ECON 357

Lecture 3: the Melitz model of trade

Thomas Chaney

University of Chicago

Empirical challenge to Krugman

- There is a lot of heterogeneity across firms, within any sector.
- Very few firms export (import, engage in FDI).
- Exporters are very different from non exporters.
- There is a lot of reallocation between firms within sectors.

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.

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

Exporters are few

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.

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

Exporters are different

Exporter Premia in U.S. Manufacturing, 2002

	Exporter premia		
	(1)	*(2)*	*(3)*
Log employment	1.19	0.97	
Log shipments	1.48	1.08	0.08
Log value-added per worker	0.26	0.11	0.10
Log TFP	0.02	0.03	0.05
Log wage	0.17	0.06	0.06
Log capital per worker	0.32	0.12	0.04
Log skill per worker	0.19	0.11	0.19
Additional covariates	None	Industry fixed effects	Industry fixed effects, log employment

Sources: Data are for 2002 and are from the U.S. Census of Manufactures.
Notes: All results are from bivariate ordinary least squares regressions of the firm characteristic in the first column on a dummy variable indicating firm's export status. Regressions in column 2 include industry fixed effects. Regressions in column 3 include industry fixed effects and log firm employment as controls. Total factor productivity (TFP) is computed as in Caves, Christensen, and Diewert (1982). "Capital per worker" refers to capital stock per worker. "Skill per worker" is nonproduction workers per total employment. All results are significant at the 1 percent level.

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

Exporters *and* importers are few

Exporting and Importing by U.S. Manufacturing Firms, 1997

NAICS industry	*Percent of all firms*	*Percent of firms that export*	*Percent of firms that import*	*Percent of firms that import & export*
311 Food Manufacturing	7	17	10	7
312 Beverage and Tobacco Product	1	28	19	13
313 Textile Mills	1	47	31	24
314 Textile Product Mills	2	19	13	9
315 Apparel Manufacturing	6	16	15	9
316 Leather and Allied Product	0	43	43	30
321 Wood Product Manufacturing	5	15	5	3
322 Paper Manufacturing	1	42	18	15
323 Printing and Related Support	13	10	3	2
324 Petroleum and Coal Products	0	32	17	14
325 Chemical Manufacturing	3	56	30	26
326 Plastics and Rubber Products	5	42	20	16
327 Nonmetallic Mineral Product	4	16	11	7
331 Primary Metal Manufacturing	1	51	23	21
332 Fabricated Metal Product	20	21	8	6
333 Machinery Manufacturing	9	47	22	19
334 Computer and Electronic Product	4	65	40	37
335 Electrical Equipment, Appliance	2	58	35	30
336 Transportation Equipment	3	40	22	18
337 Furniture and Related Product	6	13	8	5
339 Miscellaneous Manufacturing	7	31	19	15
Aggregate manufacturing	**100**	**27**	**14**	**11**

Sources: Data are for 1997 and are for firms that appear in both the U.S. Census of Manufactures and the Linked-Longitudinal Firm Trade Transaction Database (LFTTD).

Notes: The first column of numbers summarizes the distribution of manufacturing firms across three-digit NAICS industries. Remaining columns report the percent of firms in each industry that export, import, and do both.

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

Exporters *and* importers are different

Trading Premia in U.S. Manufacturing, 1997

	(1) Exporter premia	*(2) Importer premia*	*(3) Exporter & importer premi*
Log employment	1.50	1.40	1.75
Log shipments	0.29	0.26	0.31
Log value-added per worker	0.23	0.23	0.25
Log TFP	0.07	0.12	0.07
Log wage	0.29	0.23	0.33
Log capital per worker	0.17	0.13	0.20
Log skill per worker	0.04	0.06	0.03

Sources: Data are for 1997 and are for firms that appear in both the U.S. Census of Manufacturers and the Linked-Longitudinal Firm Trade Transaction Database (LFTTD).
Notes: All results are from bivariate ordinary least squares regressions of the firm characteristic listed on the left on a dummy variable noted at the top of each column as well as industry fixed effects and firm employment as additional controls. Employment regressions omit firm employment as a covariate. Total factor productivity (TFP) is computed as in Caves, Christensen, and Diewert (1982).

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

Intensive and extensive margins of trade

- One can decompose aggregate trade flows into two margins,
  - Intensive margin (exports per firm)
  - Extensive margin (number of exporters)

$$X_{ij} = \lambda_{ij} X_j \qquad \text{with } \lambda_{ij} \equiv \frac{X_{ij}}{X_j}$$
$$X_{ij} = N_{ij} \bar{x}_{ij} \quad \text{with } \bar{x}_{ij} = \frac{1}{N_{ij}} \sum x_{ij} \ (\omega)$$

$$\begin{aligned} \ln N_{ij} &= \alpha_N + \beta_N \ln \lambda_{ij} + \gamma_N \ln X_j + \varepsilon_{ij} \\ \ln \bar{x}_{ij} &= \alpha_{\bar{x}} + \beta_{\bar{x}} \ln \lambda_{ij} + \gamma_{\bar{x}} \ln X_j + \eta_{ij} \end{aligned}$$

- Eaton, Kortum and Kramarz (2004) find,

$$\begin{aligned} \beta_N &= 1 - \beta_{\bar{x}} = .875 \\ \gamma_N &= 1 - \gamma_{\bar{x}} = .617 \end{aligned}$$

The extensive margin of trade

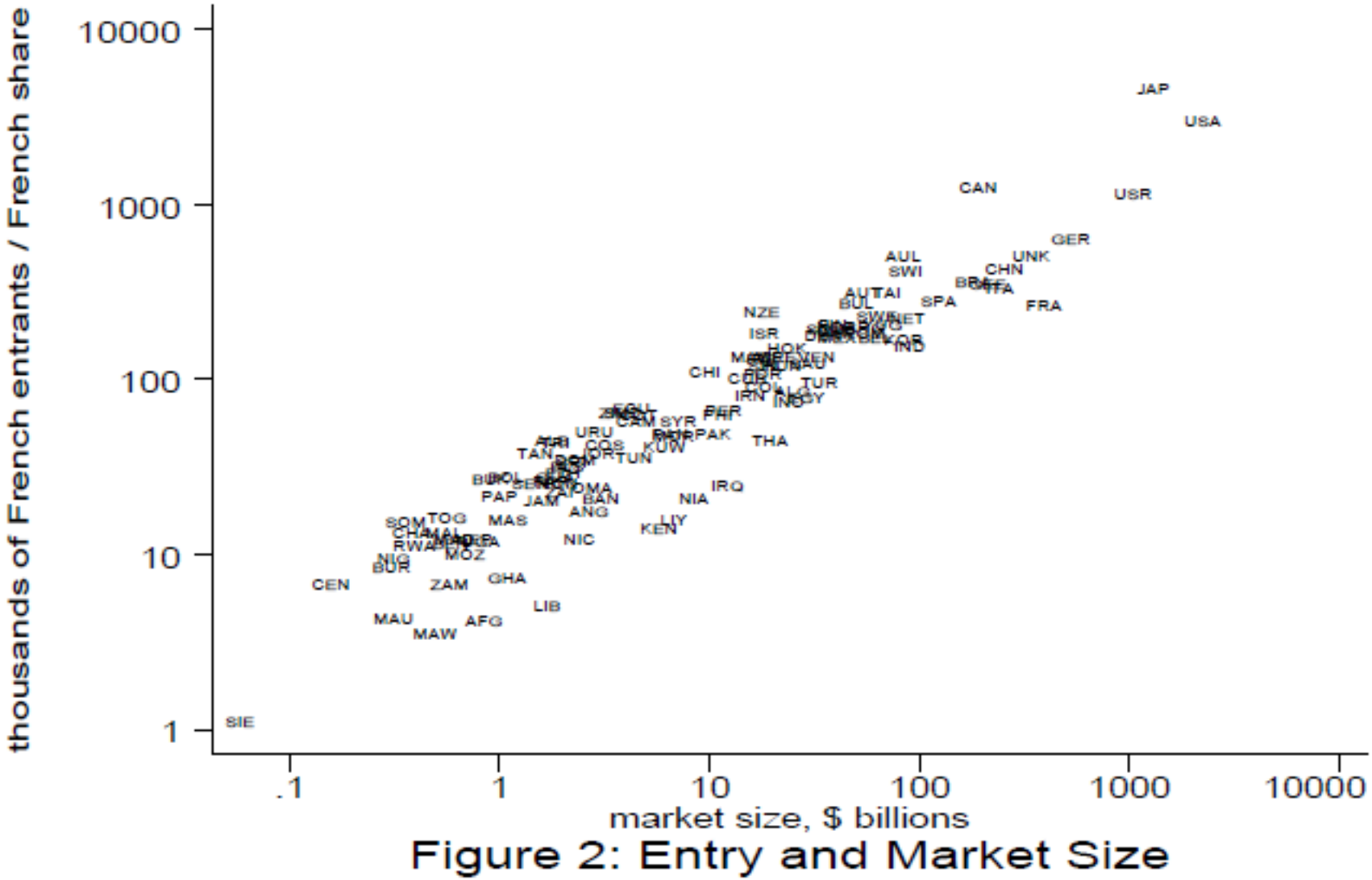


Figure 2: Entry and Market Size

Figure: Eaton, Kortum and Kramarz (2004) *AER P&P*.

Melitz model: assumptions

Heterogeneity assumptions

- Firms differ in labor productivity
- Productivity is random, unobserved before firm starts.

Trade barrier assuptions

- Firms face iceberg (variable) trade costs.
- Firms face fixed export costs.

Simplifying assuption

- Symmetric countries, so that $w = w^* = 1$.

Preferences (as in Krugman)

$$\max_{q(\omega)} U \equiv \left(\int_{\Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} \, d\omega \right)^{\frac{\sigma}{\sigma-1}}$$

$$\text{s.t.} \int_{\Omega} p(\omega) q(\omega) \, d\omega = R$$

Demand (as in Krugman)

$$
\begin{aligned}
q(\omega) &= \left(\frac{p(\omega)}{P}\right)^{-\sigma} \frac{R}{P} \\
\text{with } P &= \left(\int_{\Omega} p(\omega)^{1-\sigma} d\omega\right)^{\frac{1}{1-\sigma}}
\end{aligned}
$$

Technology and pricing (almost as in Krugman)

- Increasing returns to scale technology:

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

- Note: firm level productivity φ will differ across firms.
- Iso-elastic demand $\Rightarrow$ constant mark-up over marginal cost:

$$p(\varphi) = \frac{\sigma}{\sigma - 1}\frac{1}{\varphi}, \ \forall \omega \text{ s.t. } \varphi(\omega) = \varphi$$

Profits

- Profits increase with productivity,

$$\pi(\varphi) = \left(\frac{\sigma - 1}{\sigma}\varphi P\right)^{\sigma-1} \frac{R}{\sigma} - f$$

- Note: low productivity ($\varphi \to 0$) firms exit to avoid negative profits.

Aggregation

- Endogenous mass of firms, M.
- Endogenous distribution of productivities, $\mu(\varphi)\, d\varphi$.
- Convenient "aggregate" productivity,

$$\tilde{\varphi} = \left(\int_0^{\infty} \varphi^{\sigma-1} \mu(\varphi)\, d\varphi \right)^{\frac{1}{\sigma-1}}$$

- Aggregate variables (prices, revenue, profits),

$$\begin{aligned} P &= M^{\frac{1}{1-\sigma}} p(\tilde{\varphi}) \\ R &= M r(\tilde{\varphi}) \\ \Pi &= M \pi(\tilde{\varphi}) \end{aligned}$$

Entry and exit

- Free entry: fixed entry cost f^E, then draw productivity φ from p.d.f. $g(\cdot)$ over $\mathbb{R}^+$.
- Exogenous exit from Poisson death shock with probability δ.
- Endogenous exit if negative profits. All firms $\varphi < \bar{\varphi}$ exit,

$$\pi(\varphi^*) = 0$$

- Endogenous productivity distribution

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

"Zero cutoff profits" condition

- "Average" productivity,

$$\tilde{\varphi}\left(\varphi^{*}\right)=\left(\frac{1}{1-G\left(\varphi^{*}\right)}\int_{\varphi^{*}}^{\infty}\varphi^{\sigma-1}g\left(\varphi\right)d\varphi\right)^{\frac{1}{\sigma-1}}$$

- Average profits are profits of the "average" firm, $\bar{\pi}=\pi\left(\tilde{\varphi}\left(\varphi^{*}\right)\right)$.
- Profits of the marginal firm directly related to average profits,

$$\pi\left(\varphi^{*}\right)=0\Leftrightarrow\bar{\pi}=f\left[\left(\frac{\tilde{\varphi}\left(\varphi^{*}\right)}{\varphi^{*}}\right)^{\sigma-1}-1\right]\qquad(ZCP)$$

Endogenous entry

- Value of entering is expected stream of profits minus entry cost,

$$v^E = E\left[\sum_{t=0}^{\infty}(1-\delta)^t \pi(\varphi) - f^E\right] = \frac{1-G(\varphi^*)}{\delta}\bar{\pi} - f^E$$

- Free entry drives down expected profits to zero,

$$v^E \leq 0 \qquad (FE)$$

General equilibrium

- Firms below φ^* exit (ZCP).
- Free entry drives down (expected) profits to zero (FE).
- Labor markets clear (LMC).

$$\begin{cases} \pi(\varphi^*) = 0 & \text{(Zero Cutoff Profits)} \\ v^E = 0 & \text{(Free Entry)} \\ R = L & \text{(Labor Market Clearing)} \end{cases} \Leftrightarrow \begin{cases} \bar{\pi} = f\left[\left(\frac{\tilde{\varphi}(\varphi^*)}{\varphi^*}\right)^{\sigma-1} - \right. \\ \bar{\pi} = \frac{\delta f^E}{1-G(\varphi^*)} \\ M = \frac{L}{\sigma(\bar{\pi}+f)} \end{cases}$$

- (ZCP) and (FE) solve for φ^* and $\bar{\pi}$; (LMC) and $\bar{\pi}$ solve for M.

Survival threshold

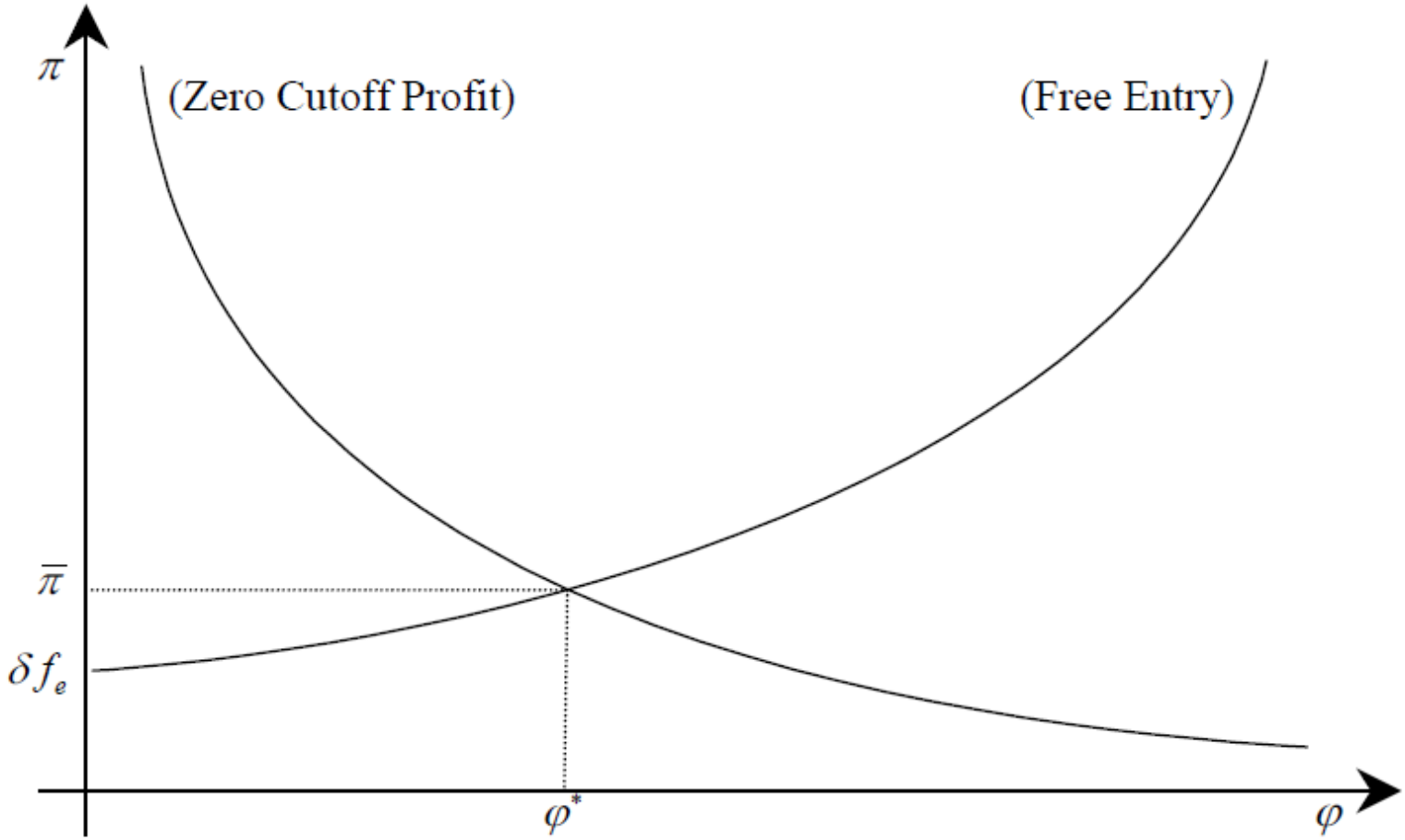


Figure 1: Determination of the Equilibrium Cutoff φ^* and Average Profit $\bar{\pi}$

Ownership structure

- Stationary equilibrium: exit mass = entry mass: $M^E = \frac{\delta M}{1-G(\bar{\varphi})}$.
- Expected profits of firm owners cover the financing of entrants: $f^E M^E = \Pi$.
- All firms owned by a continuum of competitive mutual funds that hold diversified portfolios of firms.
- Note: no financing frictions.

Variable and fixed trade costs

- Iceberg trade cost: τ.
- Fixed export cost: $F^X = \sum_{t=0}^{\infty} (1-\delta)^t f^X = f^X / \delta$.

Selection into exporting

- Export profits: $\pi^X(\varphi) = \left(\frac{\sigma-1}{\sigma}\frac{\varphi}{\tau}P\right)^{\sigma-1}\frac{R}{\sigma} - f^X$.
- Note: low productivity firms $(\varphi \to 0)$ do not export to avoid negative profits.
- Only firms with productivity above φ_X^* export,

$$\pi^X(\varphi_X^*) = 0 \Leftrightarrow \varphi_X^* = \tau\left(\frac{f^X}{f}\right)^{\frac{1}{\sigma-1}}\bar{\varphi} \qquad (ZCP^X)$$

- Empirically motivated restriction:

$$\tau\left(\frac{f^X}{f}\right)^{\frac{1}{\sigma-1}} > 1 \Rightarrow \varphi_X^* > \varphi^*$$

so that not all firms export.

Trade equilibrium

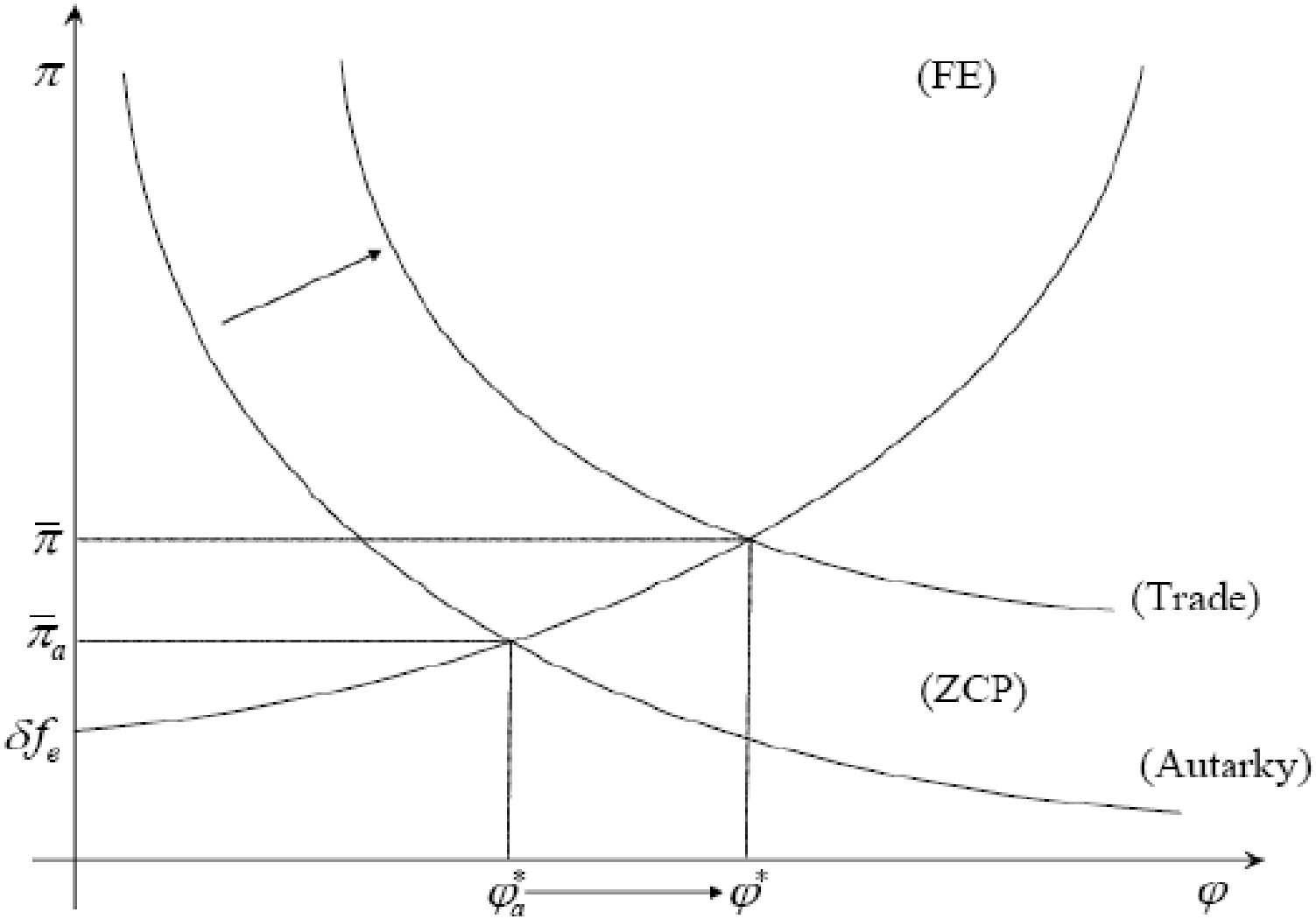
- Profits derived from domestic and export sales,

$$\bar{\pi} = \pi^D\left(\varphi^*\right) + prob^X \pi^X\left(\varphi^*_X\right), \text{ with } prob^X = \frac{1 - G\left(\varphi^*_X\right)}{1 - G\left(\varphi^*\right)}$$

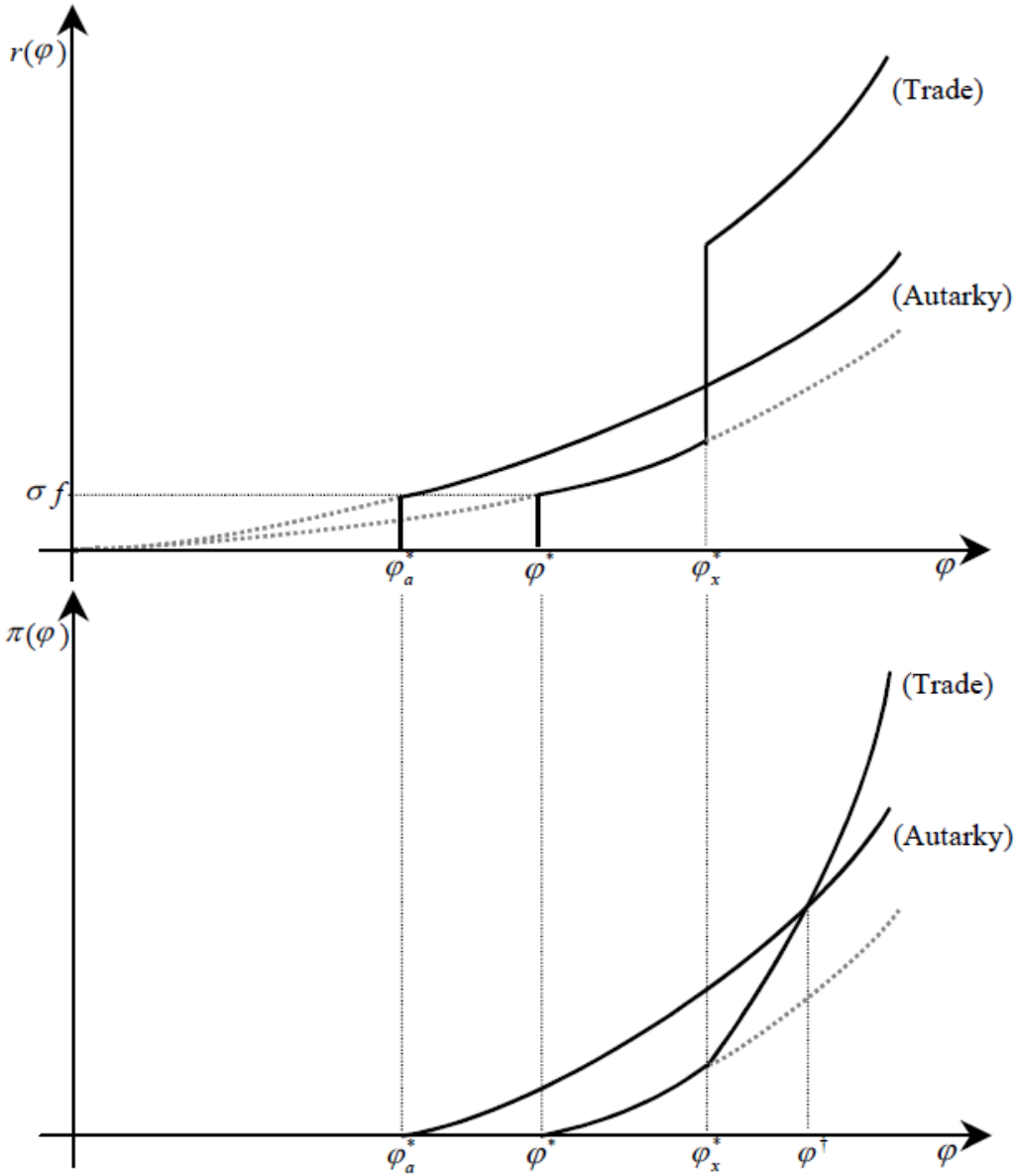
- Equilibrium determined by,

$$\begin{cases} \varphi^*_X = \tau\left(\frac{f^X}{f}\right)^{\frac{1}{\sigma-1}} \varphi^* & \left(ZCP^X\right) \\ \bar{\pi} = f\left(\left[\frac{\tilde{\varphi}(\varphi^*)}{\varphi^*}\right]^{\sigma-1} - 1\right) + prob^X f^X\left(\left[\frac{\tilde{\varphi}(\varphi^*_X)}{\varphi^*}\right]^{\sigma-1} - 1\right) & \left(ZCP\right) \\ \bar{\pi} = \frac{\delta f^E}{1-G(\varphi^*)} & \left(FE\right) \\ M = \frac{L}{\sigma(\bar{\pi}+f+prob^X f^X)} & \left(LMC\right) \end{cases}$$

Selection under trade



Sales and profits



Trade and aggregate productivity

- Opening up to trade induces reallocation towards more productive firms.
- Aggregate productivity goes up.