International Economics I

Lecture Set 5 (and 6): The Melitz model

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"New" Trade Theory: Recap

- n varieties of differentiated goods
  - total cost function

$$TC = (F + \beta q)\, w$$

- L consumer with "love of variety"
  - demand

$$q_i = (P/p_i)^{1/(1-\alpha)} wL/P \quad \alpha \in (0,1)$$

    elasticity of substitution: $1/(1-\alpha)$

- equilibrium
  - price: from profit maximization

$$p_i = p = \beta w/\alpha \quad (MC * \text{mark-up})$$

  - quantities: from free entry

$$q_i = q = \alpha F/[\beta(1-\alpha)]$$

  - number of varieties: from labor market clearing

$$n = L(1-\alpha)/F$$

Pattern of Trade

- each country exports its varieties and imports the foreign ones

$$X = \frac{L^*}{L^* + L} nq \quad \text{and} \quad M = \frac{L}{L^* + L} n^* q$$

- all firms in both countries are exporters
- trade is intra-industry trade
  - export and import same good (different varieties)

All Exporters?

- the model with IRS + differentiated goods predicts that all firms export
- in reality, only few of them export
  - share of exporters among manufacturing firms:
    - US (2007) → 17%
    - France (1986) → 17.4%
    - Japan (2000) → 20%
    - Chile (1999) → 20.9
    - Spain (2011) → 12%
    - Catalunya (2014) → 8%
- moreover, exporters differ from non-exporters:
  - exporter are bigger and more productive

Exporters in the US (2007)

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**

Exporters Are Different

	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

Source: Bernard et al. (2007)

Firm Heterogeneity: A Model

- Melitz (2003) modifies the previous model to account for these facts:
  - not all firms export
  - exporters are bigger and more productive than non-exporters
  - larger exporters export more
- new result: trade and selection
  - trade liberalization affects firms asymmetrically
  - benefit the large, more productive firms
  - harms small, non-exporting firms → some exit
  - "selection of the best fit"

Melitz (2003): Assumptions

- preferences and market structure
  - identical to previous model
  - wage is again the numeraire ($w = 1$)
- new assumptions:
  1. firms draw their productivity from some distribution
     - generates heterogeneity
  2. there is a fixed export cost
     - only the most productive firms are willing to pay it
  3. there is also a variable (iceberg) trade cost (not crucial)
- study reduction in trade costs between two symmetric countries

Firm Heterogeneity: Closed Economy

- firms differ (exogenously) in productivity $\varphi \rightarrow MC = 1/\varphi$
  - total cost of a firm with productivity φ:

$$TC = \frac{q}{\varphi} + f_D$$

  - f_D = fixed cost of production or serving the domestic ($_D$) market
- firms are monopolistically competitive
  - usual pricing formula $p = 1/\alpha\varphi$
  - (domestic) profit of a firm with productivity φ:

$$\pi_D = A\varphi^{\frac{\alpha}{1-\alpha}} - f_D \qquad \text{where } A \equiv (1-\alpha)L(\alpha P)^{\alpha/(1-\alpha)}$$

- more productive firms:
  - charge lower prices, sell more, make higher profits

Producing and Non-Producing Firms

- firms can shut down at no cost (free exit):
  - given profits
$$\pi_D = A\varphi^{\frac{\alpha}{1-\alpha}} - f_D$$
  - stay if $\pi \geq 0$, otherwise exit
  - only the most productive firms ($\varphi > \varphi_D^*$) survive where
$$A\left(\varphi_D^*\right)^{\frac{\alpha}{1-\alpha}} = f_D$$

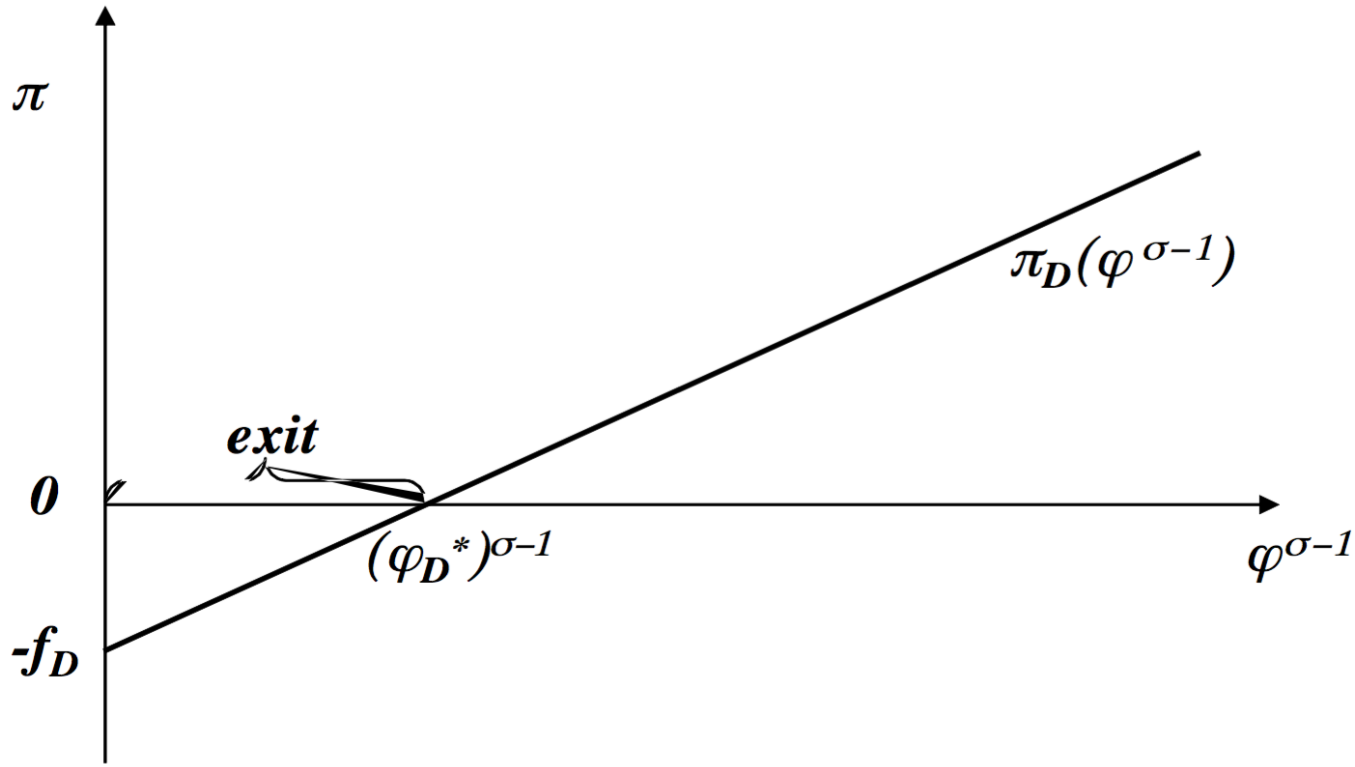
Free Entry and Cutoff Productivity

- to jointly determine A and φ_D^*: free entry + free exit
- for given cutoff productivity φ_D^*
  - ex-ante (upon entry) expected profits are

$$\mathbb{E}(\pi_D) = \int_{\varphi_D^*}^{\infty} \left[A\varphi^{\alpha/(1-\alpha)} - f_D \right] g(\varphi) d\varphi = f_E$$

    - $g(\varphi)$ = probability of drawing productivity φ
  - free entry: firms enter in the market until $\mathbb{E}(\pi_D) = f_E$
- in equilibrium, cutoff productivity is:
  - increasing in f_D (more difficult to cover the fixed cost of production)
  - decreasing in f_E (need higher expected profits/survival probability for firms to enter)
  - negatively correlated with A (survival is easier in more profitable markets)

Producing and Non-Producing Firms: Graph



$$\pi_D = A\varphi^{\alpha/(1-\alpha)} - f_D$$

Exporting: Assumptions

- suppose now that a firm can sell into a foreign market, denoted by $(_X)$
- assume countries are symmetric
  - same size, technology and preferences $\rightarrow A = A_X$
- to serve a foreign market, there are two additional costs:
  1. a new fixed cost (distribution and servicing costs) f_X
  2. an iceberg cost: ship $\tau > 1$ to deliver 1
     - marginal cost $= \tau/\varphi$

Exporting: Prices and Profits

- price of exported goods

$$p_X = \frac{\tau}{\alpha\varphi}$$

  - higher because the effective productivity in the export market is φ/τ with $\tau > 1$

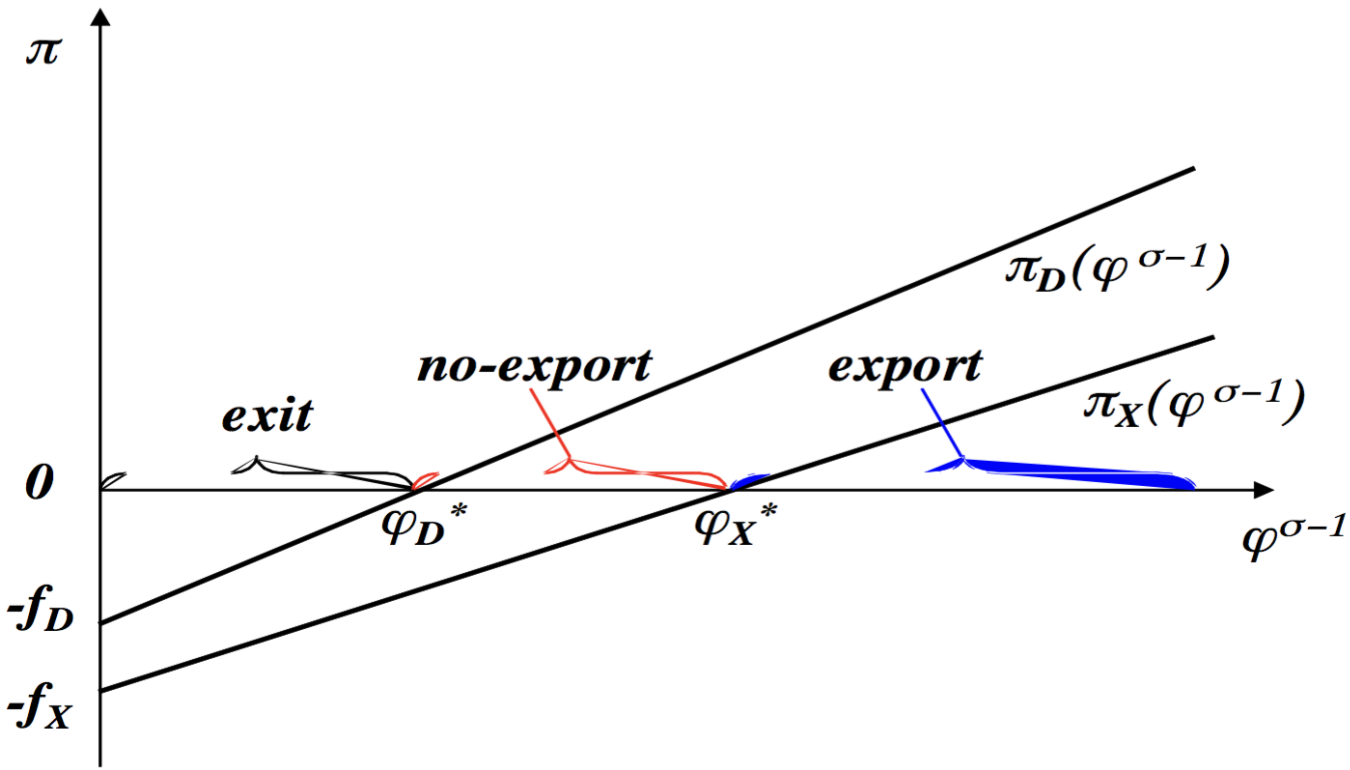
- profits from exporting:

$$\pi_X = A\left(\frac{\varphi}{\tau}\right)^{\alpha/(1-\alpha)} - f_X$$

  - positive only if φ is high enough

- assume $\tau^{\alpha/(1-\alpha)} f_X > f_D$
  - this implies that no firm prefers exporting than serving the domestic market

Exporting and Non-Exporting Firms: Graph



$$\pi_D = A\varphi^{\alpha/(1-\alpha)} - f_D \quad \text{and} \quad \pi_X = A\left(\varphi/\tau\right)^{\alpha/(1-\alpha)} - f_X$$

Exporting and Non-Exporting Firms

- recall profits:

$$\pi_D = A\varphi^{\alpha/(1-\alpha)} - f_D \quad \text{and} \quad \pi_X = A\left(\varphi/\tau\right)^{\alpha/(1-\alpha)} - f_X$$

  - both increase with productivity, π_X by less (due to τ)
- firms partition in groups:
  - firms with productivity below φ_D^* exit
  - firms between φ_D^* and φ_X^* produce in the domestic market only
  - firms above φ_X^* export too
- thus, only the most productive firms export
  - a firm must be big enough to profitably cover the fixed export cost
  - note: $\tau^{\alpha/(1-\alpha)} f_X > f_D$ guarantees that $\varphi_D^* < \varphi_X^*$

Trade and Selection

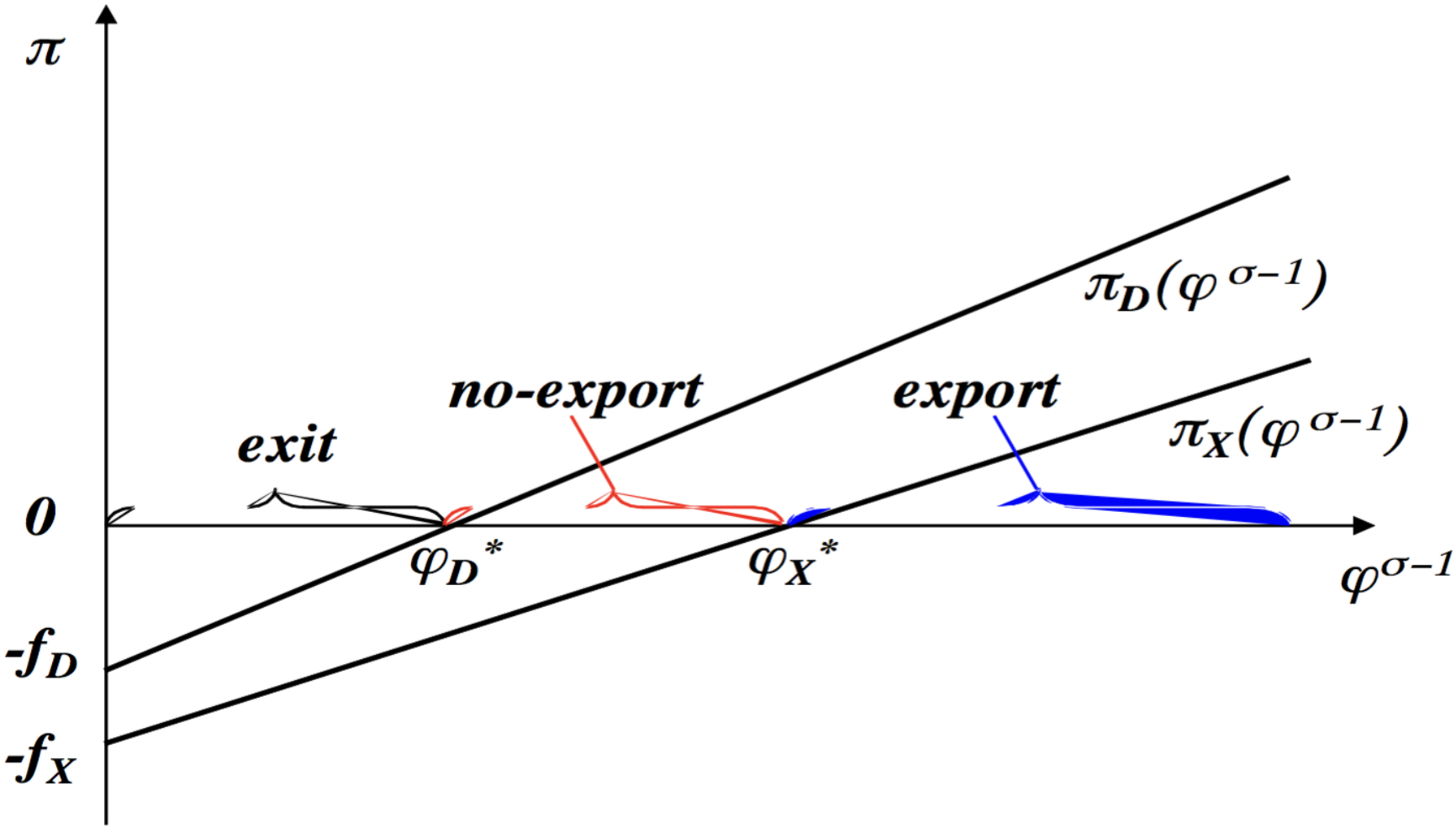
- cutoff productivity for the domestic market φ_D^* increases
  - foreign exporters enter the domestic market
    - more productive than domestic non-exporters
    - market becomes more competitive ($A \downarrow$)
  - non-exporters:
    - lose domestic sales due to foreign penetration
    - do not gain market shares in the foreign market
  - marginal (least-productive) firms are forced to exit
- selection effect:
  - fewer firms per country
  - higher average productivity of survivors
- similar effects if the costs of export (τ and/or f_X) fall

Trade and Welfare with Heterogeneous Firms

- variety effect:
  - can import foreign varieties (+)
  - some domestic varieties (firms) disappear (-)
- overall, welfare improves:
  - new imported varieties have lower marginal cost (higher productivity) → cheaper
  - lost domestic varietiles have higher marginal cost (lower productivity) → more expensive

Summary

- when firms are heterogeneous in productivity (φ):
  - more productive firms charge lower price, sell more, make higher profits
  - the least productive exit the market
- switch to free trade (with iceberg and entry cost, τ and f_X):
  - most productive firms become exporters
  - most productive foreign firms enter domestic market
  - least productive domestic firms exit the market (selection)
  - gains from variety:
    - gain foreign (high-productivity) varieties
    - lose domestic (low-productivity) varieties


π
0
-f_D
-f_X
exit
no-export
export
π_D(φ^σ−1)
π_X(φ^σ−1)
φ_D*
φ_X*
φ^σ−1

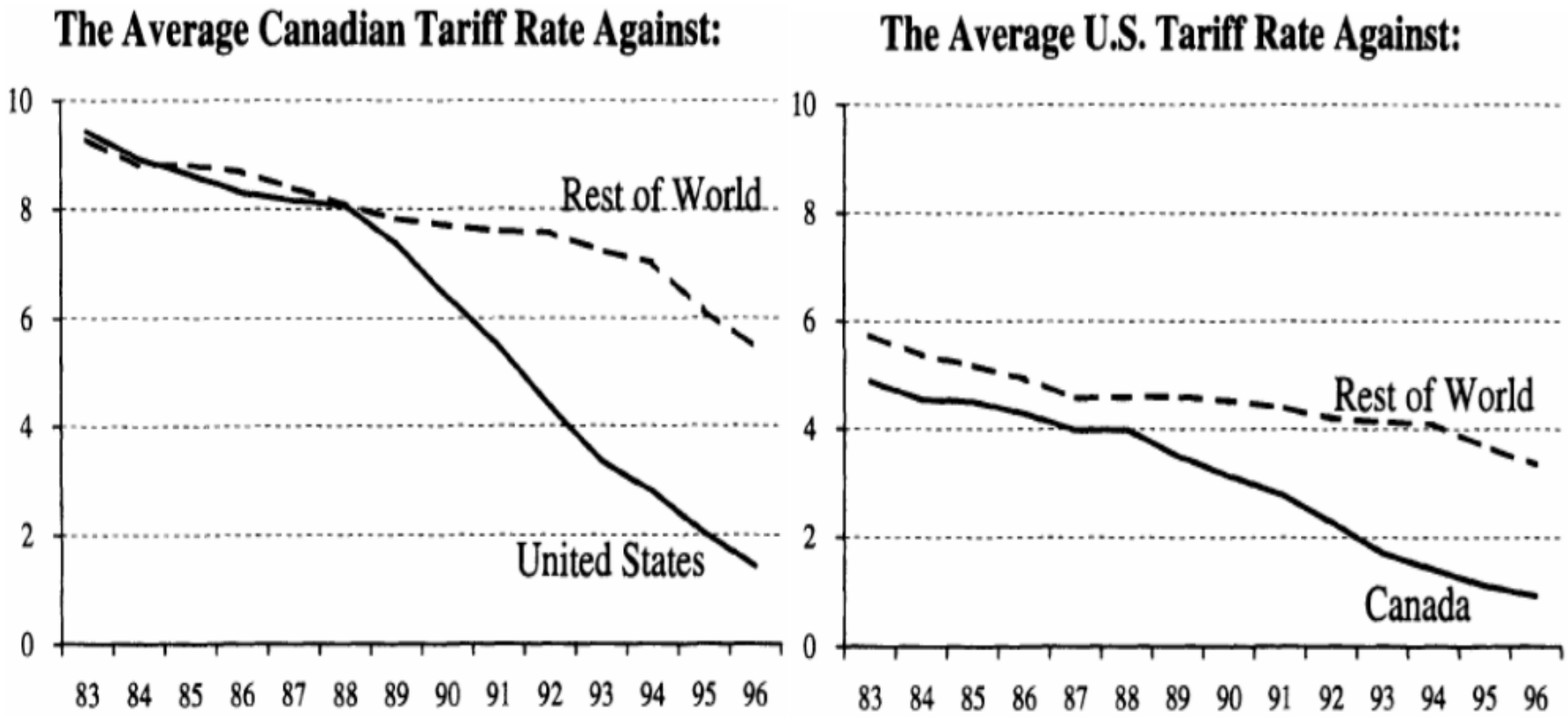
Summary: Effects of Trade Liberalization

- if trade costs (τ or f_X) fall bilaterally:
  - higher $\pi_X \uparrow \rightarrow$ more exporters $\varphi_X^* \downarrow$
  - new and old exporters gain
  - more foreign competition $\pi_D \downarrow \rightarrow$ more selection $\varphi_D^* \uparrow$
  - least productive non-exporters lose
- empirically relevant predictions
  - average productivity increases at industry level due to selection
  - increase in sales (output) of exporters
  - drop in sales (output) of import-competing firms

Empirical Evidence: Trefler (2004)

- considers the Canada-US free trade agreement (CUSFTA, 01/01/1989)
- uses data on sectors and plants (firms) in Canada during 1980-1996
- why this trade liberalization episode?
  - a well defined policy experiment (no confusion with macro shocks or other reforms)
  - allows to identify policy-mandated reductions in tariffs
  - it is a reciprocal agreement to reduce tariffs between Canada and the US, not *vis-à-vis* the rest of the world
  - semi-unexpected adoption (elections with surprise outcome)

Tariffs Before and After 01/01/1989



Empirical Strategy

- estimate for sector i

$$\Delta y_i = \theta + \beta^{CA}\left(\Delta \tau_i^{CA}\right) + \beta^{US}\left(\Delta \tau_i^{US}\right) + controls_i + \nu_i$$

  - Δ = 1988-1996 (post-liberalization) variation minus 1980-1986 (pre-liberalization) variation
    - to identify the treatment (liberalization) effect
  - y = variable of interest for Canada
  - τ^{US} = tariff applied by the US on goods form Canada
    - β^{US} quantifies the effect on (current + potential) exporters to the US
  - τ^{CAN} = tariff applied by Canada on goods from the US
    - β^{CAN} quantifies the effect of competition with import from the US

- repeat estimations for plant k in sector i

Results

- effects on employment:
  - total $\simeq -5\%$ (100.000 workers) at plant and industry level, due to $\tau^{CAN} \downarrow$ (competition from US exporters)
  - transitory effects
  - skilled/unskilled labor $\uparrow$, due to $\tau^{CAN} \downarrow$ (competition from US exporters)
- effects on labor productivity:
  - $\tau^{CAN} \downarrow \rightarrow$ up to $+15\%$ at industry level, 0 at plant level (exit of the least productive)
  - total effect $\simeq +7.4\%$ at industry ($\tau^{CAN} \downarrow$) and plant ($\tau^{US} \downarrow$) level
- production:
  - $\tau^{US} \downarrow \rightarrow +6\%$ at plant level

Summary: Evidence vs Theory

- trade liberalization:
  - raises productivity of each sector due to import competition (=theory)
    - by inducing the least productive firms to exit
  - raises productivity of exporting firms (not predicted, constant firm's φ)
    - $A \uparrow \rightarrow$ justify investment in technology upgrading $\rightarrow \varphi \uparrow$
  - reduces employment (not predicted, frictionless labor market)

Exporters, Products and Destination Markets

- destinations per U.S. firm in 2007 (Bernard et al., 2015)
  - few firms export to more than one foreign market
  - firms exporting to many markets represent an important share of total export
- exported products per U.S. firm in 2007 (Bernard et al., 2015)
  - few firms export more than one product
  - firms exporting many products represent an important share of total export
  - firms exporting many products also export to many markets
- size matters... a lot!
  - larger firms much more likely to export
  - larger firms export much more
- firms per destination (Eaton et al., 2011 on France in 1987)
  - larger markets attract more exporters
  - larger markets imply more sales per exporter

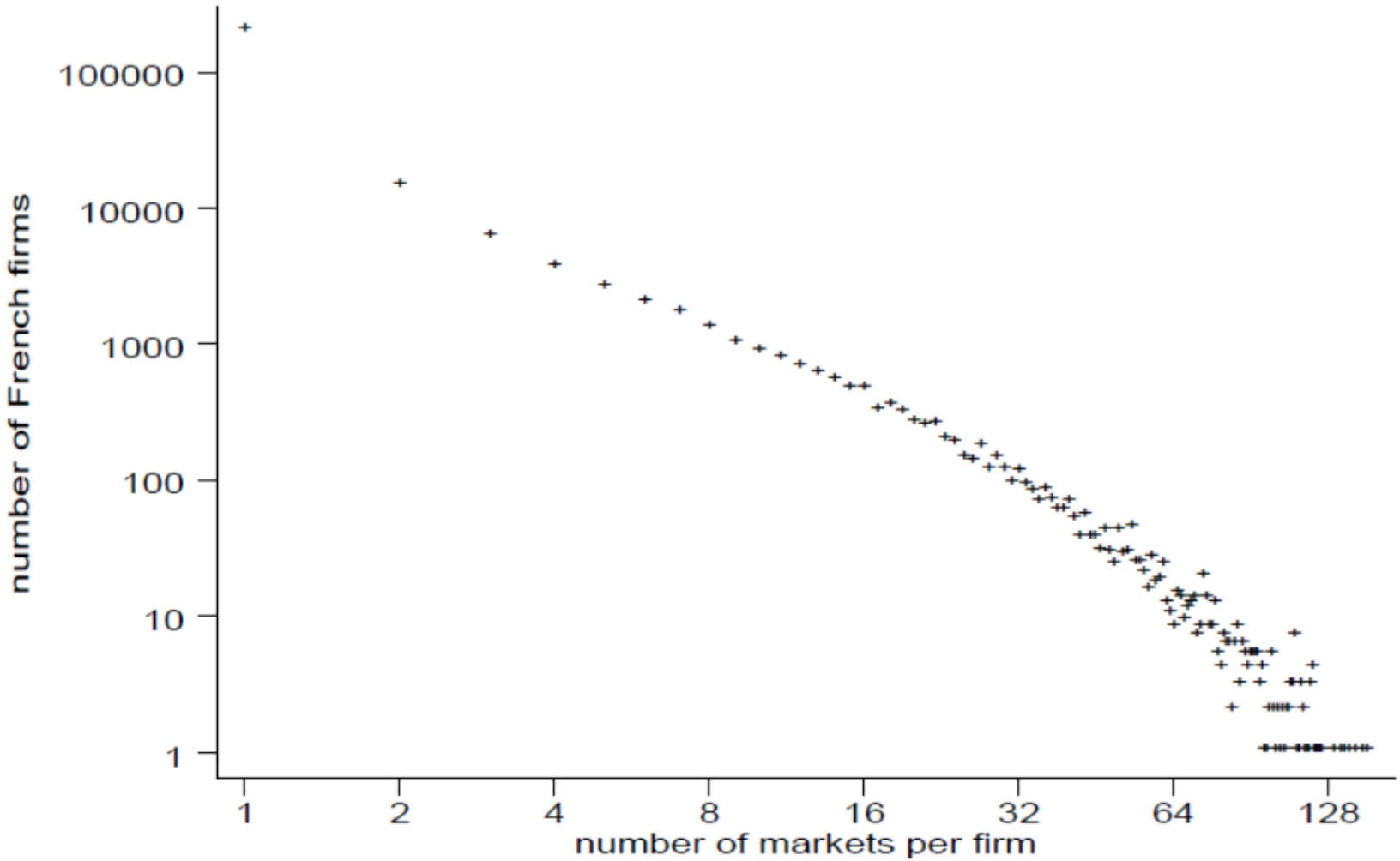
Destinations and Products per Firm: Data

TABLE 2: Penetration of Export Markets by French Firms

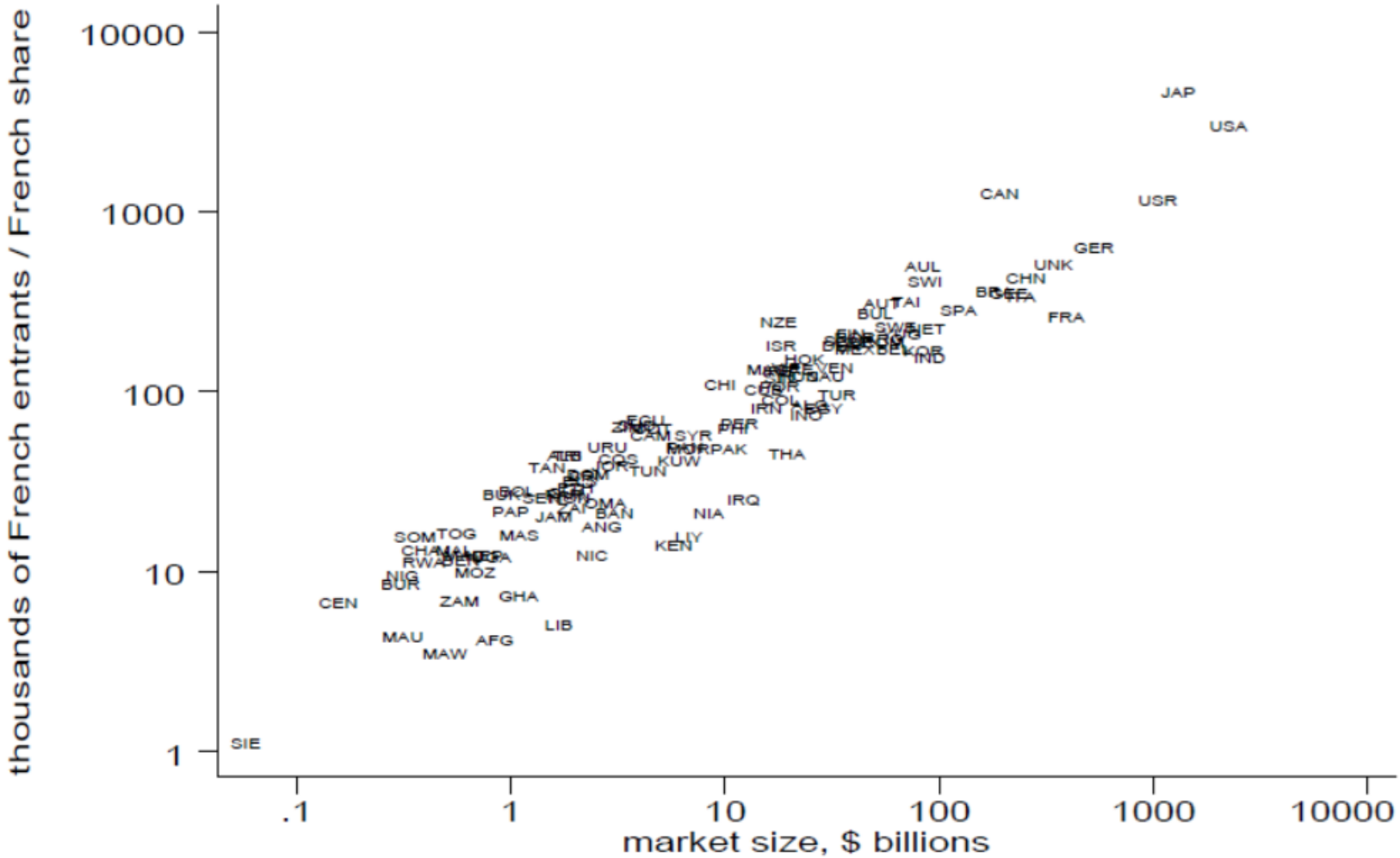
SIC	Industry	Firms Exporting to Exactly 1 Market		Firms Exporting to 10 or More Markets		Firms Exporting to 50 or More Markets	
		% exporters	% exports	% exporters	% exports	% exporters	% exports
20, 21	Food and Tobacco Products	36.2	1.8	18.4	78.5	1.6	35.9
22, 23	Textiles and Apparel	26.8	1.4	24.9	83.8	0.4	19.9
24, 25	Lumber and Furniture	50.6	5.4	4.8	45.4	0.0	0.0
26	Paper and Allied Products	25.4	0.2	24.6	89.9	1.0	30.2
27	Printing and Publishing	46.8	2.8	9.1	61.1	0.6	23.4
28	Chemicals, etc.	19.6	0.1	38.4	96.9	6.2	69.1
30	Rubber and Plastics	30.9	1.1	18.1	91.4	0.9	54.9
31	Leather and Leather Products	29.5	1.2	21.3	83.5	0.8	30.8
32	Stone, Clay, Glass, and Concrete	47.4	2.2	12.6	89.3	1.3	57.1
33	Primary Metal Industries	23.0	0.1	25.1	81.1	2.4	40.3
34	Fabricated Metal Products	41.9	3.0	13.1	71.7	0.5	19.3
35	Machinery and Computer Eqpt	30.6	0.5	26.1	93.5	2.5	58.8
36	Electronic and Electrical Eqpt	29.7	0.3	23.3	94.1	2.8	58.9
37	Transportation Equipment	28.9	0.1	24.2	96.0	2.3	65.1
38	Instruments, etc.	27.3	1.1	30.0	90.9	2.7	42.5
39	Miscellaneous Manufacturing	34.8	1.9	17.5	82.5	0.8	24.2
	Manufacturing (ex. Petroleum Ref.)	34.5	0.7	19.7	89.6	1.5	51.6

Notes: French figures are for 1986, based on Customs and BRN-SUSE data sources.

Size and Trade Participation: Data



Size and Trade Volumes: Data



Exporters and Destinations: Theory

- how to reconcile this piece of evidence?
- fixed entry cost for each product and foreign market
- more productive firms can cover more fixed costs
  - export to more countries
  - export more products
  - export disproportionately more
- larger markets deliver higher profits
  - attract more exporters
  - exporters choose them first
  - less productive exporters limit to those

An extension of Melitz (2003): Exporters vs Multinationals

- alternative to export: horizontal foreign direct investment (FDI)
  - firms settle in the foreign country to produce & sell there
- Helpman Melitz and Yeaple (2004)
  - formalize the choice beween export and FDI within the same model
- horizontal FDI entails
  - a fixed cost $f_I > f_X$ to settle production in the foreign country
  - no additional variable cost $\rightarrow$ marginal cost $1/\varphi$

Exporters vs Multinationals: Choice

- profits from FDI:

$$\pi_I = A\varphi^{\alpha/(1-\alpha)} - f_I$$

- profits from export:

$$\pi_X = A\left(\varphi/\tau\right)^{\alpha/(1-\alpha)} - f_X$$

- proximity vs concentration trade-off:
  - multinationals face higher fixed costs, but save transportation costs
  - a firm chooses FDI rather than exporting when $\pi_I > \pi_X$

Multinationals, Exporting and Non-Exporting Firms

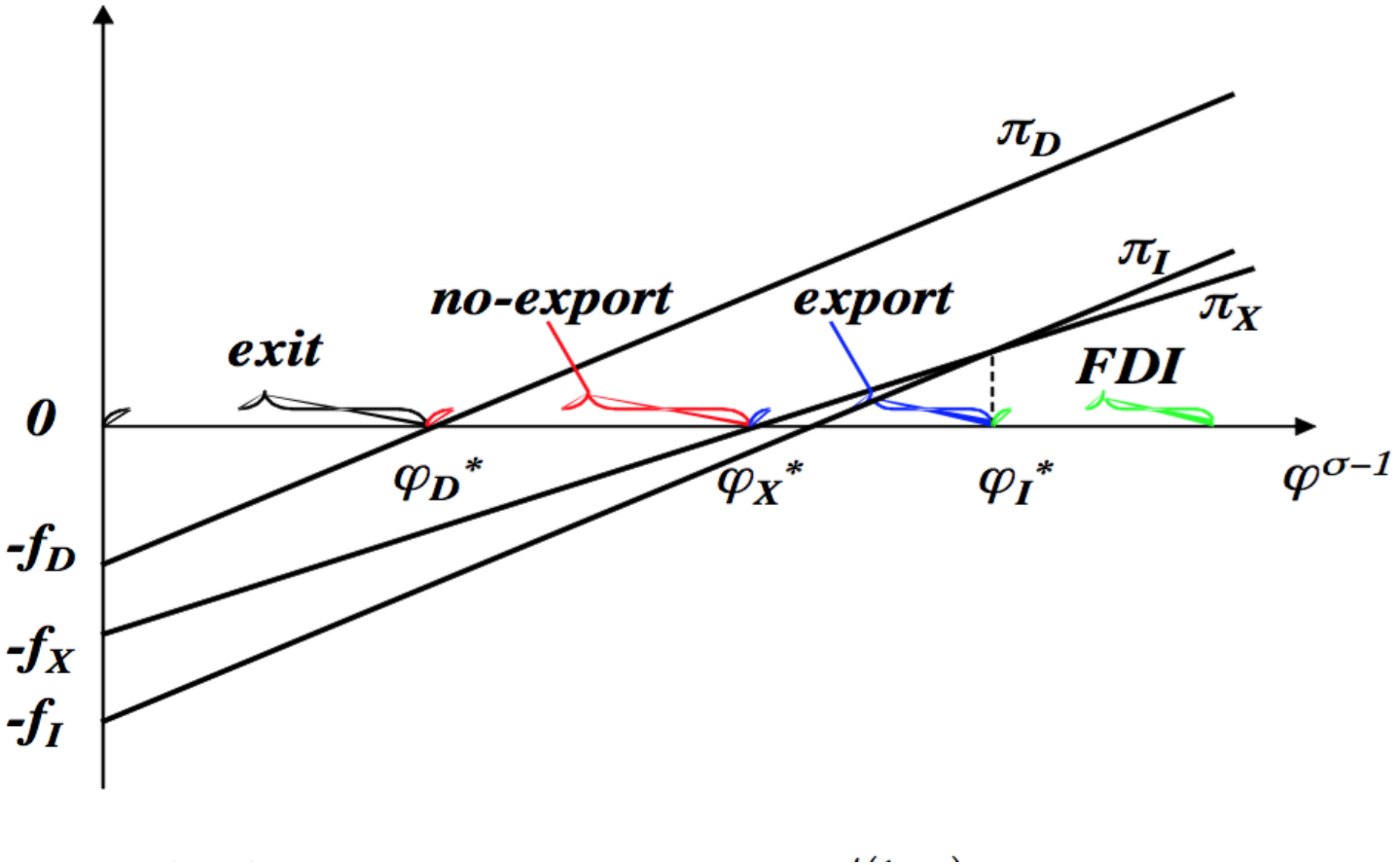
- profits from:
  - domestic sales, export, FDI

$$\pi_D = A\varphi^{\alpha/(1-\alpha)} - f_D \qquad \pi_X = A\left(\varphi/\tau\right)^{\alpha/(1-\alpha)} - f_X$$

$$\pi_I = A\varphi^{\alpha/(1-\alpha)} - f_I$$

- firms partition in groups:
  - firms with productivity below φ_D^* exit
  - firms between φ_D^* and φ_X^* produce in the domestic market only
  - firms above φ_X^* export too
  - firms above φ_I^* become multinationals

Multinationals, Exporting and Non-Exporting Firms



$$\pi_D = A\varphi^{\sigma-1} - f_D \qquad \pi_X = \tau^{1-\sigma} A\varphi^{\sigma-1} - f_X \qquad \pi_I = A\varphi^{\sigma-1} - f_I$$

Exporters vs Multinationals: Productivity

- productivity of multinationals, exporters and non-exporters is such that
  - $\varphi_I^* > \varphi_X^* > \varphi_D^*$
  - Helpman et al. (2004) estimate on US data for firms of 52 sectors:

$$\log\left(\frac{Y}{L}\right)_{ij} = \alpha + \beta MNE_{ij} + \gamma EXP_{ij} + controls + \epsilon_{ij}$$

    - $(Y/L)_{ij}$ = labor productivity of firm j in sector i
    - $MNE_{ij} = 1$ if j is multinational
    - $EXP = 1$ if j is exporter →
    - control group = non-exporters
    - $\beta \approx \varphi_I - \varphi_D$, $\gamma \approx \varphi_X - \varphi_D$ and $\beta - \gamma \approx \varphi_I - \varphi_X$

Exporters vs Multinationals: Productivity

TABLE 1—PRODUCTIVITY ADVANTAGE OF MULTINATIONALS AND EXPORTERS

Multinational	0.537
	(14.432)
Nonmultinational exporter	0.388
	(9.535)
Coefficient difference	0.150
	(3.694)
Number of firms	3,202

Exporters vs Multinationals: Sales

- more export relative to multinational sales if:
  - trade iceberg cost (τ) is low
  - fixed FDI cost (f_I) is high
- empirical evidence:
  - Helpman et al. (2004) estimate on the same data + subsidiaries in 38 countries:

$$\ln \frac{S_{jk}^X}{S_{jk}^I} = \alpha_k + \alpha_1 \ln FP_j + \beta_1 \ln FREIGHT_{jk} + \beta_2 \ln TARIFF_{jk} + \gamma Z_j + \varepsilon_{jk}$$

    - S_{jk}^X = sales in sector j in country k by export
    - S_{jk}^I = sales in sector j in country k by subsidiaries (FDI)
    - FP_j = plant-level fixed costs in sector j (represents f_I)
    - $FREIGHT$ = transport costs to country k (represents τ)
    - $TARIFF$ = tariff rate for sector j in country k (represents τ)
    - Z = controls

Exporters vs Multinationals: Sales

TABLE 3—EXPORTS VERSUS FDI

	Narrow sample (N = 961)				
	U.S. std. dev.	Europe std. dev.	France std. dev.	Europe reg. coeff.	France reg. coeff.
FREIGHT	−1.040	−0.959	−1.019	−0.935	−0.944
	(−7.392)	(−6.749)	(−7.328)	(−6.526)	(−6.594)
TARIFF	−0.365	−0.512	−0.421	−0.545	−0.539
	(−2.644)	(−3.636)	(−3.917)	(−3.781)	(−3.775)
FP	1.177	0.932	0.927	0.947	0.934
	(10.159)	(7.827)	(8.059)	(7.453)	(7.450)
DISPERSE	−2.343	−2.153	−2.061	−1.503	−1.491
	(−8.374)	(−5.250)	(−6.664)	(−4.535)	(−4.470)
KL	−0.868	−0.495	−0.456	−0.628	−0.626
	(−7.790)	(−4.529)	(−4.256)	(−5.876)	(−5.859)
RD	−0.104	0.007	0.007	0.006	−0.002
	(−2.197)	(0.150)	(0.144)	(0.125)	(−0.047)
R^2	0.373	0.340	0.364	0.332	0.334