

Firm Size and Complementarity between Geography and Products

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February 23, 2023

Question

- **Why are some firms larger than others?**

- Firm size = total sales
- Firms = manufacturing firms

- **Literature:** focuses on productivity dispersion

- Problem: the measured productivity dispersion much smaller than what a model requires
- What are the magnifying forces of productivity dispersion?

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What I do

- Demand residual in the decomposition of firm size heterogeneity (Hottman, Redding and Weinstein, 2016)

Appeal	Product scope	Cost	Markup
54%	26%	24%	-4%

- This paper: shows that product and geographic scope jointly amplifies initial productivity dispersion

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- **This paper:** shows that product and geographic scope **jointly** amplifies initial productivity dispersion

Approach of the paper

- Show **empirical facts** using Japanese transaction data
 - ▶ The importance of product scope & geographic scope
 - ▶ Three empirical patterns on firms' decisions on product and geographic scope

- Develop a **heterogeneous-firm model**
 - ▶ Higher-productivity firms develop more products and sell products in more markets
 - ▶ Structurally estimate parameters to fit empirical patterns
 - ▶ Model exercises to show the importance of complementarity between product and geographic scope
 - ▶ Welfare implication of the Japanese SME subsidy

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Outline of the talk

1 Empirical facts

2 Model

3 Conclusion

Nikkei Point of Sales (POS) data

Data	Contents
Barcode	Sales, units (quantities) and product category
Retail store	Name and address
Manufacturer	Manufacturer code and name
Frequency	Daily
Scope	350 retail stores within 38 chains
Year	2014-2018

- Observe **who** made the products and **where** they are sold
- Mainly products from CPG industry, covers 20% of CPI
- 2018 POS data includes
 - 20 billion USD worth of transactions
 - 16,000 manufacturers with 326,000 products

Firm size, product and geographic scopes

Decile-level statistics weighted by product category sales

Decile	Market share (%)	Mean # of products	Mean # of prefectures
1	89.25	58.6	28.2
2	7.22	17.5	17.4
3	2.72	9.3	12.5
4	1.20	5.1	9.5
5	1.61	3.6	7.4
6	0.32	2.8	5.4
7	0.16	2.6	4.1
8	0.08	2.2	3.0
9	0.03	1.7	2.2
10	0.01	1.3	1.5

- Larger firms ...

- develop more products (product scope)
- enter more prefectures (geographic scope)

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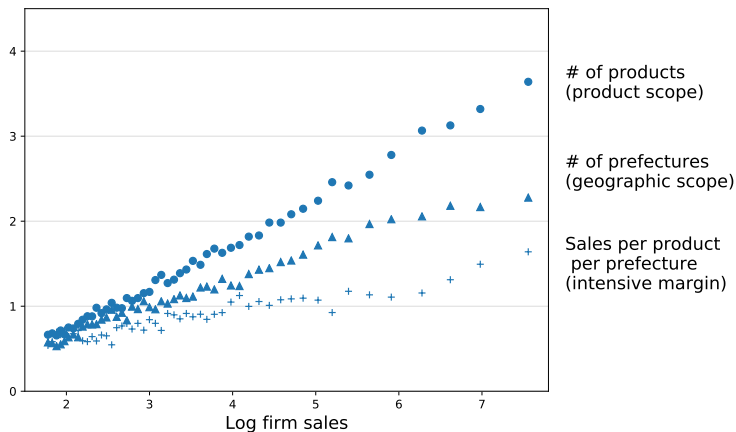
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Accounting decomposition of firm sales

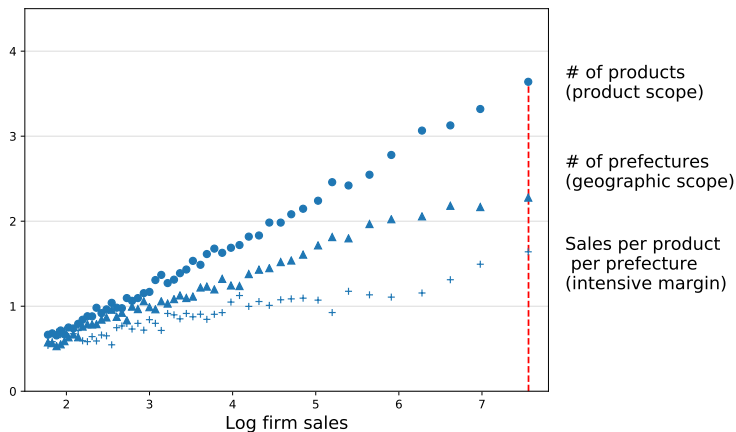
Accounting decomposition of sales by firm rank: for top 50 firms in each product category



- Product and geographic scope account for more than 75% of firm size heterogeneity

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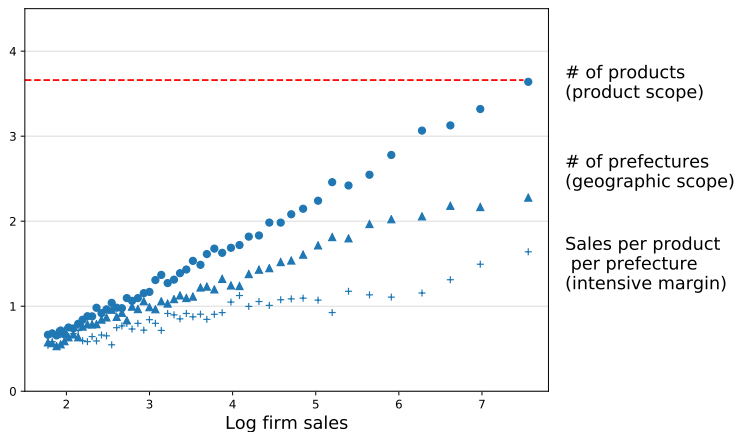
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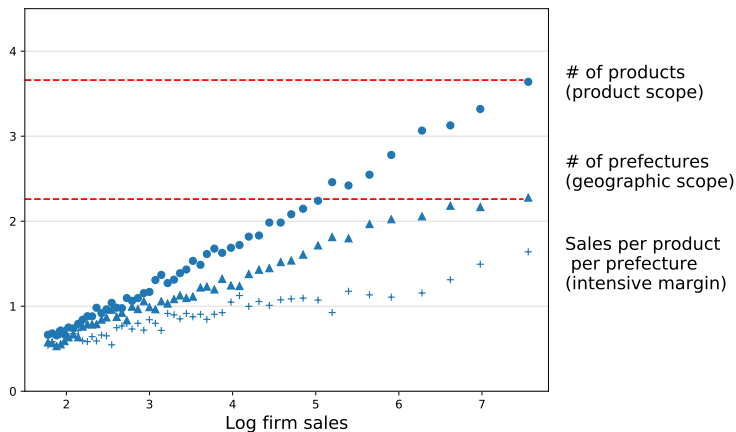
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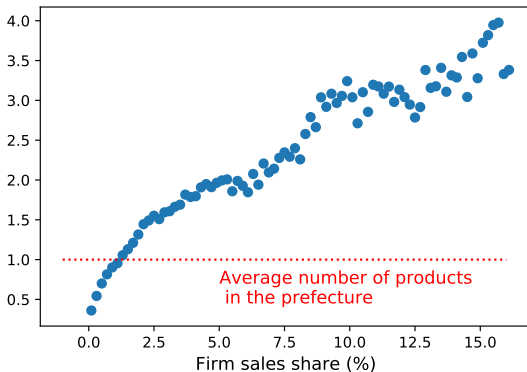
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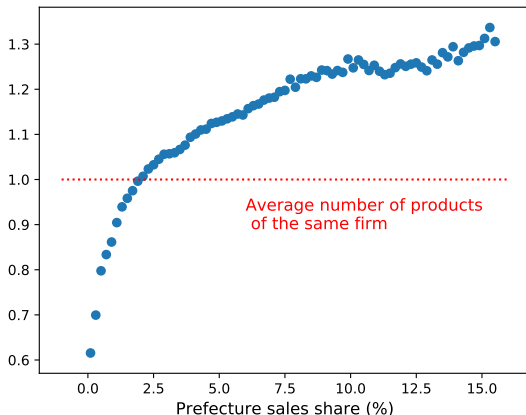
Fact 1: Larger firms sell more goods in a market

Average number of products in a market plotted on firm size



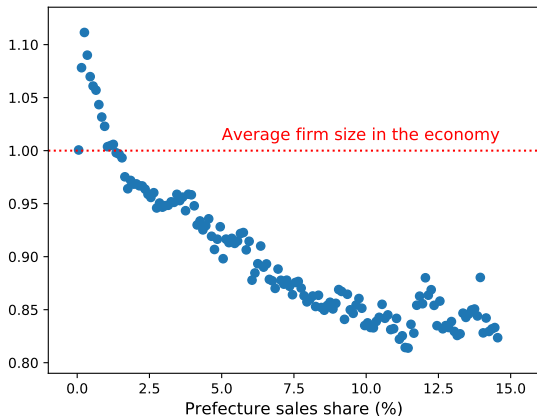
Fact 2: More goods in larger markets

Average number of products per firm in each prefecture plotted on prefecture market size



Fact 3: Larger firms enter smaller markets

Average size of firms selling in each prefecture plotted on prefecture market size



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Model summary

- Firms with heterogeneous productivity (Melitz, 2003)
- Multiple markets with different market sizes
- Firms choose:
 - ① how many products to develop
 - ② which markets to enter
 - ③ which products to sell in each market
- Fixed costs: of developing products, entering a market, and selling a product in a market

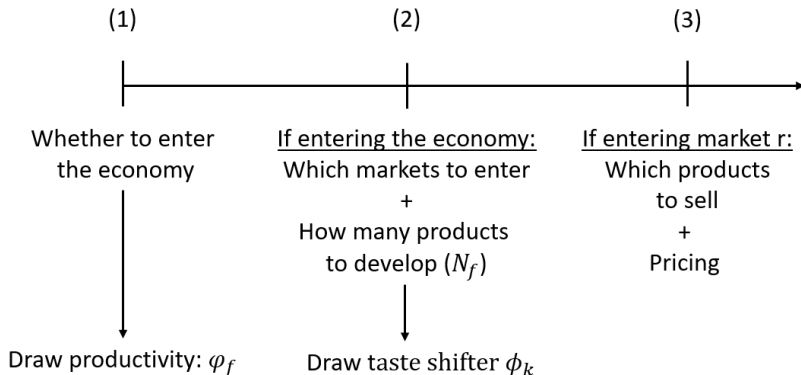
Preference

- Representative consumer in market r :

$$U^r = \left[\int_{f \in \Omega_r} \int_{k \in \Omega_{fr}} (\phi_k C_{kr})^{\frac{\sigma-1}{\sigma}} dk df \right]^{\frac{\sigma}{\sigma-1}}$$

- ▶ ϕ_k : taste shifter of product k
 - ▶ C_{kr} : consumption amount of product k in market r
 - ▶ Ω_r : set of firms in market r
 - ▶ Ω_{fr} : set of product firm f sells in market r
- In-elastically supply L_r amount of the endowed labor

Model timing: firms' decisions



Technology and market structure

- A firm's **marginal cost** is the same across products & markets:

$$MC_{kr} = MC_f = w\varphi_f^{-1}$$

- ▶ Linear production function with labor
- ▶ Firms mobile across markets (wage $w \equiv 1$)

- Monopolistic competition $\implies p_{kr} = p_f = \frac{\sigma}{\sigma-1}MC_f$

- **Fixed costs:**

- ▶ Fixed cost of entering the economy F_e
- ▶ Fixed cost of developing N_f products $F_d(N_f)^\theta$ where $\theta > 1$
- ▶ Fixed cost of entering a market F
- ▶ Fixed cost of selling each product in each market F_p

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Firm's decisions: solve backward

① Which products to sell in the entered markets

- ▶ Threshold taste shifter ϕ_{fr}^* for firm f in market r

$$\pi_{kr}(\phi_{fr}^*) \equiv (p_f - MC_f)C_{kr}(\phi_{fr}^*) = F_p$$

② How many products to develop & which markets to enter

$$\max_{N_f, \Omega_f} \pi_f = \sum_{r \in \Omega_f} \left\{ N_f \int_{\phi_{fr}^*}^{\infty} \pi_{kr} - F_p \, dF(\phi) - F \right\} - F_d (N_f)^\theta$$

- ▶ Ω_f : set of markets firm f enters
- ▶ Threshold productivity φ_r^* in market r

Firm's decisions: solve backward

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Interactions btw product and geographic scope

$\pi_f(N, M) \equiv$ Firm f 's profits when
developing N products
and entering M markets

- ① Develop more products \rightarrow enter more markets

$$\pi_f(N + 1, M + 1) - \pi_f(N + 1, M) \geq \pi_f(N, M + 1) - \pi_f(N, M)$$

- ② Enter more markets \rightarrow develop more products

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Parameter values

Parameter	Definition	Value	Target
R	Number of markets	43	Data (number of prefectures)
L^r	Market size		Data (sales in each prefecture)
$\log(\phi) \sim N(\mu, \sigma^2)$	Taste shifter distribution	$\mu = 0.47, \sigma = 0.92$	Relative sales within firm given prices
$\varphi \sim \text{Pareto}(\alpha, \bar{\varphi})$	Productivity distribution	$\alpha = 2.3, \bar{\varphi} = 1(\text{set})$	Dispersion in sales per product per market
σ	Elst. of substitution in CES	2.4	Elst. of sales per product wrt prices
F_e	FC of entering the economy	1.25	# of firms in the economy
θ	FC of developing products	2.6	Fact 1: Elst. of # of products wrt firm size
F_p	FC of selling a product in a market	1.50	Fact 2: Elst. # of products wrt market size
F	FC of entering a market	1.09	Fact 3: Elst. avg. firm size wrt market size

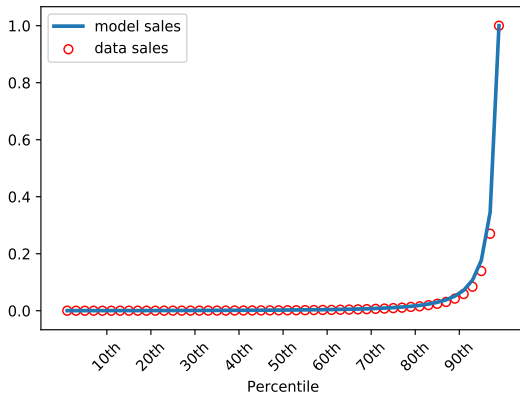
- Estimation using SMM

- Parameters: $\Theta = \{F_e, F_d, \theta, F_p, F, \sigma, \varphi\}$

- Check the model fit to non-targeted moments

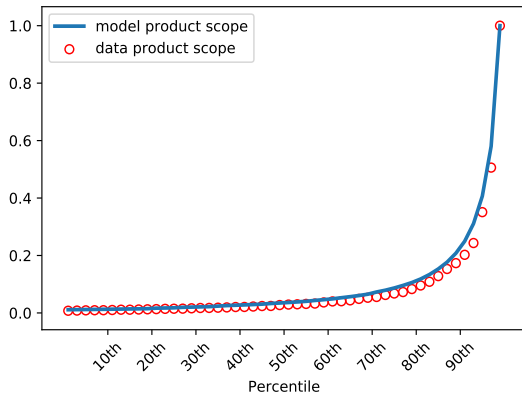
Quantitative fit: Non-targeted moments

Targeted	Sales		Product		Geographic	
	Data	Model	Data	Model	Data	Model
$\frac{\text{Top 10\%}}{\text{Median}}$	139.2	139.0	15.9	15.1	4.5	4.5



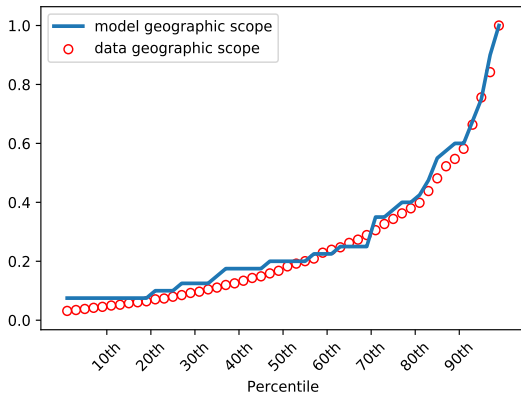
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- How important is complementarity?

My model = Heterogeneous productivity firms

+ multiple markets (ex.1)

+ multiple products (ex.2)

Exercise 1: Eliminate geographic scope

- **Baseline**

	Sales		Product		Geographic	
	Data	Model	Data	Model	Data	Model
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- **CF1: Single market economy**

	Sales		Product		Geographic	
	Data	CF2	Data	CF1	Data	CF2
$\frac{\text{Top 10\%}}{\text{Median}}$	139.2	49.8	15.9	8.7	4.5	1

Exercise 2: Eliminate product scope

- **Baseline**

	Sales		Product		Geographic	
	Data	Model	Data	Model	Data	Model
$\frac{\text{Top 10\%}}{\text{Median}}$	139.2	139.0	15.9	15.1	4.5	4.5

- **CF2: Single-product firms**

	Sales		Product		Geographic	
	Data	CF2	Data	CF1	Data	CF1
$\frac{\text{Top 10\%}}{\text{Median}}$	139.2	4.78	15.9	1	4.5	1.01

Welfare effect of SME subsidy

- The market equilibrium in the model is *efficient* = any policy interventions will be sub-optimal
- Estimate the welfare costs of size-dependent policies
 - ▶ SME subsidy for **new product development** in 2020/2021
 - ▶ the National Federation of Small Business Associations
 - ▶ Eligibility: SMEs in manufacturing industry (cutoff with the number of employment or capital)
 - ▶ Coverage: up to two-thirds of product development costs

Modeling the SME subsidy

- Modeling the Japanese SME subsidy
 - ▶ Eligibility: cutoff value in productivity (one-to-one relationship btw productivity and employment)
 - ▶ Coverage: two-thirds of the fixed costs of developing products
 - ▶ Balanced budget in the economy financed by the uniform consumption tax in each market

Welfare effect of the SME subsidy

- Inefficiency of the SME subsidy
 - Low-productivity firms receive subsidy and develop more products
 - These firms enter more markets due to the complementarity
- Results: welfare costs of the subsidy
 - Baseline model: 2.19%
 - Single-market model: 1.47%
 - Welfare costs **underestimated** with single-market model

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2 Theoretical framework:

- ▶ explains how firm size, product & geographic scope heterogeneity arise from initial productivity dispersion
- ▶ Complementarity between geographic and product scope as an important amplifier of firm size heterogeneity

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