# Increasing Returns

ECON 245, Winter 24

# Introduction

- so far, we have seen:
  - constant-returns-to-scale + perfect competition
  - gains from trade = same goods, better prices
- important features of the world:
  - large volumes of intraindustry trade, i.e., within goods categories
  - large amounts of trade among similar economies
  - markups + market power of firms
  - products appear and disappear over time

# Monopolistic competition

- monopolistic competition
  - imperfect competition without strategic interactions
  - firms face and internalize downward-sloping demand curves
- increasing returns to scale
  - fixed costs: in equilibrium firms each produce different products
  - free entry condition pins down the mass of firms by ensuring that profits are spent on fixed costs
  - $\uparrow$ market size $\Rightarrow \uparrow$ productivity, because fixed costs can be

# Roadmap

- Krugman 1980
  - combines increasing to scale and imperfect competition
  - theoretical justification for intraindustry trade between similar countries
- 80s, 90s: Mounting evidence on the importance of heterogeneity
  - heterogeneous firm models in macro, e.g., Jovannovic 92, Hopenhayn 92
  - models with household heterogeneity, e.g., Aiyagari 94
- Marc Melitz' JMP: Krugman 1980 + Hopenhayn
  - heterogeneous firms and fixed costs to exporting
  - trade has selection effects: More productive firms survive, trade raises average productivity of an industry

# Model Overview

- will think of Krugman 80 and Melitz 03 as one framework
- basic model structure in Krugman 80
  - firms pay a fixed cost to enter
  - firms set prices under monopolistic competition
  - free entry condition ensures zero profits and pins down the equilibrium number of firms
- difficulty: How to deal with “zero profits” if firms are heterogeneous?
  - if some make zero profits, shouldn’t others make profits?
- Melitz 03: Probabilistic formulation
  - producers ex-ante identical, pay fixed cost to learn productivity
  - zero-profit condition holds in expectation for ex-ante identical producers

# Krugman 80 + Melitz 03: Autarky

- one industry of production
- firms = varieties
- endogenous mass of varieties $\Omega$
- pay entry cost $f_e$ denominated in domestic labor to receive a productivity draw $\varphi$ from a cdf $G(\varphi)$
  - Krugman: $G(\varphi)$ is a degenerate distribution (homogeneous firms)
- pay overhead costs $f_d$ in domestic labor to actually produce
  - Krugman: $f_d = 0$
- choose profit-maximizing price, taking demand as given
- consumers
  - CES preferences + $L$ workers supply one unit of labor inelastically

# Consumers

- $L$ identical consumers with CES preferences and $\sigma > 1$

$$U = \left[ \int_{\Omega} q(\omega)^{(\sigma-1)/\sigma} d\omega \right]^{\sigma/(\sigma-1)}$$

- letting $Y$ denote total income, demand for variety is given by

$$q(\omega) = p(\omega)^{-\sigma} P^{\sigma-1} Y, \;\; P = \left[ \int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{1/(1-\sigma)}$$

- Income comes from wages, paid to inelastically supplied labor: $Y = wL$
- Note:
  - Diminishing marginal utility of consumption for each good
  - Love for variety if $\sigma > 1$: If varieties are homogeneous, welfare increases in the number of varieties consumed, holding fixed $q$:$U = \Omega^{\sigma/(\sigma-1)} q$

# Firms

- firms with productivity $\varphi$ behave symmetrically, index firms by $\varphi$
- technology: A firm with productivity $\varphi$ can produce $q$ using $l$ units of labor according to

$$l(\varphi) = f_d + \frac{q(\omega)}{\varphi(\omega)}$$

- upon entry, problem of a firm is

$$\max\{\max_{p(\omega)} p(\omega)q(\omega) - \frac{w}{\varphi}q(\omega) - wf_d, 0\}$$

- first order condition with respect to $p(\omega)$

$$q(\omega) + [p(\omega) - \frac{w}{\varphi}]\frac{\partial q(\omega)}{\partial p(\omega)} = 0$$

# Markup Pricing

- definition: price elasticity of demand:

$$\varepsilon(\omega) \equiv -\frac{\partial \log q(\omega)}{\partial \log p(\omega)} = -\frac{p(\omega)q'(\omega)}{q(\omega)}$$

- rewrite the FOC:

$$-\frac{p(\omega)q'(\omega)}{q(\omega)}[1 - \frac{w}{\varphi}\frac{1}{p(\omega)}] = 1 \Leftrightarrow \frac{w}{\varphi}\frac{1}{p(\omega)} = \frac{\varepsilon(\omega) - 1}{\varepsilon(\omega)}$$

- … to obtain that the price is a markup over marginal cost

$$p(\omega) = \frac{\varepsilon(\omega)}{\varepsilon(\omega) - 1}\frac{w}{\varphi}$$

- markup is decreasing in the elasticity of demand

# Pricing: CES demand + MP

- Needed to pin down price:

$$\varepsilon(\omega) = -\frac{\partial \log q(\omega)}{\partial \log p(\omega)},$$

- CES demand

$$q(\omega) = p(\omega)^{-\sigma} P^{\sigma-1} Y$$

- CES demand + monopolistic competition imply

$$\varepsilon(\omega) = -\frac{\partial \log q(\omega)}{\partial \log p(\omega)} = \sigma - (\sigma - 1)\frac{\partial \log P}{\partial \log p(\omega)} = \sigma$$

- if a firm $\varphi$ decides to produce, it sets a price

$$p(\varphi) = \frac{\sigma}{\sigma - 1}\frac{w}{\varphi}$$

- CES + monopolistic competition uniquely ensure constant markups!

# Revenue and Profits

$$p(\varphi) = \frac{\sigma}{\sigma - 1}\frac{w}{\varphi}, \quad q(\varphi) = p(\omega)^{-\sigma}P^{\sigma-1}Y$$

- revenues of $\varphi$

$$R(\varphi) = p(\varphi)q(\varphi) = \left(\frac{p(\omega)}{P}\right)^{1-\sigma} Y = \varphi^{\sigma-1}(\frac{\sigma}{\sigma - 1}\frac{w}{P})^{1-\sigma}wL \equiv \varphi^{\sigma-1}B$$

- constant markups $\Rightarrow$ variable profits are a constant fraction of sales
- operating profits:

$$\pi(\varphi) = (p(\varphi) - \frac{w}{\varphi})q(\varphi) - f_o w = (1 - \frac{\sigma - 1}{\sigma})p(\varphi)q(\varphi) - wf_o$$

$$\Rightarrow \pi(\varphi) = \frac{R(\varphi)}{\sigma} - wf_d \equiv \varphi^{\sigma-1}B - wf_d$$

# Selection: Zero-Profit-Condition

- operating profits of $\varphi$

$$\pi(\varphi) = \frac{R(\varphi)}{\sigma} - wf_d \equiv \varphi^{\sigma-1}B - wf_d$$

- Krugman 80: $f_d = 0$, so can move on to free entry
- Melitz 03: Not all firms find it profitable to produce, so need to decide who actually produces after learning their draw
- profits continuous + increasing in $\varphi$, so there is an exit threshold $\varphi_d$ pinned down by a "Zero Profit Condition"

$$\pi(\varphi_d) = 0 \Leftrightarrow \frac{1}{\sigma}r(\varphi_d) = wf_d \Leftrightarrow \varphi_d^{\sigma-1} = wf_d/B$$

- firms with draws $\varphi < \varphi_d$ exit after receiving their draw
- note: Cutoff depends on $B$, which depends on $P$ and $w$

# Free Entry (FE)

- Free entry = expected value of entry must offset entry cost $f_e w$

$$\int_{\varphi_d}^{\infty} \pi(\varphi) dG(\varphi) = w f_e$$

note: $\pi(\varphi) = (\varphi/\varphi_*)^{\sigma-1} B \varphi_d^{\sigma-1} - w f_d = [(\varphi/\varphi_d)^{\sigma-1} - 1] w f_d$

- This implies FE can be rewritten as:

$$f_e = f_d \int_{\varphi_d}^{\infty} [(\varphi/\varphi_d)^{\sigma-1} - 1] dG(\varphi) \equiv J(\varphi_d) f_d$$

- The function $J(\cdot)$ is monotonically decreasing
  - Intuition: Higher $\varphi_*$ leads to more competition and lower av. profits
  - There exists a unique $\varphi_d$ that solves FE and ZPC

# Mass of Firms

- Still need to solve for the mass of firms:
  - $M_e$ firms pay to draw a productivity
  - $M$ firms operate in equilibrium
- These two are related as follows:

$$M = M_e[1 - G(\varphi_d)]$$

- In Krugman: No cutoff, so $M = M_e$

# Equilibrium

- price index:

$$P^{1-\sigma} = M_e \int_{\varphi_d}^{\infty} p(\varphi)^{1-\sigma} dG(\varphi) = M_e \int_{\varphi_d}^{\infty} (\frac{\sigma}{\sigma - 1} w)^{1-\sigma} \varphi^{\sigma-1} dG(\varphi)$$

- labor market clearing

$$wL = M_e w f_e + M_e \int_{\varphi_d}^{\infty} \left[ \frac{\sigma - 1}{\sigma} r(\varphi) + w f_d \right] dG(\varphi)$$

- equilibrium: $\varphi_d, P, M_e, w$ satisfying
  - zero profit condition
  - price index aggregation
  - free entry
  - labor market Clearing
- Walras' law: Normalize $w = 1$ and ignore labor market clearing

# Solving for Autarky Eq'm in Melitz

- normalize $w = 1$
- already showed how to pin down $\varphi_d$
- plug price index into the free entry condition to obtain:

$$L/M_e f_e = \sigma f_d \int_{\varphi_d}^{\infty} \left(\frac{\varphi}{\varphi_d}\right)^{\sigma-1} dG(\varphi)$$

- cutoff condition

$$\varphi_d^{\sigma-1} = P^{1-\sigma} f_d / \left[ \left(\frac{\sigma}{\sigma - 1}\right)^{1-\sigma} L \right] = f_d / L \times M_e \int_{\varphi_d}^{\infty} \varphi^{\sigma-1} dG(\varphi)$$

- two equations to solve for $M_e$ and $\varphi_d$

# Equilibrium: Krugman

- in Krugman, $G(\varphi)$ is degenerate, all firms the same productivity $\bar{\varphi}$
- so we can solve the model in closed form
- price index becomes

$$P^{1-\sigma} = M(\frac{\sigma}{\sigma - 1} w)^{1-\sigma} (\bar{\varphi})^{\sigma - 1}$$

- equilibrium: $P, M, w$ satisfying
  - price index aggregation
  - free entry
  - labor Market Clearing
- normalize $w = 1$, so free entry + price index pins down equilibrium

# Equilibrium: Krugman 80

- Normalize $w = 1$, so price index becomes

$$P^{1-\sigma} = M(\frac{\sigma}{\sigma - 1})^{1-\sigma}(\bar{\varphi})^{\sigma-1}$$

- Free entry:

$$\pi(\bar{\varphi}) = f_e \Leftrightarrow \bar{\varphi}^{\sigma-1}\frac{1}{\sigma}(\frac{\sigma}{\sigma - 1})^{1-\sigma}P^{\sigma-1}L = f_e$$

- Solving for the equilibrium mass of firms, we obtain

$$M = \frac{L}{\sigma f_e}$$

# Krugman 80: Welfare

- welfare in the closed economy

$$M = \frac{L}{\sigma f_e}, \Rightarrow \frac{1}{P} = \left(\frac{L}{\sigma f_e}\right)^{1/(\sigma-1)} (\frac{\sigma-1}{\sigma})(\bar{\varphi})$$

- key insight: welfare is increasing in market size $L$
  - Intuition: Larger market allows to spread fixed costs over larger quantity produced, so more firms enter, which raises welfare

$$-d\ln P = \frac{1}{\sigma-1} d\ln L = \left(\frac{\sigma}{\sigma-1} - 1\right) d\ln L$$

- $\sigma/[\sigma-1]-1 =$ consumer surplus generated by new entrants
- with CES: $\mu = \sigma/[\sigma-1]$, i.e. private surplus = social surplus

# Introducing Trade

- introduce a second symmetric country
  - wages still normalized to 1, equal in both
- varieties are differentiated, both within and across countries.
- to export, firms have to pay another fixed cost $f_x$
  - this will imply that selection into exporting
- iceberg trade costs: ship $\tau > 1$ for $1$ unit to arrive

# Exporter prices and revenues

- domestic ZPC is still given as:

$$\frac{1}{\sigma} r_d(\varphi_d) = f_d \Rightarrow \varphi_d^{\sigma-1} = \frac{f_d \sigma^\sigma}{L P_d^{\sigma-1}(\sigma-1)^{\sigma-1}}$$

- if a firm exports, its price equals

$$p_x(\varphi) = \frac{\sigma}{\sigma-1}\tau/\varphi = \tau \times p_d(\omega)$$

- export revenues

$$r_x(\varphi) = \tau^{1-\sigma}\left(\frac{p_d(\omega)}{P^*}\right)^{1-\sigma} Y^*$$

- export profits

$$\pi_x(\omega) = \left(p_x(\omega) - \tau\frac{w}{\varphi}\right) q^*(\omega) - f_o w = \tau(1 - \frac{\sigma-1}{\sigma}) p_d(\omega) q^*(\omega) - w f_x$$

# Selection

- domestic cutoff $\varphi_d$ solves $\pi_d(\varphi_d) = 0$

$$\frac{1}{\sigma} r_d(\varphi_d) = f_d \Rightarrow \varphi_d^{\sigma-1} = f_d / [LP_d^{\sigma-1}((\sigma-1)/\sigma)^{\sigma-1}]$$

- exporter cutoff $\varphi_X$ solves $\pi_x(\varphi_x) = 0$, or

$$f_x = \frac{1}{\sigma} r_x(\varphi_x)$$

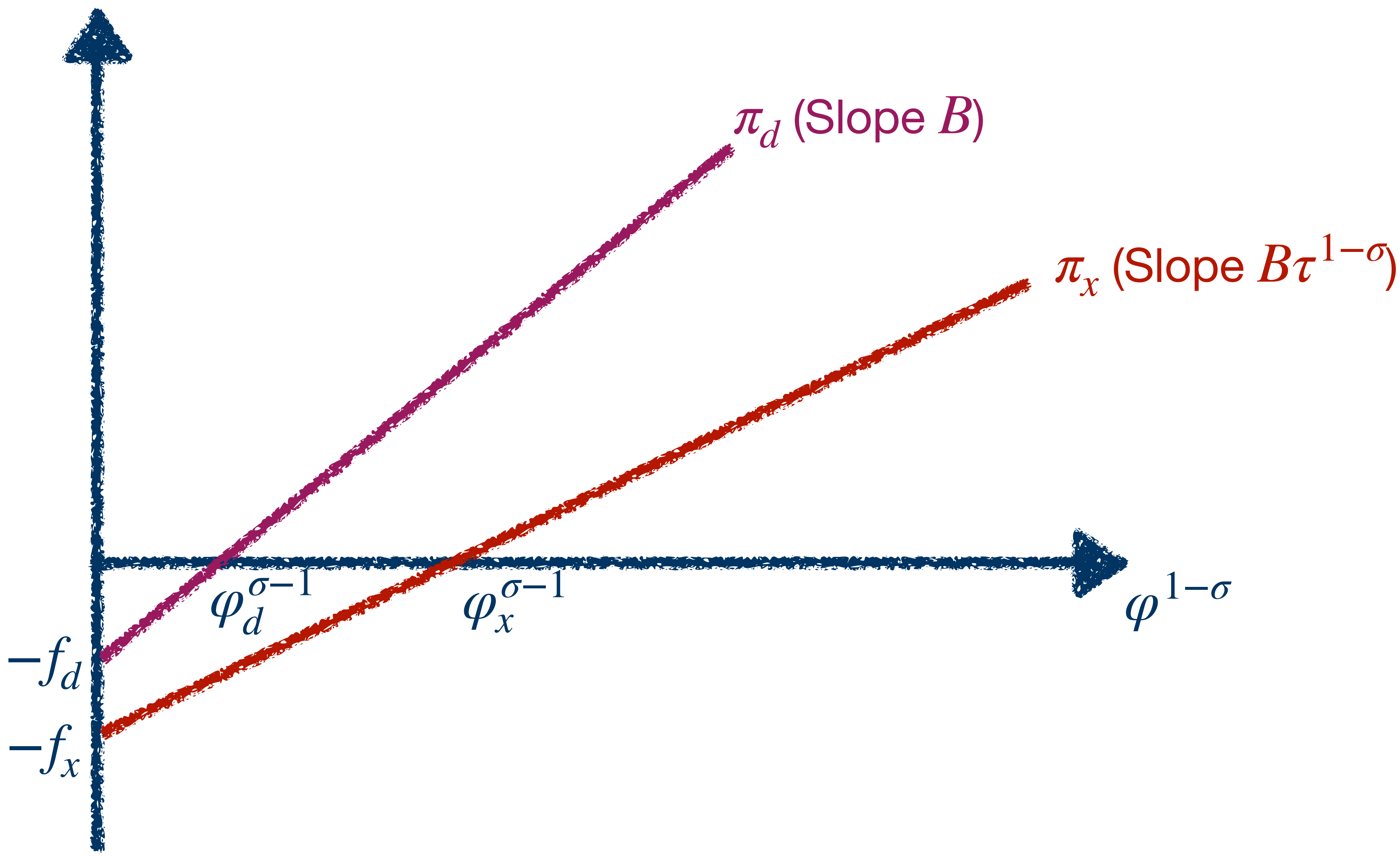
- with symmetric countries, $r_x(\varphi) = \tau^{1-\sigma} r_d(\varphi)$, or

$$\varphi_x^{\sigma-1} = f_x \tau^{\sigma-1} / [LP_d^{\sigma-1}((\sigma-1)/\sigma)^{\sigma-1}]$$

- selection into trade: $\varphi_x > \varphi_d$ if

$$\left(\frac{\varphi_x}{\varphi_d}\right)^{\sigma-1} = \tau^{\sigma-1} \times \frac{f_x}{f_d} > 1$$

# Selection Graphically



# Free Entry

- the free entry condition becomes:

$$f_e = \int_0^\infty [\pi_d(\varphi) + \pi_x(\varphi)]dG(\varphi) = \int_{\varphi_d}^\infty \left[\frac{r_d(\varphi)}{\sigma} - f_d\right] dG(\varphi) + \int_{\varphi_x}^\infty \left[\frac{r_x(\varphi)}{\sigma} - f_x\right] dG(\varphi)$$

$$= f_d \int_{\varphi_d}^\infty [(\varphi/\varphi_d)^{\sigma-1} - 1]dG(\varphi) + f_x \int_{\varphi_x}^\infty \left[(\varphi/\varphi_x)^{\sigma-1} - 1\right] dG(\varphi)$$

$$\equiv J(\varphi_d)f_d + J(\varphi_x)f_x$$

- $J(\,.\,)$ is monotonically decreasing
  - Since $\varphi_x > \varphi_d$, this implies that $\varphi_d$ is higher than under autarky

# Selection and trade costs

- with symmetric countries $\left(\frac{\varphi_x}{\varphi_d}\right)^{\sigma-1} = \tau^{\sigma-1} \times \frac{f_x}{f_d}$
- can hence rewrite free entry condition as

$$f_e = \int_{\varphi_d}^{\infty} [(\varphi/\varphi_d)^{\sigma-1} - 1] f_d dG(\varphi) + \int_{\varphi_x(\varphi_d)}^{\infty} [(\varphi/\varphi_d)^{\sigma-1} \tau^{1-\sigma} f_d/f_x - 1] f_x dG(\varphi)$$

- which implies

$$f_e = J(\varphi_d) f_d + J\left(\varphi_d \tau (f_x/f_d)^{1/(\sigma-1)}\right) f_x$$

- lower trade cost ($\tau \downarrow$) "toughen" selection ($\varphi_d \uparrow$) since

$$-\left(\frac{\partial J(\varphi_d)}{\partial \varphi_d} + \frac{\partial J(\varphi_x)}{\partial \varphi_x} \tau (f_x/f_d)^{1/(\sigma-1)}\right) d\varphi_d = \frac{\partial J(\varphi_x)}{\partial \varphi_x} \frac{\varphi_x}{\tau} d\tau \Rightarrow \frac{d\varphi_d}{d\tau} < 0$$

# Market Clearing

- Now accounts for export activity

$$wL = M_e w f_e + M_e \int_{\varphi_d}^{\infty} \left[ \frac{\sigma - 1}{\sigma} r_d(\varphi) + w f_d \right] dG(\varphi) + M_e \int_{\varphi_x}^{\infty} \left[ \frac{\sigma - 1}{\sigma} r_x(\varphi) + w f_x \right] dG(\varphi)$$

- accounts for average labor used in domestic and export activity
- symmetric country equilibrium: $\varphi_d, \varphi_x, M_e, w$ that solve
    - domestic zero profit condition
    - exporter zero profit condition
    - free entry
    - labor market clearing
- Walras' law and $w = 1$ implies one condition can be ignored
- with asymmetric countries: 4 conditions per country

# Gains from Trade

$$P_d^{1-\sigma} = M_e \int_{\varphi_d}^{\infty} \tilde{\sigma}\varphi^{\sigma-1} dG(\varphi) + M_e^* \tau^{1-\sigma} \int_{\varphi_x^*}^{\infty} \tilde{\sigma}\varphi^{\sigma-1} dG(\varphi)$$

- Three potential forces affecting gains from trade

1. Second term only shows up with trade: Positive effect of increased import varieties on welfare
2. As home opens to trade ($\tau \downarrow$), the least productive firms exit ($\varphi_d \uparrow$), inducing a selection effect, making the average product from home cheaper. Simultaneously the export cutoff falls, as more firms find it profitable to export (reallocation!)
3. $M_e$ falls as home opens to trade: Average revenues are higher per entrant, so less firms enter (this effect is due to the symmetry: in general, it is ambiguous).

# Sufficient Statistic for Welfare

- with CES preferences, the cutoff $\varphi_d$ is a sufficient statistic for welfare from zero profit condition:

$$\frac{1}{\sigma} r_d(\varphi_d) = f_d$$

$$\Rightarrow \varphi^{\sigma-1} = \sigma \frac{f_d}{L} (\frac{\sigma-1}{\sigma})^{1-\sigma} P^{1-\sigma}$$

$$\Rightarrow P^{1-\sigma} \propto \varphi_d^{\sigma-1}$$

- since $d\varphi_d / d\tau < 0$, a decline in trade costs leads to an increase in welfare.

# Welfare with asymmetric countries

- with many, asymmetric countries $i \in 1, \ldots, N$, welfare in $i$ equals

$$W_i = \frac{w_i}{P_i},$$

where

$$P_i^{1-\sigma} = \frac{\sigma}{\sigma - 1} \sum_{j=1}^{N} \left[ M_{ei} (w_j \tau_{ji})^{1-\sigma} \int_{\varphi_{ji}}^{\infty} \varphi dG_j(\varphi) \right]$$

- $\tau_{ji}$: trade costs of shipping goods from $j$ to $i$
- $\varphi_{ji}$: productivity cutoff for firms exporting from $j$ to $i$

# Welfare with asymmetric countries

- the envelope theorem implies that welfare changes satisfy

$$d \ln W_i = \frac{1}{\sigma - 1} \sum_j e_{ji} d \ln M_{je}$$

$$- \frac{1}{\sigma - 1} \sum_j e_{ji}^{\varphi_{ji}} \frac{g_j(\varphi_{ji})}{1 - G_j(\varphi_{ji})} d\varphi_{ji}$$

$$- \sum_j e_{ji} d \ln w_j \tau_j$$

- $e_{ji} \equiv M_{ej}[\int_{\varphi_{ji}}^{\infty} p_{ji}(\varphi) c_{\varphi_{ji}}) dG_j(\varphi)]/w_i L_i$ is the share of country $i$'s expenditures devoted to imports from $j$
- $e_{ji}^{\varphi ji} \equiv M_{ej}[1 - G_j(\varphi_{ji}] p_{ji}(\varphi_{ji}) c_{ji}(\omega_{ji})/w_i L_i$ the is the share of country $i$'s expenditures devoted to imports from $j$

# What did we learn?

- MP + IRS imply gains from trade even for symmetric countries
  - extensive margin adjustment is key!
  - of course, regions within the US are like “similar” countries doing intra-industry trade
- Melitz: Market-integration leads to reallocation of resources across firms within industries
  - Low productivity firms exit
  - Domestic sellers that survive contract
  - Exporting firms expand
  - Sales weighted industry productivity rises due to this reallocation

# Gravity

- with two symmetric countries, trade shares become:

$$\lambda_{FH} = \frac{X_{HF}}{X_F} = \frac{\tau^{1-\sigma}\int_{\varphi_X}^{\infty}\varphi^{\sigma-1}dG(\varphi)}{\int_{\varphi_d}^{\infty}\varphi^{\sigma-1}dG(\varphi) + \tau^{1-\sigma}\int_{\varphi_X}^{\infty}\varphi^{\sigma-1}dG(\varphi)}$$

- Krugman: integral terms are exogenous (no selection)
  - Trade elasticity is $1-\sigma$ (just as in Armington)
- Melitz: $\varphi_X$ and $\varphi_d$ are endogenous, trade elasticity depends on both $1-\sigma$ (love-of-variety) and the curvature of the productivity distribution (selection)

$$\frac{\partial \ln(X_{FH}/X_{HH})}{\partial \ln \tau} = 1 - \sigma + \gamma_X - (\gamma_X - \gamma_D)\frac{\partial \ln \varphi_d}{\partial \ln \tau},$$

where $\gamma_i \equiv d \ln \int_{\varphi_i}^{\infty} \varphi^{\sigma-1} g(\varphi) dG(\varphi) / d \ln \varphi_i$ for $i \in \{d, X\}$

- Chaney 08: if $G(\cdot)$ is Pareto($\theta$), then $\gamma_X = \sigma - 1 - \theta$ and $\gamma_X = \gamma_d$

# Chaney 2008

- Key assumption: Productivities follow a Pareto distribution

$$G(\varphi) = 1 - \varphi^{-\theta}, \text{ for } \varphi \geq 1 \text{ and } \theta > \sigma - 1 > 0$$

- In symmetric, 2 country case, yields closed form expressions for various objects

$$J(\varphi) = \frac{\sigma - 1}{\theta - \sigma + 1}(1 - G(\varphi))$$

$$M_e = \frac{\sigma - 1}{\sigma\theta}\frac{L}{f_e}$$

- In a symmetric world economy, number of firms declines in trade costs: $M_d = M_e(1 - G(\varphi_d))$ and $\varphi_d \uparrow$ as $\tau \downarrow$
- with Pareto-distributed productivity, welfare effect from decline in the number of firms at home is exactly offer by an increase in foreign varieties:

# Chaney 08: Gravity

- Under Pareto-distributed productivities, Melitz model yields a Gravity equation similar to Armington, E-K
- Generalize earlier exposition to allow for multiple countries
  - $G_i(\varphi) = 1 - (\varphi_i^{min}/\varphi)^{\theta},\ \varphi > \varphi_i^{min}$
  - $f_{ij}$ are the fixed costs associated with selling from $i$ to $j$
  - $\tau_{ij}$ are the iceberg trade costs associated with selling from $i$ to $j$
  - $M_e^i$ are entrants in country $i$
  - $\varphi_{ij}$ is the cutoff for productivity in $i$ for selling to $j$
  - $w^i$ is the wage in country $i$

# Chaney 08: Gravity

- under Pareto-distributed productivities, trade shares become

$$\lambda_{ij} = \frac{X_{ij}}{X^j} = \frac{M_e^i \int_{\varphi_{ij}}^{\infty} p_{ij}(\varphi)^{1-\sigma} dG(\varphi)}{\sum_k M_e^k \int_{\varphi^{kj}}^{\infty} p_{kj}(\varphi)^{1-\sigma} dG(\varphi)} = \frac{M_e^i \left(w_i \tau_{ij}\right)^{-\theta} \left(w_i f_{ij}\right)^{1-\frac{\theta}{\sigma-1}}}{\sum_k M_e^k \left(w_k \tau_{kj}\right)^{-\theta} \left(w_k f_{kj}\right)^{1-\frac{\theta}{\sigma-1}}}$$

- the bilateral resistance term now captures fixed and variable trade costs:

$$T_{ij} = \tau_{ij}^{-\theta} f_{ij}^{1-\frac{\theta}{\sigma-1}}$$

- can solve for wages as in Armington and EK

# Chaney 08: Gains from Trade

- the elasticity of trade flows to tariffs is governed by $-\theta$
  - unlike in Krugman and Armington, where trade elasticity is $1-\sigma$
  - intuition: no change in the net mass of firms, so all gains come from productivity
  - Similar to Eaton-Kortum 02, where $\theta$ was the variance of the productivity distribution
- Further insight: Changes in fixed trade costs lead to changes in the number of firms, and have a different elasticity than variable trade costs
- It can be shown that welfare changes are given by:

$$d \ln \frac{w_i}{P_i} = -\frac{1}{\theta} d \ln \lambda_{ii} + \text{Domestic Shocks}$$

- We have seen this before, but now even for shocks to fixed costs…
- Note: Only (!) when productivities are distributed Pareto

# Life since Melitz

- Melitz 03 has spurred an incredibly large literature
- reason: within-sector reallocations become a very powerful mechanism, e.g.,
  - inequality: If more productive firms pay higher wages or are more skill-intensive, within-sector reallocations will induce changes in inequality
  - innovation: trade liberalization unevenly shifts market size and, hence, innovation incentives across firms
- departures from CES demand introduce endogenous competition and market power, while remaining tractable
  - demand elasticity differs across firms, reallocations endogenously change the distribution of markups. etc.
  - see next lecture