# FACTOR ENDOWMENT MODELS, IMPERFECT COMPETITION, TRADE AND FIRMS

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# Background

- Differences in relative prices cause trade
  - *Different supply conditions*
  - *Different demand conditions*

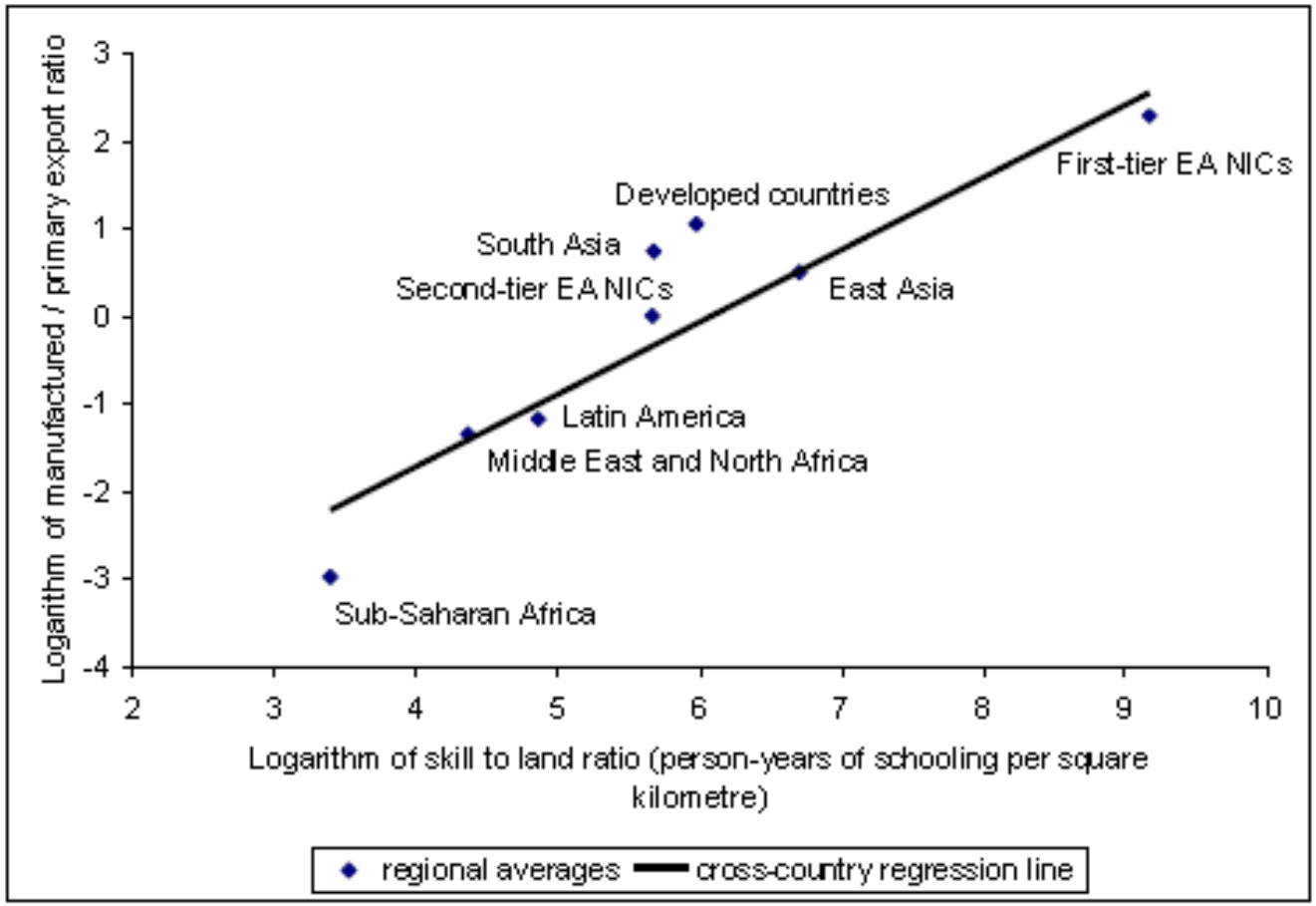
  *The trade literature does not focus as much on demand.*

- Ricardo: Differences in technology cause relative price differences
  - *Implies complete specialisation*
  - *Only one factor of production*

=> HO: Based on differences in relative factor endowments

# What explains differences in the composition of trade flows?

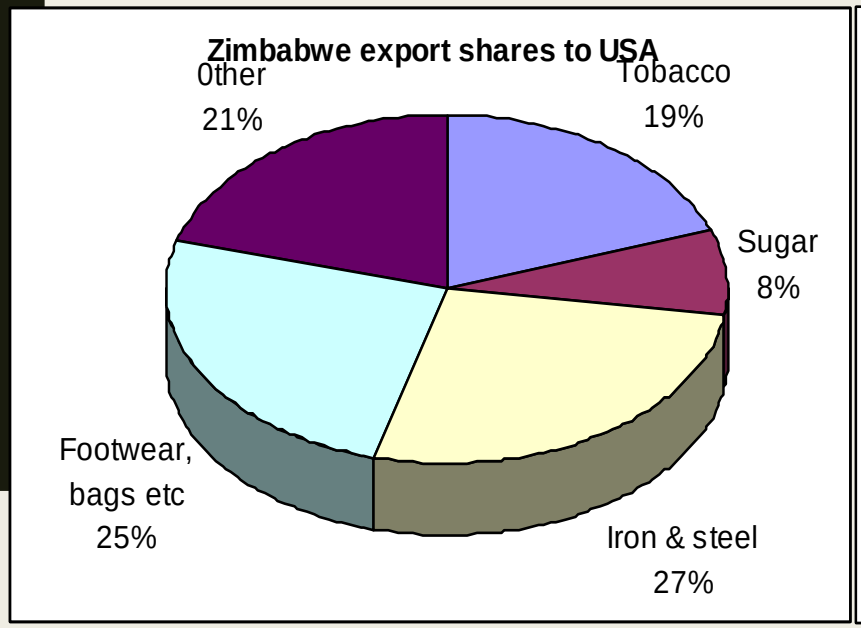
Figure 4a:
Export structure (manufactured / primary) and resources, by region, 1990

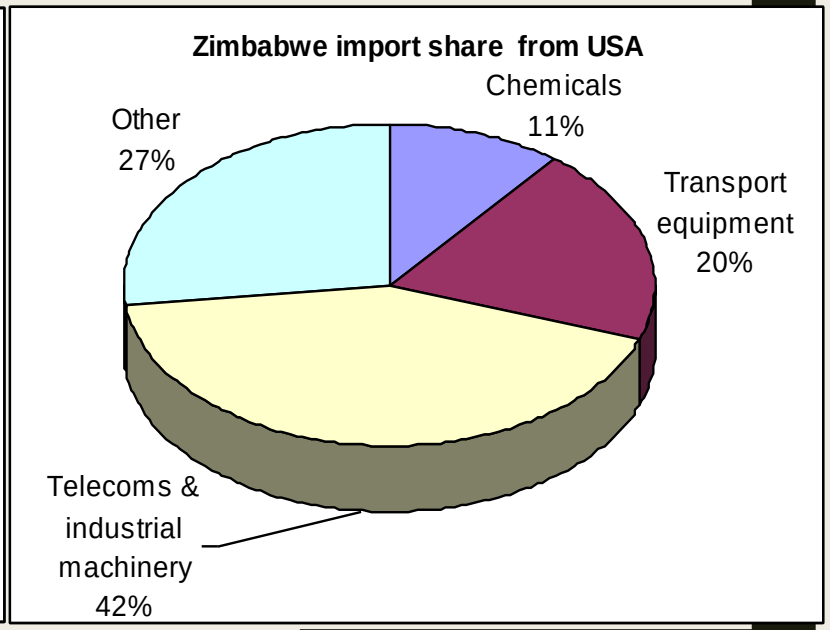



Wood and Mayer (2001)

# THE COMPOSITION OF REGIONAL TRADE

Why does the composition of Zim-US trade differ from US-Europe trade?



# Key questions for HO model

- "Why do countries trade?"

  They have different endowments

- "What determines the pattern of trade?"

  HO Theorem

- "Who benefits, who loses?"

  Stolper-Samuelson Theorem

- "How do endowment changes affect outputs? "

  *Rybczynski Theorem*

# HO Model: Assumptions

- 2 countries: Home and Foreign
- 2 factors: labour, capital
- 2 goods: Footwear (X), Machinery (Y)
- Production functions: Each good is produced with a CRTS production function
- Each country has the same production functions
- Good Y is K-intensive; Good X is L-intensive

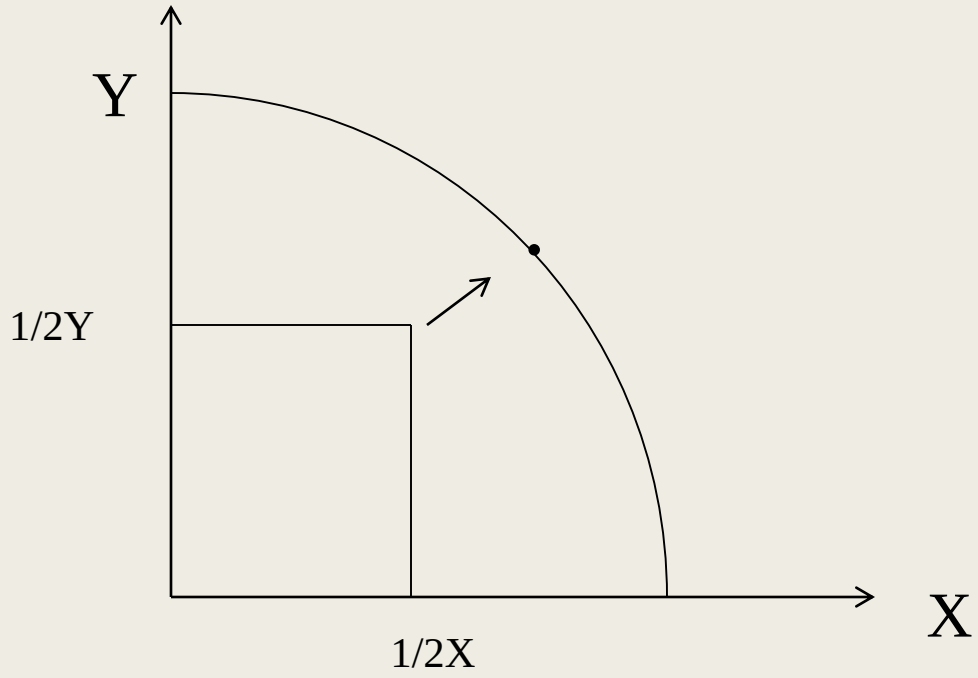
  *Definition: A good Y is capital intensive relative to good X if when both industries face the same relative factor prices (w/r) the industries minimize costs by choosing* $(K/L)_Y > (K/L)_X$.

# Assumptions, cont.

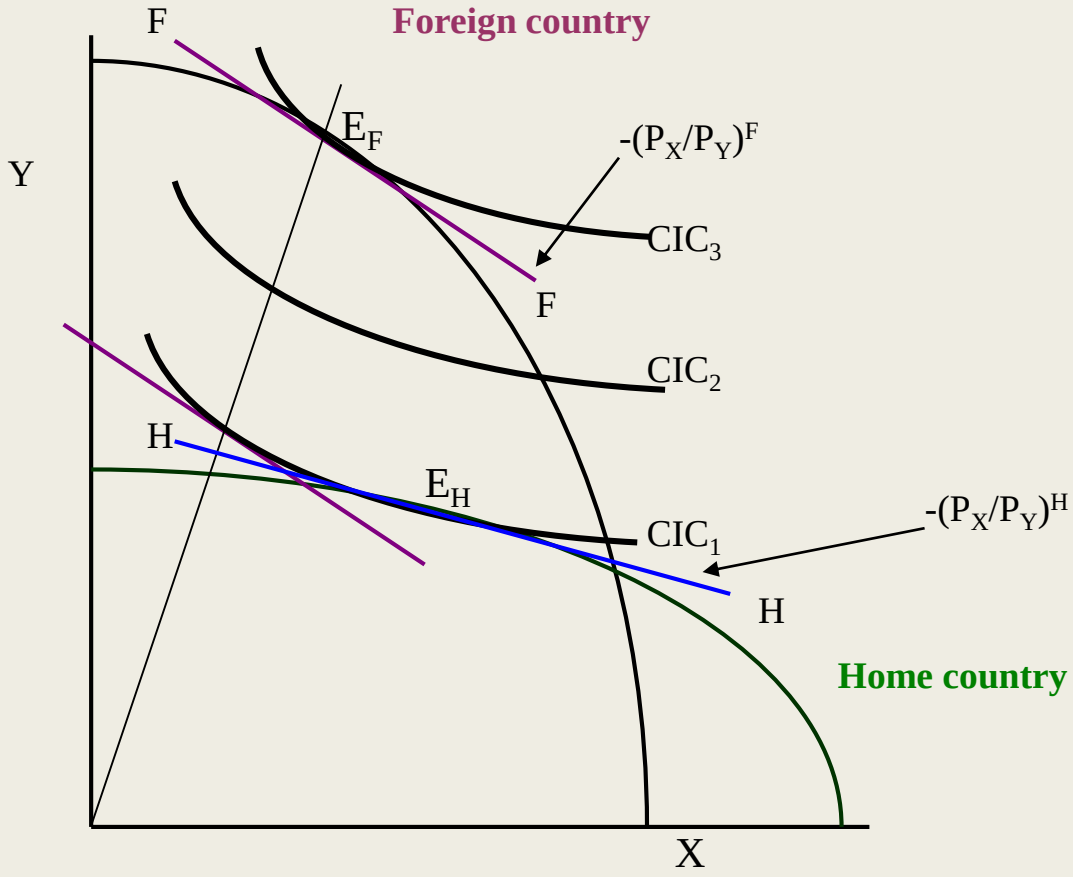
- Perfect competition in all markets
- Factors flow between industries within a country
- Factors do not flow between countries
- Home is L-abundant; Foreign is K-abundant
  - *Definition: Foreign is capital abundant when its endowment of K relative to L is higher than that in Home:* $(K/L)_H < (K/L)_F$
- Consumers at Home and in Foreign have the same identical, homothetic tastes and preferences.

# The PPF

- With one capital intensive and one labor intensive good, the PPF is bowed out.
- IRS exerts opposite pressure on shape of PPF. Resulting shape not determinate.



# Why trade occurs: Different relative prices under Autarky



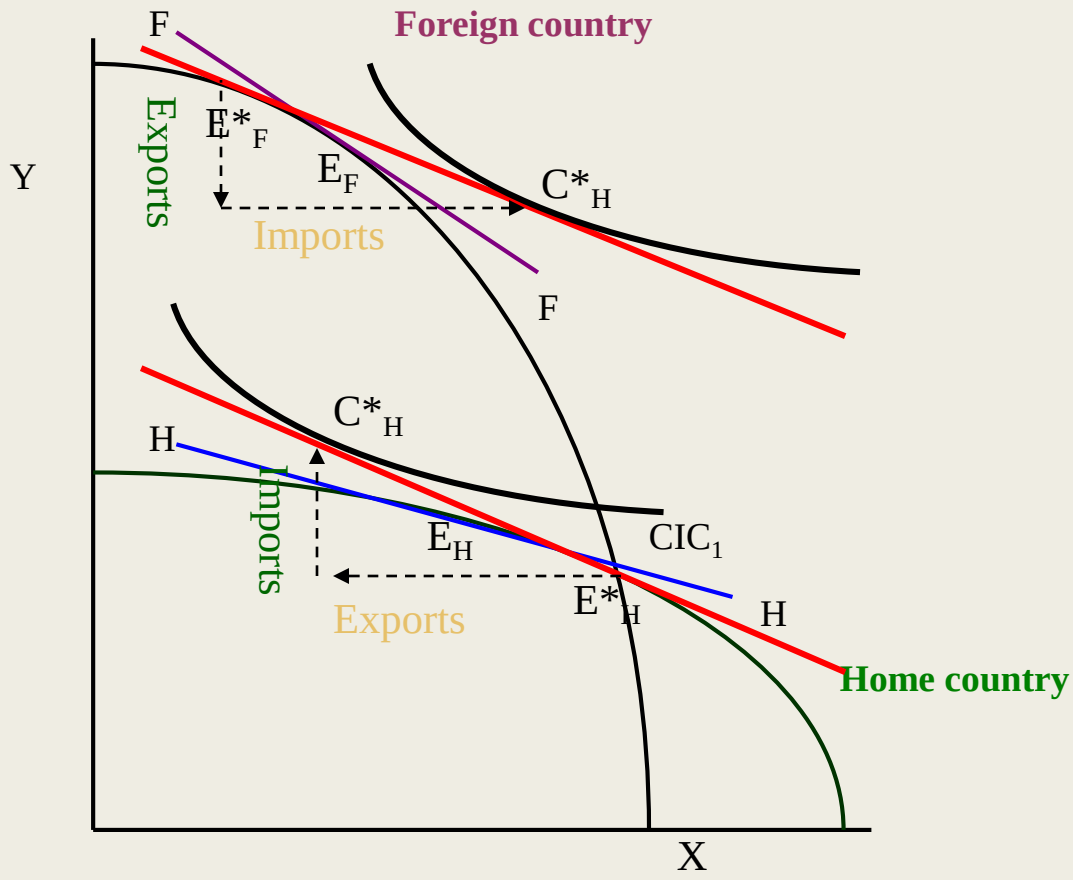

- $(P_X/P_Y)^H < (P_X/P_Y)^F$
  - ⇨ Home exports X (Footwear) and Foreign exports Y (Machinery)

# TRADE FLOWS: HECKSCHER-OHLIN THEOREM

# Heckscher-Ohlin Theorem

*A country with balanced trade will export the commodity that uses intensively its relatively abundant factor and will import the commodity that uses intensively its relatively scarce factor*

# Composition and Gains from Trade




- $(P_X/P_Y)^H < (P_X/P_Y)^F$
  - ⇨ Home exports X (Footwear) and Foreign exports Y (Machinery)
- Also: $(w/r)^H < (w/r)^F$

# STOLPER-SAMUELSON AND RYBCZYNSKI EFFECTS

# India and RCEP

- https://www.youtube.com/watch?v=fvDaqWmu_to

# HOW ARE FACTOR PRICES DETERMINED?

# Constant Returns to Scale

- Most GE trade models assume Constant Returns to Scale in the production function.
- Consider a firm minimizing cost:

$$c(w,r) = \min_{L,K \geq 0} \left\{ wL + rK \mid f(L,K) \geq Y \right\}$$

Since the production function is CRS, solutions are:

$$L^* = a_L Y \; ; K^* = a_K Y$$

If Y is 1, then

$$L^* = a_L \; ; K^* = a_K$$

are unit factor requirements.

- Also, given CRS, we can scale up from the firm to industry output and output for the whole economy.

# Two-good, Two-factor model: Algebra

$$c_i(w,r) = \min_{L_i, K_i \geq 0} \left\{ wL_i + rK_i \mid f_i(L_i, K_i) \geq 1 \right\}$$

(1) Zero profit conditions

$$P_X = c_X(w,r)$$

$$P_Y = c_Y(w,r)$$

(2) Full-employment conditions

$$a_{X,L}X + a_{Y,L}Y = L$$

$$a_{X,K}X + a_{Y,K}Y = K$$

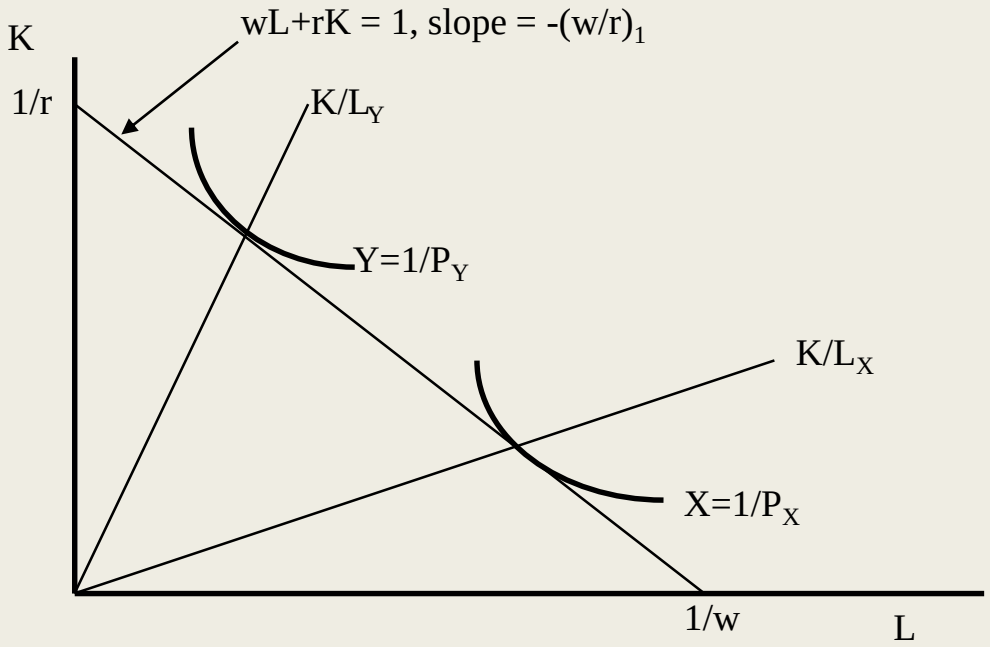
where $a_{ij}$ is unit factor requirement coefficient

Under assumption of *exogenous* prices and fixed endowments, these 4 equations solve for ($Y$,$X$) and ($w$,$r$)

# Equilibrium using Lerner diagrams

## Zero profit conditions (prices exogenous)

- Construct *unit-value isoquants* and *unit-cost isocosts*
- $P_Y Y(K,L) = 1 \Rightarrow Y = 1/P_Y$
- $P_X X(K,L) = 1 \Rightarrow X = 1/P_X$
- $wL + rK = 1$
- Zero profit ensures unit cost = unit revenue in both markets

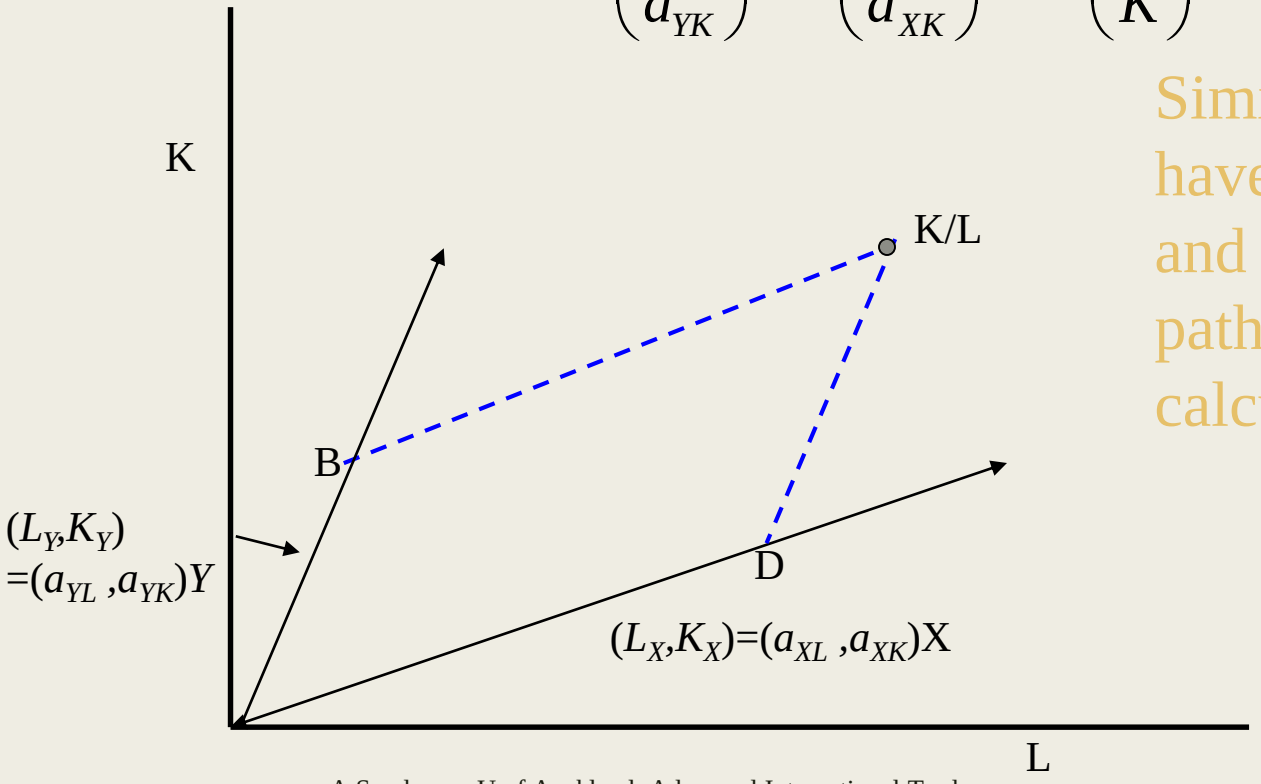


# Equilibrium: Full employment

## Determining output levels

- Given the expansion paths ($a_{iK}/a_{iL}=K_i/L_i$), total endowments are:

$$\begin{pmatrix} a_{YL} \\ a_{YK} \end{pmatrix} Y + \begin{pmatrix} a_{XL} \\ a_{XK} \end{pmatrix} X = \begin{pmatrix} L \\ K \end{pmatrix}$$

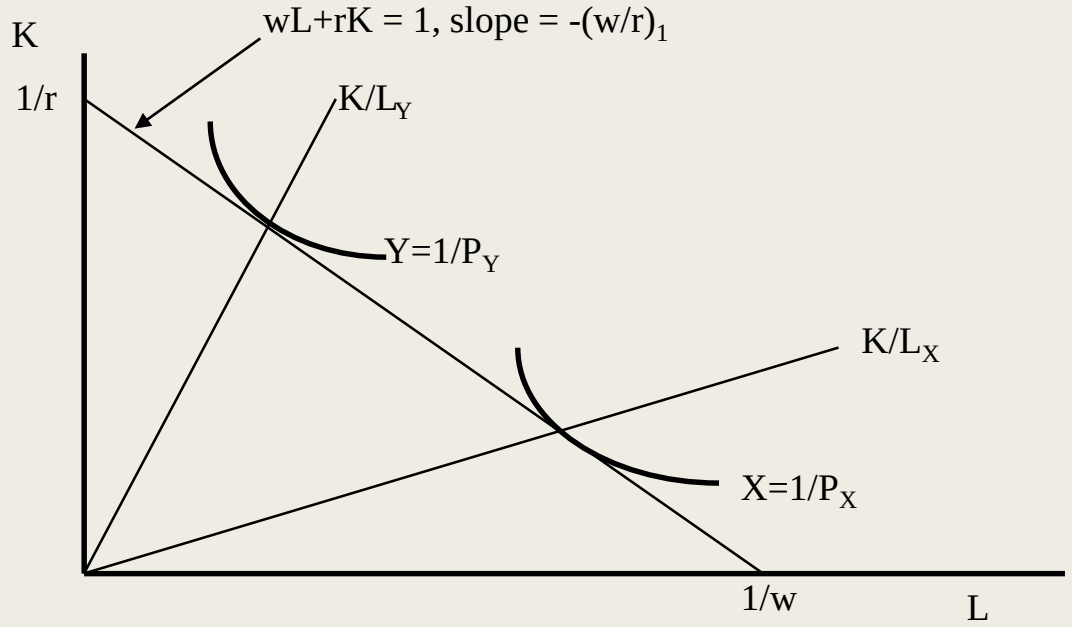



Similarly, if we have endowments and the expansion paths, we can calculate outputs

# Theorem 1: Factor Price Equalisation

*If both countries produce both goods and factor intensity reversals do not occur, then all countries have identical factor prices*

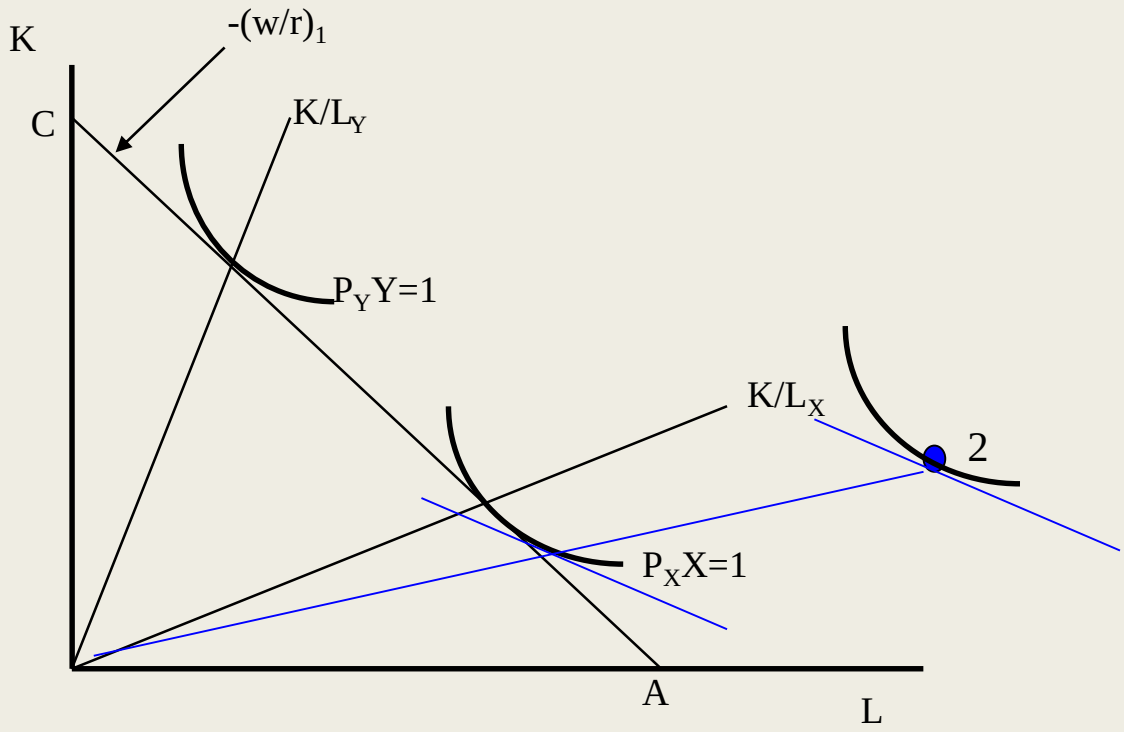
- Under free trade, both countries face same prices and produce using same technology
- If endowments in cone of diversification, zero profit condition ensures FPE




⇨ Commodity trade is a perfect substitute for trade in factors

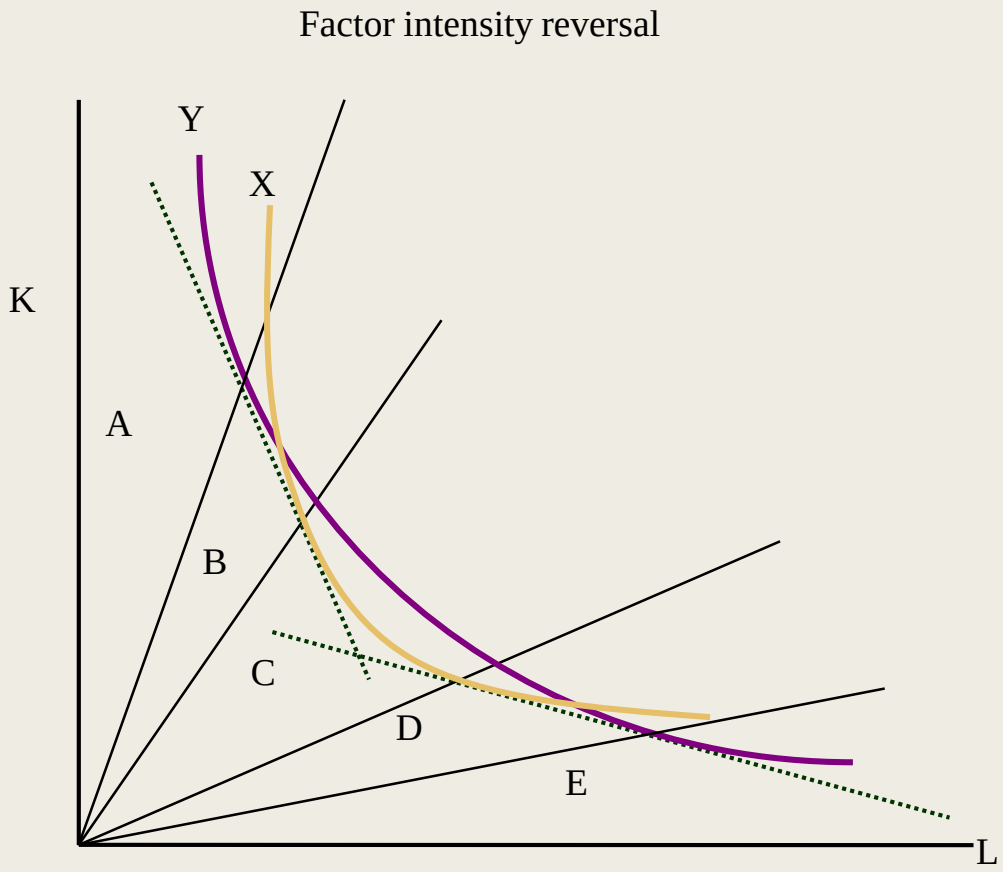
# Exceptions to FPE (1)

- Factor supplies must fall in *cone of diversification*, i.e. between $K/L_Y$ and $K/L_X$
- If outside *cone* relative w/r determined by slope of isoquant passing through point 2. Country specialises in X



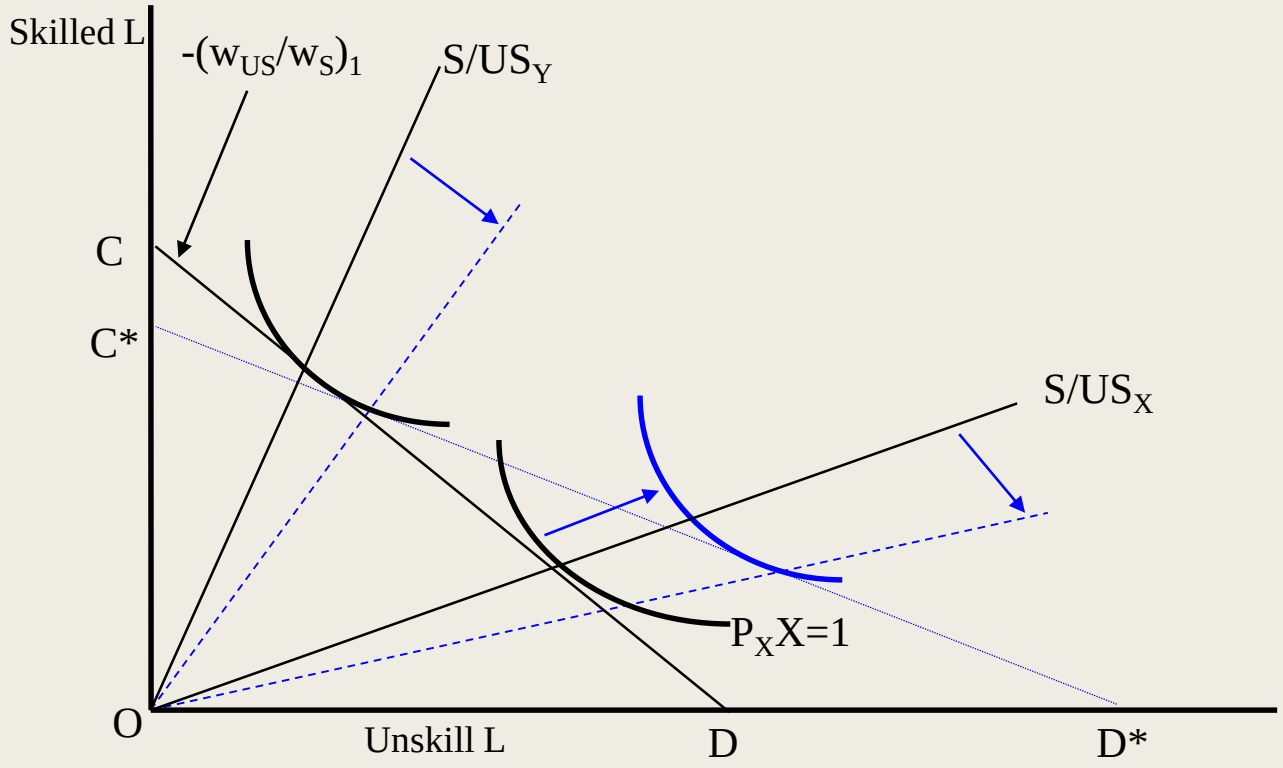
# Exceptions to FPE (2)

- *Factor intensity reversal*

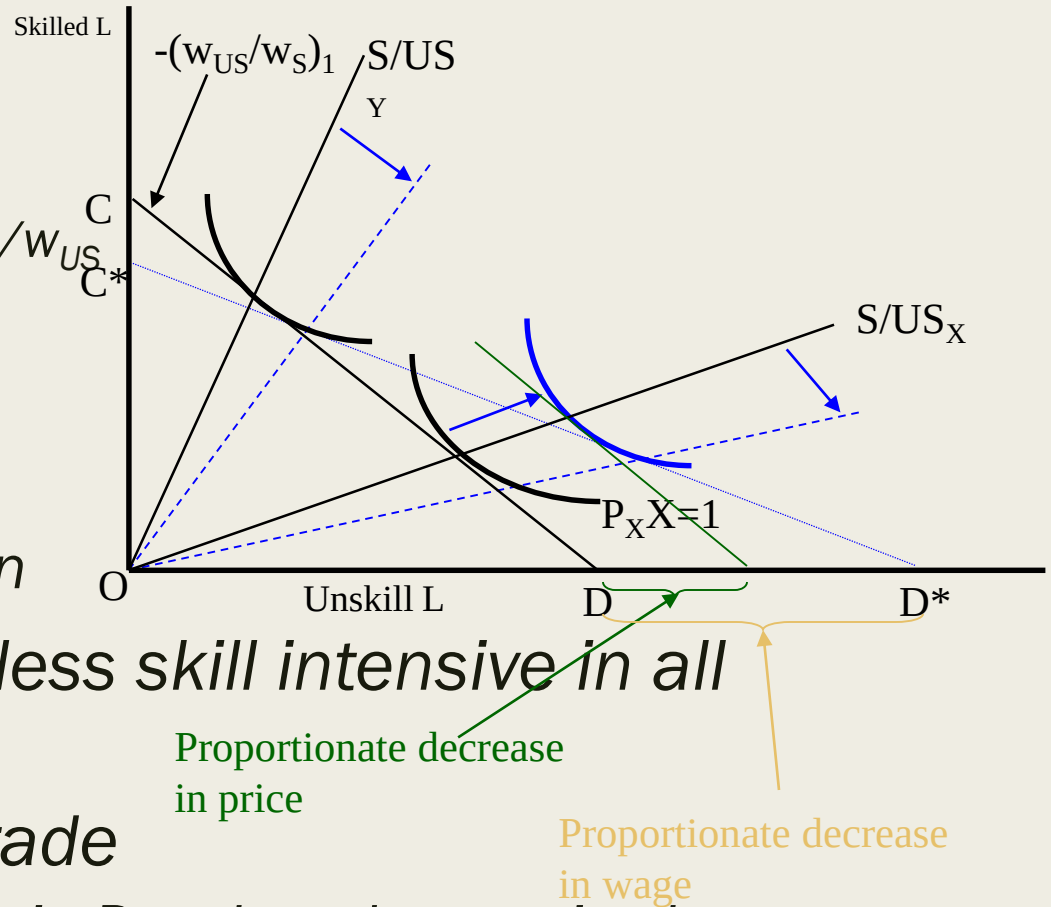


# Stolper-Samuelson Theorem

- *An increase in the relative price of a good increases the real return to the factor used intensively in that good and reduces the real return to the other factor*
- Let Y be skill-intensive and X unskill-intensive.
- Let $P_X$ fall



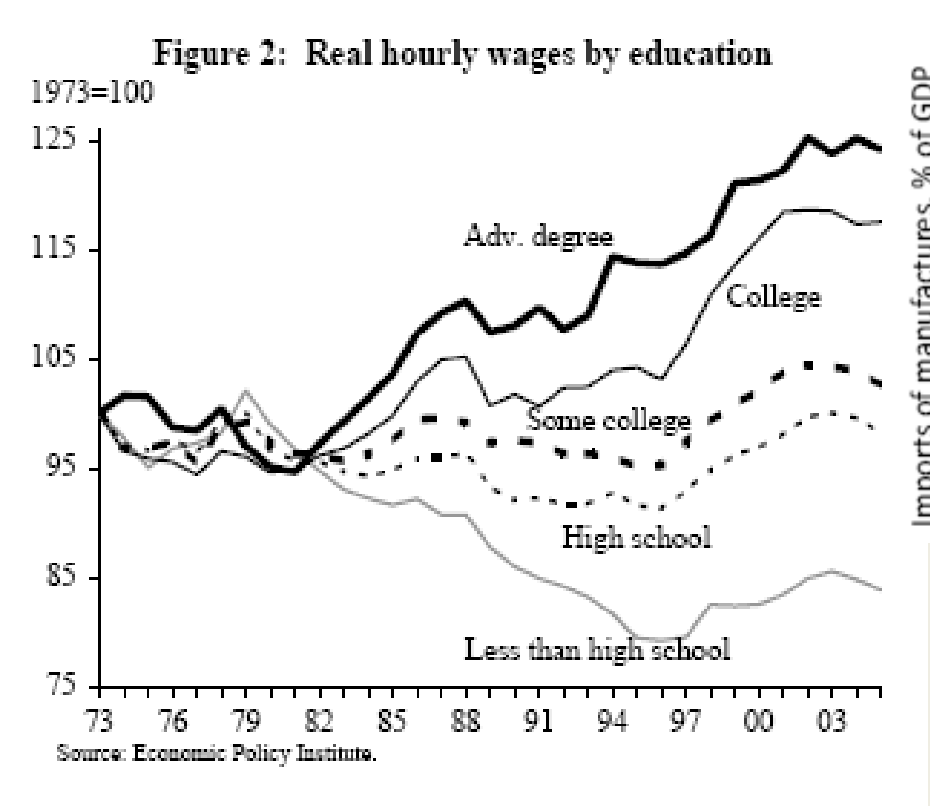
- *Unskilled wage falls*
  - *OD = budget/wage$_{US}$ = 1/w$_{US}$*
  - *OD < OD* => w$_{US}$ fallen*
- *Skilled wage rises*
  - *OC = 1/w$_S$*
  - *OC > OC* => w$_S$ risen*
- *Production becomes less skill intensive in all sectors*
- *Implications of free trade*
  - *Wage inequality rises in Developed countries but falls in Developing countries*
  - *Reduction in agricultural subsidies by developed countries, should raise return to developing country farmers*

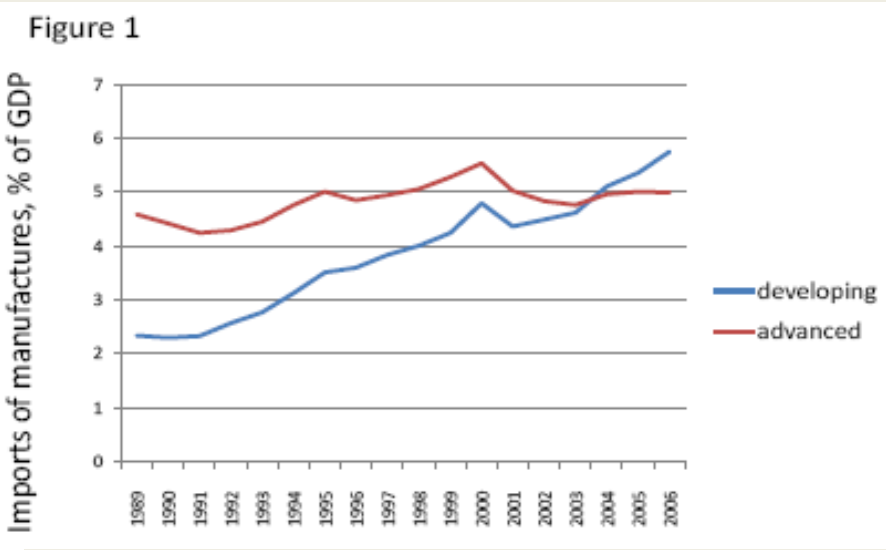


# Evidence SS

- **Empirical evidence**
  - *$W_S/W_{US}$ risen in many developed countries (US, UK)*
  - *$W_S/W_{US}$ also risen in many developing countries (Berman & Bound, 2000)*
  - *Skill-intensity of production has risen NOT fallen*
  - *No clear bias in change in $P_S/P_{US}$*
- Is technology to blame: Hicks-neutral vs skill-biased?

# Wage inequality in USA



# Autor, Dorn and Hanson (2013)

Effect of Chinese competition on the US.

Identification strategy:

- Local exposure to Chinese competition
- Instrument using OECD imports from China

Find negative effect on employment, labor force participation and wages

# Trade and Wages: Rising wage inequality in developed countries

- Significant rise in imports from developing countries
  - *USA: 5% value of output in 1978 , 11% in 1990*
- Rising unemployment of less skilled in OECD countries
- Ratio of skilled to less skilled wage rose from 1.52 to 1.65 between 1982-1990 in US.
  - *Premium earned by male graduates relative to high school rose by 30% in 1980s.Real wage of men with 12 or fewer years schooling fell 20%*
- Employment of skilled labour rose sharply during the 1980s in US
  - ⇨ *labour demand driving this*

# Evidence SS

- Trade literature documents rising inequality with trade in developing countries

- Potential explanations
  - *Exports and quality upgrading (Eric Verhoogen's work)*
  - *Outsourcing (Feenstra and Hanson, 1990s)*

# HOW DO ENDOWMENT CHANGES AFFECT FACTOR PRICES AND OUTPUT?

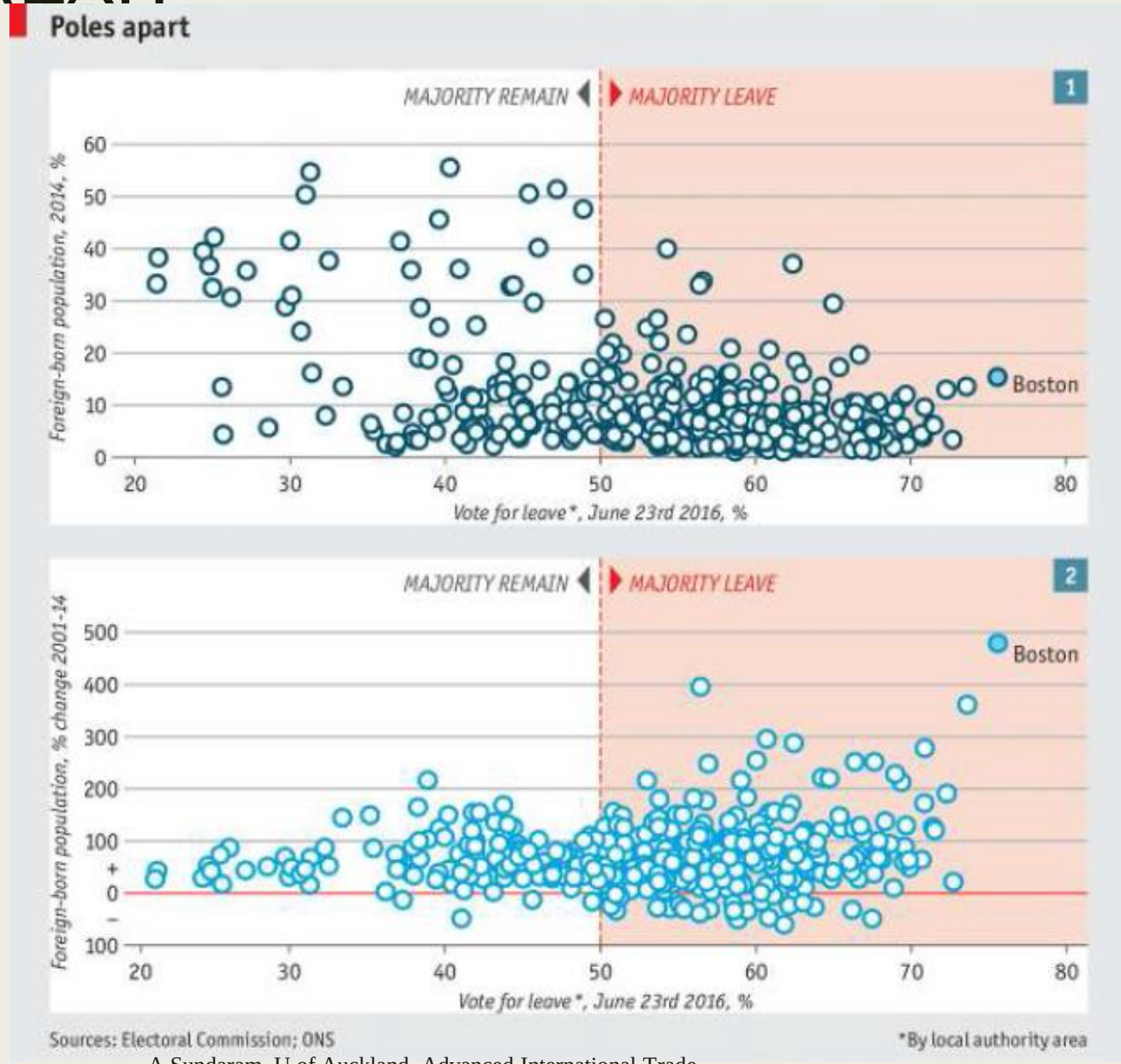
What is the impact of a rise in immigration of low skilled workers?

# Brexit vote analysis

http://www.independent.co.uk/news/uk/politics/eu-referendum-result-7-graphs-that-explain-how-brexit-won-eu-explained-a7101676.html

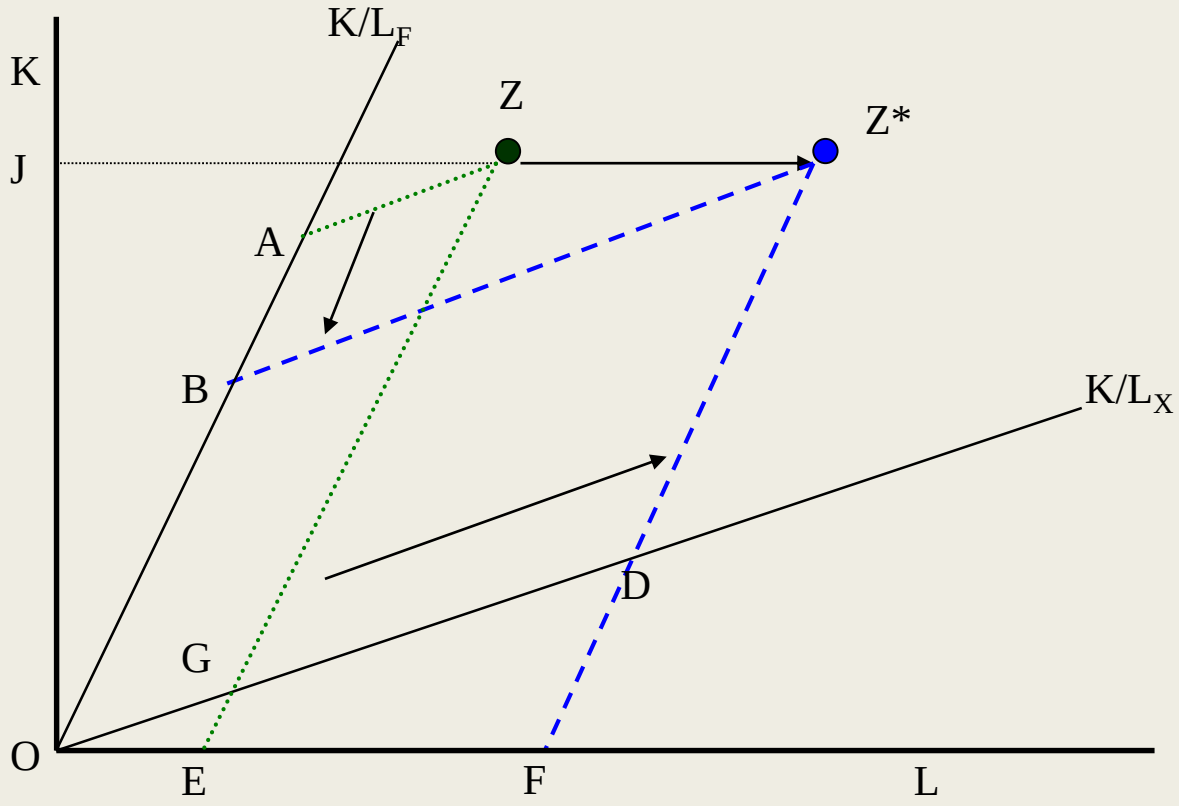
| | % who dislike and voted Brexit |
|---|---|
| Multi-culturalism (39% dislike) | 81 |
| Social liberalism (35% dislike) | 80 |
| Feminism (22%) | 74 |
| Environmentalism (26%) | 78 |
| Globalisation (36%) | 69 |
| The internet (6%) | 71 |
| Immigration (54%) | 80 |
| Capitalism (43%) | 51 |

# BREXIT


Poles apart
MAJORITY REMAIN
MAJORITY LEAVE
1
Foreign-born population, 2014, %
60
50
40
30
20
10
0
20
30
40
50
60
70
80
Boston
Vote for leave*, June 23rd 2016, %
MAJORITY REMAIN
MAJORITY LEAVE
2
Foreign-born population, % change 2001-14
500
400
300
200
100
+
0
–
100
Boston
20
30
40
50
60
70
80
Vote for leave*, June 23rd 2016, %
Sources: Electoral Commission; ONS
*By local authority area

# Rybczynski Theorem

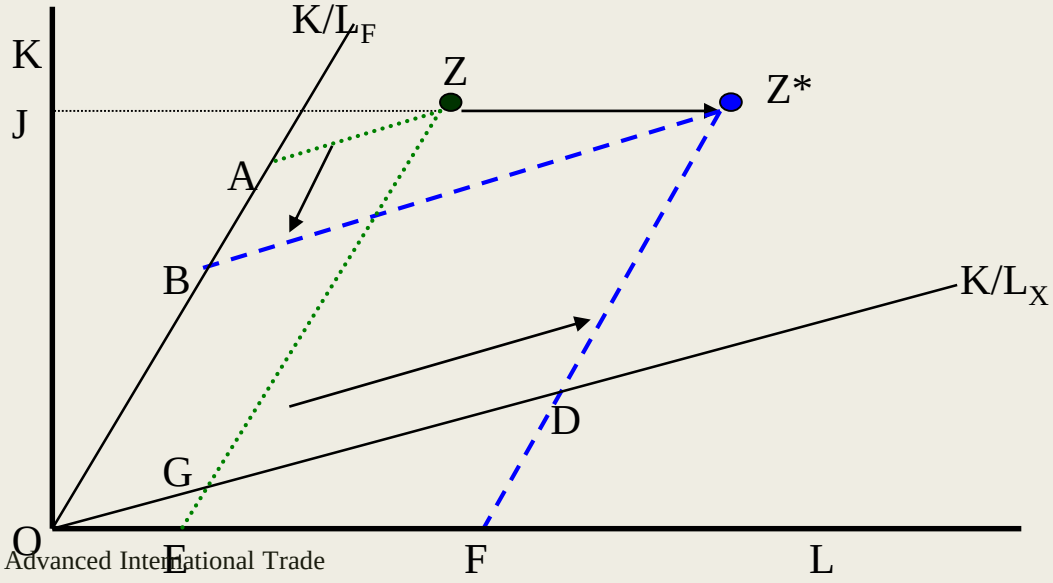
- *Question:* What happens to the wage of labour in India when immigrants from Bangladesh cross the border?



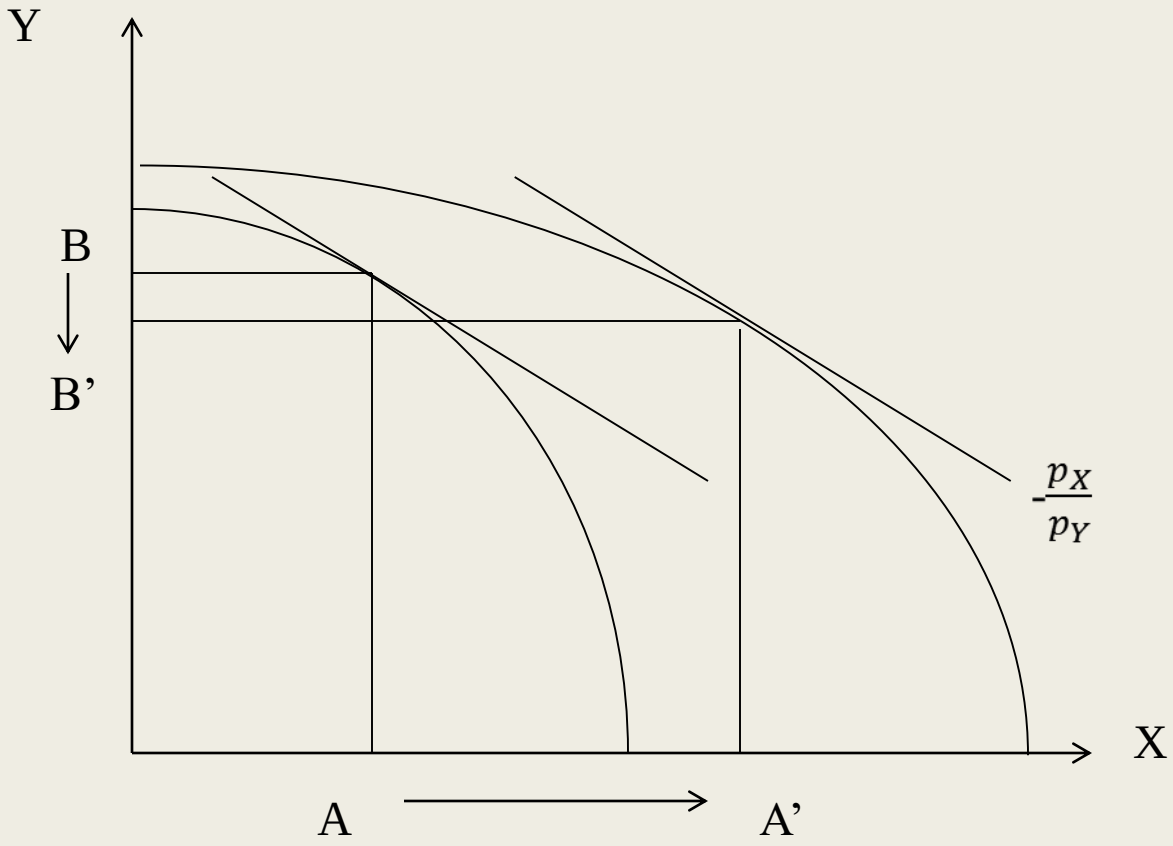
# Rybczynski Theorem, cont

*At constant commodity prices, an increase in the supply of a factor will lead to an increase in the output of the commodity that uses that factor intensively and a reduction in the output of the other commodity*

- Factor payments don't change as prices have not changed
- Z*Z/JZ < EF/OE = GD/OG => growth in X > growth in L
- Jones Magnification: %ΔX > %ΔL > %ΔK > %ΔY



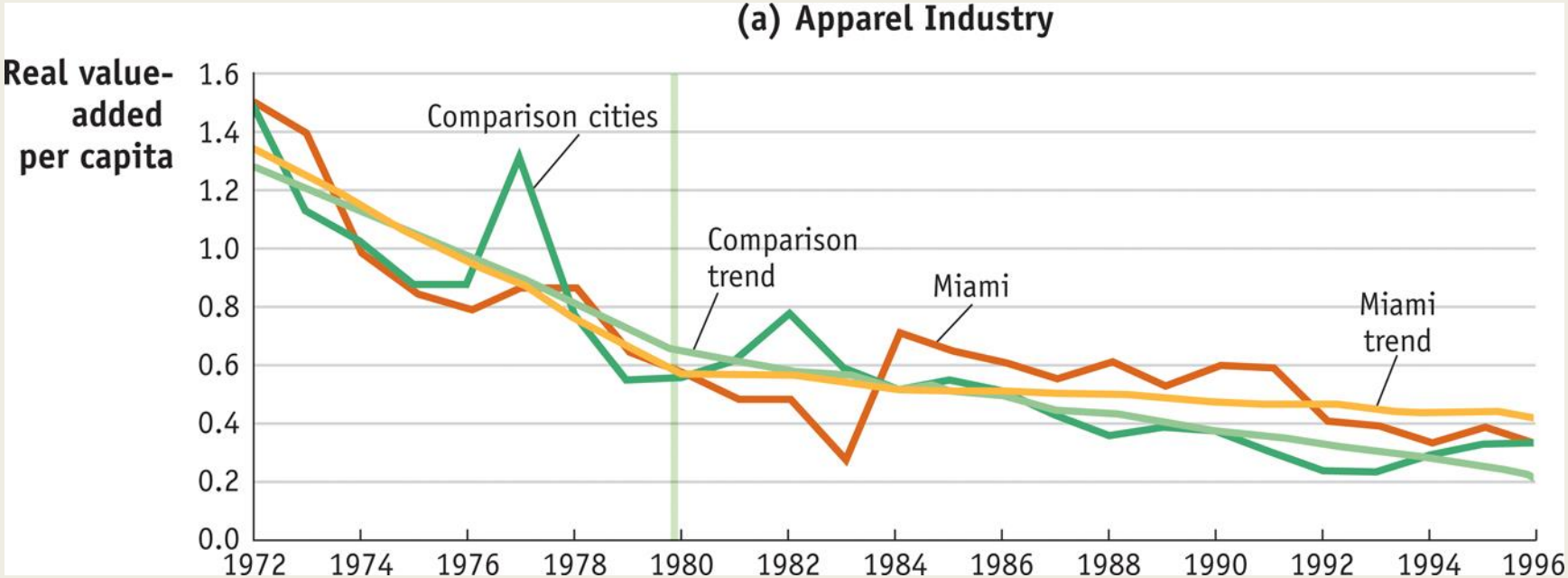
# Rybczynski on the PPF



# The Miami Boatlift

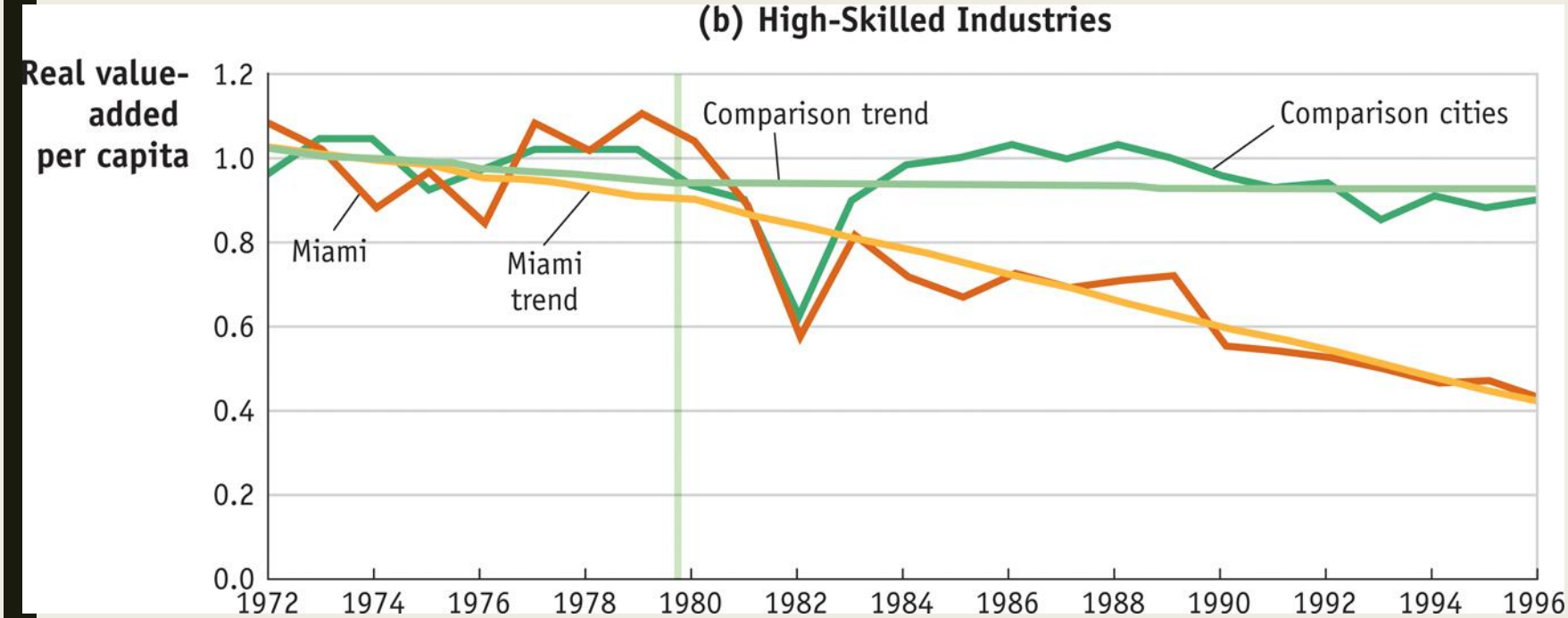
- www.wsj.com

# Evidence
(The Miami Boat Lift)



# Evidence

(The Miami Boat Lift)



# Evidence

(Giovani Peri, George Borjas, Steve Stillman)

- Are immigrants and natives truly substitutes?
- Immigrants complement highly educated natives.
- Immigrants perform manual labor-intensive tasks while natives move to communication and language-intensive tasks.
  - *Positive wage effects!*

www.express.co.uk

# INCREASING RETURNS TO SCALE

# Krugman's New Trade Theory

## Key insights of Krugman's model

- **Imperfect competition** derived from internal economies of scale (Monopolistic competition)
- Consumers have a love of variety: results in **product differentiation** which drives trade flows
- The model predicts **intra-industry trade**

The gains from trade are:

- Consumers enjoy a wider range of **product varieties**.
- There is a **pro-competitive effect**: Market power is reduced

# Increasing Returns to Scale (Krugman 1979)

Monopolistic competition + Love of variety

i=1,2,…,N product varieties

L consumers

Labor income w

Consumers face utility function into which all goods enter symmetrically:

$$U = \sum_{i=1}^{n} v(c_i) \quad v' > 0, v'' < 0$$

Where $c_i$ reflects consumption of good $i$ for the individual consumer.

Consumers choose $c_i$ to maximise Utility subject to their budget constraint

$$w = \sum p_i c_i$$

First order conditions (FOC):

$$v'(c_i) = \lambda p_i \ , i = 1,...,n$$

$\lambda$ is the Lagrange multiplier (the marginal utility of income).

What is the elasticity of demand for variety i, ($\varepsilon_i = -\frac{dc_i}{dp_i}\frac{p_i}{c_i}$)?

We can calculate ($dc_i/dp_i$) by totally differentiating the FOC (note this is a simple comparative statics exercise) to obtain:

$$v''dc_i = dp_i\lambda \Rightarrow \frac{dc_i}{dp_i} = \frac{\lambda}{v''} < 0$$

$$\varepsilon_i = -\frac{dc_i}{dp_i}\frac{p_i}{c_i} = -\frac{v'}{c_i v''} > 0$$

For reasons to be explained later, we assume that ($d\varepsilon_i/dc_i < 0$).

As consumption falls, the elasticity rises.

This occurs under a linear demand curve and any other curve less convex than a constant-elasticity curve.

# Monopolistic Competition Model

Labor is only resource:

$L_i = \alpha + \beta y_i$

$AC_i = wL_i/y_i$

$= w\alpha/y_i + w\beta$

$MC_i = w\beta$

Equilibrium:

Producer and Consumer

Solve for p, c and n

# Monopolistic competition: Equilibrium

PRODUCER:

MR=MC (Profit Max); P=AC (Zero profit);

symmetric (drop i)

MR=MC

$P(1-1/\varepsilon)=w\beta$ or

$p/w= \beta \varepsilon /(\varepsilon -1)$:  PP curve

P=AC

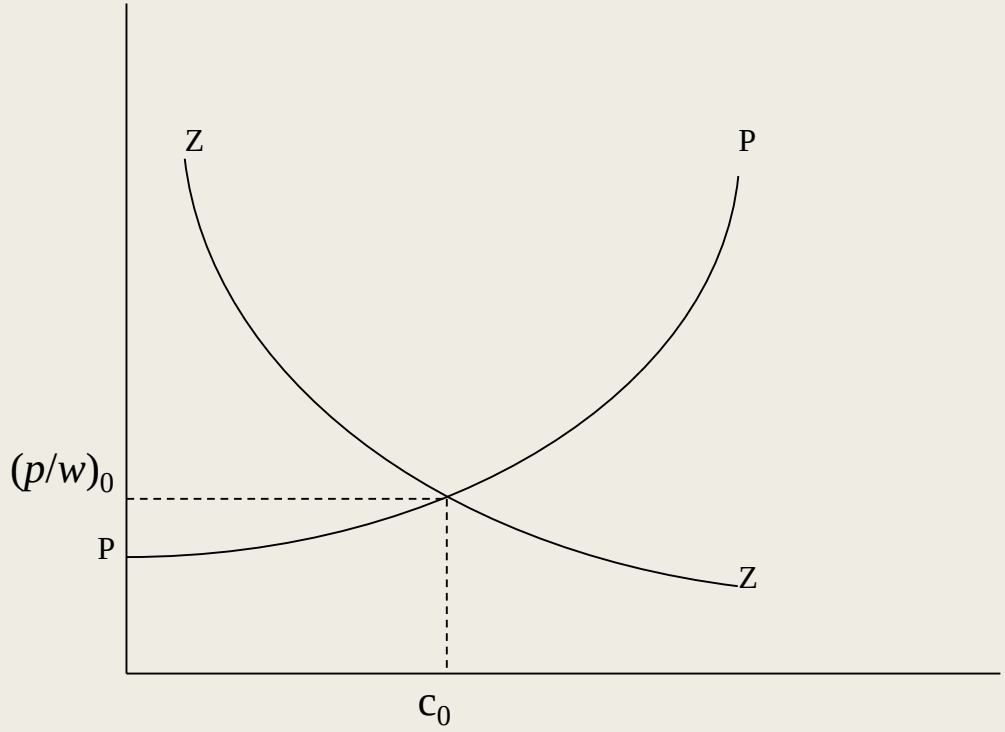
$P=(w \alpha/y)+ w\beta$ or

$p/w=(\alpha/Lc) + \beta$:  ZZ curve

# Monopolistic Competition Model

**ZZ curve**: As *c* increases, so firms are able to exploit economies of scale and average costs fall. The equilibrium price falls as a result.

**PP curve**: As c increases the elasticity of demand falls (see above) and price can increase.



*Market equilibrium*

What is the relationship between c and number of varieties or firms *(n)*?

A. Total production = consumption, i.e.

$x_i = Lc_i$ , where $L$ is the labour force.

B. Labour demand = Labour supply (Assuming full employment)

Assuming symmetry, i.e. output of each firm is then equivalent

$$L = \sum_{i=1} l_i = \sum_{i=1}^{n} (\alpha + \beta x_i) = n(\alpha + \beta x)$$

$$\Rightarrow n = \frac{L}{(\alpha + \beta x)}, \text{ or } n = \frac{1}{\left[\alpha / L + \beta c\right]}$$

The equilibrium value of $c$ therefore determines the number of products $n$. Rising $c$ reduces $n$. Also an increase in $L$ raises $n$.

# Monopolistic Competition Model

## Effects of trade

Assume 2 equivalent economies of identical size (L), tastes and technologies merge.

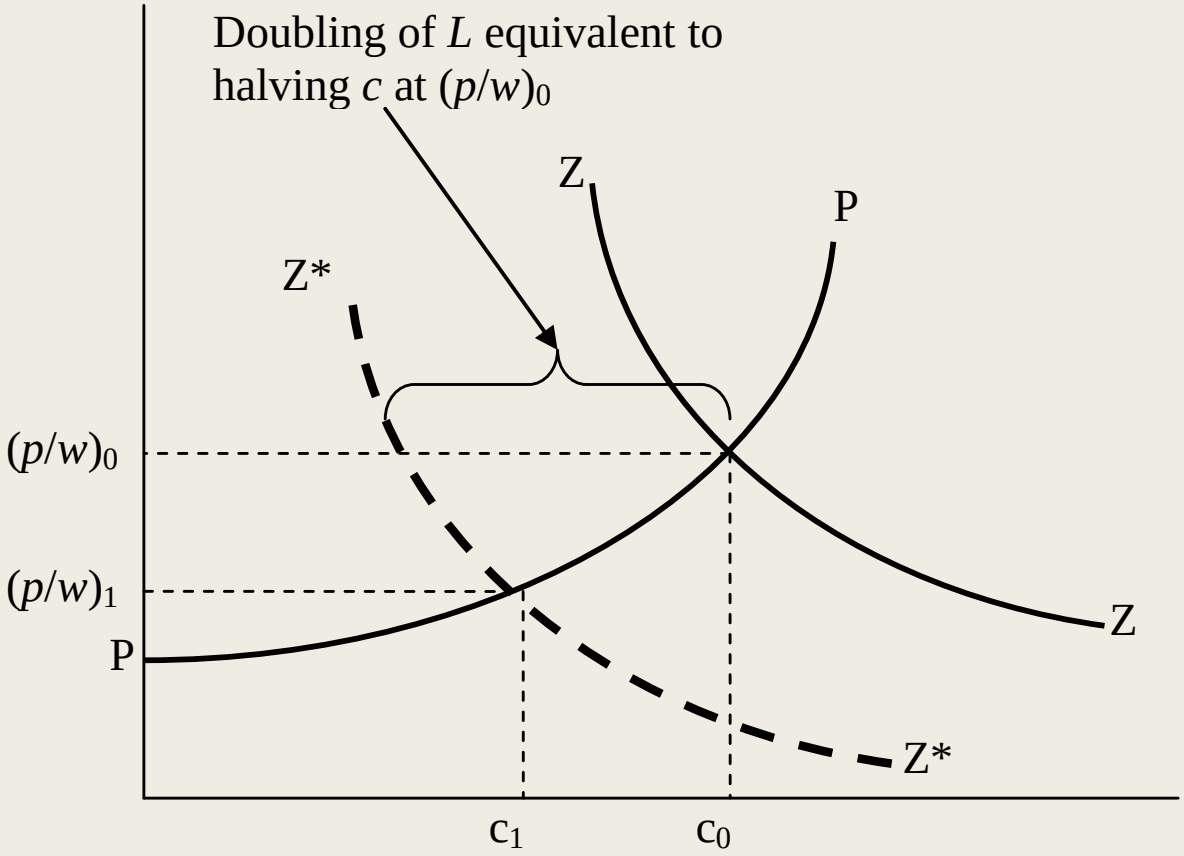
In conventional model there would be no reason for trade.

In this model, trade occurs because **firms produce differentiated products**, there is **demand for these goods** as consumers love variety and **competition** from abroad reduces prices.

## Graphical

If $L$ doubles, then from equation $\left(\frac{p}{w} = \left(\frac{\alpha}{Lc}\right) + \beta\right)$, $ZZ$ shifts to the left. $PP$ is unaffected as $L$ does not enter equation.

**Figure: Effect of trade**



## Explanation of adjustment 1:

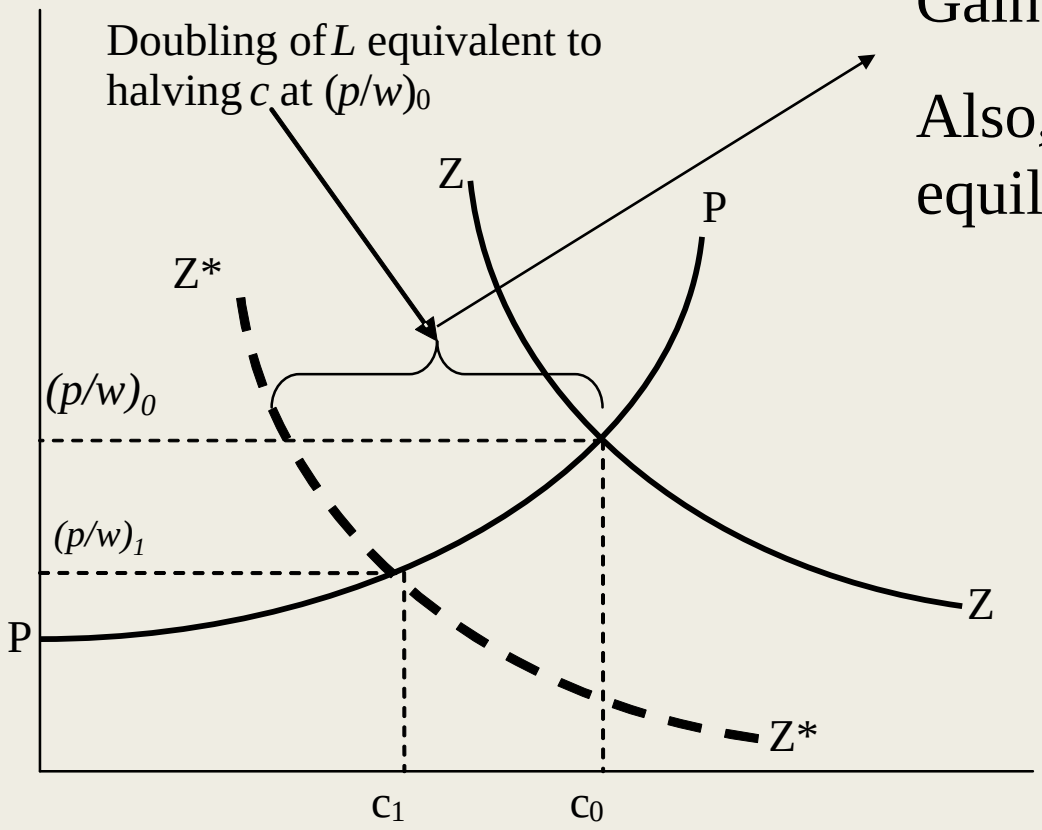
Two countries join

*L* doubles

Gain in real wage

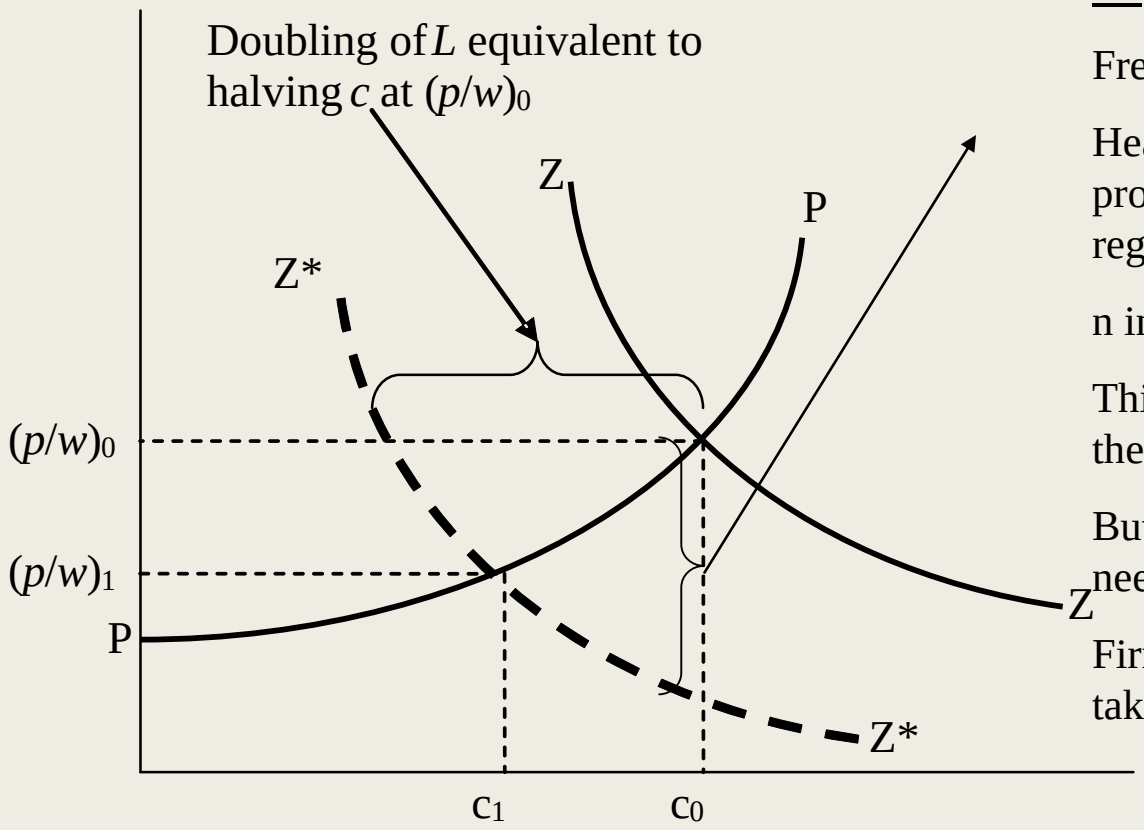
Also, number of varieties in equilibrium rises.

**Figure: Effect of trade**



If $L$ doubles then ZZ shifts to the left. PP is unaffected.

**Figure: Effect of trade**




## Explanation of adjustment 2:

Free trade doubles $L$

Head office of each variety relocates production to single factory to supply region

n in EACH country falls with trade.

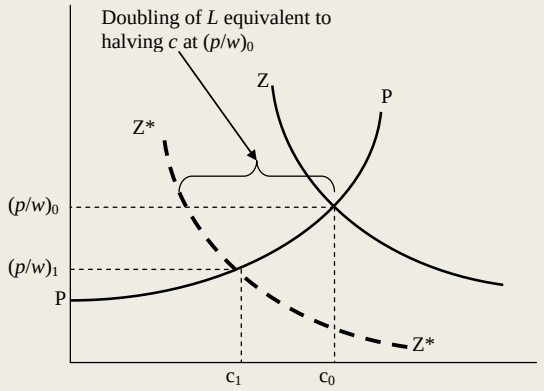
This is because firms are further along their AC curves (output per firm higher).

But given full employment, some firms need to have exited.

Firms exit, remaining firms expand and take advantage of scale economies.

**Variety effect**

What happens to number of varieties?
From ($n = \frac{1}{[\alpha/L + \beta c]}$), $n$ rises (because of both $L$ increasing and $c$ falling).
Hence, consumers who love variety gain in terms of the number of varieties available.




**Economies of scale effect**

**The number of varieties produced in each country necessarily falls**.

**Pro-competitive effect**

Opening to trade increases the competitive pressure reducing mark-ups ($p/w$ falls)

**Direction of trade**

The above figure reflects the result for the integrated economies. What can we say about the direction of trade and the impact of trade on factors?

- Direction of trade is indeterminate. Some industries locate in Foreign and other in Home.
- BUT Trade is balanced, i.e. value of imports = value of exports

# Evolution of Trade Theory

Neo-classical:  HO, Ricardian models

*Treat firms as black boxes.*

*Constant returns to scale.*

*Overall size of industry determined, not firm's.*

New Trade Theory: (Krugman)

*Imperfect competition and mark-ups.*

*Size of firm determined.*

*Homogenous export patterns: Each firm produces a variety, exports everywhere else in the world.*

# Data: Stylized facts (1)

Bernard, Eaton, Jensen, Kortum (BJEK) (2003), Kee and Krishna (2007)

Not all firms export.

Exporters sell most of their product domestically.

More productive exporters service advanced markets.

More productive firms export (or the other way around? Learning by exporting?).

Exporting firms larger.

# Data: Stylized facts (2)

Micro-level data indicate that:

*Trade liberalization leads to substantial reallocation across firms –*

*least productive firms exit, productive firms grow larger. (Bernard and Jensen, 1999, Pavcnik, 2002)*

# Data

## Productivity Dispersion

TABLE 2—PLANT-LEVEL PRODUCTIVITY FACTS

| Productivity measure (value added per worker) | Variability (standard deviation of log productivity) | Advantage of exporters (exporter less nonexporter average log productivity, percent) |
|---|---|---|
| Unconditional | 0.75 | 33 |
| Within 4-digit industries | 0.66 | 15 |
| Within capital-intensity bins | 0.67 | 20 |
| Within production labor-share bins | 0.73 | 25 |
| Within industries (capital bins) | 0.60 | 9 |
| Within industries (production labor bins) | 0.64 | 11 |

*Notes:* The statistics are calculated from all plants in the 1992 Census of Manufactures. The "within" measures subtract the mean value of log productivity for each category. There are 450 4-digit industries, 500 capital-intensity bins (based on total assets per worker), 500 production labor-share bins (based on payments to production workers as a share of total labor cost). When appearing within industries there are 10 capital-intensity bins or 10 production labor-share bins.

Source: Bernard, Eaton, Jensen and Kortum (2003) *AER*

# Exporting is Rare

*Table 2*

**Exporting By U.S. Manufacturing Firms, 2002**

| *NAICS industry* | *Percent of firms* | *Percent of firms that export* | *Mean exports as a percent of total shipments* |
|---|---|---|---|
| 311 Food Manufacturing | 6.8 | 12 | 15 |
| 312 Beverage and Tobacco Product | 0.7 | 23 | 7 |
| 313 Textile Mills | 1.0 | 25 | 13 |
| 314 Textile Product Mills | 1.9 | 12 | 12 |
| 315 Apparel Manufacturing | 3.2 | 8 | 14 |
| 316 Leather and Allied Product | 0.4 | 24 | 13 |
| 321 Wood Product Manufacturing | 5.5 | 8 | 19 |
| 322 Paper Manufacturing | 1.4 | 24 | 9 |
| 323 Printing and Related Support | 11.9 | 5 | 14 |
| 324 Petroleum and Coal Products | 0.4 | 18 | 12 |
| 325 Chemical Manufacturing | 3.1 | 36 | 14 |
| 326 Plastics and Rubber Products | 4.4 | 28 | 10 |
| 327 Nonmetallic Mineral Product | 4.0 | 9 | 12 |
| 331 Primary Metal Manufacturing | 1.5 | 30 | 10 |
| 332 Fabricated Metal Product | 19.9 | 14 | 12 |
| 333 Machinery Manufacturing | 9.0 | 33 | 16 |
| 334 Computer and Electronic Product | 4.5 | 38 | 21 |
| 335 Electrical Equipment, Appliance | 1.7 | 38 | 13 |
| 336 Transportation Equipment | 3.4 | 28 | 13 |
| 337 Furniture and Related Product | 6.4 | 7 | 10 |
| 339 Miscellaneous Manufacturing | 9.1 | 2 | 15 |
| **Aggregate manufacturing** | **100** | **18** | **14** |

*Sources:* Data are from the 2002 U.S. Census of Manufactures.

Source: Bernard, Jensen, Redding and Schott (2007) *JEP*

# Melitz type effects in the Data: Empirics Chicken and Egg

We observe in the data the fact that more productive firms are exporters.

Does exporting lead to increased productivity – learning by exporting? (Clerides et al, 1998)

Endogeneity issue – no clean solution so far.

# Implications for Theory

We need a theory that:

*Incorporates within sector  size and heterogeneity.*

And leads to:

*More productive firms exporting*

This is done by:

*Introducing fixed or sunk costs of exports*

*(Melitz, 2003)*

*Limiting product differentiation – price competition then gives rise to variable mark-ups.*

*(BEJK)*

# TRADE AND HETEROGENEOUS FIRMS

# Models

- Melitz (2003)
  - *Constant mark-up with fixed costs, CES utility*
- Melitz and Ottaviano (2008)
  - *Variable mark-ups, linear demand*
- Bernard, Redding and Schott (2011)
  - *Within firm products*

# Melitz Model

- Firms heterogeneous by productivity

# Melitz (2003): Model Set up - Demand

Utility: $$U = \left[ \int_{\omega \in \Omega} q(\omega)^{\rho} d\omega \right]^{1/\rho}$$

$$\sigma = 1/(1-\rho) > 1$$

Consumers maximize utility subject to budget constraint: $$\int_{\Omega} p(\omega) q(\omega) d\omega = R$$

Leading to demand: $$q(\omega) = Q\left[ \frac{p(\omega)}{P} \right]^{-\sigma}$$

P is the 'aggregate' price index.

$$P = \left[ \int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$$

# Melitz model set up - Supply

Supply:

*Monopolistic competition*

*Fixed costs of production*

*Costs expressed in terms of unique factor of production, L taken as numeraire.*

$$TC(\varphi) = f + \frac{q(\varphi)}{\varphi}$$

Firms with higher $\varphi$ more productive (need fewer workers to achieve same output).

They charge lower prices, produce more output, obtain more revenue and profits.

# Melitz model set up - Profit Max

Profit maximization: Price is a constant mark-up over MC

$$p(\varphi) = \frac{1}{\rho\varphi},$$

Substituting for price in the demand equation:

$$\begin{aligned} q(\varphi) &= RP^{\sigma-1}(\rho\varphi)^{\sigma} \\ r(\varphi) &= p(\varphi)q(\varphi) = R(P\rho\varphi)^{\sigma-1} \\ \pi(\varphi) &= \frac{1}{\sigma}r(\varphi) - f, \end{aligned}$$

This also means that the ratio of revenues or profits of two firms only depends on the ratio of their productivities.

# Melitz model set up - Productivity

Firms face uncertainty as to how productive they will turn out to be:

Upon entry, they pay a fixed cost: $f_e$

Firm then draws its productivity from a distribution with density $g(\varphi)$ and cdf $G(\varphi)$

After observing this productivity level, firm decides whether to produce or not.

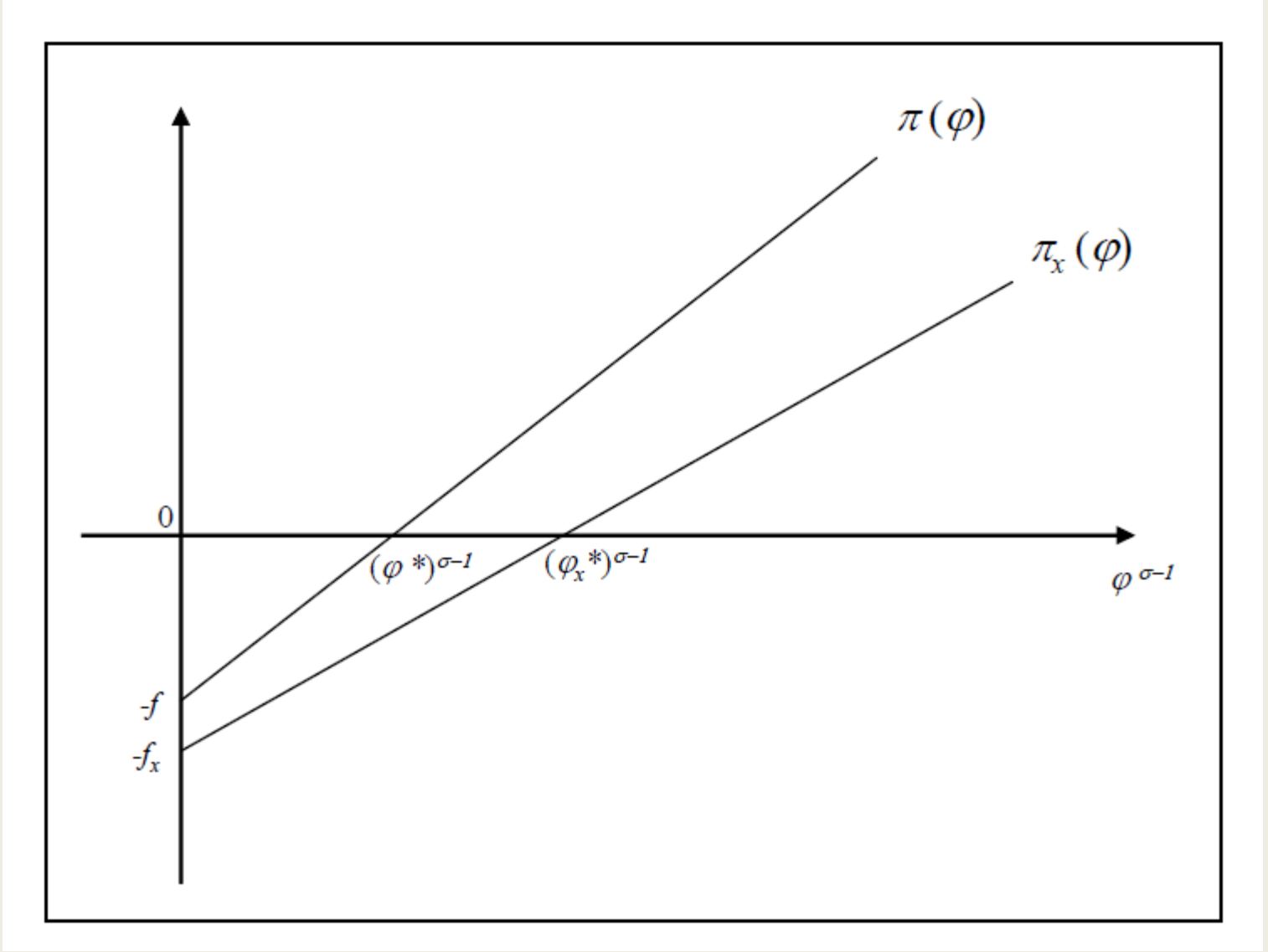
# Melitz model set up – Cut off

A firm considering production anticipates discounted profits:

$$v(\varphi) = \max\left\{0, \sum_{t=s}^{\infty} (1-\delta)^{t-s} \pi(\varphi)\right\} = \max\left\{0, \frac{1}{\delta}\pi(\varphi)\right\},$$

There exists a unique value $\varphi^*$ such that $v(\varphi) > 0$ iff $\varphi > \varphi^*$

# Melitz model set up – Profits Graph



# Melitz model: Industry equilibrium

Solve for $M$ of firms (and varieties).

And for distribution of producing firms $\mu(\varphi)$.

We can express ALL equilibrium conditions as function of $\varphi^*$

Define a weighted average of the productivity measure:

$$\widetilde{\varphi} = \left[\int_0^{\infty} \varphi^{\sigma-1} \mu(\varphi)\, d\varphi\right]^{1/(\sigma-1)}$$

Now:

$$\mu(\varphi) = \begin{cases} \frac{g(\varphi)}{1-G(\varphi^*)} & \text{if } \varphi \geq \varphi^* \\ 0 & \text{otherwise} \end{cases}$$

# Melitz model set up - ZCP

Hence, average productivity in the industry can be written as a function of the cut-off.

$$\widetilde{\varphi}\left(\varphi^{*}\right)=\left[\frac{1}{1-G\left(\varphi^{*}\right)}\int_{\varphi^{*}}^{\infty}\varphi^{\sigma-1}g\left(\varphi\right)d\varphi\right]^{1/(\sigma-1)},$$

Average profit is: $\overline{\pi}=\pi\left(\widetilde{\varphi}\right)$

$$\overline{\pi}=\frac{r\left(\widetilde{\varphi}\right)}{\sigma}-f=\left(\frac{\widetilde{\varphi}\left(\varphi^{*}\right)}{\varphi^{*}}\right)^{\sigma-1}\frac{r\left(\varphi^{*}\right)}{\sigma}-f=f\left(\left(\frac{\widetilde{\varphi}\left(\varphi^{*}\right)}{\varphi^{*}}\right)^{\sigma-1}-1\right),$$

This is the ZCP curve.

# Melitz model set up - FE

Free-entry and zero profits:

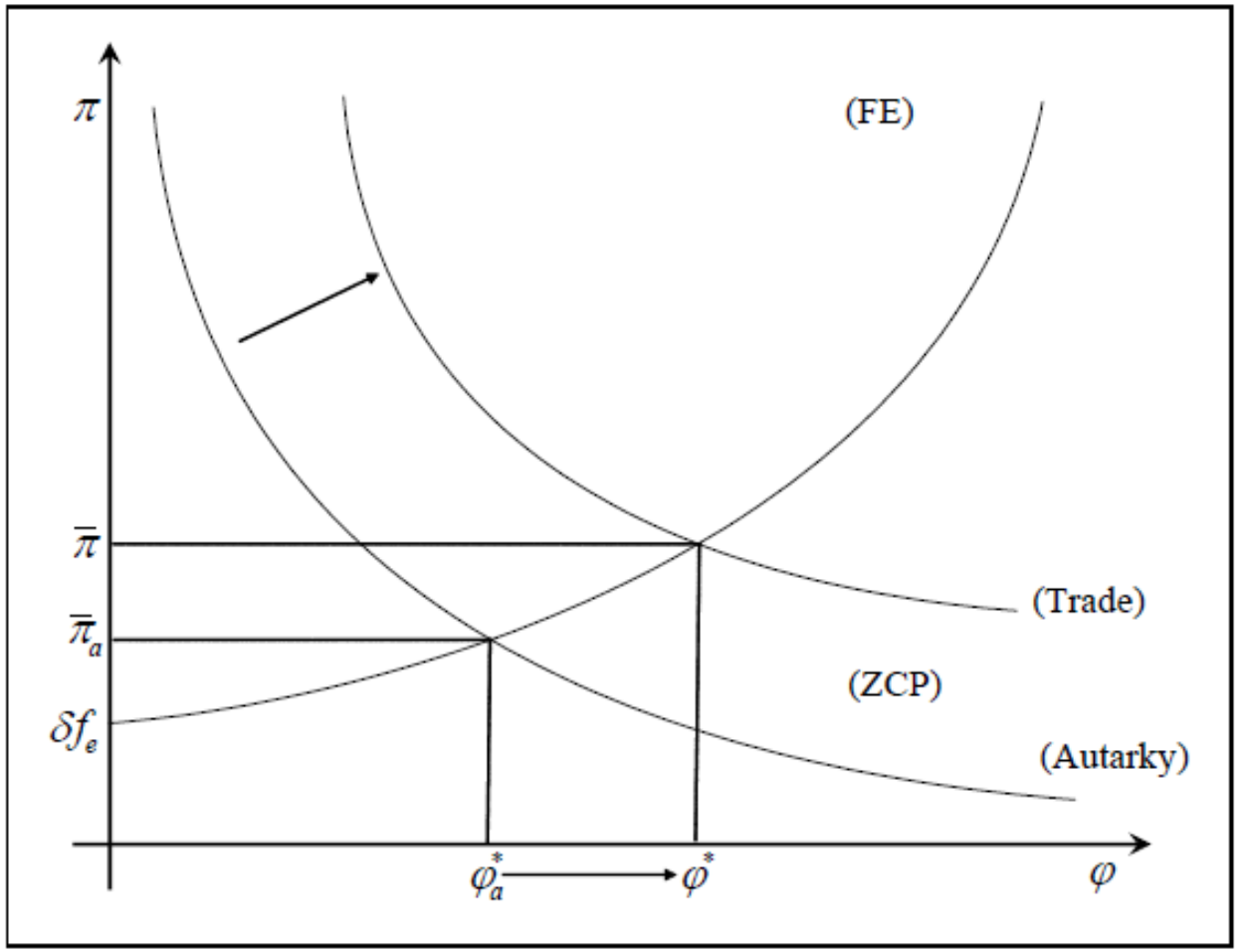
Expected discounted value of profits equals fixed cost of entry in equilibrium

$$\int_0^{\infty} v(\varphi)\, g(\varphi)\, d\varphi = f_e \Leftrightarrow \overline{\pi} = \frac{\delta f_e}{1 - G(\varphi^*)}.$$

This is the FE condition.

ZCP is downward sloping while FE is upward sloping.

# Melitz, effect of trade



# Melitz Equilibrium

We then solve for the aggregate price index, average profit and number of firms:

$$P^{1-\sigma} = \int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega = \int_0^{\infty} (\rho\varphi)^{\sigma-1} M\mu(\varphi) d\varphi = M(\rho\tilde{\varphi})^{\sigma-1}$$

And substituting in the equation for profit:

$$\overline{\pi} = \frac{1}{\sigma}\frac{R}{M} - f.$$

Then, R=L gives:

$$M = \frac{L}{\sigma(\overline{\pi} + f)},$$

– $\tilde{\varphi}, \varphi^*, \overline{\pi}$ and $\mu(\varphi)$ are independent of $L$, while $M$ is proportional to country size.

# Opening up to trade

Simply increases L (with trade) will not change anything except number of firms.

No effect on average productivity.

Introduce:

Fixed costs of exporting: $f_{ex}$

Incurred once firm learns its productivity draw.

Also, transport cost of iceberg type:

$\tau$ units need to be shipped to receive 1 unit.

Domestic economy trades with n other countries. All countries of equal size, FPE implies wages are 1.

# Melitz model under trade

Mark-up over marginal cost now higher for exports due to transport cost.

Also: $$r_d(\varphi) = R(P\rho\varphi)^{\sigma-1}$$

$$r_x(\varphi) = \tau^{1-\sigma} R_k (P_k \rho\varphi)^{\sigma-1}.$$

Firm revenue is:

$$r(\varphi) = \begin{cases} r_d(\varphi) & \text{if the firm does not export} \\ (1+n\tau^{1-\sigma}) r_d(\varphi) & \text{if the firm exports to all countries.} \end{cases}$$

# Melitz, profits under trade

$$\pi_d(\varphi) = \frac{r_d(\varphi)}{\sigma} - f,$$

$$\pi_x(\varphi) = \frac{r_x(\varphi)}{\sigma} - f_x = \frac{\tau^{1-\sigma} r_d(\varphi)}{\sigma} - f_x, \qquad (2.13$$

where $f_x$ is amortized per-period portion of the initial fixed cost (i.e., $\delta f_{ex}$).

# Melitz, Cut-off under trade

Per period profit is the sum of domestic and export profits:

$$\pi(\varphi) = \pi_d(\varphi) + \max\{0, n\pi_x(\varphi)\}$$

Present discounted value of profits:

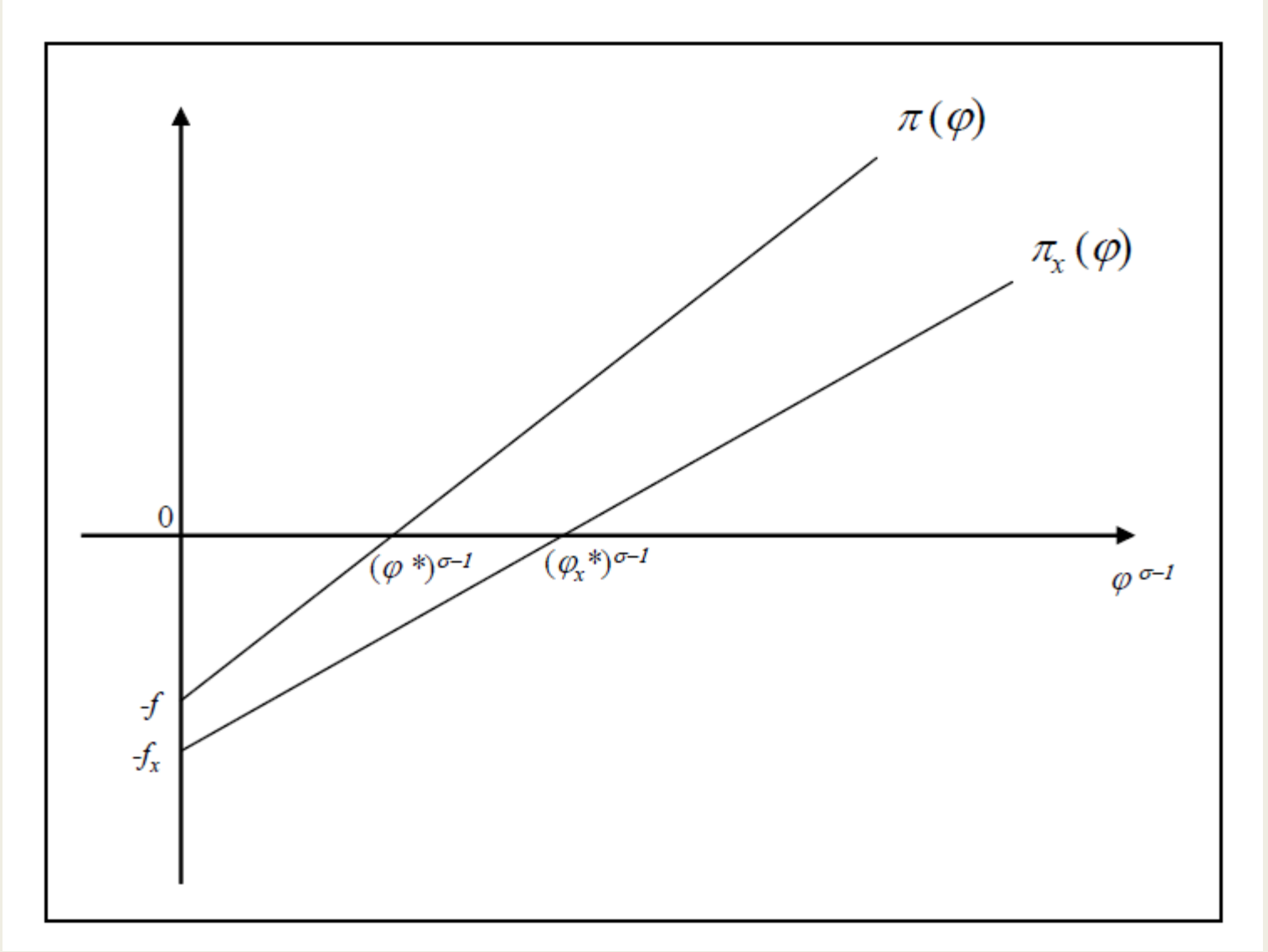
$$v(\varphi) = \max\{0, \pi(\varphi)/\delta\}$$

now defines TWO cut-off points:

$$\varphi^* = \inf\{\varphi : v(\varphi) > 0\}$$

$$\varphi_x^* = \inf\{\varphi : \varphi \geq \varphi^* \text{ and } \pi_x(\varphi) > 0\}$$

# Melitz model set up – Profits Graph



# Melitz, FE and ZCP under trade

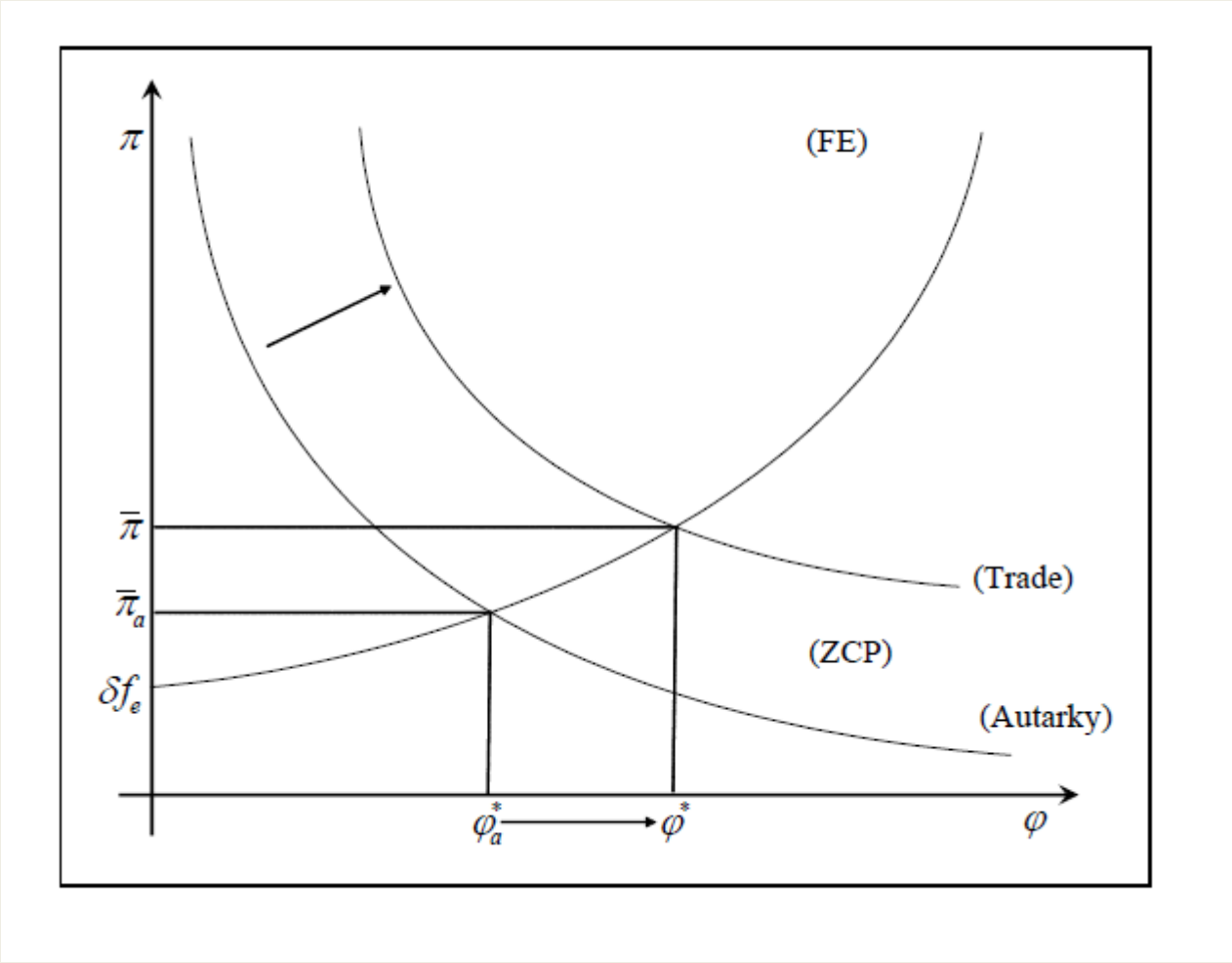
The FE condition does not change under trade.

*Expected discounted profits should equal entry cost.*

However, the new ZCP is:

$$\begin{aligned}\overline{\pi} &= \pi_d\left(\widetilde{\varphi}\right) + p_x n \pi_x\left(\widetilde{\varphi}_x\right) = \\ &= f\left(\left(\frac{\widetilde{\varphi}\left(\varphi^*\right)}{\varphi^*}\right)^{\sigma-1} - 1\right) + p_x n f_x\left(\left(\frac{\widetilde{\varphi}_x\left(\varphi^*\right)}{\varphi_x^*\left(\varphi^*\right)}\right)^{\sigma-1} - 1\right),\end{aligned}$$

# Melitz, effect of trade



# Impact of trade in Melitz model

Elasticity of demand unaffected by trade opening.

Reallocation is not through mark-ups – mark up is CONSTANT.

*Trade does not result in "squeezing out" of firms.*

Operates through factor market – trade provides an opportunity for high-productivity firms to expand by exporting.

They suck up labor from low productivity firms.

High productivity firms benefit most from trade.

# Melitz model - Extensions

- Bernard, Redding and Schott (2011)
  - *Product heterogeneity within firms*
  - *Many countries*

- Melitz and Ottaviano (2006)
  - *Variable markups*