The proximity-concentration trade-off with multiproduct multinational firms

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Research question

- This paper investigates how strategic interaction between multinational companies (MNCs) affects FDI stocks, market shares and markups
- The framework encompasses market-seeking (horizontal) FDI
- In particular, each MNC is **multiproduct** and faces a trade-off in choosing the number of domestic affiliates (concentration of activity in the domestic market) against the number of foreign affiliates (proximity to the foreign market)
- As a result of this trade-off, MNCs domestic and foreign market shares always move in opposite directions
- The trade-off stems from cannibalization among varieties (each affiliate one variety) that limits their total number

Relationship with the existing literature (1)

- Brainard (1993, 1997), Antràs and Yeaple (2014) are standard references for the proximity-concentration trade-off with single-product firms
- In this framework, single-product firms have to decide whether to serve the foreign market through exports or through a foreign plant that locally serves the foreign market
- From a theoretical point of view: High substitutability favors proximity
- From a theoretical/empirical point of view: Low trade costs favor concentration
- From an empirical point of view: A significant share of two-way FDI flows is intraindustry in nature
- **Caveat:** I will not look at trade flows, but I will concentrate on the market shares and the number of affiliates

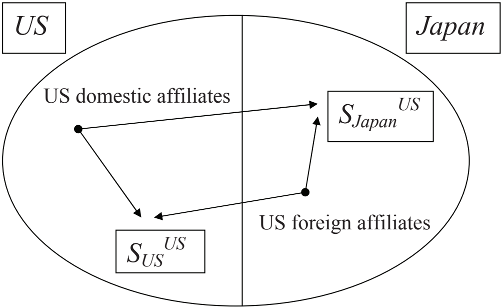
Relationship with the existing literature (2)

- Baldwin and Ottaviano (2001), *J Int Ec*, two MNCs with two varieties each: they show the existence of reciprocal FDI dumping (MNCs accept a lower rate of return on FDI) but fixing the number of varieties the extensive margin is lost. Extensive margin is crucial to understand the proximity-concentration trade-off faced by MNCs
- Baldwin and Ottaviano (1998) NBER working paper: I employ the same framework, and I fully solve their model. I derive the equilibrium market shares, and the equilbrium number of varieties and I perform comparative statics
- Feenstra and Ma (2008): multiproduct firms without FDI, and without trade costs (trade is captured by a doubling of market size)

Some raw correlations: US and Japan

- Data for U.S. and Japan, the two biggest national economies worldwide, over the period 1983-2004
- All industries
- I consider the empirical link between
  1. the average number of foreign affiliates per MNC in U.S. and Japan
  2. total market shares by U.S. and Japan MNCs, both at home and abroad
- The tricky part is to build a measure of 2.
- For, say, U.S. MNCs domestic share (i.e., the market share totalled by U.S. MNCs in the U.S.) I had to assemble data for
  i. total sales of U.S. parent companies
  ii. total export (to all countries) made by U.S. parent companies
  iii. total export of U.S. foreign affiliates located in Japan back to U.S.
  iv. current prices U.S. GDP
- I subtract total export from total sales of U.S. parent companies (to retrieve domestic sales by U.S. MNCs) and then I add export from U.S. affiliates in Japan to the U.S.

Figure: Market shares and the structure of production by U.S. MNCs



Regression results

	(1) FDI to US Coef./se	(2) FDI to US Coef./se	(3) FDI to Japan Coef./se	(4) FDI to Japan Coef./se
Foreign market share	56.092***	39.476***	0.215	1.138**
	(7.150)	(10.161)	(0.515)	(0.498)
Domestic market share	-2.119**	-1.886*	-0.340***	-0.237***
	(0.934)	(0.938)	(0.102)	(0.079)
Host GDP		-0.387		-0.005
		(0.244)		(0.009)
Source GDP		0.064		-0.074***
		(0.101)		(0.019)
Constant	-0.146	1.488	0.497***	0.602***
	(0.562)	(1.137)	(0.031)	(0.078)
Linear time trend	-0.023**	0.118	0.004***	0.032***
	(0.010)	(0.098)	(0.001)	(0.008)
Median of dep. variable	1.190	1.190	0.379	0.379
R^2	0.788	0.802	0.799	0.890
Obs.	19	19	22	22

- For both U.S. and Japan MNCs the decrease of market shares in the domestic (source) market correlates with an increase of FDI
- The increase of market shares in the foreign (host) country correlates with an increase of FDI
- I wish to build a model consistent with such a behaviour
- I take this as evidence of a proximity-concentration trade-off faced by MNCs

Model setup

- Same setup of Baldwin and Ottaviano (1998) NBER working paper: two multiproduct multinational firms located in two different countries, 1 and 2
- Two sectors: agriculture (numeraire) and manufacturing
- Manufacturing is characterized by horizontal product differentiation, each variety is produced in a different plant
- There exist "iceberg" transport costs ($\tau \geq 1$) and foreign investment costs ($\Gamma_1 \geq 1$ and $\Gamma_2 \geq 1$)
- Labor is the sole factor of production, L_1 workers in country 1 and L_2 workers in country 2

Demand side

- Quasi-linear utility function

$$\begin{aligned} U(A,M) &= A + e\log M, \quad \text{with} \quad e<1 \\ \text{s. to} \quad & A + \int_{j\in\Omega} p(j)c(j) \le y \end{aligned}$$

- M is a standard Dixit-Stiglitz (1977) preference-for-diversity CES index

$$M = \left(\sum_{j\in\Omega} c(j)^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}$$

- Following maximization of utility

$$A = y - e, \quad \text{where} \quad e = \int_{j\in\Omega} p(j)c(j)$$

- The direct and inverse demand functions in country 1 are then

$$c(i) = \frac{p(i)^{-\sigma} eL_1}{\sum_{j\in\Omega} p(j)^{-(\sigma-1)}}, \quad p(i) = \frac{c(i)^{-1/\sigma} eL_1}{\sum_{j\in\Omega} c(j)^{(\sigma-1)/\sigma}}$$

Supply side

- Through an appropriate choice of measurement units, we can normalize to one wages and the variable cost of production
- Profits of MNC 1 come from the two markets
- π_1^1 are the operating profits in market 1 of MNC 1 (its domestic market)

$$\pi_1^1 = \sum_{j \in \Omega_1^1} [p_{11}^1(j) - 1] c_{11}^1(j) + \sum_{j \in \Omega_2^1} [p_{21}^1(j) - \tau] c_{21}^1(j)$$

  e.g., Ω_2^1 is the set of MNC 1's varieties that are located in country 2 (their number is n_2^1)

  e.g., $p_{21}^1(j)$ is the price charged by MNC 1 for varieties produced in country 2 and then shipped to country 1, $c_{21}^1(j)$ is the corresponding quantity

- π_2^1 are the operating profits in market 2 of MNC 1 (its foreign market)

$$\pi_2^1 = \sum_{j \in \Omega_1^1} [p_{12}^1(j) - \tau] c_{12}^1(j) + \sum_{j \in \Omega_2^1} [p_{22}^1(j) - 1] c_{22}^1(j)$$

- Total profits are $\Pi^1 = \pi_1^1 + \pi_2^1 - (n_1^1 + n_2^1 \Gamma_2) F$

Solving the model

- Two stages game
- **First stage:** MNCs determine the number of varieties in each market. MNC 1 chooses $\{n_1^1, n_2^1\}$ and MNC 2 determines $\{n_1^2, n_2^2\}$
- **Second stage:** MNCs compete in quantities (multiproduct duopoly with two segmented markets)
- The model is solved by backward induction: first of all, I work out optimal quantities conditional on the number of varieties in each market, then I work out the optimal number of varieties
- The solution of the first stage solves the trade-off between concentration of economic activity in the domestic market $(n_1^1,\ n_2^2)$ and proximity to the foreign one $(n_2^1,\ n_1^2)$

MNCs problem in the second stage (1)

- Maximization takes place with respect to **operating profits** in each segmented market
- I maximize operating profits with respect to quantities (maximization of total profits will enter the choice of the number of varieties). Let us consider profits by MNC 1 in market 1

$$\max_{\{c_{11}^1(i), c_{21}^1(i)\}} \quad \pi_1^1 = \sum_{j \in \Omega_1^1} [p_{11}^1(j) - 1] c_{11}^1(j) + \sum_{j \in \Omega_2^1} [p_{21}^1(j) - \tau] c_{21}^1(j) \tag{1}$$

- Let us consider maximization with respect to $c_{11}^1(i)$
- The first order condition is

$$\frac{\partial \pi_1^1}{\partial c_{11}^1(i)} = 0$$

MNCs problem in the second stage (2)

- Operating profits are:

$$\pi_1^1 = \sum_{j \in \Omega_1^1} [p_{11}^1(j) - 1] c_{11}^1(j) + \sum_{j \in \Omega_2^1} [p_{21}^1(j) - \tau] c_{21}^1(j)$$

- I adapt the solution for multiproduct firms in Minniti and Turino (2013) with maximization with respect to price to the case of maximization with respect to quantity. First of all, I get

$$\frac{\partial p_{11}^1(i)}{\partial c_{11}^1(i)} c_{11}^1(i) + p_{11}^1(i) + \sum_{j \in \{\Omega_1^1 \setminus i\}} \frac{\partial p_{11}^1(j)}{\partial c_{11}^1(i)} c_{11}^1(j) - 1 + \sum_{j \in \Omega_2^1} \frac{\partial p_{21}^1(j)}{\partial c_{11}^1(i)} c_{21}^1(j) = 0 \qquad (2)$$

- Yang and Heijdra (1993) and d'Aspremont et al. (1996) point out that a central issue with the monopolistic competition version of the Dixit-Stiglitz model is to determine what effects of firms' strategic choices should be taken into account in the computation of the equilibrium and what effects should be neglected
- This is *a fortiori* crucial with multiproduct firms. What are the partial derivatives that are different from zero in (2)?

$$\frac{\partial p_{11}^{1}(i)}{\partial c_{11}^{1}(i)} \neq 0,$$
$$\frac{\partial p_{11}^{1}(j)}{\partial c_{11}^{1}(i)} \neq 0, \quad \text{with} \quad j \neq i$$
$$\frac{\partial p_{21}^{1}(j)}{\partial c_{11}^{1}(i)} \neq 0.$$

- Consider the following inverse demand function for a generic variety j

$$\ln p_{11}^{1}(j) = -\frac{1}{\sigma} \ln c_{11}^{1}(j) - \frac{\sigma - 1}{\sigma} \ln M_1 + \ln eL_1$$

where M_1 is the CES quantity index in market 1:

$$M_1 =$$
$$\left[\sum_{j \in \Omega_1^1} c_{11}^{1}(j)^{(\sigma-1)/\sigma} + \sum_{j \in \Omega_2^1} c_{21}^{1}(j)^{(\sigma-1)/\sigma} + \sum_{j \in \Omega_1^2} c_{11}^{2}(j)^{(\sigma-1)/\sigma} + \sum_{j \in \Omega_2^2} c_{21}^{2}(j)^{(\sigma-1)/\sigma} \right]^{\frac{\sigma}{\sigma-1}}$$

MNCs problem in the second stage (4)

- Solving the problem I get these equilibrium prices

$$p_{11}^1 = \frac{\sigma}{(\sigma - 1)(1 - S_1^1)}, \quad p_{21}^1 = \tau \frac{\sigma}{(\sigma - 1)(1 - S_1^1)}$$
$$p_{22}^1 = \frac{\sigma}{(\sigma - 1)(1 - S_2^1)}, \quad p_{12}^1 = \tau \frac{\sigma}{(\sigma - 1)(1 - S_2^1)}$$

where

$$S_1^1 = n_1^1 s_{11}^1 + n_2^1 s_{21}^1$$
$$S_2^1 = n_1^1 s_{12}^1 + n_2^1 s_{22}^1$$

and $s_{11}^1 \equiv p_{11}^1 c_{11}^1 / eL_1$

- Mark-ups (in percentage terms) are

on **shipments to the domestic market**: $\frac{p_{11}^1 - 1}{p_{11}^1} = \frac{p_{21}^1 - \tau}{p_{21}^1} = \frac{1}{\sigma} + \frac{\sigma - 1}{\sigma} S_1^1$

on **shipments to the foreign market**: $\frac{p_{22}^1 - 1}{p_{22}^1} = \frac{p_{12}^1 - \tau}{p_{12}^1} = \frac{1}{\sigma} + \frac{\sigma - 1}{\sigma} S_2^1$

MNCs problem in the first stage

- Maximization takes place with respect to **total profits**
- I maximize total profits with respect to the number of varieties in each market, n_1^1 and n_2^1. Let us consider total profits by MNC 1:

$$\max_{\{n_1^1, n_2^1\}} \quad \Pi^1 = \frac{1}{\sigma}\left\{eL_1 S_1^1[1+(\sigma-1)S_1^1] + eL_2 S_2^1[1+(\sigma-1)S_2^1]\right\} - (n_1^1 + n_2^1\Gamma_2)F$$

- The first order conditions are

$$\frac{\partial \Pi^1}{\partial n_1^1} = 0, \quad \frac{\partial \Pi^1}{\partial n_2^1} = 0$$

- For MNC 2 I get

$$\frac{\partial \Pi^2}{\partial n_2^2} = 0, \quad \frac{\partial \Pi^2}{\partial n_1^2} = 0$$

- The simultaneous solution of these four conditions leads to the **solution of the proximity-concentration trade-off** by MNCs
- I analyze the solution to this trade-off in terms of
  1) Equilibrium market shares
  2) Equilibrium number of affiliates, as a function of eq. market shares

Equilibrium market shares

- I get the following equation which implicitly defines the equilibrium market share S_2^1

$$\left(\frac{1-S_2^1}{S_2^1}\right)^{\sigma} = \frac{1+2(\sigma-1)(1-S_2^1)}{1+2(\sigma-1)S_2^1}\,\frac{\Gamma_2-\phi}{1-\Gamma_1\phi} \tag{3}$$

Lemma 1

In equilibrium, the value of the foreign market shares $\overline{S}_2^1$ and $\overline{S}_1^2$ is the following.

1) *When $\phi = 0$, $\overline{S}_2^1$ is strictly less than 1/2 if and only if $\Gamma_2 > 1$; $\overline{S}_1^2$ is strictly less than 1/2 if and only if $\Gamma_1 > 1$.*
2) *When $0 < \phi < 1$, both equilibrium foreign market shares $\overline{S}_2^1$ and $\overline{S}_1^2$ are strictly less than 1/2 if either $\Gamma_1 > 1$, or $\Gamma_2 > 1$, or both Γ_1 and Γ_2 are larger than one; they are equal to 1/2 if both Γ_1 and Γ_2 are equal to 1.*

- $\phi \equiv \tau^{-(\sigma-1)}$
- Investment frictions cause foreign market shares to be less than $1/2$

Dumping in trade (Proposition 1): Investment frictions are essential

- When $0 < \phi < 1$ it is enough that **either** $\Gamma_1 > 1$, **or** $\Gamma_2 > 1$ to have **both** foreign market shares strictly less than $1/2$

$$\begin{aligned} \text{MNC } 1: \quad & \overline{S}_2^1 < 1/2 \quad \text{and} \quad \overline{S}_1^1 > 1/2 \\ \text{MNC } 2: \quad & \overline{S}_1^2 < 1/2 \quad \text{and} \quad \overline{S}_2^2 > 1/2 \end{aligned}$$

  and hence to generate **dumping in trade** for both MNCs ▸ Mark-ups and mkt. shares

- Whatever it is ϕ ($0 \leq \phi < 1$), having no investment frictions in both countries ($\Gamma_1 = 1$ and $\Gamma_2 = 1$) ensures that there is **no dumping in trade**
- Comparison with the standard Brander and Krugman (1983) framework:
  - In Brander and Krugman (1983) dumping disappears when $\phi = 1$: model without FDI, the only way to secure equal market shares to the firms in the two countries is to assume that trade is free
  - In this paper dumping disappears when $\Gamma_1 = \Gamma_2 = 1$: model with FDI, a way to secure equal market shares to the firms in the two countries is to assume that foreign investment is free (even when trade is inhibited it is possible to have equal market shares)

Comparative statics on equilibrium market shares (1)

Proposition 2 (Investment liberalization and market shares)

A lower FDI friction parameter in one single country (either Γ_1 or Γ_2) affects negatively market shares and mark-ups in both domestic markets, and positively market shares and mark-ups in both foreign markets.

Explanation

- $\Gamma_2 \downarrow \Rightarrow \left\{ \overline{S}_2^1 \uparrow, \overline{S}_2^2 \downarrow \right\}$
- But relative profitability also changes: MNC 1 finds less profitable market 1 (its domestic market) and MNC 2 finds more profitable market 1 (its foreign market)
- This happens because mark-ups are increasing in market shares, hence changes in relative market shares brings a corresponding change in relative mark-ups and profitability in the two countries
- This creates room for additional investment and market shares reallocations: $\Gamma_2 \downarrow \Rightarrow \left\{ \overline{S}_2^1 \uparrow, \overline{S}_2^2 \downarrow \right\} \Rightarrow \left\{ \overline{S}_1^1 \downarrow, \overline{S}_1^2 \uparrow \right\}$
- Important result of the paper: the domestic and foreign market shares by each MNC are always **substitutes** (and not complements): cannibalization is essential for this result

Comparative statics on equilibrium market shares (2)

Proposition 3 (Trade liberalization)

A larger freeness of trade parameter, ϕ, affects positively market shares and mark-ups in both domestic markets, and negatively market shares and mark-ups in both foreign markets.

- **Domestic** market shares are **larger** with lower transport costs

Explanation

- Let us start from a situation such that trade is completely inhibited, $\phi = 0$: with some FDI frictions in both countries, it is still true that $\left\{\overline{S}_1^1 > 1/2, \overline{S}_2^2 > 1/2\right\}$
- $\phi \uparrow$, room for more investment, both at home and abroad: MNCs find convenient to invest relatively more in the more profitable market; that is, MNC 1 invests more in market 1 and MNC 2 invests more in market 2
- This gives rise to a further increase of $\overline{S}_1^1$ and $\overline{S}_2^2$, and, correspondingly, to a decrease of $\overline{S}_2^1$ and $\overline{S}_1^2$

Comparative statics on equilibrium market shares (3)

Proposition 4 (Product substitutability)

A larger substitutability parameter, σ, affects negatively market shares in the domestic markets and positively market shares in the foreign markets. This implies that, ceteris paribus, in industries where substitutability is higher, MNCs foreign market shares and mark-ups are higher.

Explanation

- $\sigma \uparrow$, overall profitability declines
- The MNCs' profitability decline differs across markets: it is stronger in the market where profitability is relatively higher (the domestic market)
- Due to the stronger decrease in domestic profitability, MNCs find convenient to reallocate affiliates so that there is now relatively more investment in foreign countries, with a relatively higher foreign market share

Equilibrium number of affiliates: gravity equation

- I get that the equilibrium number of varieties by MNC 1 in country 2 is

$$n_2^1 = \frac{eL_2[1+2(\sigma-1)\overline{S}_2^1]\overline{S}_2^1(1-\overline{S}_2^1)}{\sigma^2 F(\Gamma_2-\phi)} - \frac{\phi}{F(1-\Gamma_2\phi)}\frac{eL_1[1+2(\sigma-1)\overline{S}_1^1]\overline{S}_1^1(1-\overline{S}_1^1)}{\sigma^2}$$

- It is a **gravity equation**: the number of foreign affiliates located by MNC 1 in country 2 depends on the size of the foreign economy, eL_2, on the size of the domestic one, eL_1, and on freeness of trade, ϕ
- The overall impact of $\overline{S}_1^1$ is *a priori* ambiguous

Proposition 5

Assume that the domestic market share, $\overline{S}_1^1$, is below a threshold that is called $\overline{S}_1^{1,+}$, $\overline{S}_1^1 < \overline{S}_1^{1,+}$. Then, the number of foreign affiliates, n_2^1, is inversely related to the domestic market share $\overline{S}_1^1$, $\partial n_2^1/\partial \overline{S}_1^1 < 0$, if and only if $\overline{S}_1^1 < \overline{S}_1^{1,+}$.

- The threshold is $\overline{S}_1^{1,+} \in (1/2, 2/3)$, and is monotonically increasing in σ.
- This is consistent with raw evidence, since in the data domestic market shares are 0.58 for Japan and 0.55 for U.S

Comparative statics on the total number of foreign affiliates (1)

- The expression for the total stock of foreign affiliates is

$$n_2^1 + n_1^2 =$$

$$\frac{eL_2\overline{S}_2^1(1-\overline{S}_2^1)}{\sigma^2 F}\underbrace{\frac{1-(\Gamma_1+\Gamma_2)\phi+\phi^2}{(\Gamma_2-\phi)(1-\Gamma_1\phi)}}_{\text{Trade and FDI frictions}}\left\{1+2(\sigma-1)\underbrace{\left[\frac{1}{2}-\frac{1-(\Gamma_1-\Gamma_2)\phi-\phi^2}{1-(\Gamma_1+\Gamma_2)\phi+\phi^2}\left(\frac{1}{2}-\overline{S}_2^1\right)\right]}_{\text{Market share effect}}\right\}$$

$$+\frac{eL_1\overline{S}_1^2(1-\overline{S}_1^2)}{\sigma^2 F}\underbrace{\frac{1-(\Gamma_1+\Gamma_2)\phi+\phi^2}{(\Gamma_1-\phi)(1-\Gamma_2\phi)}}_{\text{Trade and FDI frictions}}\left\{1+2(\sigma-1)\underbrace{\left[\frac{1}{2}-\frac{1-(\Gamma_2-\Gamma_1)\phi-\phi^2}{1-(\Gamma_1+\Gamma_2)\phi+\phi^2}\left(\frac{1}{2}-\overline{S}_1^2\right)\right]}_{\text{Market share effect}}\right\}$$

- The red term is peculiar since it is neutralized for σ close to one (when σ is close to one each variety enjoys an almost perfect monopoly power and there is no interaction between the varieties' demand functions)
- What can we learn from this equation?
  1. $\overline{S}_1^2$ and $\overline{S}_2^1$ are positively related to the total number of foreign affiliates
  2. The red term identifies *a more than proportional link* between foreign market shares and the number of foreign affiliates in equilibrium that is stronger the higher it is σ

Comparative statics on the total number of foreign affiliates (2)

- Given the total stock of foreign affiliates

$$n_2^1 + n_1^2 =$$

$$\frac{eL_2\overline{S}_2^1(1-\overline{S}_2^1)}{\sigma^2 F}\underbrace{\frac{1-(\Gamma_1+\Gamma_2)\phi+\phi^2}{(\Gamma_2-\phi)(1-\Gamma_1\phi)}}_{\text{Trade and FDI frictions}}\left\{1+2(\sigma-1)\underbrace{\left[\frac{1}{2}-\frac{1-(\Gamma_1-\Gamma_2)\phi-\phi^2}{1-(\Gamma_1+\Gamma_2)\phi+\phi^2}\left(\frac{1}{2}-\overline{S}_2^1\right)\right]}_{\text{Market share effect}}\right\}$$

$$+\frac{eL_1\overline{S}_1^2(1-\overline{S}_1^2)}{\sigma^2 F}\underbrace{\frac{1-(\Gamma_1+\Gamma_2)\phi+\phi^2}{(\Gamma_1-\phi)(1-\Gamma_2\phi)}}_{\text{Trade and FDI frictions}}\left\{1+2(\sigma-1)\underbrace{\left[\frac{1}{2}-\frac{1-(\Gamma_2-\Gamma_1)\phi-\phi^2}{1-(\Gamma_1+\Gamma_2)\phi+\phi^2}\left(\frac{1}{2}-\overline{S}_1^2\right)\right]}_{\text{Market share effect}}\right\}$$

Proposition 6

The world FDI stock, $n_2^1 + n_1^2$, is decreasing as the cost of investing abroad in one of the two countries, Γ_1 or Γ_2, goes up, and as the degree of freeness of trade, ϕ, goes up.

- I identify a trade-off between proximity and concentration in relation to MNCs of the horizontal type
- I propose a model with multiproduct firms that is characterized by substitutability between foreign and domestic market shares
- The model delivers simple testable implications in terms of MNCs market shares and international trade policy
- I am able to retrieve a gravity equation for the number of foreign affiliates located in each country, and I also get an equation for the total number of affiliates in the two countries