International Economics I

Firm Heterogeneity (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: $q_i = (P/p_i)^{1/(1-\alpha)} wL/P \quad \alpha \in (0,1)$
- equilibrium
  - price: from profit maximization: $p_i = p = w\beta/\alpha$ ($MC *$ mark-up)
  - quantities: from free entry: $q_i = q = \alpha F / [\beta (1-\alpha)]$
  - number of varieties: from labor market clearing $n = L(1-\alpha)/F$

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) $\rightarrow$ 17%
    - France (1986) $\rightarrow$ 17.4%
    - Japan (2000) $\rightarrow$ 20%
    - Chile (1999) $\rightarrow$ 20.9
    - Spain (2011) $\rightarrow$ 12%
    - Catalunya (2014) $\rightarrow$ 8%
- exporters differ from non-exporters:
  - exporters 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

- Firms are different: size, profits, exporting decision...
- Fixed costs matter for exporting: access a new market is costly!
- Countries do not trade, firms trade!
- Melitz (2003) formalizes this idea $\Rightarrow$ one of the most influential papers of the decade!

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 $\rightarrow$ some exit
  - "selection of the best fit"

Outline

1. A Model with Firm heterogeneity
2. Open Economy
3. Empirical Evidence

Melitz (2003): Assumptions

- preferences and market structure
  - identical to previous model: n-goods, constant elasticity of substitution between them.
  - wage is again the numeraire $(w = 1)$
- new assumptions:
  - (i) firms draw their productivity from some distribution
    - ⋆ generates heterogeneity
  - (ii) there is a fixed export cost
    - ⋆ only the most productive firms are willing to pay it
  - (iii) 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
- The marginal cost is different across firms: some firms have high φ (low marginal cost), other have low φ (high marginal cost)
- Note: in the Krugman model: $MC = \beta$, Melitz model: $MC = 1/\varphi$.

Firm Heterogeneity: Closed Economy

- firms are monopolistically competitive
- choose the quantity q to maximize profits given the demand for the variety (exactly the same as in the Krugman model):

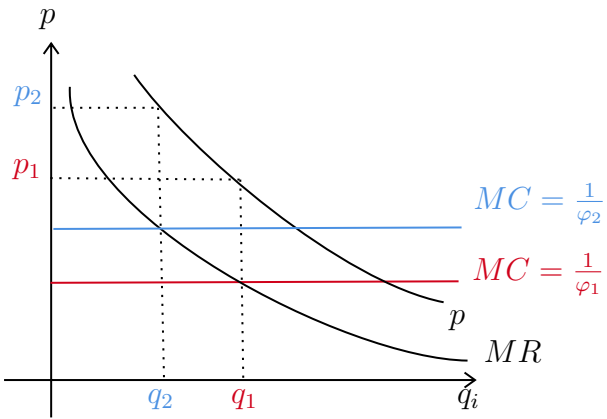
$$\pi = pq - \frac{q}{\varphi} - f_D \quad \text{s.t. } q = (P/p)^{1/(1-\alpha)} L/P$$

  - usual pricing formula $p = 1/\alpha\varphi$ (mark-up times marginal cost)
  - (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 ($\uparrow \varphi$):
  - charge lower prices, sell more, make higher profits

Monopolistic Competition

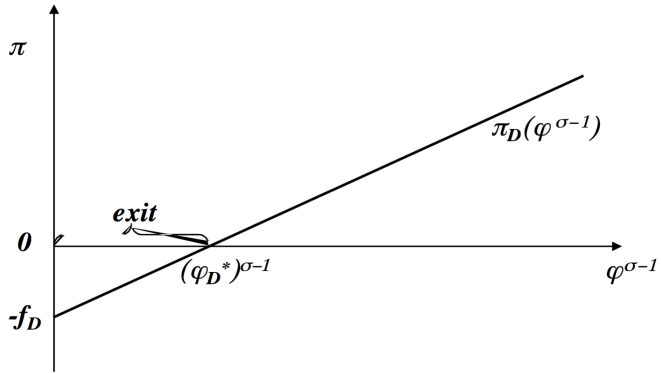


- Marginal Revenue: same for all firms (consumers have same preferences)
- MC different: $\uparrow \varphi \Rightarrow \downarrow MC_i$
- $\downarrow MC_i \Rightarrow \downarrow p_i \uparrow q_i, \uparrow \pi_i$

Producing and Non-Producing Firms

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

Producing and Non-Producing Firms: Graph



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

Free Entry and Cutoff Productivity

- Recall that A depends on the price index P, and therefore on the number of variety n.
- In the Krugman model we use the free entry condition to find n.
- Similarly, we need an additional condition to jointly determine A and φ_D^*.
- Free entry condition is now over the expected profits. **Intuition**:
  - There is a "distribution" of ideas to draw: some very good, some very bad
  - Before you start to operate, you don't know how good your idea will be
  - You have to enter and test it "in the market"
  - If it is very bad you exit ($\varphi < \varphi_D^*$)

Free Entry and Cutoff Productivity

- suppose to enter we must pay an entry cost f_E
- for given cutoff productivity φ_D^*
  - ex-ante (upon entry) expected profits are

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

    - ⋆ $g(\varphi) =$ probability of drawing productivity φ (conditional on operating)
- free entry: firms enter in the market until $\mathbb{E}(\pi_D) = f_E$

Free Entry and Cutoff Productivity

- free entry: firms enter in the market until $\mathbb{E}(\pi_D) = f_E$

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

- 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)

Free Entry and Cutoff Productivity

- To actually solve for the number of n (Melitz call the "mass" of varieties), we must define the distribution of ideas (which will not do it).
- Instead, we will focus only on the cutoff φ_D^*.
- Note that that if $\uparrow \varphi_D^*$, only more productive firms operate $\Rightarrow$ the average productivity of firms increase!
- We will see how trade changes φ_D^*.

Outline

1. A Model with Firm heterogeneity
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Exporting: Assumptions

- suppose now that a firm can sell into a foreign market, denoted by $(_X)$
- assume two symmetric countries
  - same size, technology and preferences $\rightarrow A = A_X$
  - A can be interpreted as the "condition" of each market (size of the market, competition, etc)
- to serve a foreign market, there are two additional costs:
  - (i) a new fixed cost (distribution and servicing costs): f_X
  - (ii) an iceberg cost: ship $\tau > 1$ units to deliver 1 unit of the good
    - ⋆ now we have the: marginal cost $= \tau/\varphi$

Exporting: Prices and Profits

- The profit from serving the foreign country:

$$\pi_X = q_X p_X - \frac{q_X \tau}{\varphi} - f_X$$

- price of exported goods

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

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

- profits from exporting:

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

  - positive only if φ is high enough

Exporting: Prices and Profits

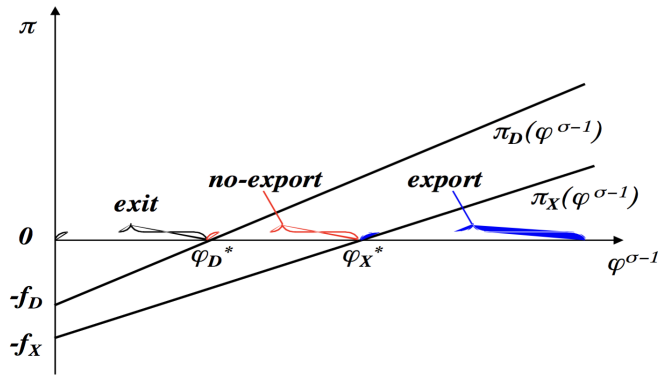
- A firm decides to export only if $\pi_X > 0$.
- Hence, there is a cutoff φ_X^* such that firms with $\varphi > \varphi_X^*$ decide to export:

$$\pi_X = A_X \left(\frac{\varphi_X^*}{\tau} \right)^{\alpha/(1-\alpha)} - f_X = 0$$

$$\Leftrightarrow \varphi_X^* = \tau \left(\frac{f_X}{A_X} \right)^{\frac{1-\alpha}{\alpha}}$$

- p.s. assume that $\pi_D(\varphi) > \pi_X(\varphi)$
  - no firm prefers exporting than serving the domestic market
  - implies $\tau^{\alpha/(1-\alpha)} f_X > f_D$

Exporting and Non-Exporting Firms: Graph



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

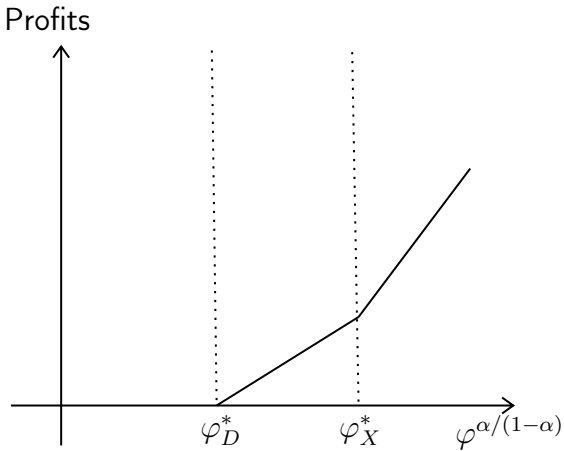
Exporting and Non-Exporting Firms

- recall profits:

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

  - 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 $\varphi_D^* < \varphi_X^*$

Profits

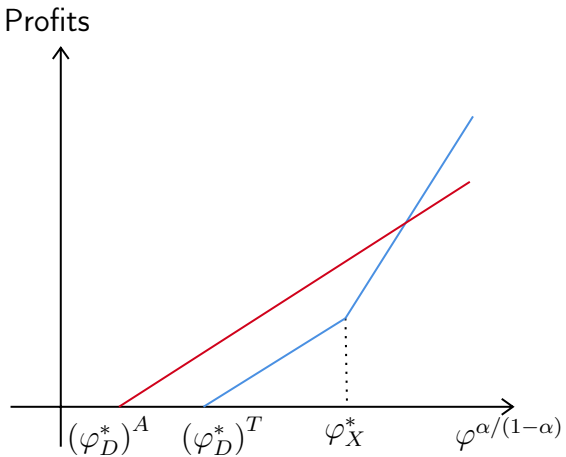


- **Profits of Domestic Producers**: $\pi_D(\varphi)$
- **Profits of Exporters**: $\pi_D(\varphi) + \pi_X(\varphi)$
- Profits increase in productivity
- Profits of exporters increase faster

Trade and Selection

- Open to trade also increases competition! $\Rightarrow$ 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

Winners and Losers



- Domestic profits in autarky π_D^A, and in trade π_D^T
- Foreign competition: $\pi_D^A < \pi_D^T$
- **Losers**: domestic producers and small exporters
  - exporting does not compensate the losses from competition
  - some firms exit
- **Winners**: big exporters

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) $\rightarrow$ cheaper
  - lost domestic varieties have higher marginal cost (lower productivity) $\rightarrow$ more expensive
  - average of productivity of our country increases

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

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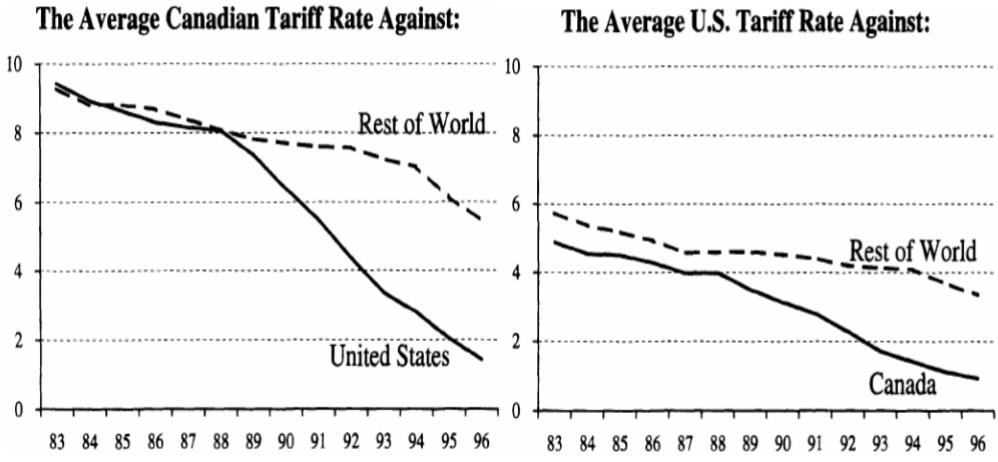
Summary: Effects of Trade Liberalization

- 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 from 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

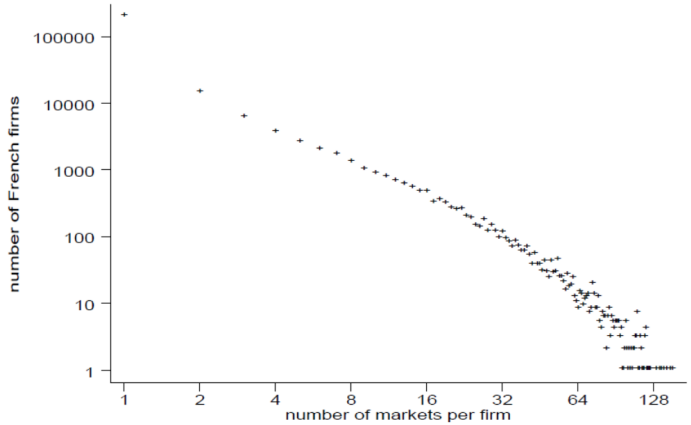
Destinations and Products per Firm: Data

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

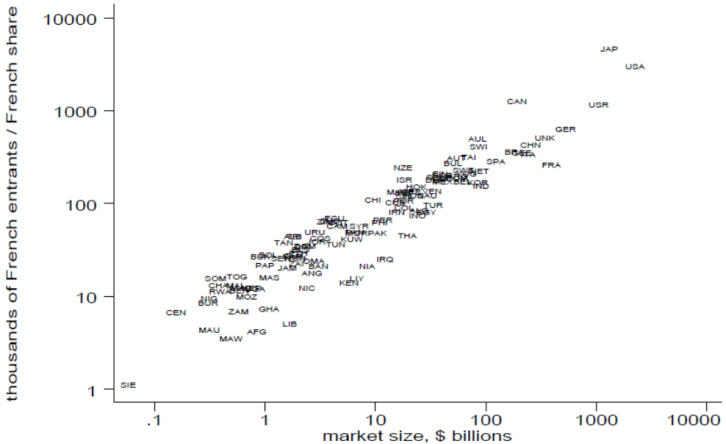
Notes: French figures are for 1986, based on Customs and BRN-SUSE data sources.

Size and Trade Participation: Data



Few firms export to many markets

Size and Trade Volumes: Data



Larger markets attract more firms

Exporters and Destinations: Theory

- how to reconcile this piece of evidence? Recall:

$$\pi_X = A_X \left(\frac{\varphi}{\tau}\right)^{\alpha/(1-\alpha)} - f_X \quad \text{where } A_X \equiv (1-\alpha)(\alpha P)^{\alpha/(1-\alpha)} L$$

- fixed entry cost (f_X) 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 ($\uparrow L$) deliver higher profits
  - attract more exporters
  - exporters choose them first
  - less productive exporters limit to those

Taking Stock

- Countries do not trade, firms trade!
- We present a model where firms are heterogeneous in their productivity
  - Trade benefits the most productivity ones
  - The least productive firms do not survive and exit
- The model is powerful and is able to explain many empirical regularities