able to consume more of each variable $\rightarrow$ pro-competitive GFT!
- The decrease in variety (relative to the case without pro-competitive) happens because: lower prices $\Rightarrow$ lower profits $\Rightarrow$ lower entry.

# Extension: Pro-Competitive GFT



# Outline

# Evidence on Intra-Industry Trade (IIT)

- How to measure IIT? Grubel y Lloyd index ($IIT$):

$$IIT_j = 1 - \frac{|e_j - i_j|}{e_j + i_j}$$

  - $j =$ sector (more or less disaggregated definition)
  - $e =$ export of the sector
  - $i =$ import of the sector
  - $IIT_j = 0$ if $j$ only imports or exports (no IIT)
  - $IIT_j = 1$ if $j$ imports as much as it exports (max IIT)
- If $e$ and $i$ very similar $\Rightarrow$ $IIT$ is close to 1 and there is lots of intra-industry trade.
- If one of $e$ or $i$ very large and the other close to 0 $\Rightarrow$ $IIT \approx 0$ and no intra-industry trade.
- The $IIT$ can be applied between two countries, or home vs rest of the world.

# Intra-Industry Trade: Data

| United States | | Germany | |
|---|---|---|---|
| Top 10 products | | | |
| Product (SITC-2) | Grubel Lloyd Index | Product (SITC-2) | Grubel Lloyd Index |
| Metalworking machinery | 0.9980 | Crude fertilizer/mineral | 0.985 |
| Dairy products & eggs | 0.9941 | Leather manufactures | 0.975 |
| Leather manufactures | 0.9915 | Railway/tramway equipment | 0.970 |
| Power generating equipment | 0.9876 | Sugar/sugar prep/honey | 0.966 |
| Electrical equipment | 0.9740 | Non-ferrous metals | 0.953 |
| Perfume/cosmetic/... | 0.9479 | Meat & preparations | 0.947 |
| Crude fertilizer/mineral | 0.9405 | Furniture/furnishings | 0.946 |
| Animal/veg oils processed | 0.9393 | Coffee/tea/cocoa/spices | 0.946 |
| Industry special machine | 0.9186 | Animal feed | 0.937 |
| Plastics non-primary form | 0.9009 | Organic chemicals | 0.935 |
| Bottom 10 products | | | |
| Cork/wood manufactures | 0.2876 | Dyeing/tanning/... | 0.55 |
| Furniture/furnishings | 0.2830 | Metalworking machinery | 0.54 |
| Gas natural/manufactured | 0.2727 | Fixed veg oils/fats | 0.47 |
| Petroleum and products | 0.1798 | Industry special machine | 0.45 |
| Travel goods/handbag/etc | 0.1612 | Vegetables and fruit | 0.45 |
| Hide/skin/fur, raw | 0.1590 | Pulp and waste paper | 0.44 |
| Oil seeds/oil fruits | 0.1384 | Petroleum and products | 0.40 |
| Apparel/clothing/access | 0.1135 | Gas natural/manufactured | 0.24 |
| Footwear | 0.1110 | Oil seeds/oil fruits | 0.18 |
| Manufactured fertilizers | 0.0789 | Coal/coke/briquettes | 0.13 |

$IIT$ higher for differentiated and high-tech goods

# Horizontal vs Vertical IIT

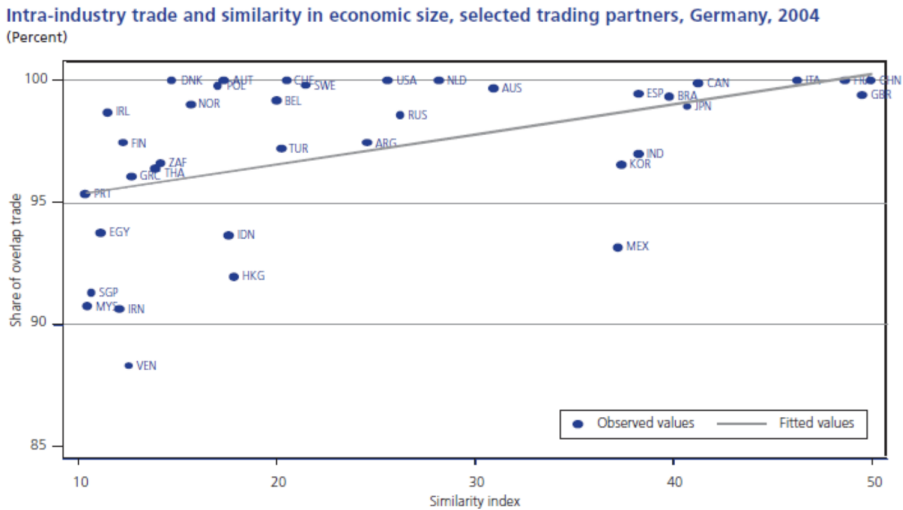
- the $IIT$ index has 2 potential limitations
  - the less disaggregated the sectors, the higher $IIT$
  - $IIT$ does not distinguish between intermediates (engines) and final goods (cars) within a sector
- solution: 2 indexes computed on super-disaggregated data
  - "vertical" $IIT$: intermediate goods imported and exported in the same industry
  - "horizontal" $IIT$: similar final goods imported and exported in the same industry
- both $IIT$ predominant between similar (advanced) countries
- unidirectional trade predominant between different countries (North-South)

# Intra-Industry Trade: Data

- share of German trade with its partners

| Partner | Horizontal | Partner | Vertical | Partner | One way |
|---|---|---|---|---|---|
| United Kingdom | 0.56 | Malaysia | 0.49 | Bangladesh | 1.00 |
| Switzerland | 0.53 | Italy | 0.41 | Zimbabwe | 0.99 |
| France | 0.52 | Spain | 0.39 | Madagascar | 0.98 |
| Austria | 0.51 | Belgium | 0.38 | Algeria | 0.98 |
| Netherlands | 0.49 | Portugal | 0.37 | Nigeria | 0.97 |
| Denmark | 0.49 | Netherlands | 0.37 | Macao, China | 0.97 |
| Czech Republic | 0.47 | France | 0.36 | Panama | 0.97 |
| US | 0.47 | Slovenia | 0.35 | FYROM | 0.97 |
| Belgium | 0.45 | Sri Lanka | 0.34 | Iran | 0.96 |
| Singapore | 0.44 | Hong Kong, China | 0.34 | Ghana | 0.96 |

# Intra-Industry Trade and Similarity



# Summary

- IRS + differentiated goods $\rightarrow$ monopolistic competition
  - monopolist's price is decreasing in substitutability
- larger markets $\rightarrow$ more varieties
- more varieties $\rightarrow$ happier consumers
- efect of trade = increase market size
  - more varieties $\rightarrow$ more varieties can be consumed in both countries
  - gains from trade = gains from variety
- pattern of specialization and trade
  - each country specializes in a number of different varieties depending on its size
  - each country exports all domestic and imports all foreign varieties: intra-industry trade
- smaller countries benefit more from trade