Gravity Trade Model with Firm Heterogeneity and Horizontal FDI

Jeff Luckstead, Stephen Devadoss, and Xin Zhao

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Introduction

- ▶ Horizontal FDI industries:
    - ▶ parent company establishes affiliate firms in foreign countries & produces similar products.
- ▶ Proximity-conentration trade-off
    - ▶ firms choose exporting if <u>fixed building costs</u> are high or MNE operations if <u>variable trade costs</u> are high.

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- ▶ Markusen (2002) FDI impacts extensive margin and trade volume

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Does controlling for the impact of MNE operation in

- ▶ the proportion of exporting firms and
- ▶ bilateral trade flows

matter when estimating gravity equations?

Introduction

- ► Key studies
  - ► Helpman et al (2008) firm-level trade theory + gravity
  - ► Helpman (2004) firm-level trade theory and horz. FDI
- ► With fixed domestic, export, and MNE costs and
  - ► fixed export cost are sufficiently high
  - ► fixed export cost < fixed MNE costs

  Natural indexing of firms by size/productivity
  - ► MNE firms > Exporting firms > domestic only firms
- ► MNEs can be a small fraction of firms with large portion of sales.

Introduction

▶ FDI in the processed food became important circa 1980.

▶ Handy (1996) processed-food FDI
  ▶ due to the bulky nature of the raw materials,
  ▶ foreign affiliates utilize host country intermediate goods
  ▶ to produce their processed food to sell in the host country

▶ For an industry with relatively high trade cost,
  ▶ firms' choice b/t exporting and horiz. MNEs (Jabara, 2001)

▶ Processed food sector: consistent with a horiz.-FDI industry.

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Introduction

▶ Eurostat (2014-2016)
▶ On average, EU affiliate sales of processed food/beverages
  ▶ 15 and 12 times higher than exports in India and Brazil,
  ▶ but only 2.5 and 1.8 times higher in Russia and China.
▶ EU exports were 3 times larger than affiliate sales in Japan
  ▶ high entry barriers and building costs.
▶ Thus FDI influences processed food trade.

Literature

Irarrazabal et al. (2013) extend Helpman et al. (2008)

- ▶ Analyze exports vs MNE production with intrafirm trade
    - ▶ affiliate production utilizes inputs imported from headquarters and local inputs.
    - ▶ firm-level data, Norwegian firms, all manufacturing
- ▶ By contrast, our model
    - ▶ doesn't require firm-level data and is specific to horiz. MNE

Literature

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Hejazi et al. (2017) utilize Helpman et al. (2008)

▶ Estimate a multinomial logit model, agri-food goods

  ▶ analyze the impact of tariffs on

  ▶ extensive margins of trade by considering the probability of

  ▶ a country-pair entering, maintaining, or exiting a trade relationship.

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Contributions

There are four contributions:

1. develop a gravity model that captures the impacts of
   - ▶ firms' endogenous choice of horizontal MNEs v. exporting

   on bilateral trade.
2. three-stage estimation procedure:
   - ▶ MNE selection equation
   - ▶ export selection equation
   - ▶ gravity estimation of bilateral trade flows
3. show model correction for omitted variable bias
4. empirically apply method to the EU processed food

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Gravity Model

CES demand for export and MNE goods:

$x_{ij}^{e}(a) = \frac{p_{ij}^{e}(a)^{-\varepsilon}Y_j}{P_j^{1-\varepsilon}}$ and $x_{ij}^{f}(a) = \frac{p_{ij}^{f}(a)^{-\varepsilon}Y_j}{P_j^{1-\varepsilon}}$

▶ where Y_j is income, P_j is the CES price index, a is productivity, elasticity of substitution $\varepsilon = \frac{1}{1-\alpha}$.

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Pricing rules: $p_{ij}^e (a) = \tau_{ij} \frac{c_i^e a}{\alpha}$ and $p_{ij}^f (a) = \frac{c_j^f a}{\alpha}$.

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Per-unit input requirement a:

▶ truncated Pareto distribution $G(a) = \frac{(a)^k - (a_L)^k}{(a_H)^k - (a_L)^k}$ with support $[a_L, a_H]$ and shape parameter $k > \varepsilon - 1$.

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Gravity Model

Using the pricing rules, operating profits can be written as

- $\pi_{ij}^e(a) = (1-\alpha)\left(\tau_{ij}c_i^e a / \alpha P_j\right)^{1-\varepsilon} Y_j - c_i^e f_{ij}^e$

  $\pi_{ij}^f(a) = (1-\alpha)\left(c_j^f a / \alpha P_j\right)^{1-\varepsilon} Y_j - c_j^f f_{ij}^f$

A firm will

- export if profit opportunities exist or
- engage in FDI if affiliate profits exceed export profits.

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Gravity Model

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A firm will

- export if profit opportunities exist or

- engage in FDI if affiliate profits exceed export profits.

MNE fixed costs sufficiently larger than fixed export costs:

- mid-level productive firms $a \in [a_{ij}^f, a_{ij}^e]$ will export

- most productive firms with $a \in [a_L, a_{ij}^f]$ engage in FDI.

The cutoff per-unit input requirements, a_{ij}^e and a_{ij}^f satisfy:

- $\pi_{ij}^e\left(a_{ij}^e\right) = 0$ and $\pi_{ij}^f\left(a_{ij}^f\right) - \pi_{ij}^e\left(a_{ij}^f\right) = 0$.

Gravity Model

Total value of exports:
$$M_{ij}^e = \left(\frac{\tau_{ij} c_i^e}{\left(1 - \frac{1}{\varepsilon}\right) P_j} \right)^{1-\varepsilon} Y_j N_i V_{ij}^e,$$
where

- N_i is the measure of firms in i.

- $V_{ij}^e = \frac{k \left(a_{ij}^f \right)^{k-\varepsilon+1}}{\left(a_H^k - a_L^k \right)(k-\varepsilon+1)} W_{ij}^e$ and

  $W_{ij}^e = \max \left(\left(\frac{a_{ij}^e}{a_{ij}^f} \right)^{k-\varepsilon+1} - 1, 0 \right)$

- V_{ij}^e and W_{ij}^e
  - include the endogenous export a_{ij}^e and MNE cutoff a_{ij}^f
  - convert the proportion of exporting firms into bilateral trade impacts

Stage 1 MNE Selection

At least one MNE operates in destination market j

- ▶ if and only if $\pi_{ij}^{f}(a_L) > \pi_{ij}^{e}(a_L)$.

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Probit equation for FDI

$$\rho_{ij}^f = \Phi\left(\gamma_0^{f*} + \zeta_i^{f*} + \zeta_j^{f*} + \beta_1^* d_{ij} - \beta_2^* b_{ij}^{fe} - \kappa^* \phi_{ij}^{fe} + \eta_{ij}^{f*}\right),$$

▶ $\Phi(\cdot)$ is standard-normal CDF; asterisk coef divided by $\sigma_{\eta_{ij}^f}$.

▶ Variable costs include

    ▶ trade frictions, d_{ij}

    ▶ relative variable cost of MNE versus exporting, b_{ij}^{fe}.

    ▶ relative fixed cost of MNE versus exporting, ϕ_{ij}^{fe}.

Stage 1 MNE Selection

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▶ $\Phi(\cdot)$ is standard-normal CDF; asterisk coef divided by $\sigma_{\eta_{ij}^f}$.

▶ Variable costs include

    ▶ trade frictions, d_{ij}

    ▶ relative variable cost of MNE versus exporting, b_{ij}^{fe}.

    ▶ relative fixed cost of MNE versus exporting, ϕ_{ij}^{fe}.

Higher trade costs $\implies$ probability of MNE will be higher.

▶ $\hat{z}_{ij}^{f} = \Phi^{-1}\left(\hat{\rho}_{ij}^{f}\right)$ feeds into the 2nd- and 3rd-stages

Stage 2 Export Selection

As least one firm exports to the destination market j

- ▶ if and only if firms with unit-cost at or above a_{ij}^f

- ▶ earn positive export profits $\pi_{ij}^e \left(a_{ij}^f \right) > 0$

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Stage 2 Export Selection

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▶ earn positive export profits $\pi_{ij}^e \left(a_{ij}^f \right) > 0$

Probit equation for exporting from country i to j is
$$\rho_{ij}^e = \Phi \left(\lambda_1^{e*} + \xi_i^{e*} + \xi_j^{e*} - \gamma^{e*} d_{ij} - \kappa^{e*} \phi_{ij}^e - \varsigma^{e*} \hat{z}_{ij}^f + \eta_{ij}^{e*} \right),$$
depends on endogenous variable a_{ij}^f through $\hat{z}_{ij}^f$.

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Stage 3 Gravity Estimation

The gravity equation can be rewritten as

$$M_{ij}^e = \exp\left[\mu_0^e + \chi_i^e + \chi_j^e - \gamma d_{ij} + \theta_{ij}^e + \omega_{ij}^e\right] + u_{ij}^e, \qquad (1)$$

where $\theta_{ij}^e = \psi_1^e \hat{z}_{ij}^f$ and $\omega_{ij}^e = \ln\left[\exp\left(\delta^e z_{ij}^{e*}\right) - 1\right]$.

Stage 3 Gravity Estimation

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where $\theta_{ij}^e = \psi_1^e \hat{z}_{ij}^f$ and $\omega_{ij}^e = \ln\left[\exp\left(\delta^e z_{ij}^{e*}\right) - 1\right]$.

Relax truncated Pareto assumption; no analytical solution V_{ij}^e.

▶ Implementing the nonparameteric technique of HMR.

▶ $\hat{\rho}_{ij}^e$ are ranked and partitioned into 250 bins of equal size

▶ I_b^e is equal to one for $\hat{\rho}_{ij}^e$ in bin b and zero otherwise.

$$M_{ij}^e = \exp\left[\beta_0^e + \chi_i^e + \chi_j^e - \gamma d_{ij} + I_b^e\right] + u_{ij}^e. \qquad (2)$$

Data and Sources

- ▶ EuroStat: Bilateral trade and MNE panel data
  - ▶ 28 EU member countries and 132 countries
  - ▶ 2010 to 2016
- ▶ USTIC, Dynamic Gravity Dataset: trade friction variables
- ▶ Economic Freedom of the World
  - ▶ Fixed Trade Costs:
    - ▶ regulatory trade barriers, the non-tariff trade barriers, and compliance cost of importing and exporting indexes
  - ▶ Relative cost of production b/t home and destination:
    - ▶ centralized collective bargaining, labor market regulations, and hiring regulations and minimum wage.
  - ▶ Relative fixed MNE costs to fixed trade costs
    - ▶ extra payments/bribes/favoritism, administrative requirements, licensing restrictions

Results

	Baseline	Two-Stage		Three-Stage		
	Gravity	Trade Sel	Gravity	FDI Sel	Trade Sel	Gravity
Dist	-0.11*	0.08*	-0.04*	-0.28*	-0.06*	-0.08*
Com Lang	-0.52*	-0.01*	-0.62*	-0.22*	-0.12*	-0.53*
Cont Bor	1.97*	0.27*	2.42*	0.93*	0.82*	2.26*
Colony	0.69*	0.73*	2.42*	0.61*	1.05*	1.95*
FTA	0.16*	0.51*	0.68*	0.06*	0.54*	0.48*
Fix Trade		0.76*			0.67*	
Rel Var				-40.38*		
Rel Fix MNE				65.87*		
$\hat{z}_{ij}^f$					-0.96*	
I^b (250 bins)	No	No	Yes	No	No	Yes

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