Firms in the open economy

A review

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Overview

Trade theory and stylized facts

Gains from inter-industry specialization

- Focus: Inter-industry trade
- Theory: Comparative advantage (David Ricardo, ...)

Gains from intra-industry specialization

- Focus: Intra-industry trade
- Theory: Scale economy, love-for-variety (Krugman 1980)

Gains from inter-firm specialization

- Focus: Firm heterogeneity
- Theory: Reallocation effect, procompetitive effect, etc. (Melitz 2003, Melitz & Ottaviano 2008)

Gains from within-firm specialization

- Focus: Fragmentation, factor matching, MNE boundaries
- Theory: Transaction cost, span of control, contract theory (Coase 1937, Lucas 1978, Grossman & Hart 1986, Antràs et al. 2006)

Firm heterogeneity

Traditional trade theories usually simply assumes a representative firm within each industry.

Phenomenon

- Firm participation in international trade is exceedingly rare.
- Ex(Im)porters and non-ex(im)porters are different.

Mechanism

- Reallocation effect (Melitz 2003)
- Procompetitive effect (Bernard et al. 2003, Melitz & Ottaviano 2008)
- Productivity effect (Pavcnik 2002, Trefler 2004)
- etc.

Unbundling the production process / Fragmentation

Suppose firm n produces output $y_i(n)$ by completing a set of $M_i(n)$ tasks. Let T_i be the scale of task i. Assume the firm's output to be

$$y_i(n) = f_{i,n}(T_1, T_2, ..., T_{M_i}). \tag{1}$$

The origin of fragmentation

- Improvements in communication and transportation technology.

Grossman & Rossi-Hansberg 2008

Reductions in communication and trade costs imply that

- By trading tasks, firms can enjoy the productivity benefits of worker specialization without sacrificing the gains of placing production in the most economical location.

The effects of fragmentation

Jones & Kierzkowski 1991, 2001

Settings

- H-O framework, with two industries and two factors;
- The production process can be fragmented into two intermediate goods with different factor intensities within an industry.

$\Rightarrow$ If the two stages have factor intensities that vary sufficiently, firms will unbundle the stages in distinct countries.

Possibility of trading intermediate stages $\Leftrightarrow$ TFP improvement

Overall welfare gains v.s. Distributional conflicts

The effects of fragmentation

Yi 2003

Two features of trade share growth in the world economy

- The growth is generally thought to be driven by falling tariff barriers worldwide. But tariff barriers have dropped by only 11% since 1960.
- Tariff declines were much smaller after the mid 1980s, while trade growth accelerates.

Settings

- Three sequential stages of production
  - The first two stages can be produced offshore;
  - The third stage must be completed close to the firm's headquarters.

Finding

- Multistage production amplifies the effects of tariff reduction.
- Logic: Tariff applies to the gross value of production, not value added.

The effects of fragmentation

Baldwin & Robert-Nicoud 2007, Grossman & Rossi-Hansberg 2012

Features of the studies above

- Countries have different technologies or different factor endowments.
- Tasks are performed offshore due to lower costs or higher productivity.

Settings

- Countries have similar aggregate TFP and still trade tasks.
- Scale economy at the task level / Agglomeration.

The effects of fragmentation

Rodríguez-Clare 2007

Statics $\Rightarrow$ Dynamics

Settings

- EK (2002) setup embedded in a quality-ladder growth model;
- The dynamics of technology or factor accumulation.

Finding

- In the long run, although the rich country always gains from a reduction in offshoring costs, the poor country may reduce research effort and therefore suffer.

1 Introduction

2 Firm Organization Problem

- Fragmentation in otherwise Neoclassical Models
- Matching and Factor Heterogeneity
- Contractual Frictions and Multinational Firm Boundaries

3 Trading Firms and the Environment: An Application

4 Conclusion

The most basic organization problem

Lucas 1978

Settings

- All agents are heterogenous in management ability A;
- They are identical as workers;
- Production function $AF(n)$ concave in $F(\cdot)$.

$$\pi(A) = \max_n \{AF(n) - wn\}$$
$$\Rightarrow n^* = F'^{-1}(w/A) \equiv G(A) \text{ increasing in } A. \tag{2}$$

Not a well-determined matching problem

- No skill complementarity: the ablity as a single worker is irrelevant for his management skill.

How the skill distribution matters for the organization

Kremer & Maskin 1996

Three technological requirements

- Skill complementarity
  - Better teammates increase a worker's marginal product.
- Imperfect substitutability among workers' skills
  - Workers with different skills perform different roles in production.
- Differential sensitivity to the skill of different workers
  - Marginal increases in worker skill lead to differential marginal increases in output.

International teams: One-to-one matching

Kremer & Maskin 1996, 2006

Settings

- Two countries and just one consumption good;
- The *rich* country has workers of 2 skill levels A and B; the *poor* country has workers of 2 skill levels C and D. $A > B > C > D$.
- Each competitive firm has 2 tasks: managerial task L_m and blue-collar task L_b.
- Output price $\equiv 1$ and the production function is

$$y = L_m^2 L_b = \begin{cases} A^2B & \text{if} \quad L_m = A, L_b = B, \\ B^2A & \text{if} \quad L_m = B, L_b = A. \end{cases} \tag{3}$$

International teams: One-to-one matching

Kremer & Maskin 1996, 2006

Cross-matching beats self-matching if

$$2A^2B > A^3 + B^3 \quad \Leftrightarrow \quad A < \left(\frac{1+\sqrt{5}}{2}\right)B. \tag{4}$$

If A-workers are self-matched in equilibrium,

$$A^3 - 2w_A = 0 \quad \Rightarrow \quad w_A = \frac{A^3}{2}; \tag{5}$$

if A- and B-workers are cross-matched in equilibrium,

$$A^2B - w_A - w_B = 0. \tag{6}$$

International teams: One-to-one matching

Kremer & Maskin 1996, 2006

After globalization, all cross-matches are in principle possible.

Proposition

Given $B > \left(\frac{1+\sqrt{5}}{2}\right) D$, globalization (weakly) increases inequality in the poor country, in the sense that w_C (weakly) rises and w_D (weakly) falls. Furthermore, there is a broad range of parameters for which the increase in inequality is strict.

International teams: Hierarchical one-to-many matching

Antràs et al. 2006

Settings

- Two countries and one sector; countries differ in the skill distribution;
- Agents with skill z can solve problems requiring knowledge below z;
- The skill level of manager: z_m; the skill level of worker: z_p;
- Manager spends $0 < h < 1$ units of time communicating with workers.

Producer problem

$$R(z_m) = \max_{z_p} z_m n(z_p) - w(z_p)n(z_p) = \max_{z_p} \frac{z_m - w(z_p)}{h(1 - z_p)} \quad (7)$$

$$\text{s.t.} \quad h(1 - z_p)n = 1 \qquad \text{(Time Constraint)}$$

$$\Rightarrow \quad w'(z_p) = \frac{z_m - w(z_p)}{1 - z_p}. \quad (8)$$

Agent problem: $\max\{R(z), w(z)\}$.

International teams: Hierarchical one-to-many matching

Antràs et al. 2006

Equilibrium

- Labor markets clear: wages and earnings equalize;
- $\Rightarrow$ Agents with skill levels in $[0, z^*]$ become workers and agents in $[z^*, \bar{z}]$ become managers.

Closed-economy equilibrium

- Complementarity effect: Positive assortative matching. $\Rightarrow$ The best managers form teams with the best workers.

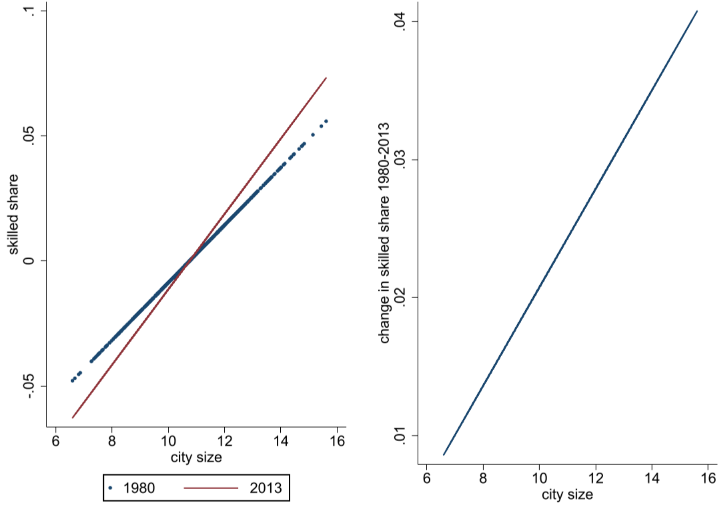
Open-economy equilibrium

- Managers can form teams with foreign workers.
- This reorganization of international production will increase wage inequality in the South.
  - Good workers in the South benefit from the possibility of being matched with better managers in the North.

Domestic fragmentation

Jiao & Tian 2021

Specialization and the widening human capital gap across cities



Domestic fragmentation

Jiao & Tian 2021

Settings

- Two inputs: more skill-intensive knowledge inputs and relatively less skill-intensive standardized production;
- Worker heterogeneity: high-skill & low-skill;
- Labor mobility;
- Fragmentation costs: the costs of communicating and coordinating due to the fragmentation.

Domestic fragmentation

Jiao & Tian 2021

Manager's optimization

- First, choose where to live, which is also where she works or where the firm's headquarters are located;
- Second, choose the location of the production team;
- Finally, decide on the production scale (how many workers to hire).

$\Rightarrow$ Backward induction.

Worker's optimization

- The same indirect utility across cities.

A temporary summary

Models above identify potential gains to fragment production across borders, or to use managerial know-how in a foreign country;

Not designed to explain

- Why these activities occur within firm's boundaries (i.e. foreign insourcing or FDI), rather than through arm's-length subcontracting, licensing, or outsourcing.

$\Rightarrow$ They are not theories of the MNE, but theories of the international production organization.

Internalization decision

Intel Corporation assembles most of its microchips in wholly owned subsidiaries in China, Costa Rica, Malaysia, and the Philippines.

v.s.

Nike subcontracts most of its manufacturing to independent producers in Thailand, Indonesia, Cambodia, and Vietnam.

Transaction cost theory

Williamson 1975, 1985

Settings

- The investments are relation-specific. $\Rightarrow$ stickiness.
- At the renegotiation stage, parties cannot costlessly switch to alternative trading partners, partially locked into a bilateral relationship.

$\Rightarrow$ The combination of bilateral bargaining & sunk costs may generate

- ex-post inefficiencies (e.g., inefficient termination or execution of the contract);
- ex-ante or hold-up inefficiencies (e.g., suboptimal provision of relationship-specific investments).

Transaction cost theory in international economics

Ethier 1986

Vertical integration v.s. transaction at arm's length

- Transaction at arm's length cannot offer quality-contingent contracts to downstream producers or distributors.
- $\Rightarrow$ Headquarters cannot always devise a contract that ensures ex-post efficiency and extracts all surplus from contracting partners.

$\Rightarrow$ Integrating downstream producers may be better.

McLaren 2000, Grossman & Helpman 2002

Vertical integration v.s. outsourcing

- Suppliers undertake relationship-specific investments.
- In outsourcing, the final-good producer will hold up the supplier at the ex-post bargaining stage by offering him low payment.

$\Rightarrow$ The suppliers invest less ex ante, or pay cost to integrate.

Property rights theory

Grossman & Hart 1986

The transaction-cost approach is silent on the sources of vertical integration costs. Or there is only one super-firm in the world...

- Ownership means the residual rights of control when contracts are incomplete.
- Vertical integration reduces the incentives of the integrated firm to make investments that are partially specific to the integrating firm,
- $\Rightarrow$ lowering the overall surplus of the relationship.

Property rights theory in international economics

Antràs 2003

- **Phenomenon:** Capital-intensive goods are transacted within firm boundaries, while labor-intensive goods are traded at arm's length.
- **Reason:**
  - Noncontractible investments by headquarters are more capital-intensive.
  - Those who invest more should have the residual rights of control to ensure incentives. (Grossman & Hart 1986)
- $\Rightarrow$ Integration beats outsourcing in headquarter intensive industries.

Antràs & Helpman 2004

- Allow for intra-industry heterogeneity;
- Only the most productive firms in an industry should be expected to vertically integrate their foreign suppliers.

Trading firms and the environment

Two tools

Decomposition

- Grossman & Krueger (1993) and Copeland & Taylor (1994) etc.
- Allow for both within-industry and within-firm changes in production.

Partial equilibrium model

- Firms choose the abatement level and decide whether to produce intermediate goods at home or outsource production abroad.

Trading firms and the environment

New hypotheses from firm heterogeneity

- The **pollution reduction by rationalization hypothesis (PRR)** links market share reallocations and selection effects in the Melitz (2003) model to changes in industry emissions.
- The **distressed and dirty industry hypothesis (DDI)** links changes in abatement and emission intensities to heightened foreign competition brought about by trade liberalization.
- The **pollution offshoring hypothesis (POH)** links firm-level decisions to offshore dirty intermediate inputs to trade liberalization with a partner that differs greatly in their pollution policy.

Industry-level decomposition

Consider an economy with aggregate pollution emissions Z generated by N industries. Each industry i emits Z_i units of pollution. S_i denotes the scale of production in industry i.

$$Z = \sum_{i=1}^{N} S_i E_i, \tag{9}$$

where $E_i = Z_i / S_i$ is the emission intensity of industry i.

$$\Rightarrow \hat{Z} = \hat{S} + \sum_{i=1}^{N} \Theta_i \hat{\Phi}_i + \sum_{i=1}^{N} \Theta_i \hat{E}_i, \tag{10}$$

- $S = \sum_{i=1}^{N} S_i$ is the economy-wide scale of output,
- $\Theta_i = Z_i / Z$ is the fraction of overall emissions Z from industry i,
- $\Phi_i = S_i / S$ is industry i's share of the economy's final output,
- $\hat{Z} = dZ/Z$, etc.

Industry-level decomposition

$$\hat{Z} = \hat{S} + \sum_{i=1}^{N} \Theta_i \hat{\Phi}_i + \sum_{i=1}^{N} \Theta_i \hat{E}_i$$

- $\hat{S}$: scale effect; changes in the overall level of economic activity.
- $\sum_{i=1}^{N} \Theta_i \hat{\Phi}_i$: composition effect; changes in the composition of economic activity across industries.
- $\sum_{i=1}^{N} \Theta_i \hat{E}_i$: technique effect; changes in the emission intensities of each industry.

Firm-level decomposition

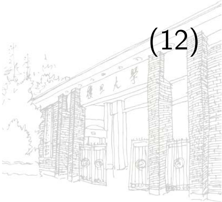
Suppose each industry i has a continuum of firms on the interval $[0, n_i]$. $z_i(n)$ denotes the emissions produced by firm n.

Aggregate industry emissions are

$$Z_i = \int_0^{n_i} z_i(n)\,dn \tag{11}$$

Denoting the value added produced by firm i as $v_i(n)$, the scale of output in industry i is

$$S_i = \int_0^{n_i} v_i(n)\,dn. \tag{12}$$



Firm-level decomposition

The emission intensity of industry i is

$$E_i = \frac{Z_i}{S_i} = \int_0^{n_i} e_i(n)\varphi_i(n)\,dn, \tag{13}$$

where

- $e_i(n) = \frac{z_i(n)}{v_i(n)}$ is the emission intensity of firm n,
- $\varphi_i(n) = \frac{v_i(n)}{S_i}$ is the value-added share of firm n in industry i.

$$\Rightarrow \hat{E}_i = \int_0^{n_i} \hat{e}_i(n)\theta_i(n)\,dn + \int_0^{n_i} \hat{\varphi}_i(n)\theta_i(n)\,dn + n_i[\theta_i(n_i) - \varphi_i(n_i)]\hat{n}_i, \tag{14}$$

where $\theta_i(n) = z_i(n)/Z_i$ is firm n's share of emissions in industry i.

- $\int_0^{n_i} \hat{e}_i(n)\theta_i(n)\,dn$: changes in firm-level emission intensities;
- $\int_0^{n_i} \hat{\varphi}_i(n)\theta_i(n)\,dn$: industry composition effect;
- $n_i[\theta_i(n_i) - \varphi_i(n_i)]\hat{n}_i$: the impact of entry and exit.

Within-firm adjustment

Suppose firm n produces output $y_i(n)$ by completing a set of $M_i(n)$ tasks. Let T_i be the scale of task i. Assume the firm's output to be

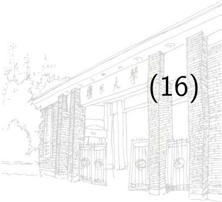
$$y_i(n) = f_{i,n}(T_1, T_2, ..., T_{M_i}). \tag{15}$$

Let

- $\lambda^I_{ij}(n)$ be the fraction of task j performed in-house by firm n,
- $\lambda^d_{ij}(n)$ be the fraction of task j outsourced domestically,
- $\lambda^*_{ij}(n)$ be the fraction of task j completed offshore.

We require

$$\lambda^I_{ij}(n) + \lambda^d_{ij}(n) + \lambda^*_{ij}(n) = 1. \tag{16}$$



Within-firm adjustment

$$p_i(n)y_i(n) = [1 + \mu_i(n)] \sum_{j=1}^{M_i} w_{ij}(n)\, T_{ij}(n), \tag{17}$$

where

- $p_i(n)$ is the price used to value output,
- w_{ij} is the price used to value a unit of task j,
- $\mu_i(n)$ is the rate at which firm n marks up the unit cost of tasks.

The value added produced by firm n is

$$\begin{aligned} v_i(n) &= p_i(n)y_i(n) - \sum_{j=1}^{M_i} [1 - \lambda_{ij}^I(n)]\, w_{ij}(n)\, T_{ij}(n) \\ &= \sum_{j=1}^{M_i} \lambda_{ij}^I(n) w_{ij}(n)\, T_{ij}(n) + \mu_i(n) \sum_{j=1}^{M_i} w_{ij}(n)\, T_{ij}(n). \end{aligned} \tag{18}$$

Within-firm adjustment

Denote the firm's domestic emission intensity of task j (per unit value) as $e_{ij}(n)$. The firm's domestic emissions level from task j is then

$$z_{ij}(n) = e_{ij}(n)\lambda_{ij}^{I}(n)\, w_{ij}(n)\, T_{ij}(n). \tag{19}$$

The total level of pollution emitted domestically by firm n in industry i is

$$z_i(n) = \sum_{j=1}^{M_i} z_{ij}(n) = \sum_{j=1}^{M_i} \lambda_{ij}^{I}(n)\, e_{ij}(n)\, w_{ij}(n)\, T_{ij}(n), \tag{20}$$

so the overall emission intensity of firm n (per dollar of value added) is

$$e_i(n) = \frac{z_i(n)}{v_i(n)} = \frac{\sum_{j=1}^{M_i} \lambda_{ij}^{I}(n)\, e_{ij}(n)\sigma_{ij}(n)}{\sum_{j=1}^{M_i} \lambda_{ij}^{I}(n)\sigma_{ij}(n) + \mu_i(n)}, \tag{21}$$

where

$$\sigma_{ij}(n) = \frac{w_{ij}(n)\, T_{ij}(n)}{\sum_{j=1}^{M_i} w_{ij}(n)\, T_{ij}(n)} \tag{22}$$

is the share of task j in the total cost of all tasks.

Within-firm adjustment

Decompose the emission intensity of firm n in industry i:

$$
\begin{aligned}
\hat{e}_i(n) = & \underbrace{\sum_{j=1}^{M_i} \theta_{ij}(n)\hat{e}_{ij}(n)}_{\text{technique effect}} + \underbrace{\sum_{j=1}^{M_i} [\theta_{ij}(n) - \varphi_{ij}(n)]\hat{\sigma}_{ij}(n)}_{\text{composition / reorganization effect}} \\
& \underbrace{- \sum_{j=1}^{M_i} \frac{\lambda_{ij}^d(n)}{\lambda_{ij}^I(n)} [\theta_{ij}(n) - \varphi_{ij}(n)] \hat{\lambda}_{ij}^d(n)}_{\text{domestic outsourcing effect}} \\
& \underbrace{- \sum_{j=1}^{M_i} \frac{\lambda_{ij}^*(n)}{\lambda_{ij}^I(n)} [\theta_{ij}(n) - \varphi_{ij}(n)] \hat{\lambda}_{ij}^*(n)}_{\text{offshoring effect}} \underbrace{-\varphi_{i\mu}(n)\hat{\mu}_i(n)}_{\text{markup effect (-)}},
\end{aligned}
\tag{23}
$$

- $\theta_{ij} = z_{ij}(n)/z_i(n)$ is task j 's in-house emissions share in firm n,
- $\varphi_{ij}(n)$ is the firm's in-house production share of task j in value added,
- $\varphi_{i\mu}(n)$ is the share of revenue from markups in value added.

Within-firm adjustment

$$
\begin{aligned}
\hat{Z} = {} & \hat{S} + \sum_{i=1}^{N} \Theta_i \hat{\Phi}_i + \sum_{i=1}^{N} \Theta_i \int_0^{n_i} \hat{\varphi}_i(n)\theta_i(n)\,dn + \sum_{i=1}^{N} \Theta_i n_i [\theta_i(n) - \varphi_i(n_i)]\hat{n}_i \\
& + \sum_{i=1}^{N} \Theta_i \int_0^{n_i} \left[\sum_{j=1}^{M_i} [\theta_{ij}(n) - \varphi(n)]\hat{\sigma}_{ij}(n) \right] \theta_i(n)\,dn \\
& - \sum_{i=1}^{N} \Theta_i \int_0^{n_i} \left[\sum_{j=1}^{M_i} \frac{\lambda_{ij}^{d}(n)}{\lambda_{ij}^{I}(n)} [\theta_{ij}(n) - \varphi_{ij}(n)] \hat{\lambda}_{ij}^{d}(n) \right] \theta_i(n)\,dn \\
& - \sum_{i=1}^{N} \Theta_i \int_0^{n_i} \left[\sum_{j=1}^{M_i} \frac{\lambda_{ij}^{*}(n)}{\lambda_{ij}^{I}(n)} [\theta_{ij}(n) - \varphi_{ij}(n)] \hat{\lambda}_{ij}^{*}(n) \right] \theta_i(n)\,dn \\
& + \sum_{i=1}^{N} \Theta_i \int_0^{n_i} \left[\sum_{j=1}^{M_i} \theta_{ij}(n)\hat{e}_{ij}(n) \right] \theta_i(n)\,dn - \sum_{i=1}^{N} \Theta_i \int_0^{n_i} [\varphi_i(n)\hat{\mu}_i(n)]\theta_i(n)\,dn
\end{aligned}
\tag{24}
$$

Technology and costs

Settings: (Melitz 2003)

- Produce differentiated goods; monopolistic competition
- CES preference
- Firms must pay a fixed entry cost to obtain a productivity draw and a fixed cost to engage in any production.
- Firms have to pay an additional fixed cost F_e (in terms of labor) to export and incur variable shipping costs.

Technology and costs

The firm produces final goods by using a Leontief technology to assemble a continuum of intermediates $x(j), j \in [0, 1]$.

Each intermediate good j is produced with a CES production technology using clean and dirty inputs:

$$x(L, D; j) = \gamma[a_j^{1-\delta} L^\delta + b_j^{1-\delta} D^\delta]^{1/\delta}, \tag{25}$$

where $\delta < 1$, $a_j > 0$, and $b_j > 0$.

- L is a clean input (such as labor) with factor price w
- D is a dirty input available at price r
- $\gamma > 0$ is a productivity parameter
- j increases in the dirty input intensity of intermediates b_j/a_j.

Technology and costs

Firms can pay a fixed cost A to invest in abatement technology. So the pollution emissions are

$$z = g(A)D, \tag{26}$$

where $g(A)$ is decreasing in A and $0 \leq g(A) \leq 1$.

The government regulates pollution with an emission tax τ, so the full price τ_D for the dirty input is

$$\tau_D = r + \tau g(A). \tag{27}$$

Technology and costs

Firms decide to produce intermediates in-house or offshore abroad by comparing relative costs. Assume that the pollution charges at home are relatively high, [1]

$$\frac{\tau_D}{w} > \frac{\tau_D^*}{w^*}. \tag{28}$$

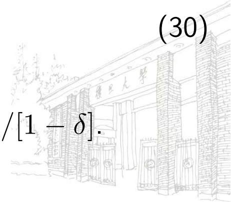
The domestic firm offshores intermediates for which

$$[1+\kappa]c^*(w^*, \tau_D^*; j) < c(w, \tau_D; j), \tag{29}$$

where

$$c(w, \tau_D; j) = \frac{1}{\gamma}\left[a_j w^{1-\sigma} + b_j \tau_D^{1-\sigma}\right]^{\frac{1}{1-\sigma}}. \tag{30}$$

- $\kappa > 0$ shows the variable costs of outsourcing; $\sigma = 1/[1-\delta]$.



[1] $*$ denotes foreign variables.

Technology and costs

$$[1+\kappa]\, c^*(w^*, \tau_D^*; j) < c(w, \tau_D; j), \quad \Leftrightarrow \quad \frac{w}{w^*} > [1+\kappa]\, T_j \tag{31}$$

where

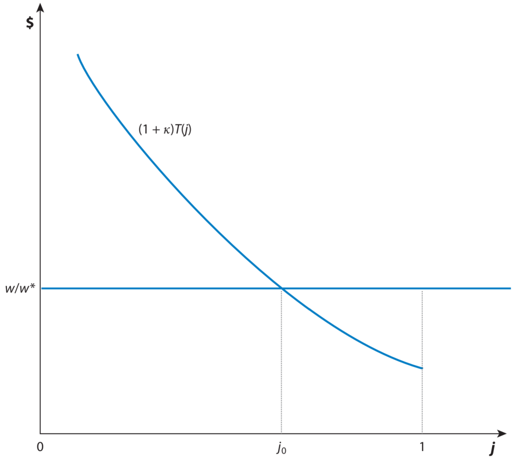
$$T_j \equiv \frac{\gamma}{\gamma^*} \left[\frac{1 + \frac{b_j}{a_j}[\tau_D^*/w^*]^{1-\sigma}}{1 + \frac{b_j}{a_j}[\tau_D/w]^{1-\sigma}} \right]^{1/[1-\sigma]} \tag{32}$$

measures the role of environmental policy and emission intensities in determining the cost of foreign production relative to home production.

- Intermediates on the interval $(j_0, 1]$ are offshored because of the relatively stringent environmental policy at home.

Technology and costs

The Decision to Offshore



Source: Cherniwchan et al 2017.

With-firm Adjustment

POH

Technology and costs

Finally, the firm minimizes costs by choosing abatement:

$$C(A) = \int_0^{j_0} c(w, \tau_D(A); j)\, dj + \int_{j_0}^{1} c^*(w^*, \tau_D^*; j)\, dj. \tag{33}$$

$$\Rightarrow \quad \tilde{C}(A) = \min_A \{yC(A) + A\}. \tag{34}$$

- Higher emission charges increase the incentive to abate, as do higher output levels.
- For given output levels, more productive firms abate less.

$\Rightarrow$ If a firm's output were to increase more than in proportion to an increase in productivity, then abatement would rise.

The effects of trade liberalization

Across-firm adjustments

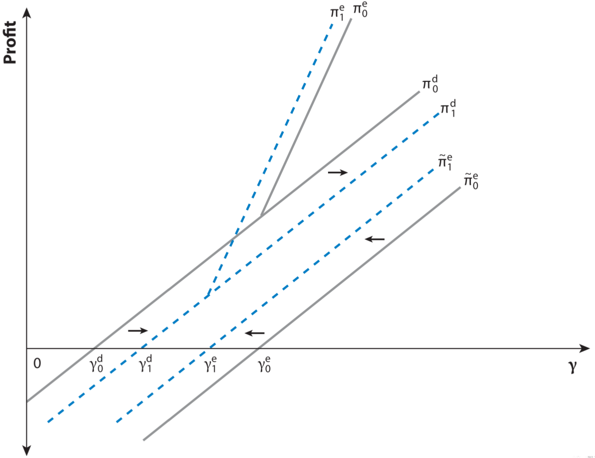
To focus on adjustments across firms, assume that

- firm-level emission intensities are constant (abatement is fixed, no outsourcing, and the price of dirty inputs is fixed)
- only one industry.

The effects of trade liberalization

Across-firm adjustments

The Decision to Export and the Effects of Trade Liberalization



Source: Cherniwchan et al. 2017.

The effects of trade liberalization

Across-firm adjustments

Because emission intensities are constant, the effect of trade liberalization on emissions is

$$dZ = \underbrace{dS}_{\text{scale effect } (+)} + \underbrace{\int_0^{n_0} e(n)\,d\varphi(n)\,dn}_{\text{market share reallocation (-)}} + \underbrace{\varphi(n)[e(n) - E]\,dn_0}_{\text{selection effects (-)}}, \tag{35}$$

where n_0 is the marginal firm.

$\Rightarrow$ **Pollution Reduction by Rationalization (PRR) hypothesis:** trade liberalization lowers industry emissions because a mix of exit, entry, and market share reallocations overwhelms the positive scale effects created by new export opportunities.

The effects of trade liberalization

Within-firm adjustments

For a single firm, $z = ve$. Hence,

$$\hat{z} = \hat{v} + \hat{e}, \tag{36}$$

where

$$\hat{e} = \underbrace{\int_0^{j_0} \theta_j \hat{e}_j dj}_{\text{emission intensity change}} + \underbrace{[\theta_{j_0} - \varphi_{j_0}] d_{j_0}}_{\text{offshoring}}. \tag{37}$$

▸ Figure

The effects of trade liberalization

Emission intensities and abatement

Key question: whether firms' endogenous abatement choices reinforce the rationalization and selection effects that operate at the industry level.

Three complications

1. Sensitive to the demand structure:
   - Cao et al. (2016) use a preference structure by Melitz & Ottaviano (2008) and show that more productive firms may abate less.
2. Investment in abatement need not lower emission intensities.
   - Direct effect: emissions per unit of the dirty input fall.
   - Classic rebound effect: abatement encourages substitution towards dirty inputs.
3. Winners v.s. losers: exporters expand output and become cleaner, while surviving domestic firms reduce output and thus abatement.

The effects of trade liberalization

Emission intensities and abatement

Endogenous abatement complicates the set of adjustments and may introduce a negative but novel potential outcome from trade liberalization.

- **Distressed and Dirty Industry (DDI) hypothesis:** trade liberalization increases industry emissions because of reductions in pollution control or abatement that downsize as a result of trade.

The effects of trade liberalization

Offshoring dirty inputs

Pollution Offshoring Hypothesis (POH): domestic firms become cleaner not because they have reduced the emission intensity, but because they have shifted the dirtiest parts of production abroad.[2] Figure

Two implications

- Abatement investments and offshoring dirty intermediates are substitutes for firms to react to more stringent environmental policy.
- If the POH holds, trade liberalization may reduce the incentives for pollution abatement investments.

[2] Unlike PHH, POH is more subtle as it concerns the fragmentation of production — only the dirtiest parts of the production process are shifted abroad.

Conclusion

- The development of trade theory is, to a large extent, the process of increasingly deepening specialization, from industry-level to firm-level and then to production-stage-level.
- Corresponding to this development, heterogeneity at different levels takes place. New sources of gains from trade and the possibility of distortions emerge.

The End

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