Stanford Econ 266: International Trade
— Lecture 10: Firm-Level Trade (Theory I) —

Today's Plan

1. **Introduction**
2. A brief introduction to firm-level trade facts (more in Lectures 12-13)
3. Melitz (2003)

Introduction

- Hallak and Levinsohn (2005): "Countries don't trade. Firms trade."
- Since around 1990, trade economists have increasingly used data from individual firms in order to better understand:
  - Why countries trade.
  - The nature of trade costs.
  - The mechanisms of adjustment to trade liberalization: mark-ups, entry, exit, productivity changes, factor price changes.
  - How important trade liberalization is for economic welfare.
  - Who are the winners and losers of trade liberalization (across firms, across workers)?
- This has been an extremely influential development for the field. These are all new and interesting questions that a firm-level approach has enabled access to.

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Stylized Facts about Trade at the Firm-Level

- Exporting is extremely rare.
- Exporters are different:
  - They are larger.
  - They are more productive.
  - They use factors differently.
  - They pay higher wages.
- We will go through some of these findings first.

Exporting is Rare

- Two papers provide a clear characterization of just how rare exporting activity is among firms:
  1. Bernard, Jensen, Redding and Schott (2007, JEP) on US manufacturing.
  2. Eaton, Kortum and Kramarz (2011, Ecma) on French manufacturing. (We will have more to say about this paper in the next empirical lecture, when we discuss how exporting varies across firms and partner countries.)
- It has been hard to match firm-level datasets (which typically contain data on total output/sales, but not sales by destination) to shipment-level trade datasets, but fortunately this has now been achieved (by researchers such as the above authors).

BJRS (2007)

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.
Notes: The first column of numbers summarizes the distribution of manufacturing firms across three-digit NAICS manufacturing industries. The second reports the share of firms in each industry that export. The final column reports mean exports as a percent of total shipments across all firms that export in the noted industry.

BJRS (2007)

Table 7

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

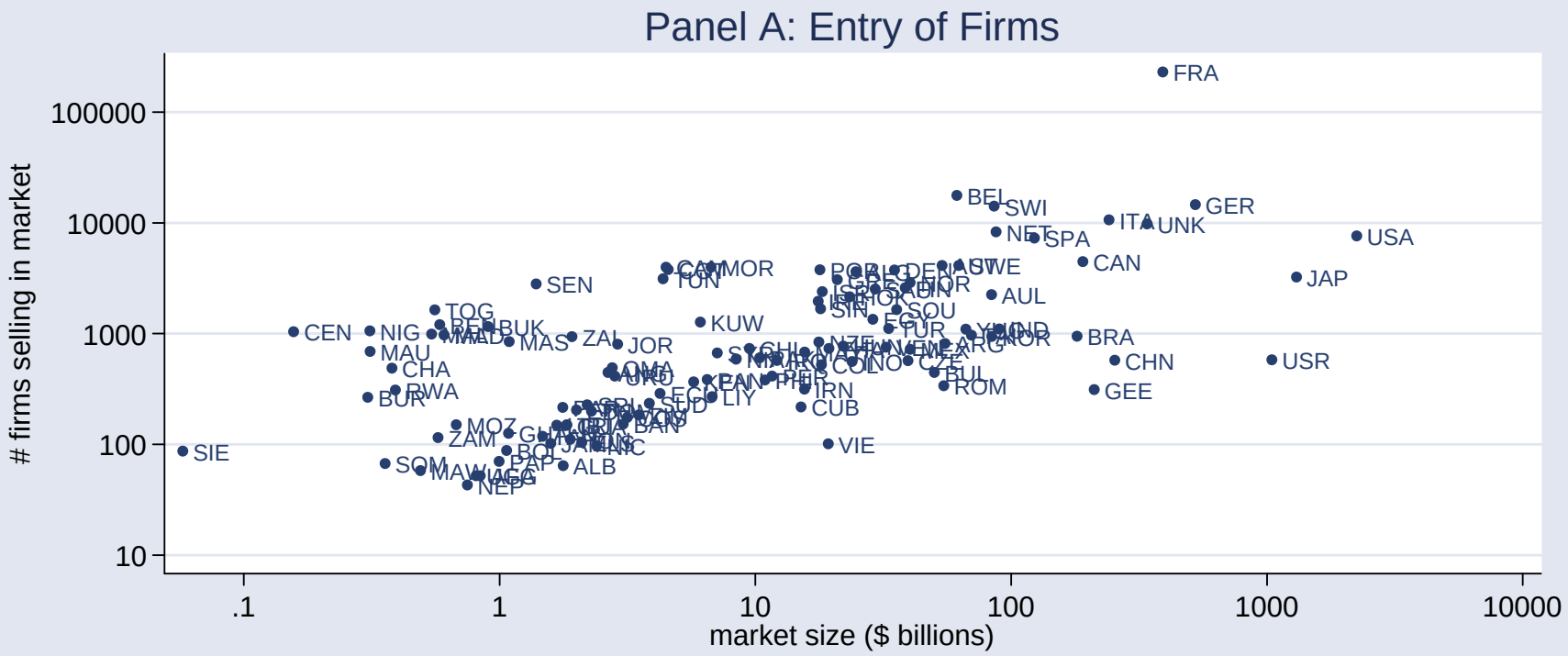
NAICS industry	*Percent of all firms*	*Percent of firms that export*	*Percent of firms that import*	*Percent of firms that import & export*
311 Food Manufacturing	7	17	10	7
312 Beverage and Tobacco Product	1	28	19	13
313 Textile Mills	1	47	31	24
314 Textile Product Mills	2	19	13	9
315 Apparel Manufacturing	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.

EKK (2011)

Out of 229,9000 French manufacturing firms, only 34,035 sell abroad

Figure 1: Entry and Sales by Market Size



Exporters are Different

- The most influential findings about exporting and intra-industry heterogeneity have been related to:
  - Exporters being larger.
  - Exporters being more productive.
- But there are other "exporter premia" too.
- Clearly there is an issue of selection versus treatment here that is of fundamental importance (for policy and for testing theory).
  - This difficult issue has been best tackled with respect to the correlation between exporting and productivity, covered in Lectures 12-13.
  - For now, we focus on the stylized fact that concerns the association between exporting and some phenomenon (like size).

Exporter Premia in the United States

BJRS (JEP, 2007)

Table 3

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.

Exporter Premia in the United States

BJRS (JEP, 2007)

Table 8

Trading Premia in U.S. Manufacturing, 1997

	(1) Exporter premia	*(2) Importer premia*	*(3) Exporter & importer premia*
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).

The Exporter Premium: Productivity

Bernard, Eaton, Jensen and Kortum (AER, 2003) for US data

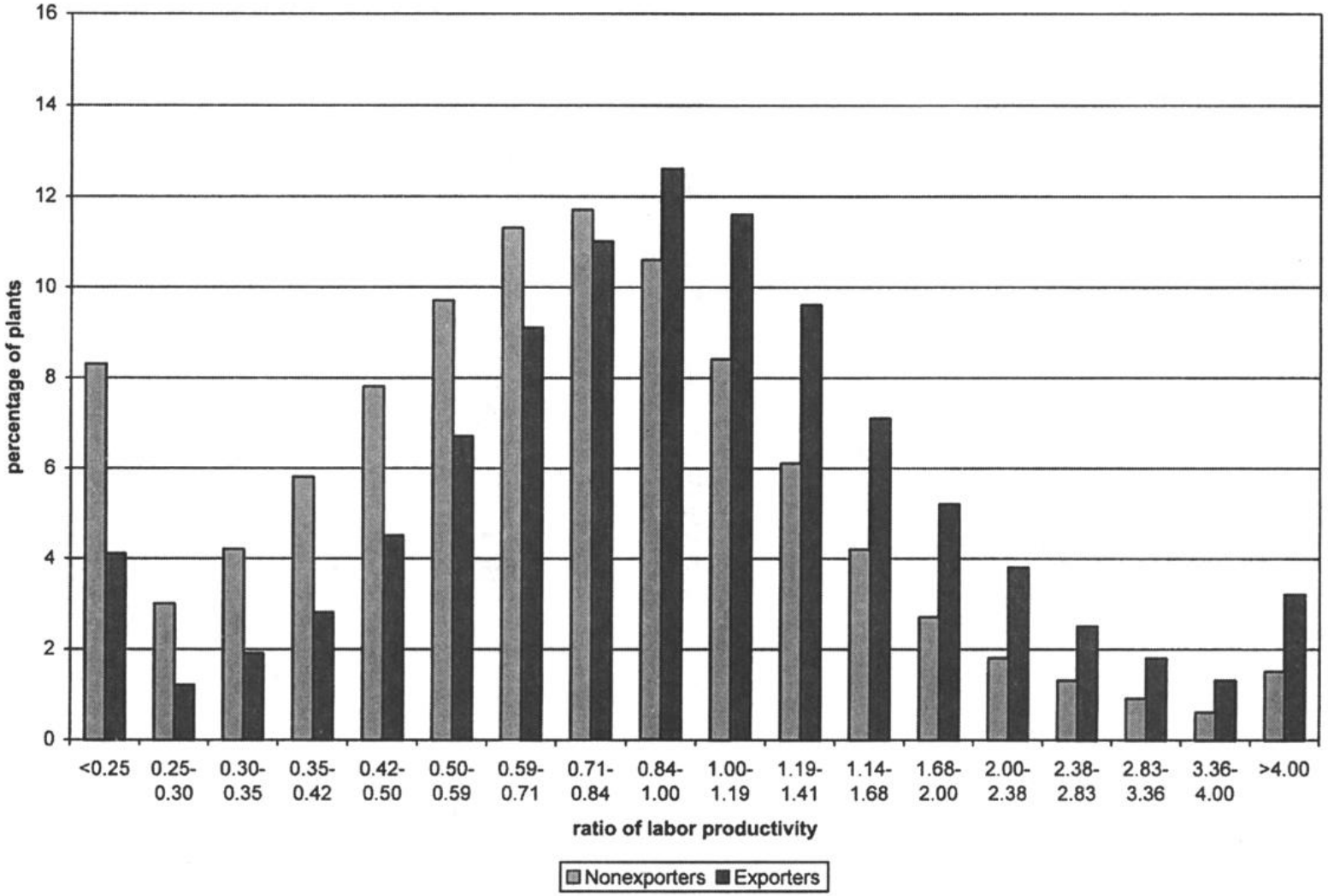


FIGURE 2A. RATIO OF PLANT LABOR PRODUCTIVITY TO OVERALL MEAN

The Exporter Premium: Productivity

Bernard, Eaton, Jensen and Kortum (AER, 2003) for US data

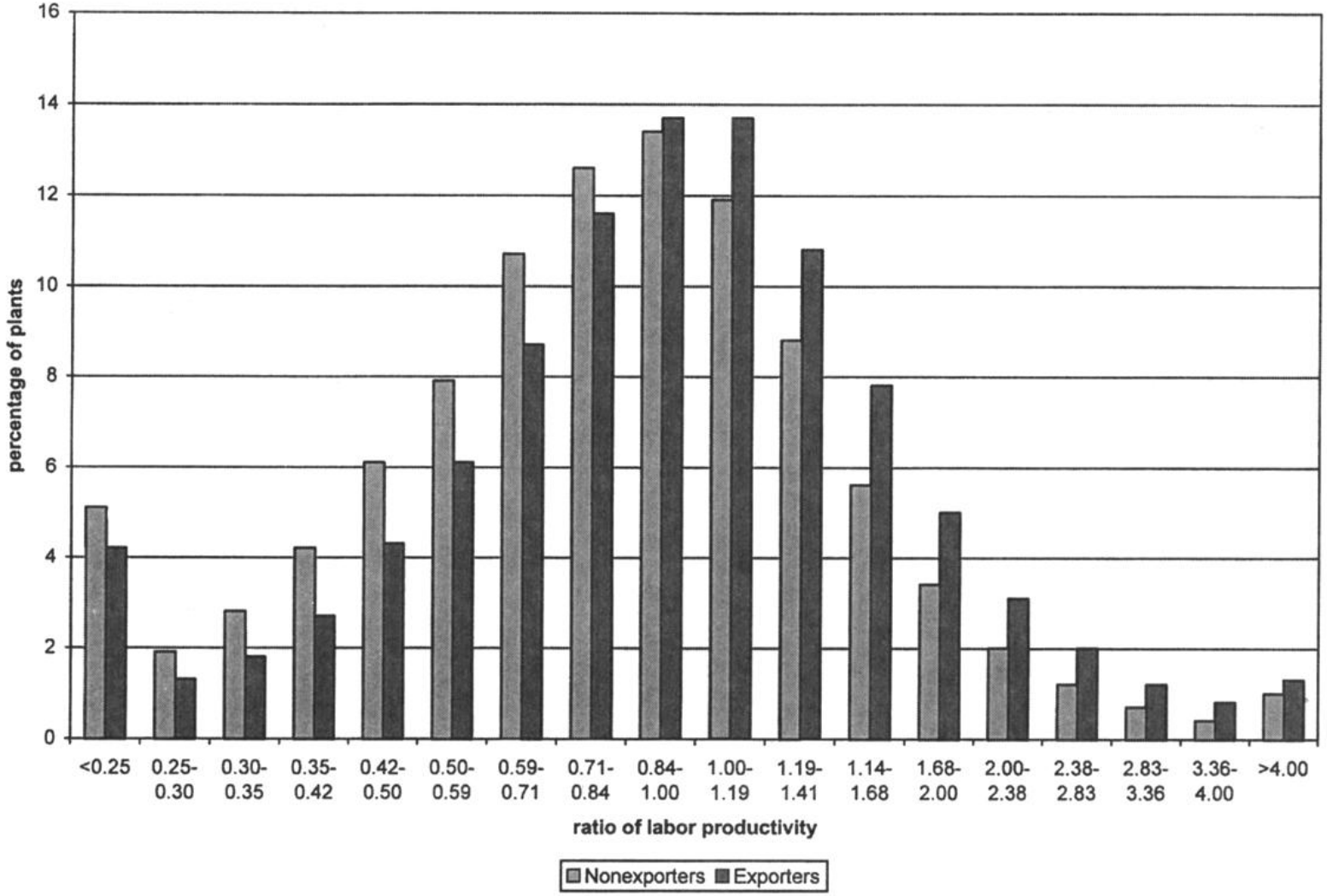
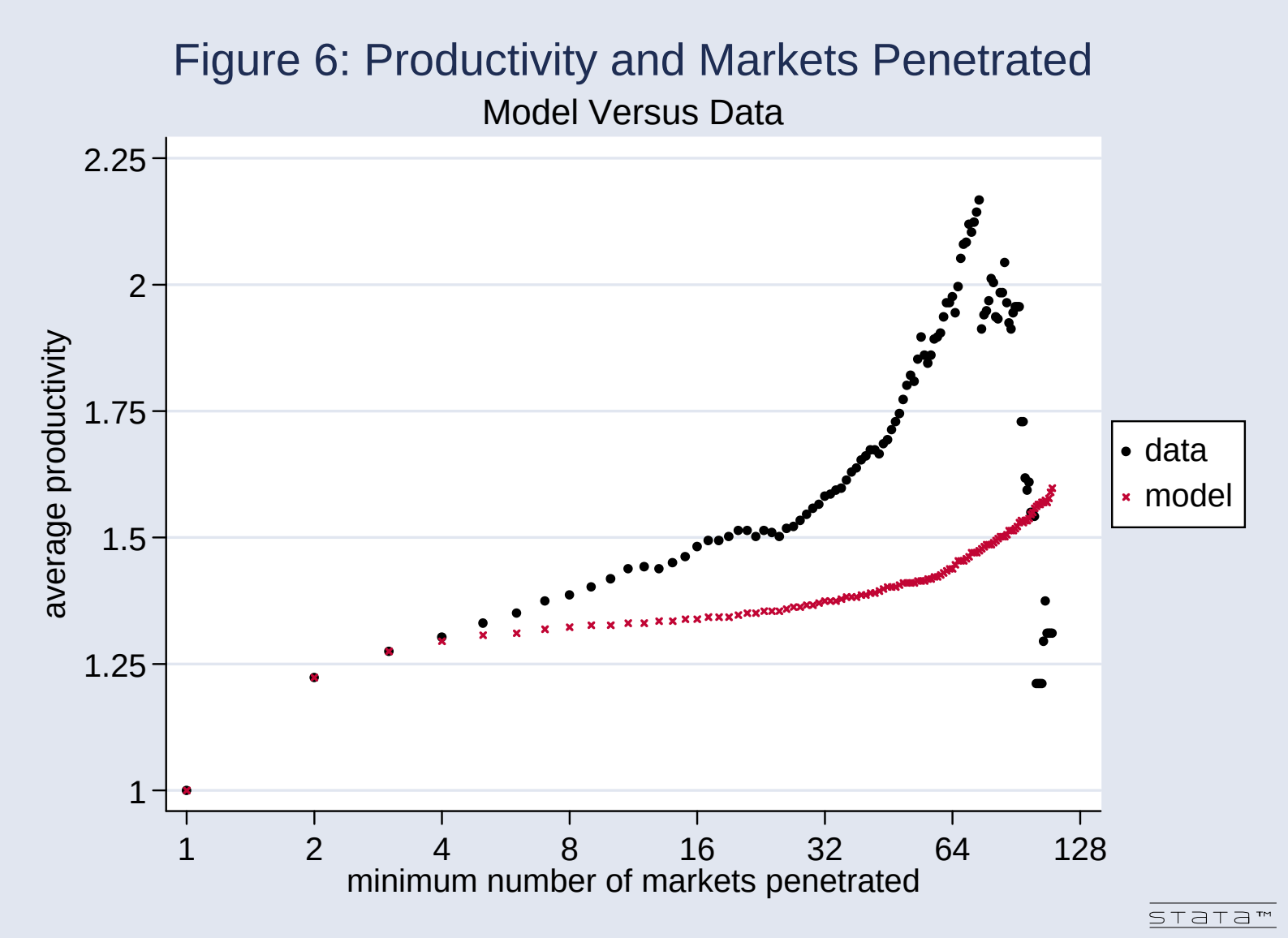


FIGURE 2B. RATIO OF PLANT LABOR PRODUCTIVITY TO 4-DIGIT INDUSTRY MEAN

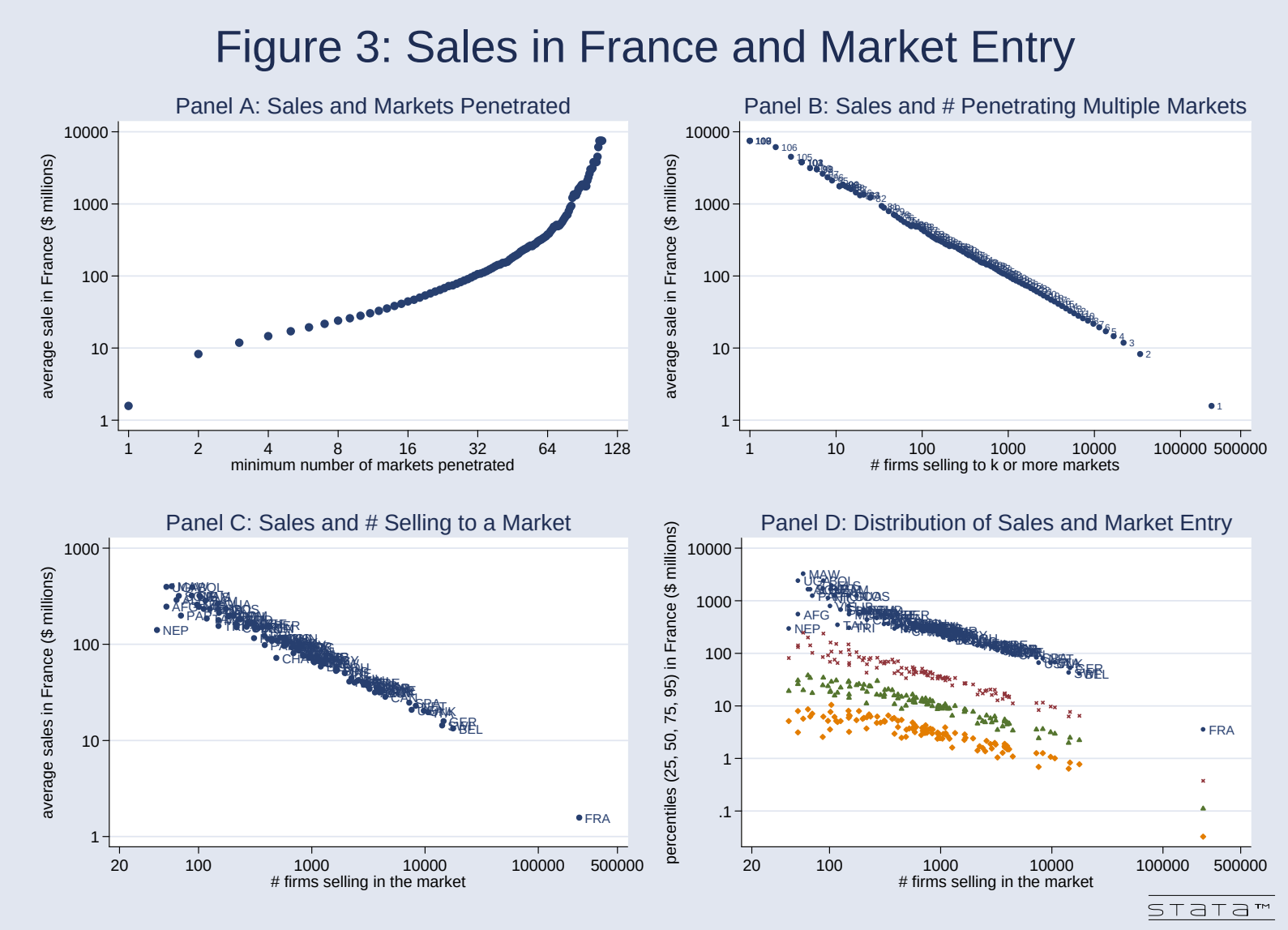
The Exporter Premium: Productivity

EKK (2011) on France (we'll talk about the model in Lectures 12-13)



The Exporter Premium: Domestic Sales

EKK (2011) on France



Other Exporter Premia

- Examples of other exporter premia seen in the data (and there are many more):
  - Produce more products: BJRS (2007) and Bernard, Redding and Schott (QJE, 2011)
  - Higher Wages: Frias, Kaplan and Verhoogen (2009 wp) using employer-employee linked data from Mexico (i.e., when a given worker moves from a purely domestic firm to an exporting firm, his/her wage rises).
  - More expensive (i.e. probably indicating higher quality) material inputs: Kugler and Verhoogen (REStud, 2012) using very detailed data on inputs used by Colombian firms.
  - Innovate more: Aw, Roberts and Xu (AER, 2011).
  - Pollute less: Holladay (2015)

Firm-Level Heterogeneity and Trade Facts: Summary

What's wrong with previous theories?

- **Problem:** previous theories in this course are at odds with (or cannot account for) many micro-level facts (some described above, others that we'll see in Lectures 12-13):
  1. Within a given industry, there is *firm-level heterogeneity* in export behavior.
  2. *Fixed costs of exporting appear to matter* in export-related decisions.
  3. Within a given industry, more productive firms are more likely to export.
  4. Trade liberalization leads to intra-industry reallocation across firms.
  5. These reallocations are correlated with productivity and export status.

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Firm-Level Heterogeneity and Trade

What does Melitz (2003) do about it?

- Melitz (2003, Ecma) will develop a model featuring facts 1 and 2 that can explain facts 3, 4, and 5
- This is probably the most influential trade paper in the last 15 years
- **Two building blocks:**
  1. Krugman (1980, AER): CES, IRS technology, monopolistic competition
  2. Hopenhayn (1992, JPE): equilibrium model of entry and exit
- From a normative point of view, Melitz (2003) may also provide "new" source of gains from trade if trade induces reallocation of labor from least to most productive firms (more on that in later lectures).

Melitz (2003)

Demand

- Like in Krugman (1980), representative agent has CES preferences:

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

where $\sigma > 1$ is the elasticity of substitution

- Consumption and expenditures for each variety are given by

$$q(\omega) = Q \left[\frac{p(\omega)}{P} \right]^{-\sigma} \quad (1)$$

$$r(\omega) = R \left[\frac{p(\omega)}{P} \right]^{1-\sigma} \quad (2)$$

where:

$$P \equiv \left[\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}, \; R \equiv \int_{\omega \in \Omega} r(\omega), \text{ and } Q \equiv R/P$$

Melitz (2003)

Production

- Like in Krugman (1980), labor is the only factor of production
  - $L \equiv$ total endowment, $w = 1 \equiv$ wage
- Like in Krugman (1980), there are IRS in production

$$l = f + q/\varphi \tag{3}$$

- Like in Krugman (1980), monopolistic competition implies

$$p(\varphi) = \frac{1}{\rho\varphi} \tag{4}$$

- CES preferences with monopoly pricing, (2) and (4), imply

$$r(\varphi) = R(P\rho\varphi)^{\sigma-1} \tag{5}$$

- These two assumptions, (3) and (4), further imply

$$\pi(\varphi) \equiv r(\varphi) - l(\varphi) = \frac{r(\varphi)}{\sigma} - f$$

Melitz (2003)

Production

- **Comments:**

1. Higher productivity φ in the model implies higher *measured* productivity (which is important, as measuring productivity is hard, especially in differentiated product industries like this one).

$$\frac{r(\varphi)}{l(\varphi)} = \frac{1}{\rho}\left[1 - \frac{f}{l(\varphi)}\right]$$

2. More productive firms produce more and earn higher revenues

$$\frac{q(\varphi_1)}{q(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\sigma} \text{ and } \frac{r(\varphi_1)}{r(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\sigma-1}$$

3. φ can also be interpreted in terms of quality. This is isomorphic to a change in units of account, which would affect prices, but nothing else

Aside: decentralized equilibrium is efficient

- To see this, note that (following Spence (1976) and Dhingra and Morrow (2013)) the decentralized equilibrium solves:

$$\max_{q_i,n} \int_0^n p_i(q_i)\, q_i di$$

$$\text{subject to:} \qquad nf + \int_0^n \frac{q_i}{\varphi} di \leq L.$$

- A social planner would solve:

$$\max_{q_i,n} \int_0^n (q_i)^{\frac{\sigma-1}{\sigma}} di$$

$$\text{subject to:} \qquad nf + \int_0^n \frac{q_i}{\varphi} di \leq L.$$

- Under CES, $p_i(q_i)\, q_i \propto q_i^{1-\frac{1}{\sigma}} \Rightarrow$ two solutions coincide
  - This is unique to CES (in general, entry is distorted)
  - So inherits many properties (essentially, all aggregate properties) of perfectly competitive models, conditional on L.

Melitz (2003)

Aggregation

- By definition, the CES price index is given by

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

- Since all firms with productivity φ charge the same price $p(\varphi)$, we can rearrange CES price index as

$$P = \left[\int_{0}^{+\infty} p(\varphi)^{1-\sigma} \, M\mu(\varphi) \, d\varphi \right]^{\frac{1}{1-\sigma}}$$

where:

  - $M \equiv$ mass of (surviving) firms in equilibrium
  - $\mu(\varphi) \equiv$ (conditional) pdf of firm-productivity levels in equilibrium

Melitz (2003)

Aggregation

- Combining the previous expression with monopoly pricing (4), we get

$$P = M^{\frac{1}{1-\sigma}} / \rho \widetilde{\varphi}$$

where

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

- One can do the same for all aggregate variables

$$R = Mr(\widetilde{\varphi}), \ \Pi = M\pi(\widetilde{\varphi}), \ Q = M^{\frac{\sigma}{\sigma-1}} q(\widetilde{\varphi})$$

- **Comments:**
  1. These are the same aggregate variables we would get in a Krugman (1980) model with a mass M of identical firms with productivity $\widetilde{\varphi}$
  2. But productivity $\widetilde{\varphi}$ now is an *endogenous* variable which may respond to changes in trade cost, leading to *aggregate* productivity changes

Melitz (2003)

Entry and exit

- In order to determine how $\mu(\varphi)$ and $\widetilde{\varphi}$ get determined in equilibrium, one needs to specify the entry and exit of firms.
- Timing is similar to Hopenhayn (1992):
  1. There is a large pool of identical potential entrants deciding whether to become active or not.
  2. Firms deciding to become active pay a fixed cost of entry $f_e > 0$ and get a productivity draw φ from a cdf G.
  3. After observing their productivity draws, firms decide whether to remain active or not.
  4. Firms deciding to remain active exit with a constant probability δ.

Melitz (2003)

Aside: Pareto distributions

- In variations and extensions of Melitz (2003), most common assumption on the productivity distribution G is Pareto:

$$\begin{aligned} G(\varphi) &\equiv 1 - \left(\frac{\underline{\varphi}}{\varphi}\right)^{\theta} \text{ for } \varphi \geq \underline{\varphi} \\ g(\varphi) &\equiv \theta \underline{\varphi}^{\theta} \varphi^{-\theta-1} \text{ for } \varphi \geq \underline{\varphi} \end{aligned}$$

- Pareto distributions have two advantages:
  1. Combined with CES, it delivers closed-form solutions.
  2. Distribution of firm sizes remains Pareto, which is not a bad approximation empirically (at least for the upper tail).
- But like CES, Pareto distributions will have very strong implications for equilibrium properties (more on this in Lecture 14).

Melitz (2003)

Productivity cutoff

- In a stationary equilibrium, a firm either exits immediately or produces and earns the same profits $\pi(\varphi)$ in each period.
- Expected value of a firm with productivity φ is then

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

- So there exists a unique productivity level $\varphi^* \equiv \inf\left\{\varphi \geq 0 : \frac{\pi(\varphi)}{\delta} > 0\right\}$.
- Productivity cutoff φ^* can also be written as:

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

Melitz (2003)

Aggregate productivity

- Once we know φ^*, we can compute the pdf of firm-productivity levels

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

- Accordingly, the measure of aggregate productivity is given by

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

Melitz (2003)

Free entry condition

- Let $\overline{\pi} \equiv \Pi / M$ denote average profits per period for surviving firms.
- Free entry requires the total expected value of profits to be equal to the fixed cost of entry:

$$0 \times G\left(\varphi^{*}\right) + \frac{\overline{\pi}}{\delta} \times \left[1 - G\left(\varphi^{*}\right)\right] = f_e$$

- **Free Entry Condition (FE):**

$$\overline{\pi} = \frac{\delta f_e}{1 - G\left(\varphi^{*}\right)} \tag{6}$$

- Holding constant the fixed costs of entry, if firms are less likely to survive, they need to be compensated by higher average profits.

Melitz (2003)

Zero cutoff profit condition

- Definition of φ^* can be rearranged to obtain a second relationship between φ^* and $\overline{\pi}$.
- By definition of $\overline{\pi}$, we know that

$$\overline{\pi} = \Pi / M = \pi \left[\widetilde{\varphi} \left(\varphi^* \right) \right] \Leftrightarrow \overline{\pi} = f \left[\frac{r \left[\widetilde{\varphi} \left(\varphi^* \right) \right]}{\sigma f} - 1 \right]$$

- By definition of φ^*, we know that

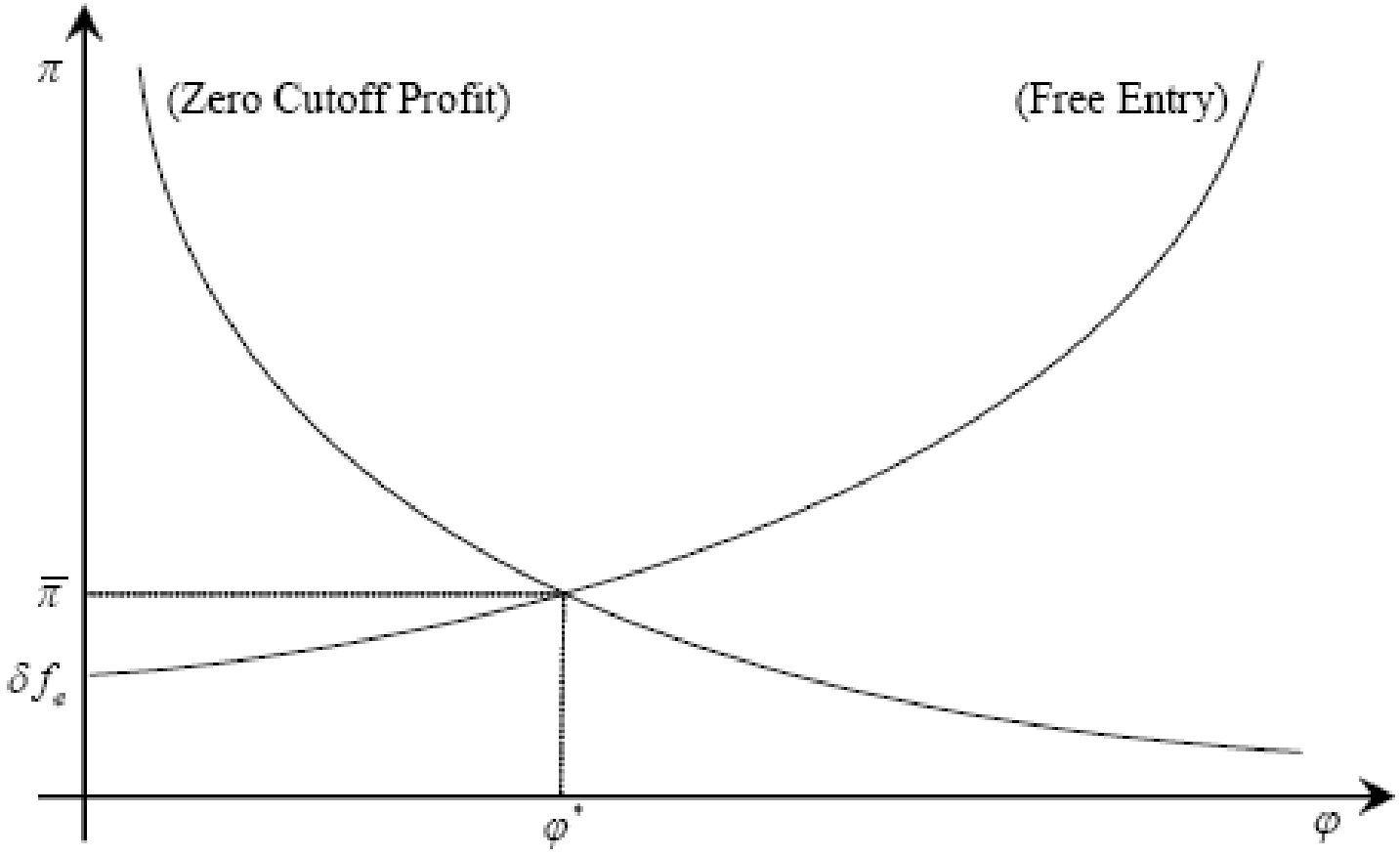
$$\pi \left(\varphi^* \right) = 0 \Leftrightarrow r \left(\varphi^* \right) = \sigma f$$

- Two previous expressions imply **ZCP condition:**

$$\overline{\pi} = f \left[\frac{r \left[\widetilde{\varphi} \left(\varphi^* \right) \right]}{r \left(\varphi^* \right)} - 1 \right] = f \left[\left(\frac{\widetilde{\varphi} \left(\varphi^* \right)}{\varphi^*} \right)^{\sigma - 1} - 1 \right] \tag{7}$$

Melitz (2003)

Closed economy equilibrium (assuming ZCP is downward-sloping; see next slide though)



Melitz (2003)

Aside: the shape of the ZCP schedule

- FE and ZCP, (6) and (7), determine a unique $(\overline{\pi}, \varphi^*)$, and therefore $\widetilde{\varphi}$, independently of country size L.
  - The only variable left to compute is M, which can be done using free entry and labor market clearing as in Krugman (1980).
- However, ZCP is not necessarily downward sloping:
  - It depends on whether $\widetilde{\varphi}$ or φ^* increases relatively faster
  - ZCP is downward-sloping for most common distributions
- In the Pareto case, it is easy to check that $\widetilde{\varphi}/\varphi^*$ is constant:
  - So ZCP is flat and average profits are independent of φ^*

Melitz (2003)

Number of varieties and welfare

- Free entry and labor market clearing imply:

$$L = R = \overline{r}M$$

- We can rearrange the previous expression as:

$$M = \frac{L}{\overline{r}} = \frac{L}{\sigma\left(\overline{\pi} + f\right)}$$

- Like in Krugman (1980), welfare of a representative worker is given by:

$$U = 1/P = M^{\frac{1}{\sigma-1}}\rho\widetilde{\varphi}$$

- Since $\widetilde{\varphi}$ and $\overline{\pi}$ are independent of L, growth in country size and costless trade will also have the same impact as in Krugman (1980):
  - welfare $\nearrow$ because of $\nearrow$ in total number of varieties in each country

Melitz (2003)

Open economy model

- In the absence of trade costs, we have seen trade integration does not lead to any intra-industry reallocation ($\widetilde{\varphi}$ is fixed)
- In order to move away from such (counterfactual) predictions, Melitz (2003) introduces two types of trade costs:
  1. **Iceberg trade costs:** in order to sell 1 unit abroad, firms need to ship $\tau \geq 1$ units
  2. **Fixed exporting costs:** in order to export abroad, firms must incur an additional fixed cost f_{ex} (information, distribution, or regulation costs) *after learning their productivity* φ
- In addition, Melitz (2003) assumes that $c = 1, ..., n$ countries are symmetric so that $w_c = 1$ in all countries

Melitz (2003)

Production

- Monopoly pricing now implies

$$p_d(\varphi) = \frac{1}{\rho\varphi},\ p_x(\varphi) = \frac{\tau}{\rho\varphi}$$

- Revenues in the domestic and export markets are

$$r_d(\varphi) = R_d\left[P_d\rho\varphi\right]^{\sigma-1},\ r_x(\varphi) = \tau^{1-\sigma}R_x\left[P_x\rho\varphi\right]^{\sigma-1}$$

- Note that by symmetry, we must have

$$P_d = P_x = P \text{ and } R_d = R_x = R$$

- Let $f_x \equiv \delta f_{ex}$. Profits in the domestic and export markets are

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

Melitz (2003)

Productivity cutoffs

- Expected value of a firm with productivity φ is

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

- But total profits of are now given by

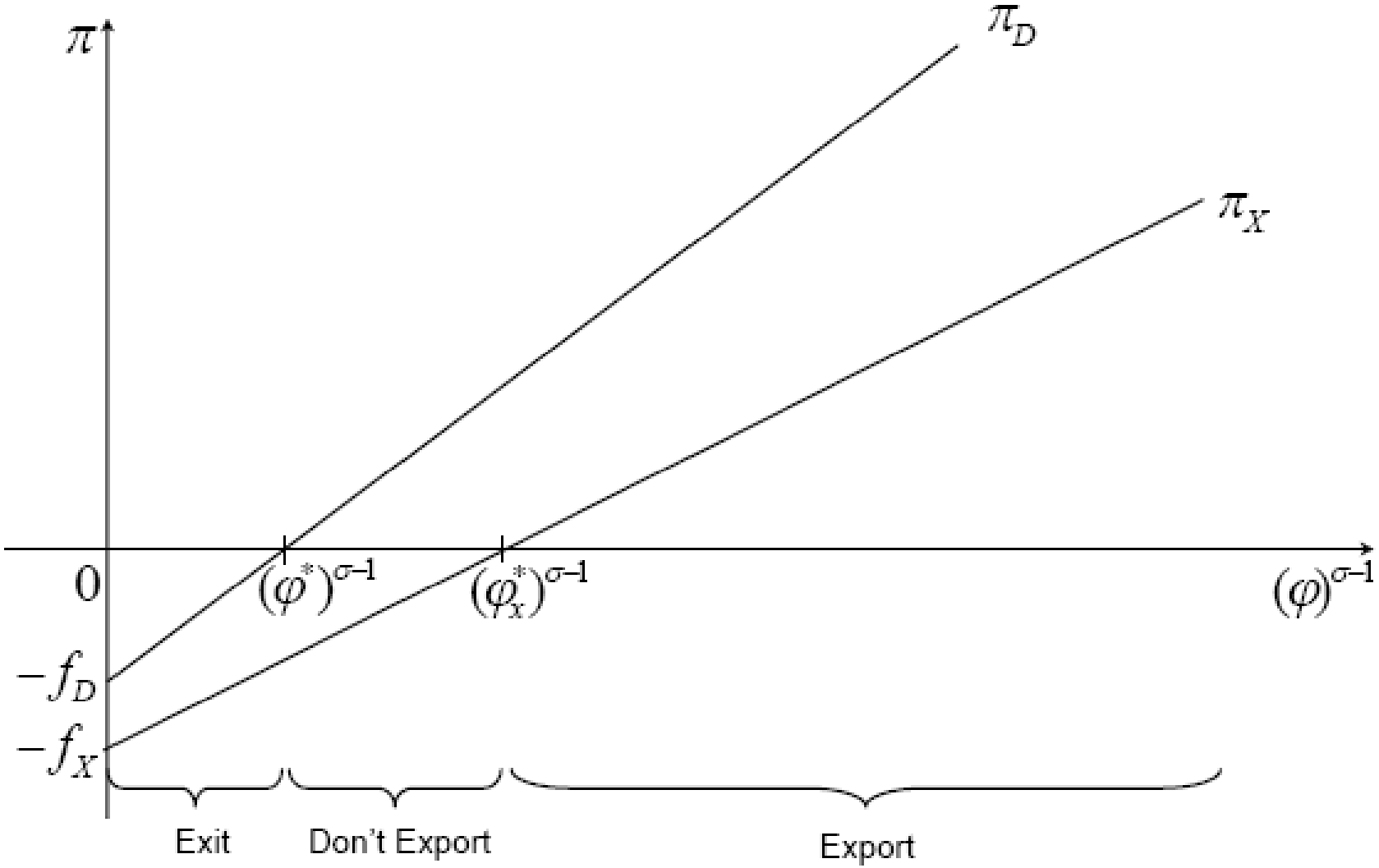
$$\pi(\varphi) = \pi_d(\varphi) + \max\{0, \pi_x(\varphi)\}$$

- Like in the closed economy, we let $\varphi^* \equiv \inf\left\{\varphi \geq 0 : \frac{\pi(\varphi)}{\delta} > 0\right\}$
- In addition, we let $\varphi_x^* \equiv \inf\left\{\varphi \geq \varphi^* : \frac{\pi_x(\varphi)}{\delta} > 0\right\}$ be the export cutoff
- In order to have both exporters and non-exporters in equilibrium, $\varphi_x^* > \varphi^*$, we assume that:

$$\tau^{\sigma-1} f_x > f$$

Melitz (2003)

Selection into exporting



Melitz (2003)

Are exporters more productive than non-exporters?

- In the model, more productive firms (higher φ) select into exports
- Empirically, this directly implies larger firms (higher $r(\varphi)$)
- **Question:** Does that also mean that firms with higher *measured* productivity select into exports?
- **Answer:** Yes. For this to be true, we need

$$\frac{r_d(\varphi) + nr_x(\varphi)}{l_d(\varphi) + nl_x(\varphi)} > \frac{r_d(\varphi)}{l_d(\varphi)},$$

  which always holds if $\tau^{\sigma-1} f_x > f$
- **Comment:** Like in the closed economy, this crucially relies on the fact that fixed labor costs enter the denominator

Melitz (2003)

Aggregation

- In the open economy, aggregate productivity is now given by

$$\widetilde{\varphi}_t = \left\{ \frac{1}{M_t} \left[M\widetilde{\varphi}^{\sigma-1} + nM_x \left(\widetilde{\varphi}_x / \tau \right)^{\sigma-1} \right] \right\}^{\frac{1}{\sigma-1}}$$

where:

- $M_t \equiv M + nM_x$ is the total number of varieties
- $\widetilde{\varphi} = \left[\frac{1}{1-G(\varphi^*)} \int_{\varphi^*}^{+\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi \right]^{\frac{1}{\sigma-1}}$ is the average productivity across all firms
- $\widetilde{\varphi}_x = \left[\frac{1}{1-G(\varphi_x^*)} \int_{\varphi_x^*}^{+\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi \right]^{\frac{1}{\sigma-1}}$ is the average productivity across all exporters

Melitz (2003)

Aggregation

- Once we know $\widetilde{\varphi}_t$, we can still compute all aggregate variables as:

$$
\begin{aligned}
P &= M_t^{\frac{1}{1-\sigma}} / \rho \widetilde{\varphi}_t, \\
R &= M_t r\left(\widetilde{\varphi}_t\right), \\
\Pi &= M_t \pi\left(\widetilde{\varphi}_t\right), \\
Q &= M_t^{\frac{\sigma}{\sigma-1}} q\left(\widetilde{\varphi}_t\right)
\end{aligned}
$$

- **Comment:**
  - Like in the closed economy, there is a tight connection between welfare ($1/P$) and average productivity ($\widetilde{\varphi}_t$)
  - But in the open economy, this connection heavily relies on symmetry: welfare depends on the productivity of *foreign*, not *domestic* exporters

Melitz (2003)

Free entry condition

- The condition for free entry is unchanged
- **Free Entry Condition (FE):**

$$\overline{\pi} = \frac{\delta f_e}{1 - G\left(\varphi^*\right)} \tag{8}$$

- The only difference is that average profits now depend on export profits as well

$$\overline{\pi} = \pi_d\left(\widetilde{\varphi}\right) + np_x\pi_x\left(\widetilde{\varphi}_x\right)$$

where:

  - $p_x = \frac{1-G(\varphi_x^*)}{1-G(\varphi^*)}$ is probability of exporting conditional on successful entry

Melitz (2003)

Zero cutoff profit condition

- By definition of the cut off productivity levels, we know that

$$\begin{aligned} \pi_d(\varphi^*) &= 0 \Leftrightarrow r_d(\varphi^*) = \sigma f \\ \pi_x(\varphi_x^*) &= 0 \Leftrightarrow r_x(\varphi_x^*) = \sigma f_x \end{aligned}$$

- This implies

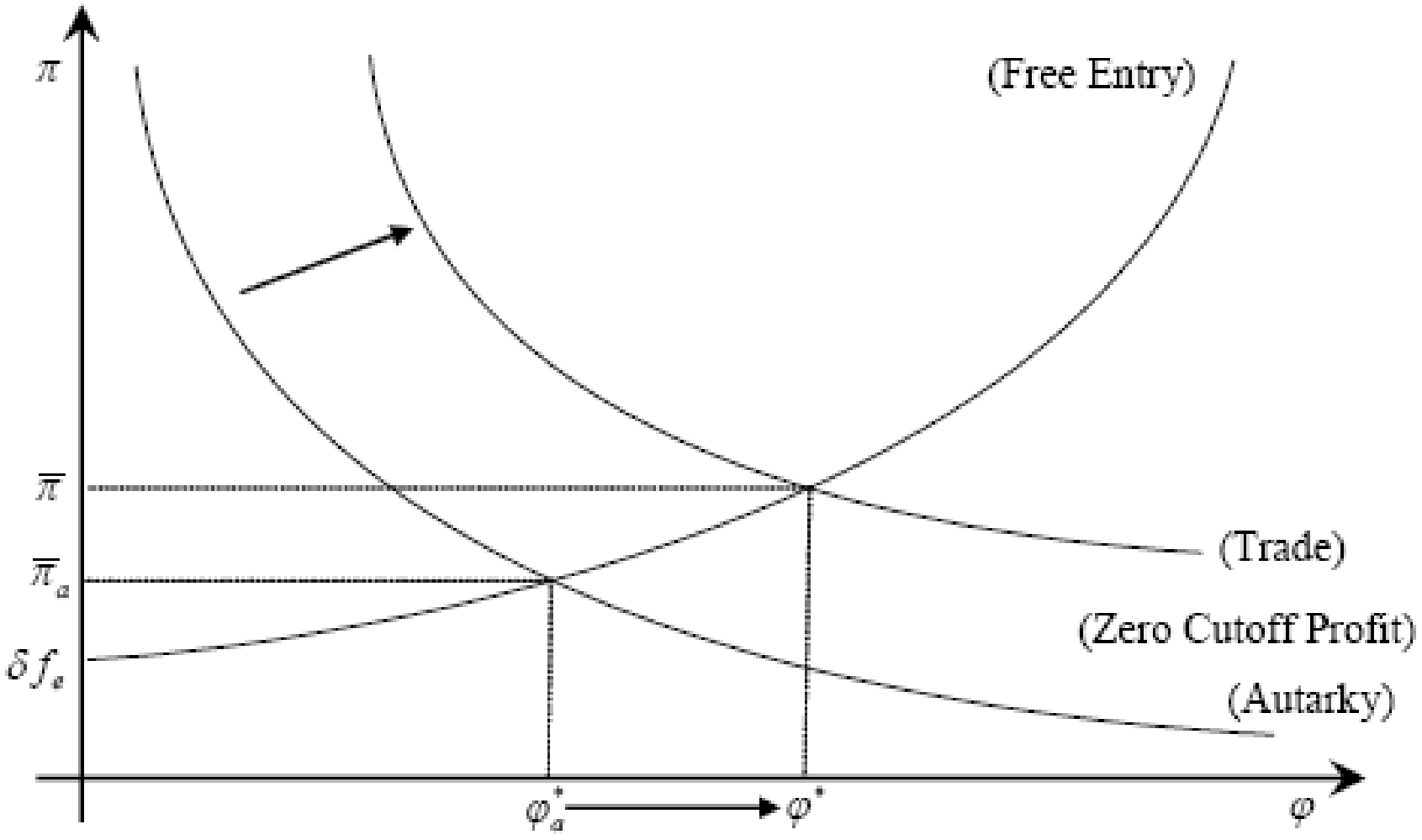
$$\frac{r_x(\varphi_x^*)}{r_d(\varphi^*)} = \frac{f_x}{f} \Leftrightarrow \varphi_x^* = \varphi^* \tau \left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}}$$

- By rearranging $\overline{\pi}$ as a function of φ^*, we get new **ZCP condition**:

$$\overline{\pi} = f\left[\left(\frac{\widetilde{\varphi}(\varphi^*)}{\varphi^*}\right)^{\sigma-1} - 1\right] + np_x f_x \left[\left(\frac{\widetilde{\varphi}_x(\varphi^*)}{\varphi_x^*(\varphi^*)}\right)^{\sigma-1} - 1\right]$$

Melitz (2003)

The Impact of Trade



Melitz (2003)

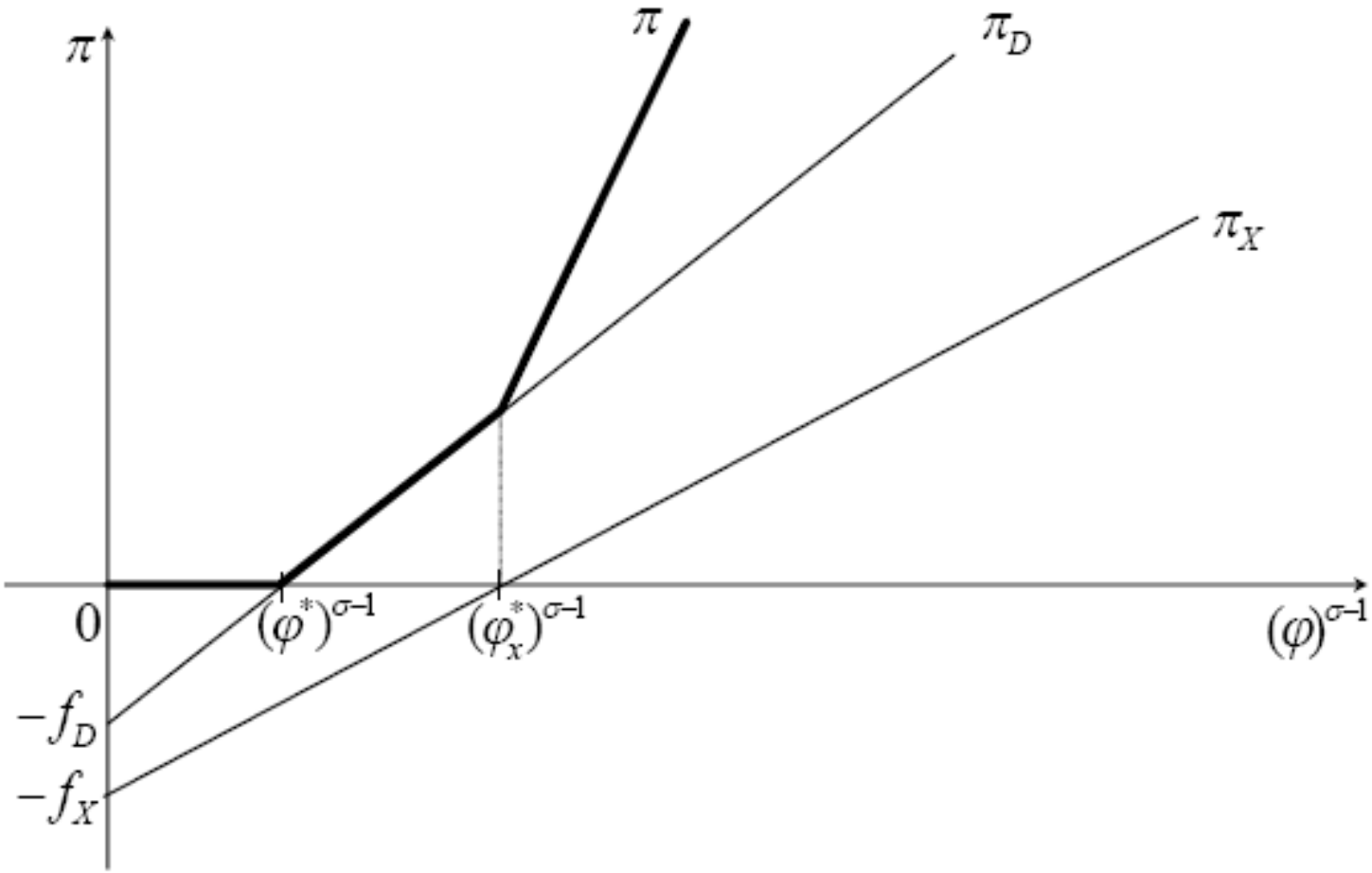
The Impact of Trade

- In line with empirical evidence (see Lectures 12-13), exposure to trade forces the least productive firms to exit: $\varphi^* > \varphi_a^*$
- **Intuition:**
  - *For exporters:* Profits $\nearrow$ due to export opportunities, but $\searrow$ due to the entry of foreign firms in the domestic market ($P \searrow$)
  - *For non-exporters:* only the negative second effect is active
- **Comments:**
  - The $\nearrow$ in φ^* is not really a "new source" (depending on your definition of that phrase) of gains from trade. It's *because* there are gains from trade ($P \searrow$) that $\varphi^* \nearrow$increases
  - Welfare unambiguously $\nearrow$, even though number of domestic varieties $\searrow$

$$M = \frac{R}{\overline{r}} = \frac{L}{\sigma\left(\overline{\pi} + f + p_x n f_x\right)} < M_a$$

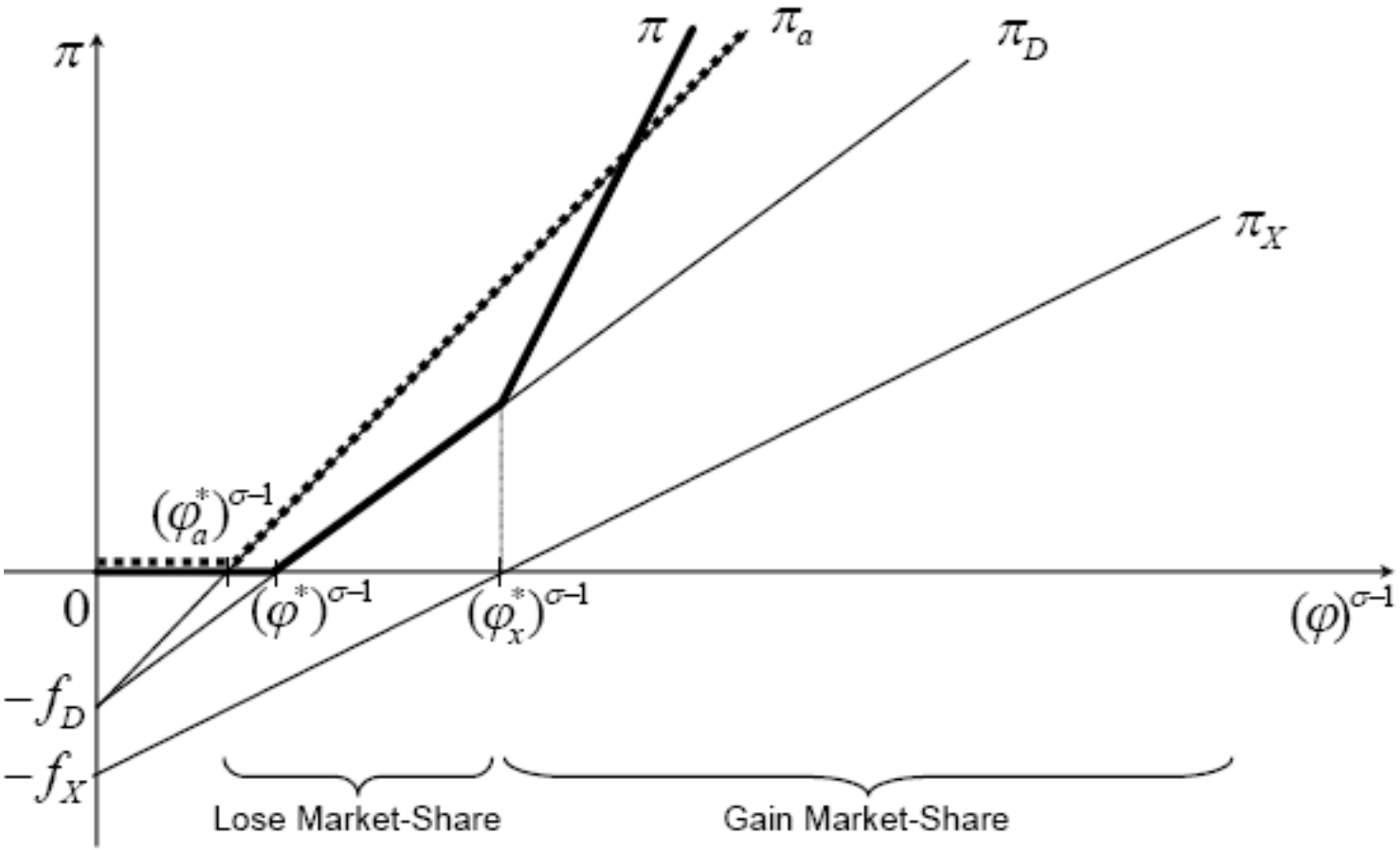
Melitz (2003)

The Impact of Trade



Melitz (2003)

The Impact of Trade



Melitz (2003)

Other comparative static exercises

- Starting from autarky and moving to trade is theoretically standard, but not empirically appealing
- Melitz (2003) also considers:
  1. Increase in the number of trading partners n
  2. Decrease in iceberg trade costs τ
  3. Decrease in fixed exporting costs f_x
- Same qualitative insights in all scenarios:
  - Exit of least efficient firms
  - Reallocation of market shares from less from more productive firms
  - Welfare gains
- Melitz and Redding (2013, *Handbook of International Economics*) offers an excellent overview of various extensions of Melitz (2003)