International Economics B
9. Monopolistic competition and international trade: Firm Heterogeneity

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Introduction

- **Krugman (1979, 1980) and subsequent studies on monopolistic competition and international trade have assumed homogeneous firms.**
  - **There are no productivity differences among firms within an industry.**
- **In practice, firms are heterogeneous.**
- **Moreover, recent research has shown that taking into account firm heterogeneity is crucial to capture some important facts about international trade.**
  - **Based on empirical analysis using plant- or firm-level data**

- **Facts about international trade:**
  1. **Few firms export.**
  2. **Exporting firms are different.**
  3. **Trade liberalization raises industry productivity.**
- **Models with heterogeneous firms provide an explanation for the above findings (and other features of disaggregated trade data), which cannot be directly interpreted using representative firm models.**
  - **Pioneering work: Melitz, M.J. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity,"** *Econometrica* **71, pp.1695–1725.**

Empirical findings from firm-level data

Fact 1: Few firms export.

- **Bernard, A., B. Jensen, S. Redding, and P. Schott (2007), "Firms in International Trade,"** *Journal of Economic Perspectives* **21, pp.105–130.**
- **Overall share of U.S. manufacturing firms that export in 2002 is relatively small, at 18 percent, with a wide range across industries.**
  - **38 percent of computer and electronic products firms export, while the share among apparel manufacturing firms is only 8 percent.**

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.

Fact 2: Exporting firms are different.

- Firms that export look very different from nonexporters along a number of dimensions, as reported by U.S. manufacturing exporters' "export premia."
  - Average percent difference between exporters and nonexporters for a particular firm characteristic
- The export premia indicates that exporters are larger, more productive, more capital intensive, and more skilled-labor intensive, and pay higher wages.
  - For instance, exporting firms have 119 percent, in logarithms ($100 * e^{1.19} - 1 = 229$ percent), more employment than nonexporters.

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.

Fact 3: Trade liberalization raises industry productivity.

- **Welfare gains from trade**
  - **Old trade theory: due to specialization according to comparative advantage**
  - **New trade theory: combination of economies of scale and the expansion of product varieties available to consumers**
- **Empirical analyses of trade liberalization at the firm level $\Rightarrow$ an additional source of welfare gains:**
  - **Aggregate productivity growth driven by the contraction and exit of low-productivity firms and the expansion and entry into export markets of high productivity firms**

- **2/3 of the 19% increase in aggregate productivity following Chile's trade liberalization (late 1970s and early 1980s) were due to the relatively greater survival and growth of high-productivity plants, and the remaining 1/3 was due to within-plant productivity gains.**
  - **Pavcnik, N. (2002), "Trade Liberalization, Exit, and Productivity Improvement: Evidence from Chilean Plants,"** *Review of Economic Studies* **69, pp.245–76.**
- **Similar findings emerge from a large number of studies of trade liberalization reforms in developing countries.**

- **Canada-U.S. FTA $\Rightarrow$ For industries that experienced the deepest Canadian tariff cuts, the contraction of low-productivity plants reduced employment by 12% while raising industry level labor productivity by 15%.**
  - **Trefler, D. (2004), "The Long and Short of the Canada-U. S. Free Trade Agreement,"** *American Economic Review* **94, pp.870–95.**

Melitz model

- **Original model: Krugman's model of monopolistic competition and increasing returns + Hopenhayn's dynamic industry model**
  - **Hopenhayn, H. (1992), "Entry, Exit, and Firm Dynamics in Long Run Equilibrium,"** *Econometrica* **60, pp.1127–50.**
- **Key features:**
  - **Heterogenous firms**
  - **Fixed as well as variable costs of trade**
- **To understand the key insight, it is sufficient to consider a static version of Melitz's model w/o firm dynamics.**
  - **Helpman E. (2006), "Trade, FDI, and the Organization of Firms,"** *Journal of Economic Literature* **44, pp.589–630.**

- **The model explains the empirical facts.**
  - **Because of the fixed costs of exporting, only the most productive firms find it profitable to export (Facts 1 & 2).**
  - **Since only the most productive firms export, only the most productive firms expand following trade liberalization, where as the less productive firms are forced to contract (Fact 3).**

Model setup

- **Preferences and demand**
  - **A representative consumer's preferences are assumed to be CES:**

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

    - **Measure of the set Ω: mass of available goods**
  - **Demand for individual varieties:**

$$q(\omega) = Ap(\omega)^{-\sigma}, \quad A \equiv E/P^{1-\sigma}$$

    - $P = \left[\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$: **price index**
    - $E = \int_{\omega \in \Omega} p(\omega) q(\omega)$: **aggregate expenditure**

- **Technology and production**
  - **A continuum of firms, each choosing to produce a differentiated variety ω**
  - **Each firm discovers its productivity $\theta(\omega)$ only after it enters the industry $\Rightarrow$ $c/\theta(\omega)$: variable production cost per unit of output and cf_D: fixed overhead cost**
    - **c measures the cost of resources (e.g., the wage rate when there is only labor input).**
    - **All firms share the same fixed cost, but may have different marginal costs because of different productivity levels.**
  - **Each firm chooses its price to maximize its profits subject to a downward-sloping residual demand curve with constant elasticity σ $\Rightarrow$ FOC yields a pricing rule:**

$$p(\omega) = \frac{c}{\rho\theta(\omega)}, \quad \rho \equiv (\sigma - 1)/\sigma$$

- **Technology and production (cont'd)**
  - **Equilibrium firm profits:**

$$\pi(\omega) = \theta(\omega)^{\sigma-1} B - c f_D, \quad B \equiv (1-\rho) A (c/\rho)^{1-\sigma}$$

  - **A more productive firm (higher θ) will**
    - **charge a lower price,**
    - **be bigger (larger output), and**
    - **earn higher profits**

    than a less productive firm.

Domestic production and export

- **Profits as a function of the productivity measure $\Theta \equiv \theta^{\sigma-1}$:**

$$\phi_D(\Theta) = \Theta B - cf_D \tag{1}$$

- **Let $\Theta_D \equiv cf_D/B \Rightarrow$ Firms with productivity levels below Θ_D choose not to produce.**
  - **For these firms, variable profits do not cover their fixed cost.**
- **Firms with higher productivity ($\Theta > \Theta_D$) supply their products to the market.**
- **Given a productivity distribution $G(\Theta)$, we can calculate the fraction of firms that serve the market as the fraction of firms with productivity above the cutoff Θ_D.**

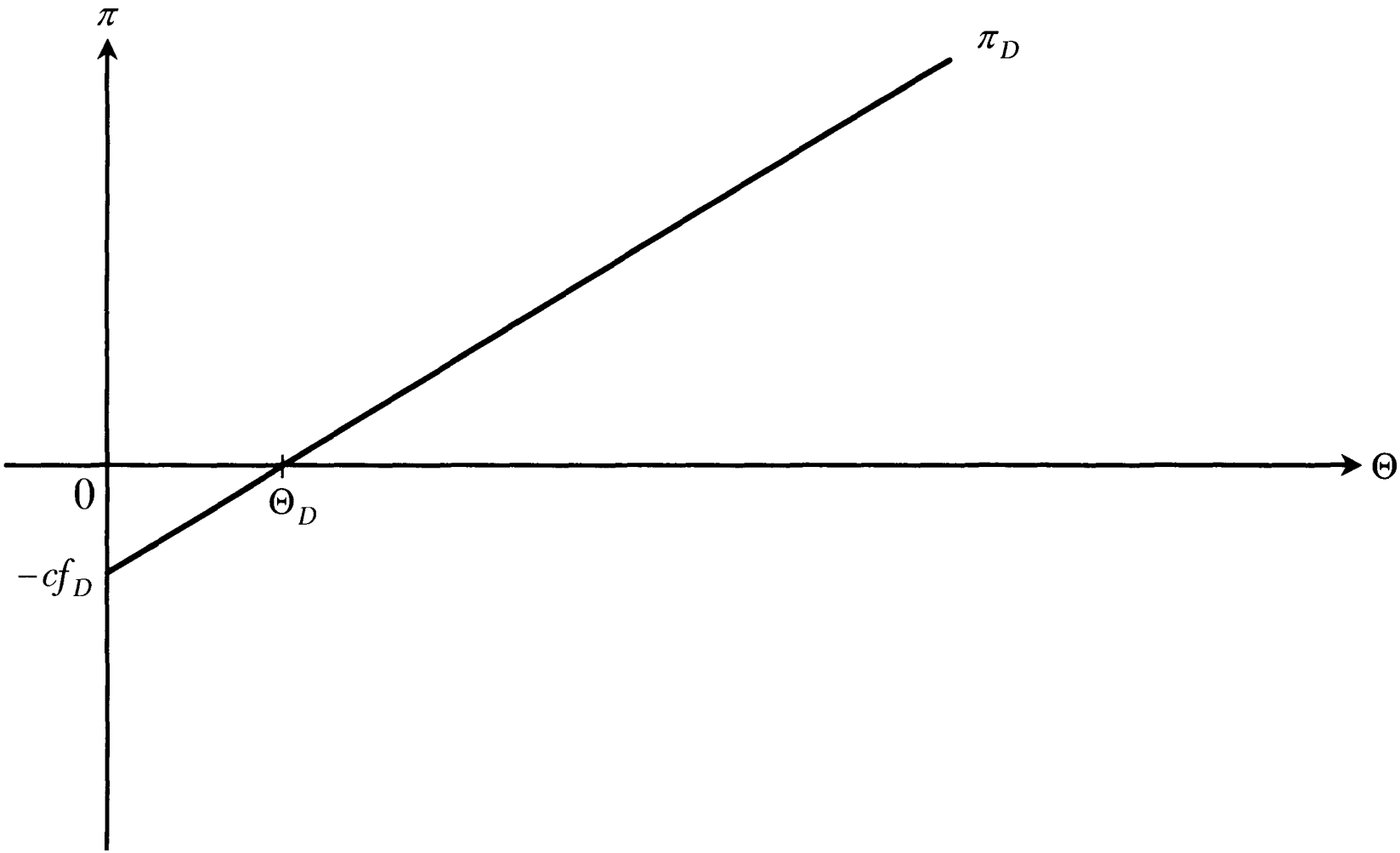

Figure 1. Producing and Nonproducing Firms

- **Interpret the profit function $\pi_D(\Theta)$ as applying to sales in the domestic market, and suppose that firms can sell their products in country l as well.**
  - **Demand function: $q^l(\omega) = A^l p(\omega)^{-\sigma}$; demand elasticity is the same in the two markets but the demand levels are not necessarily the same.**
- **Firms incur variable and fixed costs for exporting.**
  - **Variable trading costs: iceberg-type; $\tau > 1$ units of the product must be shipped from home for 1 unit to arrive in country l.**
    - **Transport costs, insurance, fees, duties, and other impediments that may stem from language barriers, differences in the legal systems, etc.**
  - **Fixed export costs: cf_X**
    - **Distribution and servicing costs in foreign markets**

- **A firm that chooses to sell in the domestic market (i.e., one with productivity $\Theta > \Theta_D$) can make additional profits from export sales:**

$$\pi_X^l(\Theta) = \tau^{1-\sigma}\Theta B^l - cf_X, \quad B^l \equiv (1-\rho)A^l(c/\rho)^{1-\sigma} \tag{2}$$

- **Let $\Theta_X^l \equiv cf_X/\tau^{1-\sigma}B^l \Rightarrow$ Assuming the same demand levels ($A^l = A$ and thus $B^l = B$) and sufficiently higher fixed export costs ($\tau^{\sigma-1}f_X > f_D$), it holds that $\Theta_X^l > \Theta_D$.**
  - **The π_D–schedule is steeper than the pi_X^l–schedule as a result of the trading costs.**

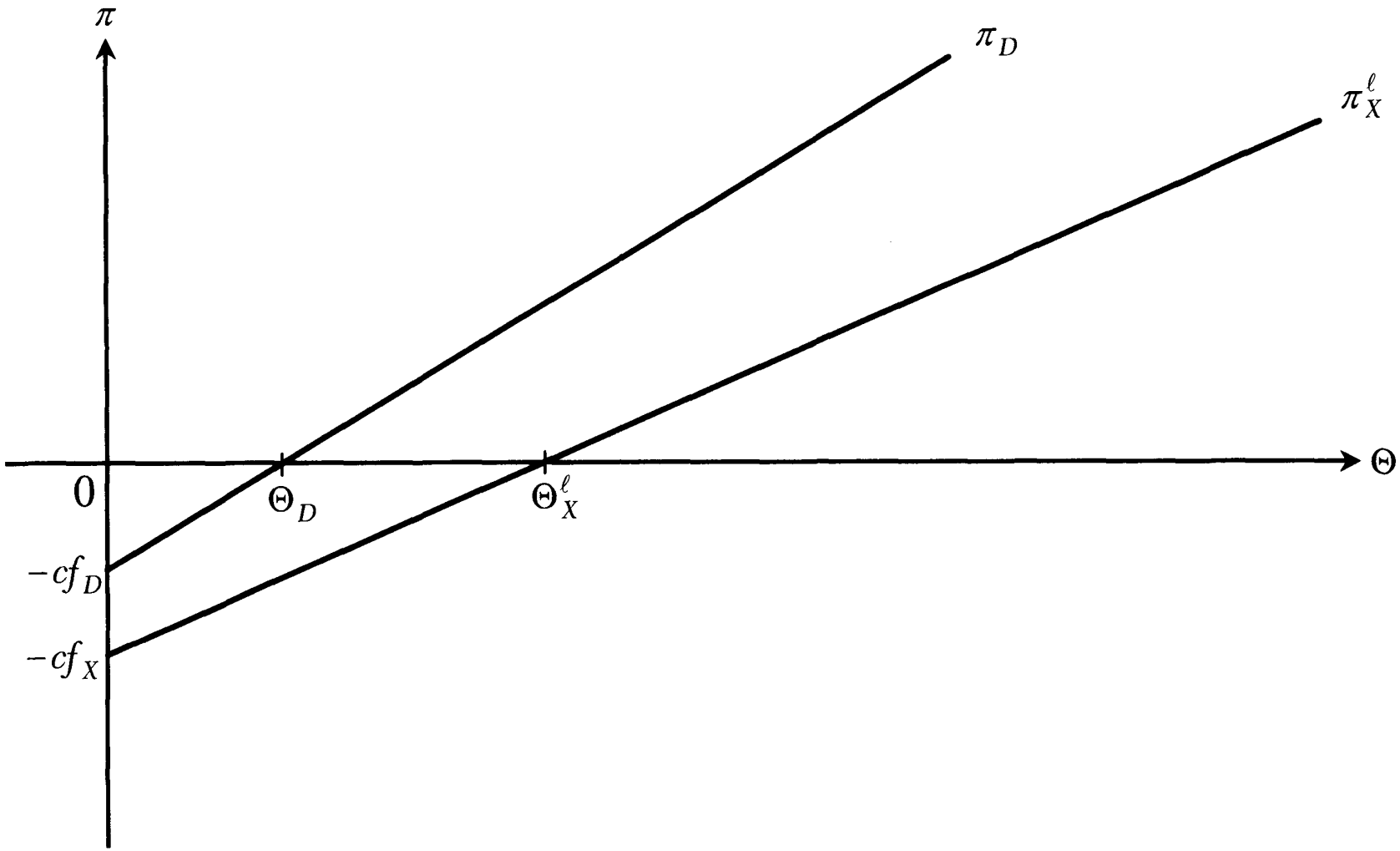

Figure 2. Exporting and Nonexporting Firms

- **Firm productivity and sales pattern:**
  - **Low-productivity firms ($\Theta < \Theta_D$) still choose to close down.**
  - **High-productivity firms ($\Theta > \Theta_X^l$) can make money from exporting $\Rightarrow$ choose to serve the market in l as well as the domestic market.**
  - **Firms with intermediate productivity levels ($\Theta_D < \Theta < \Theta_X^l$) choose not to export and only serve the domestic market.**
- **Exporting firms are more productive than nonexporters, and they are bigger since they sell more in the domestic market and sell in the foreign country as well.**
  - **Consistent with the data, in which exporters are larger and more productive than nonexporters.**

Effects of trade liberalization

- **Consider multilateral trade liberalization; a proportional reduction of trading costs τ in all countries.**
- **Exporters' profits increase (the π_X^l–schedule becomes steeper) $\Rightarrow$ reduction in the cutoff Θ_X^l, i.e., a larger proportion of firms choose to export.**
- **At the same time, the general equilibrium effects make the π_D– and π_X^l–schedules flatter.**
  - **Larger number of exporters in a market means a smaller demand facing every supplier (A).**
  - **More demand for productive resources (e.g., labor) by high-productivity firms can push up the factor prices (c).**

- **Final outcome: lower export cutoff Θ_X^l and higher domestic cutoff Θ_D**
  - **Only the more-productive firms can survive.**
- **Trade liberalization leads to higher average productivity, and output is reallocated toward more productive firms.**
  - **Consistent with the empirical facts in e.g., Trefler (2004).**

Extension: foreign direct investment (FDI)

- **FDI: an investment made in another country, in the form of establishing business operations or acquiring business assets in the other country**
- **Traditional classification of FDI:**
  - **Horizontal FDI: Subsidiaries that serve the local market in the host country**
  - **Vertical FDI: Subsidiaries that add value to products that are not destined (necessarily) for the host country market**
- **Melitz's model can be generalized to handle horizontal FDI.**
  - **Helpman, E., M.J. Melitz, and S.R. Yeaple (2004), "Export versus FDI with Heterogeneous Firms,"** *American Economic Review* **94, pp.300–316.**

- **Suppose that a home-country firm can build a (second) production facility in country l, at cost cf_I, that will enable it to produce in country l at unit cost c^l/θ.**
- **If the firm exports to country l, its profits from exporting are given by $\pi_X^l(\Theta) = \tau^{1-\sigma}\Theta B^l - cf_X$, while if it chooses to serve the foreign market via FDI, the firm's profits from FDI are**

$$\pi_I^l(\Theta) = \Theta B_I^l - cf_I, \quad B_I^l \equiv (1-\rho)A^l(c^l/\rho)^{1-\sigma} \quad (3)$$

- **Assume that $f_I > f_X$ and $c^l < c\tau$.**
  - **By choosing FDI instead of exporting, the firm gives up concentration of production, which raises its fixed costs, but saves on variable unit costs by avoiding trade costs.**

- **Assuming the same resource costs ($c^l = c$) and demand levels ($B_I^l = B^l = B$), and $f_I > \tau^{\sigma-1} f_X > f_D$, it holds that $\Theta_I^l > \Theta_X^l > \Theta_D$.**
- **Firm productivity and sales pattern:**
  - **The most productive firms ($\Theta > \Theta_I^l$) serve the foreign market via subsidiary sales;**
  - **Lower productivity firms ($\Theta_X^l < \Theta < \Theta_I^l$) serve the foreign market via export;**
  - **Still lower productivity firms ($\Theta^D < \Theta < \Theta_X^l$) serve only the domestic market.**

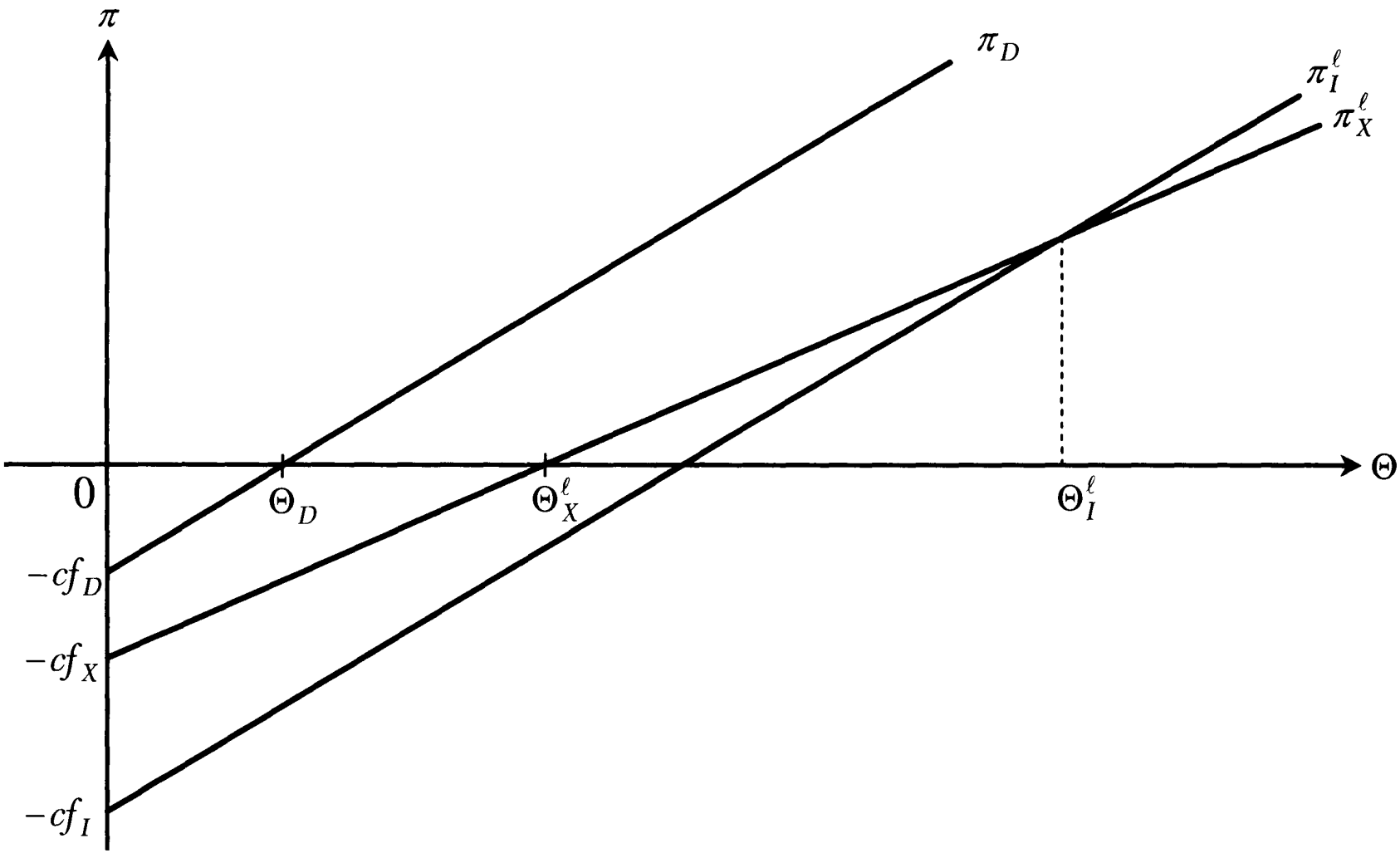

Figure 3. Multinationals, Exporting, and Nonexporting Firms

- **This sorting pattern is consistent with the empirical evidence.**
  - **Multinational corporations are more productive than exporters who are not multinationals, and exporters who are not multinationals are more productive than firms who serve only the domestic market.**
  - **HMY (2004): in 1996, U.S. firms that engaged in FDI had a 15 percent labor productivity advantage over exporters who did not engage in FDI, and the latter had a 39 percent labor productivity advantage over firms who engaged in neither export nor FDI.**