Trade and Industrial Sector Performance in Developing Countries

by

James Tybout
Pennsylvania State University and NBER

Lectures prepared for the Second Summer School
in Trade, Industrialisation and Development

Palazzo Feltrinelli, Gargnano (BS), ITALY

September 5-8, 2004

Organized by the CEPR, The University of Milan and the University of Turin

I. BIG PICTURE

Ways that Openness Affects the Industrial Sector:

- traditional relative price effects
- degree of domestic competition
- size of the markets—home and foreign
- access to foreign technologies

Dimensions of Industrial Sector Responses

- traditional comparative advantage effects
- pricing and output decisions
- distribution of technical efficiency
- technological catch-up
- changes in the rate of productivity growth

Factors that Condition Industrial Sector Responses

- threshold costs and scale economies
- product differentiation
- marginal cost heterogeneity
- knowledge spillovers
- agglomeration economies
- strength of learning by doing effects
- transport costs

II. FEATURES OF LDC MANUFACTURING THAT AFFECT POLICY RESPONSES

A. Scale economies and start-up costs

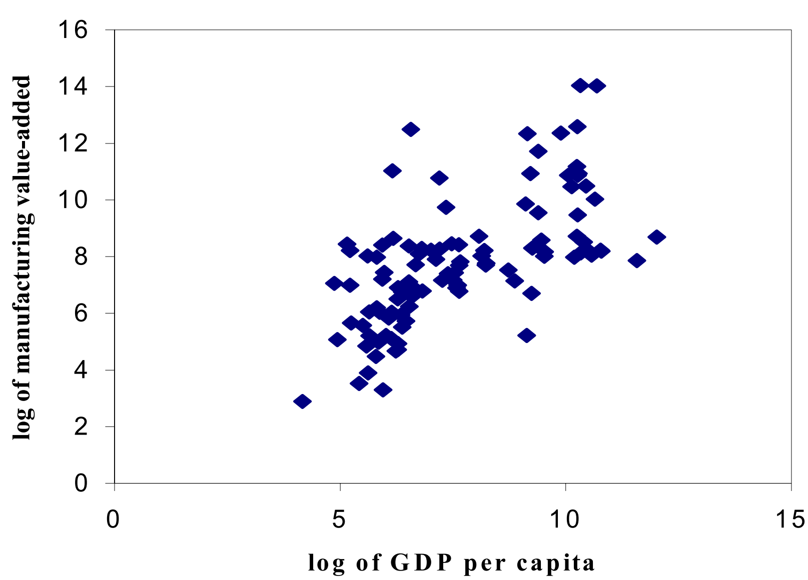
Internal Economies of Scale (declining long-run average costs) derive from:

- indivisibilities/economies of specialization—allow firms operating on a larger scale to match inputs more closely to tasks.
- Large pieces of capital may be more efficient than small pieces for technological reasons

Engineering and econometric studies confirm that internal scale economies are certainly present, but they are modest at observed plant sizes.

The presence of internal returns ensures that the number of firms in a finite market is bounded. Since most LDCs are relative small, they operate with relatively fewer firms.

Figure 1: Size of the Manufacturing Sector and Level of Development



Does a small number of firms imply oligopolistic market structures? The key issue is: how costly is it to get into or out of an industry?

Sunk start-up costs are incurred to begin production and cannot be recouped when the firm is liquidated:

- product development;
- setting up production lines;
- firm-specific capital goods;
- training workers to operate production lines.
- bureaucratic red tape.

We see more turnover in the LDCs that have been studied than in DCs, suggesting that sunk costs are lower there.

PLANT AND JOB TURNOVER IN DEVELOPING VERSUS DEVELOPED COUNTRIES*

Country	***Turnover rates***				***Market Shares of Entrants***			***Minimum Plant Size Covered***
(period covered)	*Plants*		*Jobs*		*<1 year olds*	*<5 year olds*	*<10 year olds*	
	1 year	*5 year*	*1 year*	*5 year*				
Chile	8.5[a]	--	26.9[a]	--	3.6[a]	15.3[a]	--	10 workers
Colombia	11.9[a]	--	24.6[a]	--	4.9[a]	19.8[a]	--	10 workers
Morocco	9.5[a]	--	30.7[a]	--	3.2[a]	--	--	10 workers
Korea	--	64.2[b]	--	--	--	32.5[b]	--	5 workers
Taiwan	--	67.9[c]	--	--	--	43.9[c]	63.2[c]	1 worker[g]
United States	--	26.9[d]	18.9[e]	58.4[f]	--	10.3[d]		5 workers
Canada	--	--	21.9[e]	--	--	--	--	5 workers

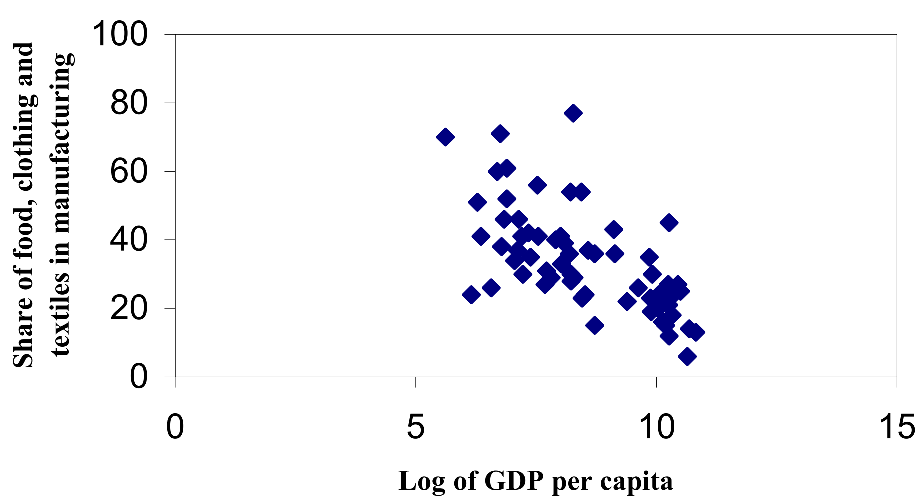
Cross-country differences partly reflect policy: compare relative unfettered Korea and (especially) Taiwan with Colombia.

But differences also reflect Engel effects and level of economic development.

Average Annual Employment Turnover Rates by Three-Digit ISIC Industry

Iron and Steel	.11	Professional/Scientific Equip.	.19
Industrial Chemicals	.12	Printing	.20
Glass	.12	Non-metallic Mineral Prod.	.20
Ceramic Products	.12	Leather	.20
Paper	.13	Plastic Products	.20
Rubber	.14	Footwear	.21
Beverages	.14	Fabricated Metal Products	.22
Nonferrous Metal Refining	.14	Non-electrical Machinery	.22
Electrical Machinery	.16	Furniture	.24
Transport Equipment	.16	Apparel	.24
Other Chemical Products	.16	Food Processing	.24
Textiles	.18	Wood Products	.28

Figure 2: Light Manufacturing and Level of Development



B. Product Differentiation

- Although oligopolistic market structures are probably not common in LDCs, products are generally differentiated—both spatially, and in terms of characteristics.

- Thus most producers have some ability to set prices, and are able to survive at prices above the best-practice minimum long run average cost.

C. Dispersion in productive efficiency

- Even within narrowly defined industries, one almost always observes a wide range of plant sizes. This suggests associated variation in marginal production costs and/or in product appeal.

- Similarly, studies of productivity routinely reveal lots of dispersion within narrowly defined industries. The productivity measures are flawed—they reflect mark-ups as well as efficiency—but surely some of the heterogeneity in productivity is real.

D. Induced innovation

- We also observe productivity *growth* through time. No doubt this partly reflects conscious decisions by managers to invest in process or product innovation.

- But it may also reflect learning-by-doing and/or externalities of various sorts:

  - Krugman and Venables-style (1995) backward and forward linkages may make industrial sectors more efficient when they are large.

  - Learning spillovers may allow firms to benefit from their neighbors' knowledge.

***In sum*, we'd like our models of firms in developing countries to be characterized by**

- modest scale economies,

- low entry barriers,

- product differentiation with endogenous pricing,

- lots of producer heterogeneity

- at least one source of induced innovation.

III. Course Outline

Part 1

I. A static theory of trade with heterogeneous firms (Melitz/Ottaviano, 2003)

A. The closed economy case
B. Frictionless trade
C. Costly trade

II. Evidence on the static theory

A. Do bigger economies have bigger plants?
B. Does trade lead to scale-based efficiency gains?
C. Does trade reduce productivity dispersion and increase average productivity?
D. Are productivity gains due to selection effects or intra-firm improvements?
E. Does opening force firms to reduce their mark-ups?
F. Are exporters more efficient?
G. When are Melitz/Ottaviano gains likely to be important?

Part 2

I. Competitive pressure and innovation

A. Schumpeterian effect versus incentives to distance one's self from competitors (Aghion, et al, 2001).
B. A bit of Evidence (Aghion, Burgess, Redding and Zilibotti, 2004).

II. Learning and Spillovers

A. A simple learning model (Lucas, 1988)
B. Learning by doing with a continuum of goods (Young, 1991)
C. Evidence on the relevance of learning effects and spillovers (Irwin and Klenow, 1994; Thompson and Thorton, 2001)
D. Learning by Exporting (Clerides, et al, 1998)

III. Pulling Some Pieces Together (Erkan and Tybout, 2004)

A. A dynamic industrial evolution model
B. Simulating the transition to openness

PART 1: TRADE WITH HETEROGENEOUS FIRMS

I. A THEORY OF TRADE WITH HETEROGENEOUS FIRMS (MELITZ AND OTTAVIANO, 2003)

How should domestic market size and integration with the global economy affect:

- Mark-ups?
- Productivity distributions?
- Welfare?

Melitz and Ottaviano (2003) provide a tractable model that generates answer.

A. The Closed Economy

Preferences (from Ottaviano and Thisse, 1999):
The set of potentially available goods, Ω, is fixed. Consumers are identical; each has the following utility function:

$$U = q_0^c + \alpha \int_{i\in\Omega} q_i^c \, di - \frac{1}{2}\gamma \int_{i\in\Omega} \left(q_i^c\right)^2 di - \frac{1}{2}\eta \left(\int_{i\in\Omega} q_i^c \, di \right)^2$$

Maximizing utility subject to a unit budget constraint yields the inverse demand schedules:

$$p_i = \alpha - \gamma q_i^c - \eta Q^c$$

where $Q^c = \int_{i\in\Omega} q_i^c \, di$.

Total demand for an individual product
Inverting to isolate q_i^c, then summing over L identical consumers (each with income is normalized to 1) yields the market demand:

$$q_i = L q_i^c = \frac{\alpha L}{\eta N + \gamma} - \frac{L}{\gamma} p_i + \left(\frac{\eta N}{\eta N + \gamma} \right) \frac{L}{\gamma} \bar{p} \qquad \forall i \in \Omega$$

where N is the number of varieties available and $\bar{p} = \frac{1}{N} \int_{i\in\Omega^*} p_i \, di$ is the average price of these available goods. To reduce clutter, write this demand schedule as:

$$q_i = \frac{L}{\gamma} \cdot \left[I(N, \bar{p}) - p_i \right],$$

where $I(N,\overline{p}) = \dfrac{\alpha\gamma + \eta N \overline{p}}{\eta N + \gamma}$.

Production and firm behavior

Labor is the only factor of production; it is mobile across firms.

The numeraire good is produced with a constant returns technology—one unit of labor per unit output. It is always in positive supply, so it anchors the wage at one.

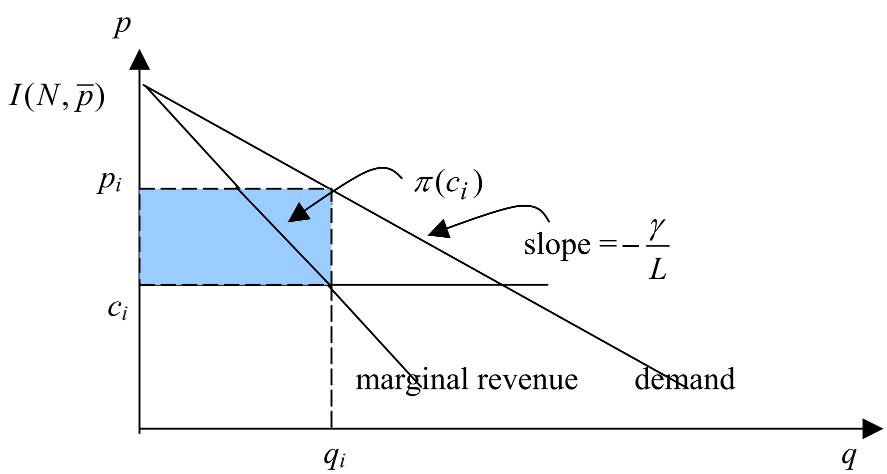
Potential entrepreneurs can pay an entry cost f_E to establish a firm that produces a unique product.

Once established, firms learn their (idiosyncratic) marginal production costs, c, which are drawn from a known distribution $G(c)$ with support on $[0, c_M]$.

Product market equilibrium

Firms are only active in the product market a single period; during that time they engage in pure Bertrand competition.

Marginal revenue equal to marginal cost implies: $I(N,\overline{p}) - \dfrac{2\gamma}{L} q_i = c_i$.



Call the maximum cost at which operating profits are positive: $c_D = I(N,\overline{p})$. Looking across firms with costs below this cut-off, it is easy to demonstrate that:

$$p(c) = \frac{1}{2}(c_D + c), \quad \mu(c) = \frac{1}{2}(c_D - c), \quad q(c) = \frac{L}{2\gamma}(c_D - c),$$

$$r(c) = \frac{L}{4\gamma}\left[(c_D)^2 - c^2\right], \quad \pi(c) = \frac{L}{4\gamma}(c_D - c)^2$$

Things to note

- Lower cost firms set lower prices, have higher mark-ups, sell more output, generate more revenue and have larger operating profits.
- Given costs, a firm will be bigger and have larger profits when its residual demand curve is higher.
- Relatively inefficient firms can survive when c_D is large.
- Further, the conditions for positive demand ensure $\alpha > p_i, \bar{p}$, so $I_N < 0, I_{\bar{p}} > 0$. When more firms are around, or when the average price of goods is lower, the zero profit cost is lower—i.e., efficiency is higher.

Entry

Anyone can enter, but to do so costs f_E . Upon entry one learns one's marginal production cost, which is randomly drawn from the known distribution $G(c)$.

If the outcome is below c_D, it pays to stay in the market. Other entrants cut their losses by shutting down.

The cost distribution

Let $G(c)$ be Pareto: $$G(c) = \left(\frac{c}{c_M}\right)^k$$

Then: $$E[c \mid c < c_D] = \frac{k}{k+1} c_D; \; E[c^2 \mid c < c_D] = \frac{k}{k+2} (c_D)^2 .$$

Using these results in the previous expressions:

$$\bar{p} = \frac{2k+1}{2k+2} c_D, \qquad \bar{q} = \frac{L}{2\gamma} \frac{1}{k+1} c_D, \qquad \bar{\mu} = \frac{1}{k+1} c_D .$$

Things to note

When inefficient firms survive,

- the average price is high,
- the average quantity is large (*given L*)
- the average mark-up is high

How is c_D determined?
With an unbounded pool of potential entrants *ex ante* expected profits must match the cost of entry:

Free entry:
$$\int_0^{c_D} \pi(c)dG(c) = f_E$$

Since $\pi(c)$ is a function of c_D and exogenous variables this expression pins down c_D .

$$c_D = \left[\frac{2(k+1)(k+2)\gamma \left(c_M \right)^k f_E}{L} \right]^{\frac{1}{k+2}}$$

How is N determined?
The average price expression, substituted into the demand schedule for the zero-profit firm (i.e., the firm for which $c = c_D = p$), allows one to express c_D in terms of N:

Optimal shut-down:
$$c_D = \gamma\alpha \left\{ \left(\frac{\eta N}{2k+2} \right) + \gamma \right\}^{-1}$$

Thus, once c_D is known, N can be obtained by inverting this expression:

$$N = \frac{2(k+1)}{\eta} \gamma \frac{\alpha - c_D}{c_D} \quad .$$

Things to note
- Big L attracts lots of firms (big N) and therefore lots of competition (low c_D).

- This makes average prices low, and combined with big N, ensure higher per capita welfare in large countries.
- Since c_D falls less than proportionately with L, $\overline{q} = \frac{L}{2\gamma} \cdot \frac{1}{k+1} c_D$ must rise with L.

Empirical issues
Are firms bigger in big markets?
Is productivity less disperse in large markets?
Is average productivity higher in large markets?
Are mark-ups lower in large markets?

B. The Open Economy: Frictionless Trade

Suppose two economies, home (*H*) and foreign (*F*), have the same technologies and tastes, but let their sizes differ.

If trade is frictionless, then the effects of integrating markets are the same as the effects of increasing country size:

- The number of varieties goes up,
- The average efficiency level goes up,
- Average prices go down, and
- Welfare goes up for everyone.
- All producers sell in all markets.

Empirical issues

Does opening tend to reduce mark-ups?
Does opening tend to improve average productivity?
Does opening reduce productivity dispersion?

C. The Open Economy: Costly Trade

Set-up

Next assume that trade is possible between these economies, but there are trade costs.

Also, assume that markets are segmented.

The iceberg assumption: the cost of getting a unit of output to a foreign market is $\tau^{\ell} c$, where $\ell = H, F$ and $\tau^{\ell} > 1$.

Open economy cut-off s

Think of a given market just as in the closed economy case, but with *all* of the producers in the world being potential suppliers, and those producers located abroad having their marginal costs scaled up by trade costs.

For each market, there will be some maximum delivered cost at which profits are non-negative. This cost will match the maximum price observed in that market:

$$p^{\ell} = \frac{\gamma\alpha + \eta N^{\ell} \bar{p}^{\ell}}{\eta N^{\ell} + \gamma} = I(N^{\ell}, \bar{p}^{\ell}) .$$

Here N^{ℓ} is the number of firms active in market ℓ, and $\bar{p}^{\ell}$ is the average delivered price among producers active in that market. It includes both imported and domestically produced varieties.

Open economy profits

A firm will supply market ℓ if its costs per unit (inclusive of trade costs) fall below p^ℓ. It will earn $\pi_D^\ell(c) = \lfloor p_D^\ell - c \rfloor q_D^\ell(c)$ from domestic sales and, if it exports, it will earn $\pi_X^\ell(c) = \lfloor p_X^\ell - \tau^\ell c \rfloor q_D^\ell(c)$ from its foreign sales.

The maximum cost at which a firm will supply the domestic market is $c_D^\ell = p^\ell$ ($\ell = H, F$) and the maximum cost at which a firm will supply the foreign market is $c_X^\ell = \dfrac{p^h}{\tau^h}$. ($h \neq \ell$, $h = H, F$)

So when prices are the same in both markets, lower costs are required to break into foreign markets because they will be scaled up by transport costs and tariffs.

Since the cut-off (zero profit) productivity in market ℓ for delivered goods must be the same, regardless of their origin, we also have $\tau^\ell c_X^\ell = c_D^\ell$.

Summary of cost cut-offs by market and country of origin

	Home (H)	Foreign (F)
Domestic Sales (D)	$c_D^H = c_D^F / \tau^H$	$c_D^F = c_X^H \cdot \tau^F$
Exports (X)	$c_X^H = c_D^F \cdot \tau^F$	$c_X^F = c_D^H / \tau^H$

Zero expected profit conditions for potential entrants now reflect expected profits in both markets. They pin down the equilibrium number of producers in each country, as well as the number of producers active in each market.

Note that in a given market—say, home's domestic—the cost distribution for delivered goods of H and F firms is identical:

$$G(c|c < c_D^H) = \left(\frac{c}{c_M}\right)^k \Big/ \left(\frac{c_D^H}{c_M}\right)^k = \left(\frac{c}{c_D^H}\right)^k;$$

$$G(\tau^H c \,|\, \tau^H c < c_D^H) = \left(\frac{\tau^H c}{c_M}\right)^k \Big/ \left(\frac{c_D^H}{c_M}\right)^k = \left(\frac{\tau^H c}{c_D^H}\right)^k.$$

Thus the home market cost distribution is determined by the cut-off for home firms alone, as in the closed economy case. An analogous statement holds for the foreign market.

Solving for cost cut-offs in each market

The market-specific profit functions take the same form as before, but now we must figure in trade costs for exports:

$$\pi_D^\ell(c) = \frac{L^\ell}{4\gamma}\left(c_D^\ell - c\right)^2, \quad \pi_X^\ell(c) = \frac{L^\ell}{4\gamma}\left(\tau^h\right)^2\left(c_X^\ell - c\right)^2$$

Substituting these into the free entry condition (i.e., the *ex ante* zero profit condition),

$$\int_0^{c_D^\ell} \pi_D^\ell(c)dG(c) + \int_0^{c_X^\ell} \pi_X^\ell(c)dG(c) = f_E,$$

and continuing to assume a Pareto distribution with dispersion parameter *k* for costs, one may write the free entry condition as:

$$L^\ell\left(c_D^\ell\right)^{k+2} + L^h\left(c_D^h\right)^{k+2}\left(\tau^h\right)^2 = \gamma\phi \qquad h \neq \ell,\ h,\ \ell = H, F$$

where $\phi = 2(k+1)(k+2)(c_M)^k$ is a technology index that reflects the effects of better cost draws and lower entry costs.

Using these two free entry conditions in combination with the earlier result that $\tau^\ell c_X^\ell = c_D^\ell$, we have two expressions that can be solved for the domestic cut-offs in each country:

(home firms) $$L^H\left(c_D^H\right)^{k+2} + L^F\left(c_D^F\right)^{k+2}\left(\tau^F\right)^{-k} = \gamma\phi \qquad (22a)$$

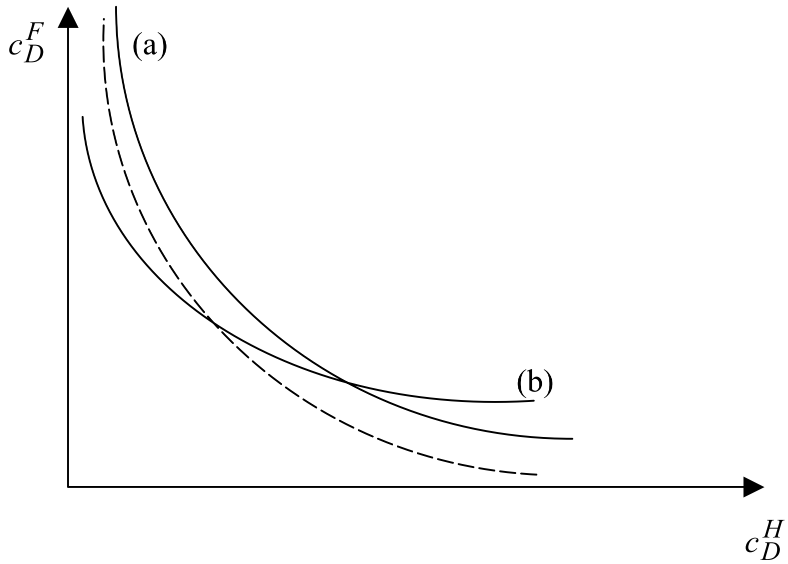
(foreign firms) $$L^F\left(c_D^F\right)^{k+2} + L^H\left(c_D^H\right)^{k+2}\left(\tau^H\right)^{-k} = \gamma\phi \qquad (22b)$$

Things to note

- Along each line, a low cut-off in one country (implying low expected profits, *ex ante*) is offset by a high cut-off in the other country (implying high expected profits, *ex ante*).

- But trade costs make the home market matter more than the foreign market, so the trade-off differs from the perspective of foreign versus home firms.

These two conditions can be represented graphically as:



The slope of (22a) is $\frac{dc_D^H}{dc_D^F} = -\frac{L^F}{L^H}\left(\frac{c_D^F}{c_D^H}\right)^{k+1}\left(\tau^F\right)^{-k}$, so it must get steeper as the ratio of foreign to home domestic market cut-offs increases.

Implications regarding country size

- Starting from symmetry, if the foreign market gets bigger, both lines shift inward. But the foreign curve shifts in more, so the cut-off falls more abroad.

- Bigger countries thus have:
  - more products
  - lower prices
  - higher average efficiency

Implications for trade policy

- Bilateral liberalization improves efficiency everywhere.

- If only foreign tariffs fall, the home line must shift inward and get steeper—refer to the dotted line. (Switching axes, the same relationships obviously hold for 22b.)
  - Thus a reduction in *foreign* tariffs causes the cut-off c_D^H to *fall* because producers in the home country now have better access to the foreign market.

  - The opposite result occurs in the liberalizing country. It makes itself worse off by unilaterally liberalizing because it reduces the relative access of its own producers to its domestic market.

Expected profits fall at initial cut-off c_D^F; this cut-off must fall to restore free entry equilibrium. How does it fall? Reductions in the number of foreign firms. Average prices, mark-ups, and quantities supplied adjust in response, as discussed. (Note contrast on mark-up prediction with earlier papers.)

- The number of producers increases in the country that gets better market access, and it declines in the other (liberalizing) country.

  This mercantilist result is very much in line with the way policy makers usually think about trade liberalization, but it is starkly different from the traditional result that unilateral liberalization is good for you. (It can also be found in Melitz's 2003 *Econometrica* article.)

  A comment: One important implication of the model is that there may be important omitted variable biases in the empirical literature on openness and productivity. Specifically, trading partners' policy is a critical determinant of performance.

Empirical issues
Does unilateral liberalization hurt productivity distributions but increase firm size?
Does unilateral liberalization increase mark-ups?
Do exporters have lower unit costs?

Related papers

Melitz (*Econometrica*, 2003)

Similar in spirit, but based on a CES demand system, so the elasticity and firm size effects are missing.

Not as well suited for policy analysis—symmetry needed.

Bernard, Eaton, Jensen and Kortum (*American Economic Review*, 2003).

Similar in that multilateral liberalization creates new opportunities for a countries' best firms, and new problems for the rest.

Explicitly multi-country; calibrated to plant size distributions and trade share data.

Limit pricing with multiple potential suppliers of each product creates the possibility that mark-ups and sizes vary across firms.

Helpman, Melitz and Yeaple (*American Economic Review*, 2004)

Generalizes Melitz (2003) to allow firms to service foreign markets through direct investments (FDI) instead of exports.

Baldwin and Yi (2004)

> Generalizes Melitz and Ottaviano, using Ottaviano and Thisse's (1999) representation of equilibrium with multi-product firms. Liberalization affects the range of products produced by each firm and thus economies of scope.

II. THE EVIDENCE (STATIC EFFECTS)

A. Are firms bigger in big markets?

THE DISTRIBUTION OF EMPLOYMENT SHARES ACROSS PLANT SIZES

<table>
<tr><th></th><th colspan="6">Number of Workers</th></tr>
<tr><th></th><th>1-4</th><th>5-9</th><th>10-19</th><th>20-49</th><th>50-99</th><th>>99</th></tr>
<tr><td>United States, 1992[a]</td><td>1.3</td><td>2.6</td><td>4.6</td><td>10.4</td><td>11.6</td><td>69.4</td></tr>
<tr><td>Mexico, 1993[h]</td><td>13.8</td><td>4.5</td><td>5.0</td><td>8.6</td><td>9.0</td><td>59.1</td></tr>
<tr><td>Indonesia, 1986[c]</td><td>44.2</td><td colspan="2">17.3</td><td colspan="3">38.5</td></tr>
<tr><td>S. Korea, 1973 [d]</td><td>7.9</td><td colspan="3">22.0</td><td colspan="2">70.1</td></tr>
<tr><td>S. Korea, 1988[e]</td><td colspan="3">12</td><td colspan="2">27</td><td>61</td></tr>
<tr><td>Taiwan, 1971 [c]</td><td colspan="4">29.1</td><td colspan="2">70.8</td></tr>
<tr><td>Taiwan, 1986[f]</td><td colspan="3">20</td><td colspan="2">29</td><td>51</td></tr>
<tr><td>India, 1971[g]</td><td colspan="2">42</td><td colspan="2">20</td><td colspan="2">38</td></tr>
<tr><td>Tanzania, 1967 [g]</td><td colspan="2">56</td><td colspan="2">7</td><td colspan="2">37</td></tr>
<tr><td>Ghana, 1970 [g]</td><td colspan="2">84</td><td colspan="2">1</td><td colspan="2">15</td></tr>
<tr><td>Kenya, 1969 [g]</td><td colspan="2">49</td><td colspan="2">10</td><td colspan="2">41</td></tr>
<tr><td>Sierra Leone, 1974 [g]</td><td colspan="2">90</td><td colspan="2">5</td><td colspan="2">5</td></tr>
<tr><td>Indonesia, 1977 [g]</td><td colspan="2">77</td><td colspan="2">7</td><td colspan="2">16</td></tr>
<tr><td>Zambia, 1985 [g]</td><td colspan="2">83</td><td colspan="2">1</td><td colspan="2">16</td></tr>
<tr><td>Honduras, 1979 [g]</td><td colspan="2">68</td><td colspan="2">8</td><td colspan="2">24</td></tr>
<tr><td>Thailand, 1978 [g]</td><td colspan="2">58</td><td colspan="2">11</td><td colspan="2">31</td></tr>
<tr><td>Philippines, 1974 [g]</td><td colspan="2">66</td><td colspan="2">5</td><td colspan="2">29</td></tr>
<tr><td>Nigeria, 1972 [g]</td><td colspan="2">59</td><td colspan="2">26</td><td colspan="2">15</td></tr>
<tr><td>Jamaica, 1978 [g]</td><td colspan="2">35</td><td colspan="2">16</td><td colspan="2">49</td></tr>
<tr><td>Colombia, 1973 [g]</td><td colspan="2">52</td><td colspan="2">13</td><td colspan="2">35</td></tr>
<tr><td>Korea, 1975 [g]</td><td colspan="2">40</td><td colspan="2">7</td><td colspan="2">53</td></tr>
</table>

Source: Tybout (2000)

This pattern probably reflects more than the effects at work in Melitz/Ottaviano:

- Small diffuse pockets of demand and poor transportation/communication reduce incentives to exploit scale economies.

- Also, the mix of product demands is skewed toward simple goods (food, clothing, metal products) that can be produced efficiently on a small scale.

B. What about changes in plant size distributions with trade liberalization?

example: Roberts, Mark and James Tybout. "Size Rationalization and Trade Exposure in Developing Countries, " in R. Baldwin, ed., *Empirical Studies of Commercial Policy*, Chicago: U. Chicago Press for the NBER, 1991.

Using data on Chile and Colombia (1979-1986), this paper fits regressions relating plant size in different industries to

- total market size
- degree of import competition (proxied with import shares or effective protection rates)
- amount of industry turnover

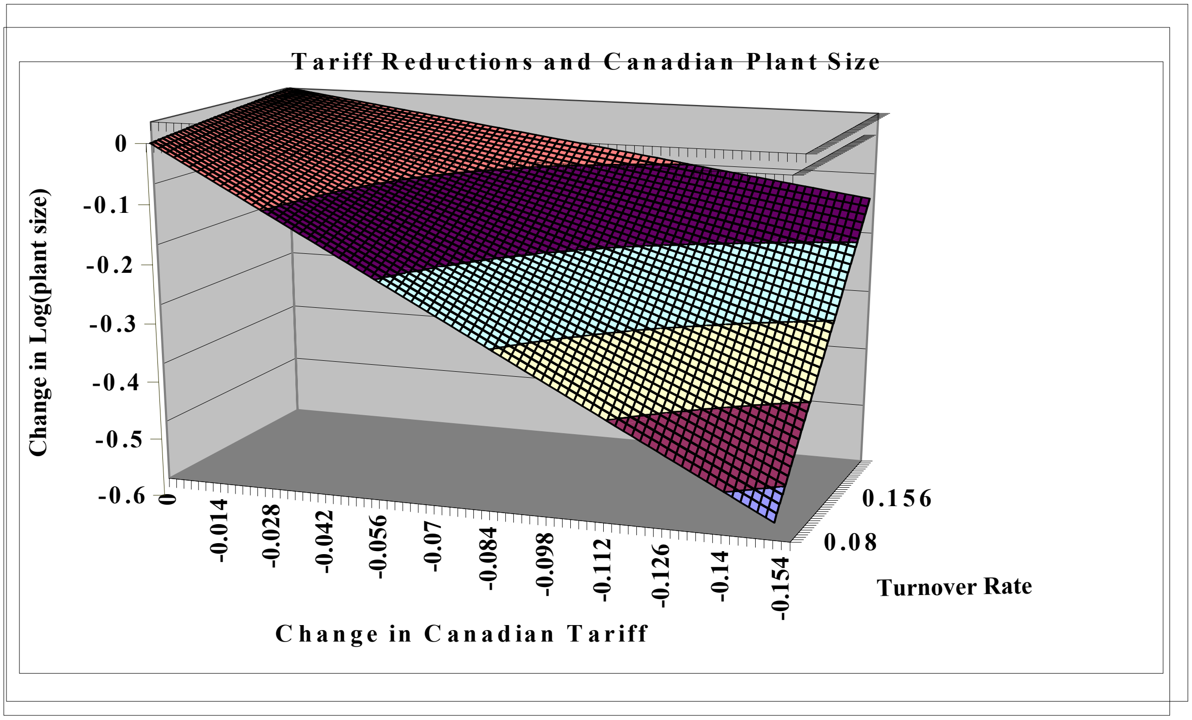
$$Size_{cjt} = \mu_j + \alpha_c + \beta_1(protect_{cjt} \times turnover_{cjt}) + \beta_2 protect_{cjt} + \beta_3 turnover_{cjt} + \beta_4 \ln(GDP)_{ct} + \varepsilon_{cjt}$$

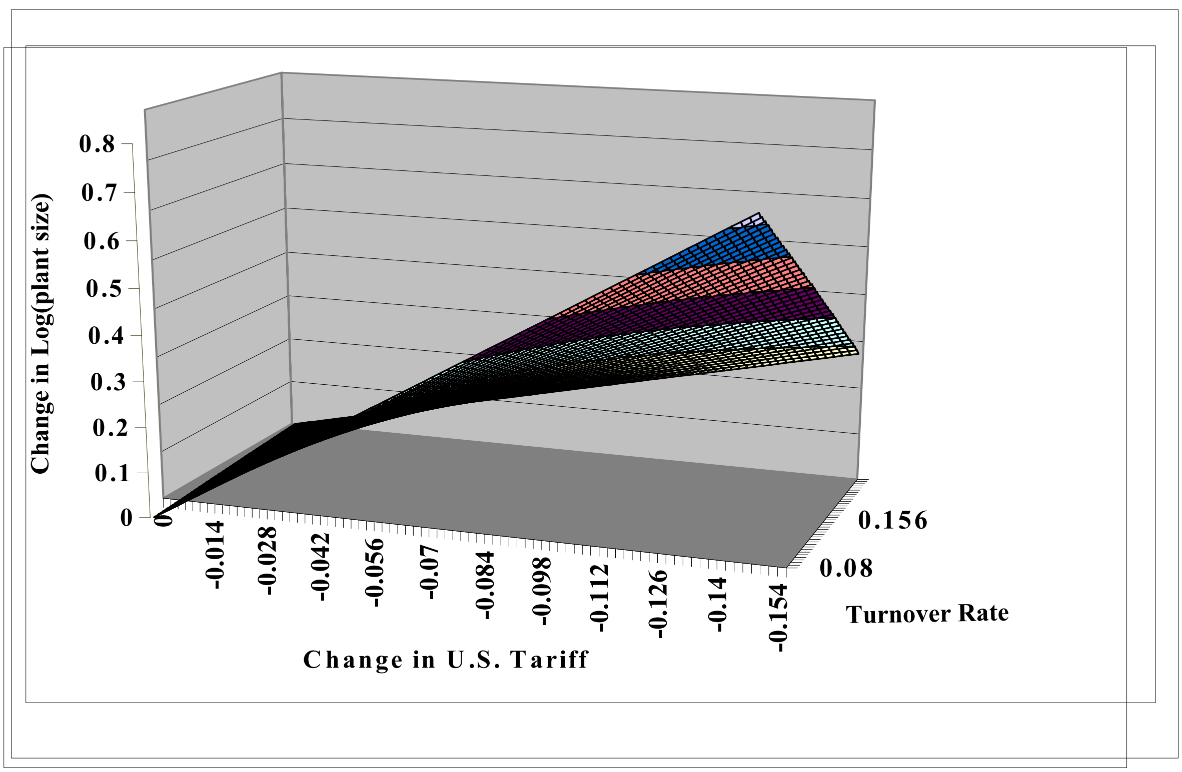
	Low Turnover Industries			High Turnover Industries		
Level of import share or ERP:	low	Medium	high	low	medium	High
	Import competition proxy: Import Share					
Ave. plant employment	73.4	52.1	31.1	56.7	48.0	37.3
	Import competition proxy: Effective Rate of Protection (ERP)					
Ave. plant employment	76.3	78.6	80.9	67.7	67.9	68.1

Eample: Head and Ries's (1999) study of the Canada-US FTA:

- Foreign competition is associated with smaller firms in import-competing industries.
- Foreign liberalization increases firms' size
- Size adjustments depend upon industry-specific turnover rates, which are used to proxy entry/exit barriers.

$$\ln(y_{it}) = \alpha_i + \beta_t + \gamma_{CAN}\tau_{it}^{c} + \gamma_{US}\tau_{it}^{US} + \lambda_{CAN}\left(\tau_{it}^{c} \cdot r_i\right) + \lambda_{US}\left(\tau_{it}^{US} \cdot r_i\right) + \varepsilon_{it}$$


Tariff Reductions and Canadian Plant Size
Change in Log(plant size)
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
0
-0.014
-0.028
-0.042
-0.056
-0.07
-0.084
-0.098
-0.112
-0.126
-0.14
-0.154
0.156
0.08
Turnover Rate
Change in Canadian Tariff


Change in Log(plant size)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
-0.014
-0.028
-0.042
-0.056
-0.07
-0.084
-0.098
-0.112
-0.126
-0.14
-0.154
0.156
0.08
Turnover Rate
Change in U.S. Tariff

What about scale Efficiency Effects?

- Scale economies at the margin are modest. Exporting plants tend to already be the largest in their industry (Andrew Bernard and J. Bradford Jensen, 1995 and 1997; Bernard and Wagner, 1997; Bee-Yan Aw, Chen and Roberts, 1997; Sanghamitra Das, Roberts and Tybout, 2000).

- Similarly, since most of the production in *any* industry comes from large plants, scale efficiency losses due to contraction in import-competing sectors are also typically minor (Tybout and Westbrook, 1995).

- A caveat: if scale effects are reaped through the consolidation of product lines, they will show up as productivity effects. This possibility remains relatively unexplored empirically.

C. Do large markets exhibit less productivity dispersion and higher average productivity?

Define

$x_{it} = A_{it}h(v_{it})$ production function

$\ln(A_{it}) \sim \phi(\cdot \mid I_{it})$,

I_{it} proxy for openness.

Option 1 (augmented production functions):

$\ln(A_{it}) = \gamma I_{it} + \varepsilon_{it}$:

$$\ln(x_i) = \sum_{j=1}^{J} \beta_i \ln(v_{ij}) + \gamma I_{it} + \varepsilon_{it}$$

Option 2 (stochastic frontier models):

$\ln(A_{it}) = \alpha_{it} + \varepsilon_{it}$

$$\ln(x_i) = \sum_{j=1}^{J} \beta_i \ln(v_{ij}) + \alpha_{it} + \varepsilon_{it}$$

Here α_{it} has a one-sided distribution that depends on I_{it}, and ε_{it} is noise. Less dispersion in α_{it} implies higher productivity.

Findings on Productivity Dispersion and Levels

- Looking across studies of different countries, there is no obvious tendency for developed countries to show less productivity dispersion than developing countries. (Refer to Tybout 2000, tables 2 and 3).

- However, many studies find that the distribution of productivity residuals improves after a country opens (table below). This runs counter to Melitz/Ottaviano.

<u>Liberalization Episodes</u>:

Chile: ERPs > 100% in 1967 to nearly uniform 15% in 1979

Mexico: Coverage ratios 92% and average ERPs $\approx$ 30% in 1983 to 11% and 9% in 1990

Cote d'Ivoire: nominal tariffs reduced by 30 percentage points, 1984-86

Brazil: average nominal tariffs $\approx$ 80% in 1985, 21% in 1995; NTBs removed

India: average tariffs fell 22% 1990 and 1992; cumulative reduction of 51% by 1997

Openness and Plant Level Productivity

Country and liberalization episode	Performance Measure	Performance Determinant	Finding on Productivity
Chile, 1973-79			
Tybout et al (1991)	Econometrically estimated TFP residuals	Effective protection rates	Sectors undergoing large reductions in protection exhibit the largest gains
Pavcnik* (2002)	Olley-Pakes (1996) estimates of TFP residuals	Tariff rates	Productivity grew faster in import-competing sectors with trade liberalization
Brazil, 1991-94			
Muendler (2003)	Olley-Pakes (1996) estimates of TFP residuals	Tariff rates, market penetration rates	Import competition substantially increases productivity
Hay (2001)	Econometrically estimated TFP residuals; operating profits	Tariff rates, effective rates of protection, Exchange rate	Import competition increases productivity
Mexico, 1984-89			
Tybout and Westbrook (1995)	Production function-based TFP residuals	Effective protection, import penetration, license coverage ratios	Sectors with most exposure to import competition showed the most gain
India, 1991			
Krishna and Mitra (1998)	Hall (1988)-type estimates of TFP residuals and mark-ups	Trade liberalization dummy	Productivity gains with trade liberalization
Cote d'Ivoire			
Harrison (1994)	Hall (1988)-type estimates of TFP residuals and mark-ups		Productivity growth tripled after trade liberalization
Harrison (1996)	Production function-based TFP residuals; price-cost margins	Tariff rates, controlling for FDI in plants, sector	High tariffs are negatively associated with productivity, controlling for FDI

Methodological problems.

- Older (pre-2000) studies do not deal with the simultaneity bias that results from the dependence of factor inputs on productivity levels.

- Tendency toward pro-cyclic bias because of factor "hoarding".

- All of the studies use industry-wide price deflators to convert plant-specific revenues to plant-specific measures of physical output. But since products within each industry are heterogeneous, this procedure attributes relative price fluctuation to physical output fluctuation, and it thus confounds efficiency with monopoly power. Trade-induced reductions in measured "productivity" dispersion may be no more than the reductions in mark-ups among firms with market power that I discussed in section A above. More formally:

Output = Efficiency Index × Factor Usage: $Q_i = A_i \cdot F_i$

Price = Mark-up × Marginal cost: $P_i = m_i \cdot \left(\frac{W_i}{A_i} \right)$

Suppose inputs are measured in expenditure terms

Measured productivity = Relative price effect + "True" productivity:

$$\ln \hat{A}_i = \ln\left(\frac{P_i \cdot Q_i}{\overline{P}} \right) - \ln\left(\frac{W_i \cdot F_i}{\overline{W}} \right) = \ln\left(\frac{P_i}{W_i} \right) - \ln\left(\frac{\overline{P}}{\overline{\overline{W}}} \right) + \ln A_i$$

Measured productivity =Mark-up + Deflator effect (in logs)

$$\ln \widehat{A}_i = \ln\left(\frac{m_i}{A_i} \right) - \ln\left(\frac{\overline{P}}{\overline{\overline{W}}} \right) + \ln A_i = \ln m_i - \ln\left(\frac{\overline{P}}{\overline{\overline{W}}} \right)$$

In cross section, measured productivity is correlated with "true" productivity, $\ln \omega$, if and only if mark-ups (m) are correlated with efficiency.

Why would this be?

- Elasticity effects
- Limit pricing *a la* Bernard, Eaton, Jensen and Kortum (2003)

In time series, *average* measured productivity will recover average true productivity if the appropriate price deflator is used. This follows from averaging both sides of:

$$\ln \hat{A}_i = \ln\left(\frac{P_i \cdot Q_i}{\overline{P}} \right) - \ln\left(\frac{W_i \cdot F_i}{\overline{W}} \right) = \ln\left(\frac{P_i}{W_i} \right) - \ln\left(\frac{\overline{P}}{\overline{\overline{W}}} \right) + \ln A_i$$

Suppose instead that inputs are measured in physical terms

Measured productivity = mark-up effect + factor price effect

$$\ln \hat{A}_i = \ln\left(\frac{P_i \cdot Q_i}{\overline{P}}\right) - F_i = \ln\left(\frac{P_i}{\overline{P}}\right) + \ln A_i = \ln\left(\frac{m_i W_i}{A_i}\right) - \ln \overline{P} + \ln A_i = \ln m_i + \ln\left(\frac{W_i}{\overline{P}}\right)$$

In cross section, measured productivity reflects factor prices and mark-ups. Firms that pay a lot for their labor (perhaps because their in urban centers) will appear to be more productive, other things equal.

In time series, average measured productivity will recover average true productivity once again, presuming that the appropriate output price deflator is used.

- Finally, a general problem with this literature is that it tends to equate measured efficiency gains with welfare improvements. Thus when these gains are associated with trade liberalization, they are touted as a beneficial effect of foreign competition. But:
    - The costs of productivity gains are often embodied in overhead, license fees, training and other items that do not get measured in the input vector.
    - Further, the benefits these expenditures generate are not fully reaped in the same periods in which their are incurred.
    - Finally, and most importantly, there is no role for differences in product appeal. A company that produces an unwanted product very efficiently is as highly value as a company that produces a very desirable product. The demand side is missing.

D. Are productivity gains due to selection or intra-firm improvements?

Turnover-based gains seem to matter:

Country and liberalization episode	**Performance Measure**	**Performance Determinant**	**Finding on Productivity**
Chile, 1973-79			
Liu (1993)	Econometrically estimated TFP residuals		Entry/exit a significant determinant of productivity growth
Pavcnik* (2002)	Olley-Pakes (1996) estimates of TFP residuals	Tariff rates	Most of the post-liberalization productivity gains came from market share reallocations and entry/exit
Brazil, 1991-94			
Muendler (2003)	Olley-Pakes (1996) estimates of TFP residuals	Tariff rates, market penetration rates	Exit significantly contributed to efficiency gains; other forms of market share reallocation not studied
Mexico, 1984-89			
Tybout and Westbrook (1995)	Production function-based TFP residuals	Effective protection, import penetration, license coverage ratios	About 1 percent out of 11 percent of the total efficiency gain came from market share reallocations. The effect was bigger in open industries.

Example: Pavcnik (2002):

One can write sector wide TFP as a share-weighted average of plant-level TFP indices (e.g., Olley and Pakes, 1992):

$$B_t = \sum_{i=1}^{n_t} s_{it} A_{it} = \overline{A}_t + \sum_{i=1}^{n_t} (s_{it} - \overline{s}_t)(A_{it} - \overline{A}_t)$$

If the more productive firms have larger market shares, the covariance term will contribute to sector-wide productivity.

	$B_{86}/B_{79}-1$	$\overline{A}_{86}/\overline{A}_{79}-1$	$Cov_{86}/Cov_{79}-1$
Import Competing	0.319	0.107	0.213
Export Oriented	0.254	0.087	0.166
Non-tradeable	0.062	0.038	0.024

The covariance term (market share reallocations) became more important over time following Chile's liberalization, especially among tradeable goods.

E. Does opening tend to reduce mark-ups?

There are several ways to measure mark-ups.

Methodology 1

The most common approach is to use the price-cost margin (*PCM*)—that is, sales net of expenditures on labor and materials over sales. Assume unit labor, enery and material costs are flat with respect to output;

Define c as short-run marginal costs:

$$PCM_{it} = \frac{p_{it}q_{it} - c_{it}q_{tt}}{p_{it}q_{it}} = \frac{p_{it} - c_{it}}{p_{it}},$$

$$PCM_{it} = \frac{\pi_{it}}{p_{it}q_{it}} + \frac{(r_t + \delta)k_{it}}{p_{it}q_{it}},$$

where k_{it} is the capital stock, r is the market return on capital, and δ is the depreciation rate.[i]

$$PCM_{it} = \beta_0 + \beta_1(k_{it}/p_{it}q_{it}) + \beta_2 I_{it} + \cdots + \varepsilon_{it}$$

where i may index either firms or industries, and I_{it} is a proxy for the intensity of import competition—either the import penetration rate, the effective protection rate, or a license coverage ratio.

Methodology 2

An alternative methodology for linking foreign competition and pricing begins from the standard Tornqvist growth decomposition. Suppose the i^{th} firm produces output according to $q_{it} = A_{it} h(v_{it})$, where $v_{it} = \left(v_{it}^1, v_{it}^2 \cdots v_{it}^J\right)$:

$$d\ln(q_i) = \sum_{j=1}^{J} \frac{\partial \ln(h)}{\partial \ln(v_i^j)} d\ln(v_i^j) + d\ln(A_i)\,.$$

Hall notes that, using the cost-minimization conditions $c_i = \dfrac{w_j}{\partial q_i / \partial v_i^j}$, $\forall j$, and the mark-up condition, $P_i = \left[1 - \eta^{-1}\right] c_i$, this becomes:

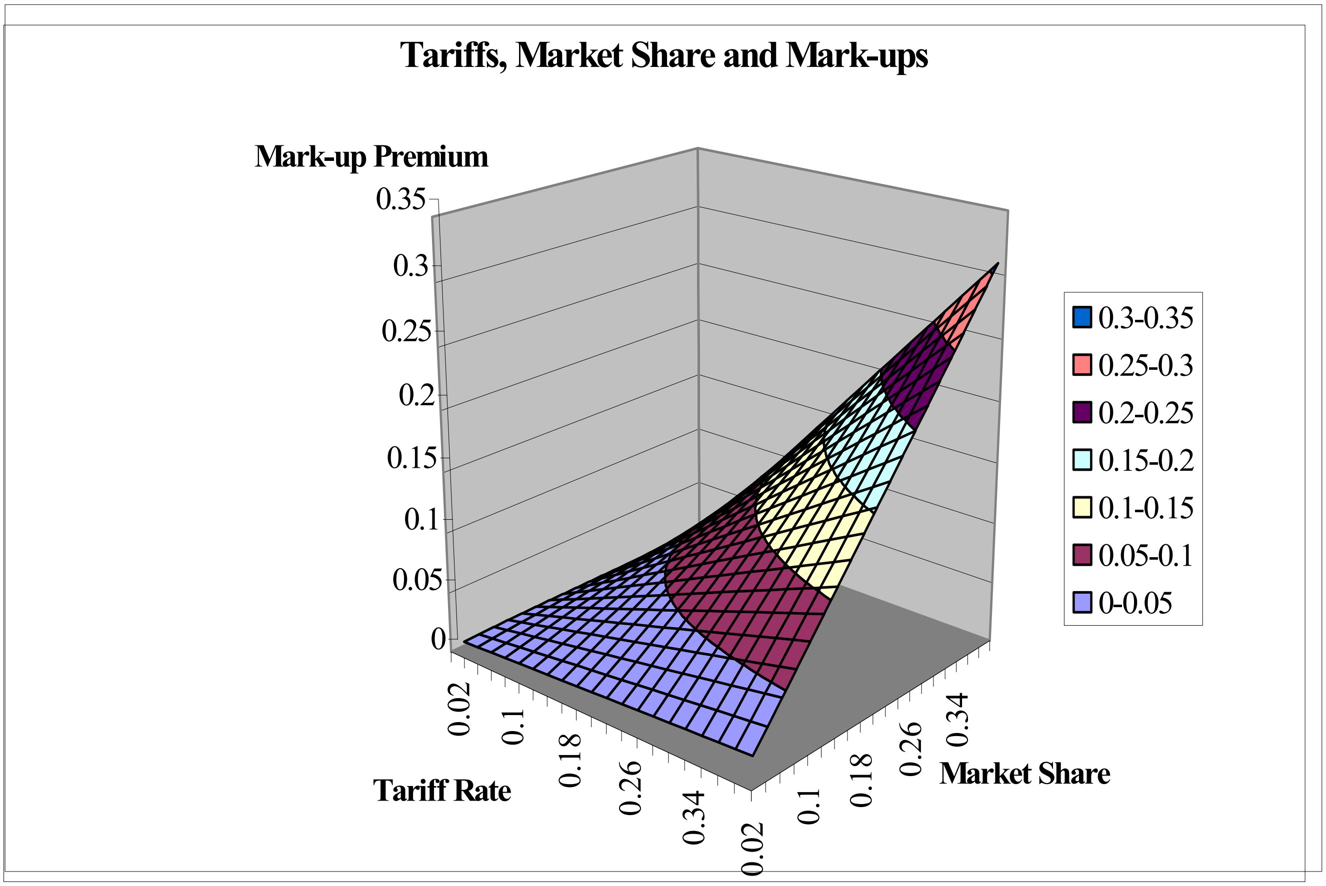
$$d\ln(q_i) = \left(\frac{\eta}{\eta - 1}\right) \sum_{j=1}^{J} \left(\frac{v_i^j w_j}{p_i q_i}\right) d\ln(v_{ij}) + d\ln(A_i)\,.$$

Treating $d\ln(A_i)$ as the mean productivity growth rate plus noise, and allowing η to vary through time with trade reforms, one can test whether import competition affects mark-ups.

Openness and Mark-ups

Country and liberalization episode	**Performance Measure**	**Performance Determinant**	**Finding on Mark-ups**
Chile, 1973-79			
DeMelo and Urata (1986)	Price-cost margin	Import penetration rate	Post-reform penetration of imports reduced mark-ups most in highly concen-trated sectors.
Tybout* (1996)	Price-cost margin	Import penetration rate	Margins are negatively affected by import penetration, especially among large plants.
Brazil, 1991-94			
Hay (2001)	Operating profit rate	Tariff rates, effective rates of protection, Exchange rate	Operating profits are positively associated with nominal protection rates.
Mexico, 1984-89			
Grether (1996)	Price cost margin	Effective protection rates, official protection rates, license coverage rates	Big firms undergoing the most reduction in protection show the biggest reduction in margins
India, 1991			
Krishna and Mitra (1998)	Hall (1988)-type estimates of TFP residuals and mark-ups	Trade liberalization dummy	Significant reductions in mark-ups after trade liberalization.
Cote d'Ivoire			
Harrison (1994)	Hall (1988)-type estimates of TFP residuals and mark-ups		Weak evidence that price-cost margins fell with trade liberalization
Harrison (1996)	Price-cost margins	Tariff rates, controlling for FDI in plants, sector	High tariffs are associated with high margins and low productivity.

Exp: Mexican Trade Liberalization
Recall that in the 1980s, Mexico underwent a dramatic trade liberalization. Between 1985 and 1990, effective protection rates went from weighted average of 31% to 9% for manuf., and license coverage ratios went from 92% to 11%.



Source: Grether (1996) "Mexico, 1985-90: Trade Liberalization, Market Structure, and Manufacturing Performance," in M. Roberts and J. Tybout, eds., *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity and Market Structure*. 1996. Oxford: Oxford University Press.

$$PCM_{it} = \beta_0 + \beta_1 s_{it} + \beta_2 s_{it}^2 + \beta_2 TAR_{it} + \beta_2 TAR_{it} s_{it} + \sum_{j=1}^{J} \mu_j IND_{it}^j + \tau_t + \varepsilon_{it}$$

Even stronger results emerge with license coverage ratios.

In sum, the evidence runs strongly counter to the Melitz/Ottaviano result that unilateral liberalization should increase mark-ups at home. It is, rather, consistent with the notion that foreign competition disciplines domestic market power.

<u>Things to ponder</u>

1. Is monopoly power "disciplined"? Perhaps, but concentration may reflect large sunk entry costs instead of market power. Then foreign competition cuts into the revenues that firms had expected would cover their entry costs (e.g., Albuquerque and Rebelo, 2000).

2. Are the empirical studies picking up short-run effects, which downplay the importance of entry/exit?

<u>Methodological issues</u>

1. It is problematic to equate the book value of average variable costs with marginal costs.

2. Hall's approach is subject to several criticisms:

   Recall the estimating equation: $d\ln(q_i) = \left(\frac{\eta}{\eta - 1}\right)\sum_{j=1}^{J}\left(\frac{v_i^j w_j}{p_i q_i}\right) d\ln(v_{ij}) + d\ln(A_i)$

   - It requires instruments that are correlated with factor stock growth but not with transitory productivity growth. It is difficult to argue that any available instruments satisfy this criterion, so mark-up estimates are probably biased upward, and may exhibit spurious correlation with the trade regime (Abbott, Griliches, and Hausman, 1989).

   - If some or all of the factors are subject to such costs they will be paid less than their marginal revenue product during upswings (when factor inputs are growing rapidly) and more during downswings (when factor inputs are growing slowly or shrinking). This measurement error is counter-cyclic and productivity growth tends to be *pro*-cyclic, so the estimated mark-up may be understated.

   - Similarly, if import competition depresses demand for domestic goods, it may appear to eliminate monopoly power when it merely creates under-utilization of capacity.

   - The problem of equating real revenues with physical quantities (discussed earlier) is present in this literature.

F. Do exporters have lower unit costs?

Many studies of developing countries have established that exporters tend to be bigger, more skill-intensive, and more productive than their domestically oriented counterparts (Aw and Hwang, 1995; Aw, Chen and Roberts, 1997; Handoussa, Nishimizu and Page, 1986; Chen and Tang, 1987).

Of course, these are based on the same kind of productivity index that we have discussed above, so they are subject to the same complaint. Suffice it say that exporters appear to be relatively profitable, and that this profitability probably traces partly to relatively efficient production processes.

I. Heterogeneity and Export Dynamics (Das, Roberts, Tybout)

When are Melitz/Ottaviano-type efficiency gains likely to be important?

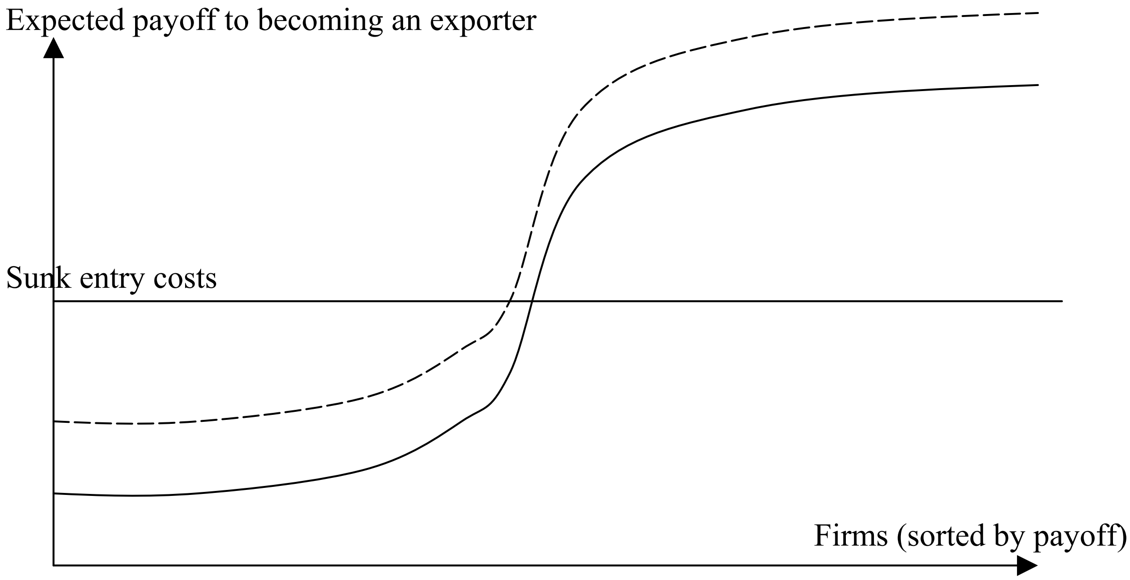
The volume of an export response to opening (and other shocks) depends upon:

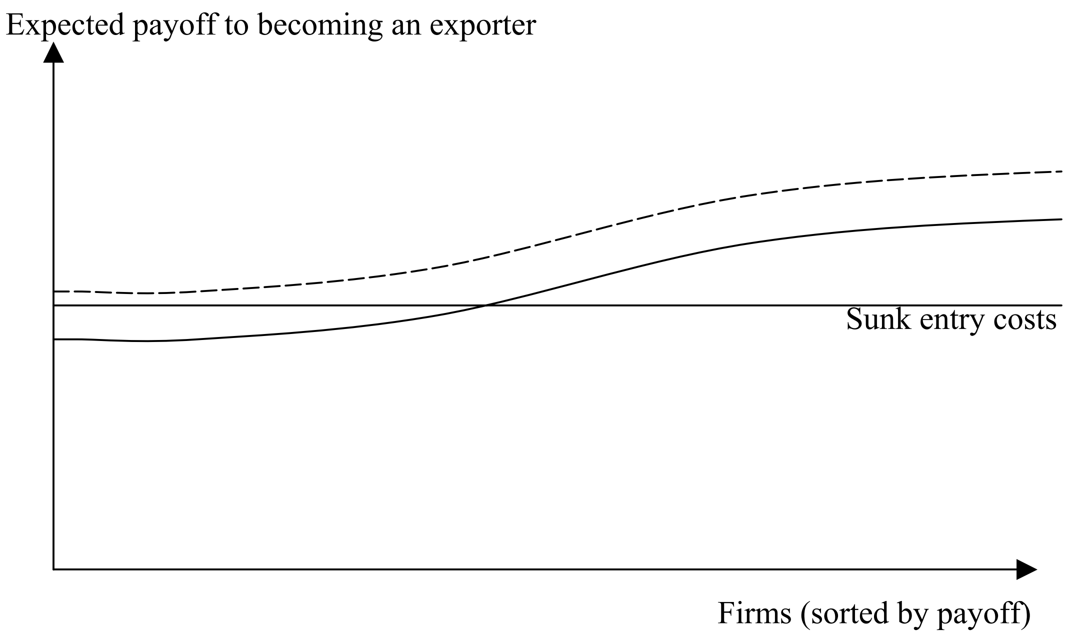
- Sunk entry costs associated with breaking into foreign markets—re-developing and re-packaging product for sales abroad, establishing transportation/distribution network, learning bureaucratic procedures

- History: how many firms have already borne these costs? For them export expansion is simply a volume adjustment.

- Heterogeneity. Each firm has its own distinctive product and production process. Thus the returns to becoming an exporter vary across firms with product appeal in foreign markets and with their marginal production costs.

  Depending upon the nature of this heterogeneity, there may be many or few firms poised on the brink of becoming exporters when the policy regime shifts:





Das, Roberts and Tybout (2004) develop an empirical model of exporting behavior and attempt to quantify the roles of sunk costs, history and heterogeneity in shaping export responses.

Key modeling assumptions

- The foreign and domestic market for each firm's product are monopolistically competitive and segmented.
- Producers are heterogeneous in terms of their marginal production costs and the foreign demand schedules they face for their products.
- Future realizations on the exchange rate, marginal costs, and foreign demand shifters are unknown, but each evolves according to a known Markov process.
- Firms are risk-neutral and maximize the expected sum of their discounted earnings stream.
- Marginal costs do not respond to output shocks.

Operating profits among exporters

$$\ln(\pi_{it}^{*}) = \psi_0 + \varphi_1 z_i + \varphi_2 e_t + \left(x_{1it} + x_{2it} + \cdots + x_{mit}\right)$$

π_{it}^{*} exporting profits awaiting the i^{th} firm in period t ; realized only if it becomes an exporter

z_i: vector of time invariant characteristics of firm i (e.g., business type, location, initial size in domestic markets)

e_t real effective manufacturing exchange rate, year t

x_{jit} j^{th} AR(1) process. Sum of m processes is ARMA(m, m-1). Let the roots of these processes and the variances of their innovations be collected in the diagonal matrices Λ_x and Σ_ω, respectively.

Linking export profits and profits revenues

$$P_{it}^{f}\left(1-\left[\eta_{i}^{f}\right]^{-1}\right)=\alpha_{it}$$

P_{it}^{f} Domestic currency price received per unit of exports, firm i

η_{i}^{f} Foreign elasticity of demand for the i^{th} firm's product.

α_{it} Marginal cost of producing a unit of exportable goods, firm i, year t

Multiplying both sides of the mark-up rule by the optimal quantity exported yields an expression relating potential export revenue to the total variable costs of exporting:

$$R_{it}^{f*}\left(1-\left[\eta_{i}^{f}\right]^{-1}\right)=C_{it}^{*}$$

Rearranging yields a relationship between potential profits and potential revenues:

$$\pi_{it}^{*}=R_{it}^{f*}-C_{it}^{f*}=\left(\eta_{i}^{f}\right)^{-1}R_{it}^{f*}$$

Substituting the log of this expression back into the potential profit equation yields:

$$\ln(R_{it}^{*})=\psi_{0}-\ln\left[\eta_{i}^{f}\right]+\varphi_{1}z_{i}+\varphi_{2}e_{t}+\left(x_{1it}+x_{2it}+\cdots+x_{mit}\right)$$

The decision to export

If there were no sunk start-up costs associated with becoming an exporter, firms would jump into foreign markets whenever gross potential exporting profits exceeded the fixed costs of operating in foreign markets:

$$\pi(x_{it},z_{i},e_{t}\mid\eta_{i}^{f},\Psi)>\gamma_{F}-\varepsilon_{1it}$$

But those firms that are not already exporting must pay an additional start-up cost to reconfigure their product for foreign consumers, establish distributors and learn the bureaucratic procedures necessary at home and abroad. (These costs may depend upon firms' observable characteristics, and they are likely to exhibit some random variation across firms and time:

$$\gamma_{S}z_{i}+\varepsilon_{1it}-\varepsilon_{2it}$$

So the net current profits from exporting, hereafter $u(\,)$, may be written as:

$$u(x_{it},z_i,e_t,y_{it-1},y_{it}\mid\cdot)=\begin{cases}\pi(x_{it},z_i,e_t\mid\cdot)-\gamma_F+\varepsilon_{1it} & if \quad y_{it}=1,\ y_{it-1}=1\\ \pi(x_{it},z_i,e_t\mid\cdot)-\gamma_F-\gamma_S z_i+\varepsilon_{2it} & if \quad y_{it}=1,\ y_{it-1}=0\\ 0 & if \quad y_{it}=0\end{cases}$$

Let $(\gamma_F,\gamma_S)\equiv\Gamma$ and $(\varepsilon_{1it},\varepsilon_{2it})\equiv\varepsilon_{it}\sim i.i.d.N(0,\Sigma_\varepsilon)$. Further, collect all of the parameters we have introduced in the vector $\theta=(\Psi,\eta,\Lambda_x,\Sigma_\omega,\Gamma,\Sigma_\varepsilon)$.

By choosing the optimal sequence of export market participation decisions, firms are assumed to maximize the expected present value of their net export profit stream over an H period horizon:

$$V(x_{it},z_i,e_t,\varepsilon_{it},y_{it-1}\mid\theta)=\max_{y(\cdot)}\quad E_t\sum_{\tau=t}^{t+H}\delta^\tau u(x_{i\tau},z_i,e_\tau,y_{i\tau-1},y_{i\tau}\mid\theta).$$

Here expectations are conditioned on all currently available information: $(x_{it},z_i,e_t,\varepsilon_{it})$. (Lagged values of the stochastic variables are irrelevant.) The value of this maximized expected profit stream is equal to the value function evaluated at $(x_{it},z_i,e_t,\varepsilon_{it})$:

$$V(x_{it},z_i,e_t,\varepsilon_{it},y_{it-1}\mid\theta)=\max_{y_{it}}\quad[u(x_{it},z_i,e_t,\varepsilon_{it}\mid\theta)+\delta E_tV(x_{it+1},z_i,e_{t+1},\varepsilon_{it+1},y_{it}\mid\theta)]$$

So another way to characterize behavior is to say that firms use the decision rule

$$y(x_{it},z_i,e_t,\varepsilon_{it},y_{it-1}\mid\theta)=\arg\max_{y_{it}}\quad[u(x_{it},z_i,e_t,\varepsilon_{it}\mid\theta)+\delta E_tV(x_{it+1},z_i,e_{t+1},\varepsilon_{it+1},y_{it}\mid\theta)]$$

That is, firm *i* exports in period *t* when net current profits plus the option value of being able to export next period without paying start-costs is positive:

$$u(x_{it},z_i,e_t,\varepsilon_{it}\mid\theta)\quad+$$

$$E_tV(x_{it+1},z_i,e_{t+1},\varepsilon_{it+1}\mid y_{it}=1,\theta)-E_tV(x_{it+1},z_i,e_{t+1},\varepsilon_{it+1}\mid y_{it}=0,\theta)\ >0$$

The option value term creates a role for expectations.

Estimation

In a typical panel data set, we observe potential export revenues when firms are in foreign markets, otherwise this is a censored variable. We also observe some exogenous firm characteristics, and total variable production costs.

The export market participation rule, the revenue function, and the rule relating revenues to profits in the home and foreign market provide a basis for estimation.

Application: Colombian leather products, knitted fabrics, basic chemicals.

Likelihood function isn't globally concave, so Bayesian estimator MCMC used.

Things to note concerning parameter estimates (below):

- Sunk costs of entering are similar across industries. In millions of 1986 pesos they range from 50 to 75. In dollars, this amounts to roughly $300,000 to $500,000.

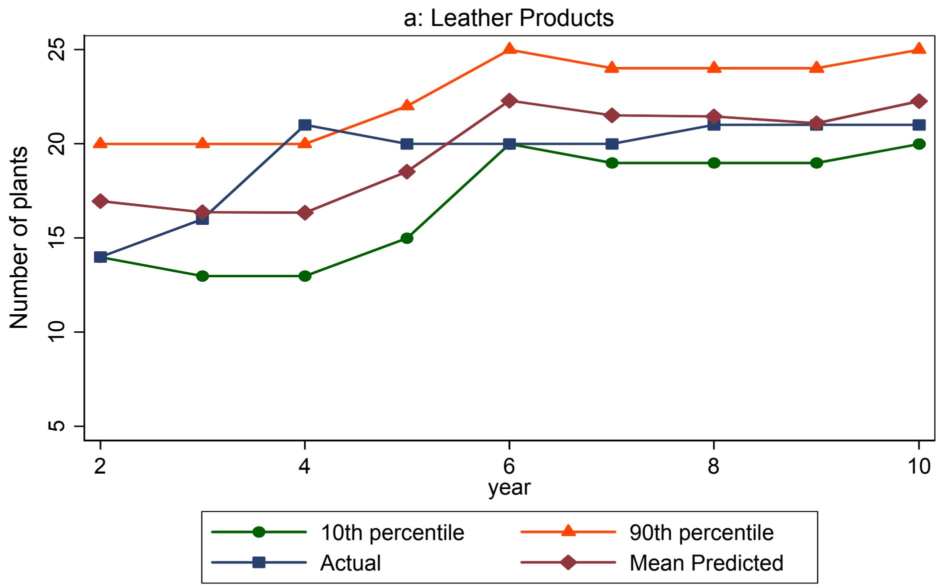
- The exchange rate effect—which includes changes in the incentive to export— varies across industries. Knitted fabrics and leather products much more sensitive than basic chemicals.

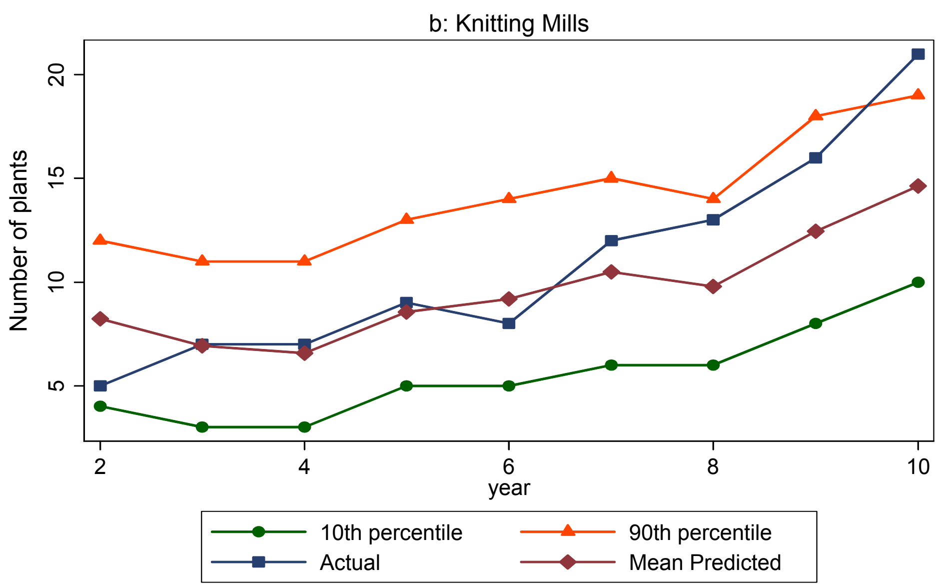
- Heterogeneity in demand elasticities, idiosyncratic shocks to profits, and sunk and fixed costs.

Table 1: Posterior Parameter Distributions
(Means and Standard Deviations)

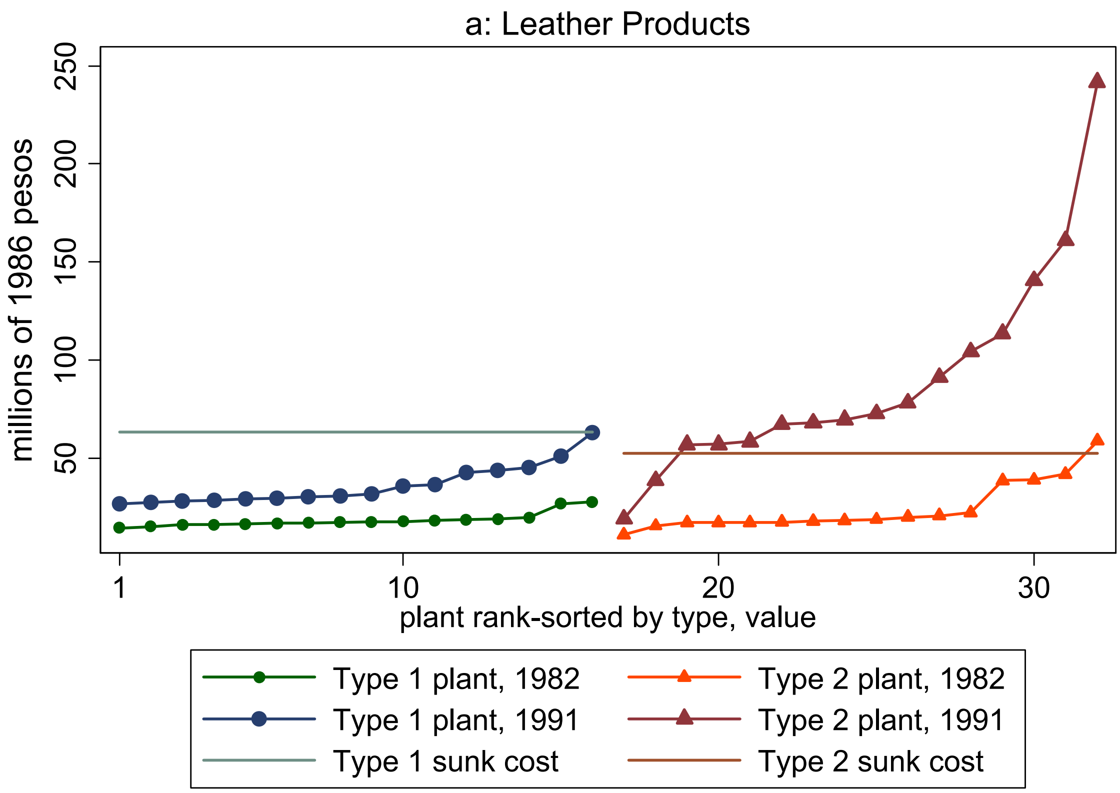
	Leather Products	Basic Chemicals	Knitted Fabrics	Priors
	Profit Function Parameters			
ψ_0 (Intercept)	-13.645 (4.505)	2.794 (1.794)	-12.965 (3.058)	N(0, 500)
ψ_{01} (Domestic size dummy)	1.544 (0.789)	1.750 (0.767)	1.362 (0.449)	N(0, 500)
ψ_1 (Exchange rate coefficient)	4.323 (0.957)	0.630 (0.378)	4.047 (0.640)	N(0, 500)
λ_{z1} (Root, first AR process)	0.787 (0.180)	-0.374 (0.188)	0.458 (0.258)	U(-1,1)
λ_{z2} (Root, second AR process)	0.952 (0.018)	0.948 (0.022)	0.709 (0.103)	U(-1,1)
$\sigma^2_{1\omega}$ (Variance, first AR process)	0.282 (0.144)	0.310 (0.110)	0.469 (0.250)	N(0,20)
$\sigma^2_{2\omega}$ (Variance, second AR process)	0.422 (0.146)	0.507 (0.141)	0.809 (0.264)	N(0,20)
υ (Foreign elasticity premium)	-0.016 (0.022)	0.840 (0.128)	0.950 (0.047)	U(-1,1)
λ_ξ (Root, measurement error)	0.011 (0.001)	0.963 (0.016)	1.312 (0.264)	U(-1,1)
σ_ξ (Std. error, ξ innovations)	0.336 (0.070)	1.316 (0.371)	0.935 (0.013)	N(0,20)
	Foreign Demand Elasticities (Quartiles only)			
(Demand elasticity, quartile 1)	8.020 (2.907)	11.413 (11.858)	10.289 (12.032)	$\ln(\eta-1) \sim N(2,1)$
(Demand elasticity, quartile 2)	12.282 (13.351)	13.033 (15.547)	12.314 (8.330)	$\ln(\eta-1) \sim N(2,1)$
(Demand elasticity, quartile 3)	17.866 (11.089)	14.279 (17.212)	13.780 (16.725)	$\ln(\eta-1) \sim N(2,1)$
(Demand elasticity, quartile 4)	37.189 (25.331)	22.429 (22.072)	36.279 (32.844)	$\ln(\eta-1) \sim N(2,1)$
	Dynamic Discrete Choice Parameters			
γ_{S_1} (Sunk cost, size class 1)	63.690 (1.934)	65.511 (1.882)	61.064 (2.628)	N(0, 500)
γ_{S_2} (Sunk cost, size class 2)	52.615 (4.398)	49.298 (4.882)	59.484 (2.361)	N(0, 500)
γ_F (Fixed cost)	-0.610 (1.042)	1.318 (0.793)	1.372 (1.340)	N(0, 500)
$\sigma_{\varepsilon 1}$ (Std. error, ε_1)	12.854 (6.171)	6.564 (3.637)	32.240 (8.382)	N(0,20)
$\sigma_{\varepsilon 2}$ (Std. error, ε_2)	30.627 (7.831)	34.124 (3.384)	17.630 (4.737)	N(0,20)

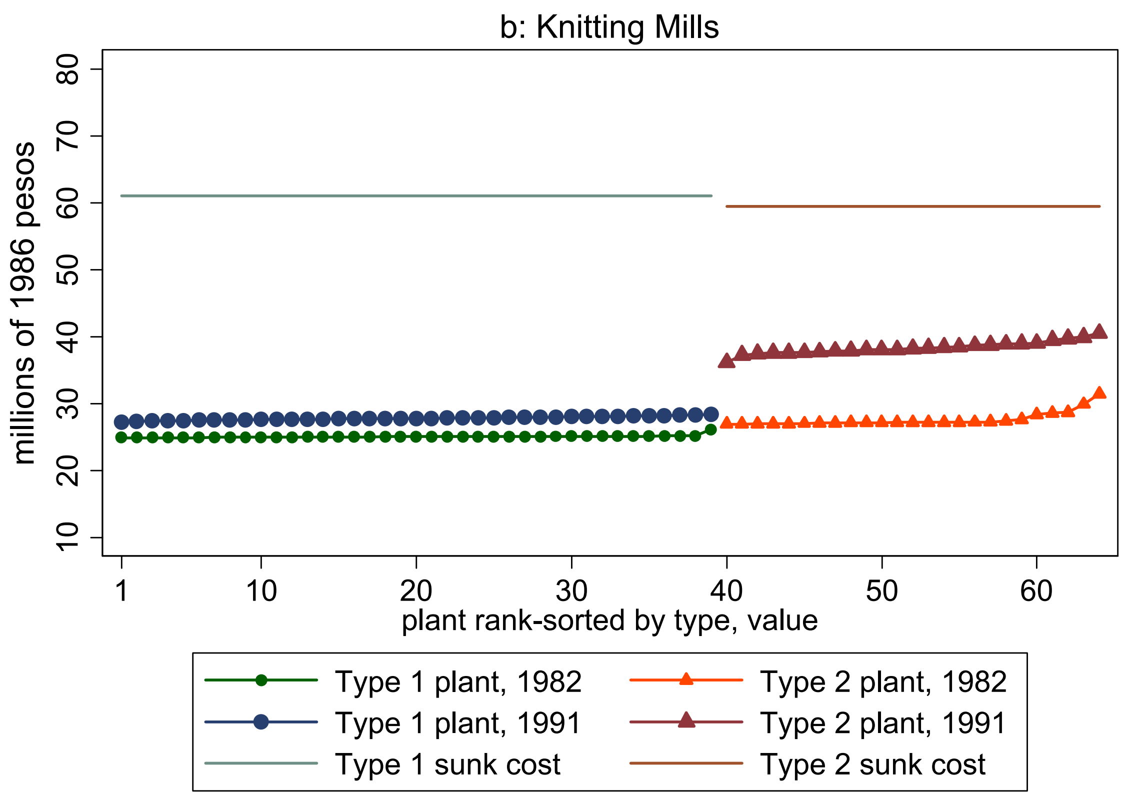
Predicted and Actual Number of Exporting Plants





<u>How important is heterogeneity?</u>
The value of being an exporter is plotted below, sorted as before. Both 1982 and 1991 are presented. The main reason the two lines differ is that the exchange rate depreciated about 33 percent between these two years.





<u>Things to note concerning heterogeneity</u>

- More heterogeneity is apparent in leather products than in knitted fabrics.

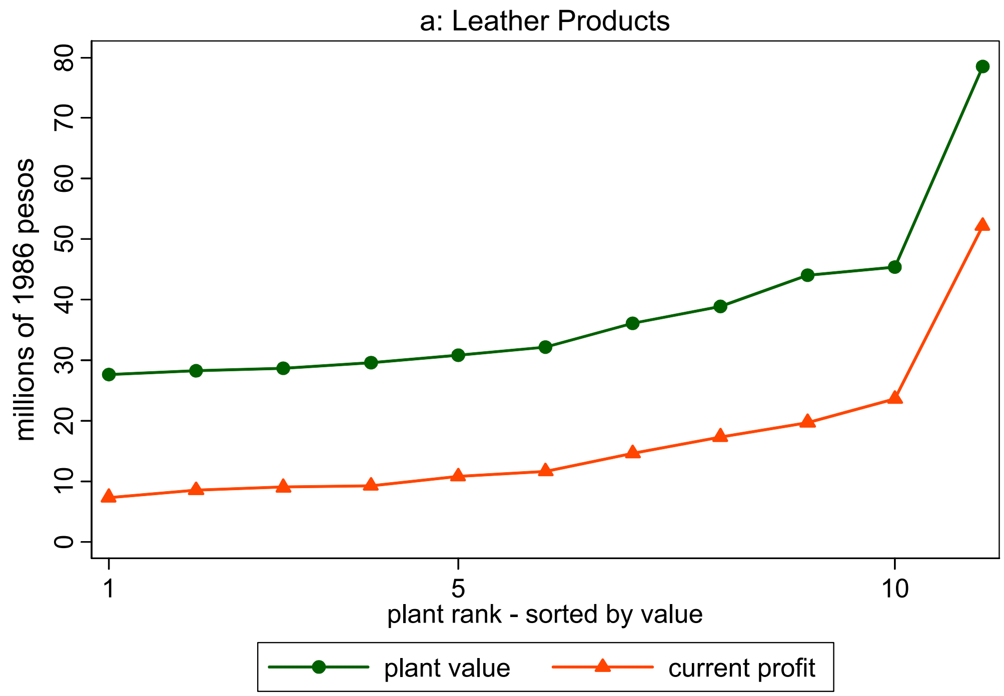
- It looks like more firms get dragged into exporting in leather products between 1981 and 1991. But:

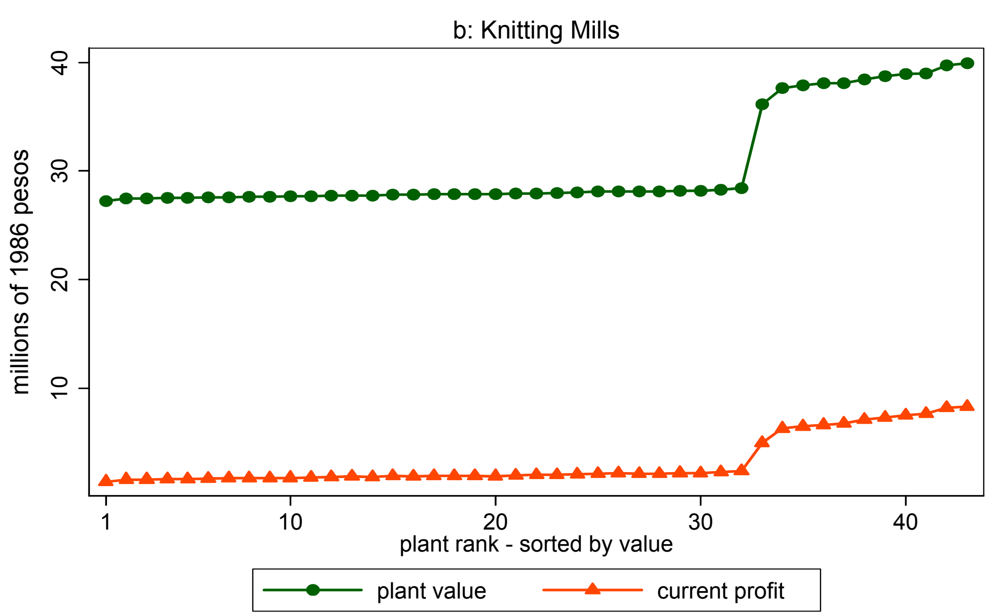
    - Most of the plants that shift above the line were *already* exporting; few of the knitting mills were exporters in 1891.

    - Although it appears that none of the knitting mills get pushed into the export market, this was not the case. The picture shows expected values over x's and ε's. Adding in idiosyncratic noise results in positive payoffs for some. In fact, because the line is so flat, large numbers are induced to enter.

The significance of expectations can be seen in the large option value component in the total pay-off to exporting (below).

Option Value for Non-exporting Plants





The roles of history and heterogeneity can also be seen in the experiments where the exchange rate is devalued 10 percent and 50 percent.

Exchange Rate Devaluation and the Number of Exporting Plants