Firm Size and Complementarity between Geography and Products

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Question

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

Motivation

- The mechanism of firm size heterogeneity is crucial for
  - Trade: export pattern, welfare gains from trade
  - Macro: aggregate productivity, size-dependent policies

Literature

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

Appeal	Product scope	Cost	Markup
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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
  - Counterfactual exercise 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
- 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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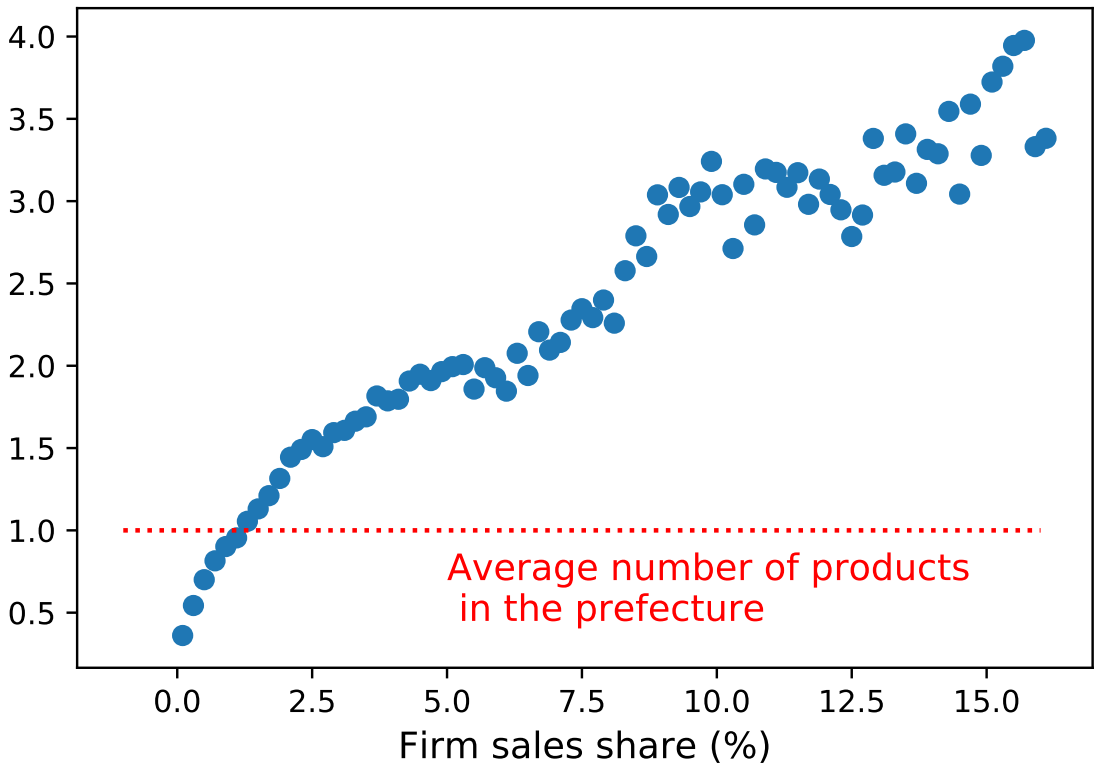
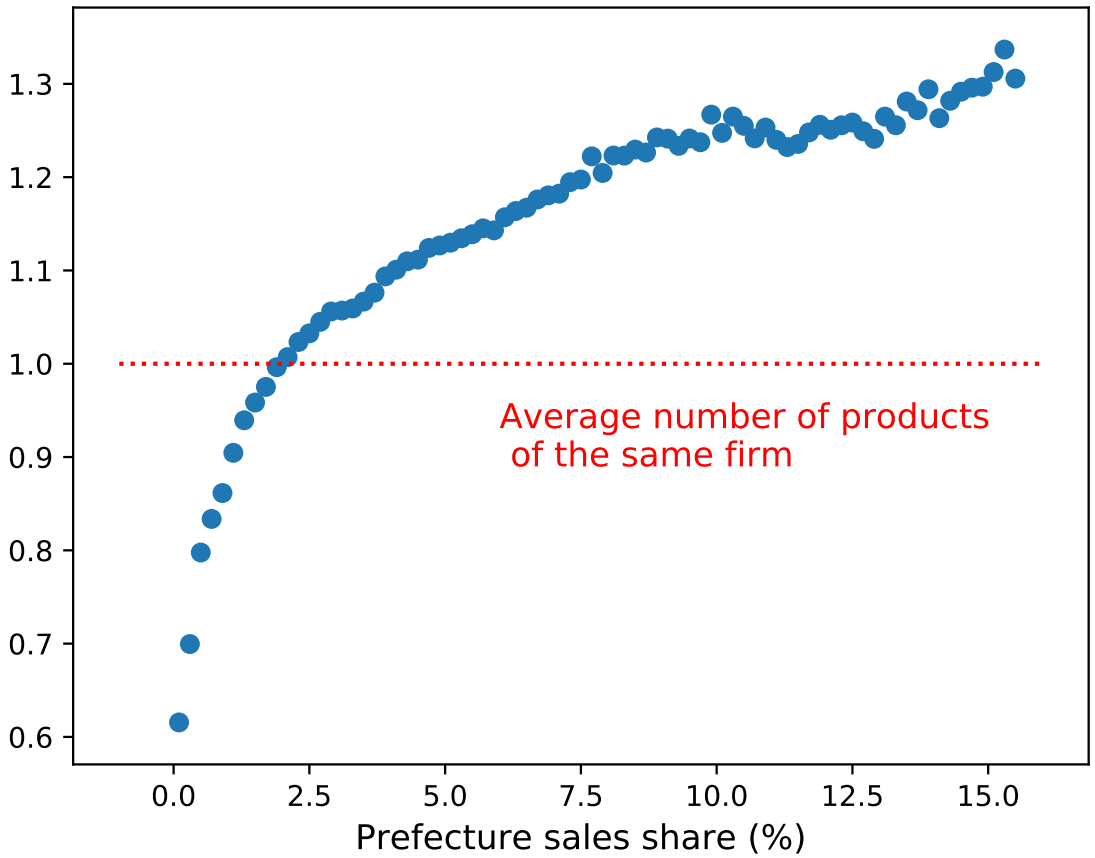
Fact 1: Larger firms sell more goods in a market

Average number of products in a market plotted on firm size



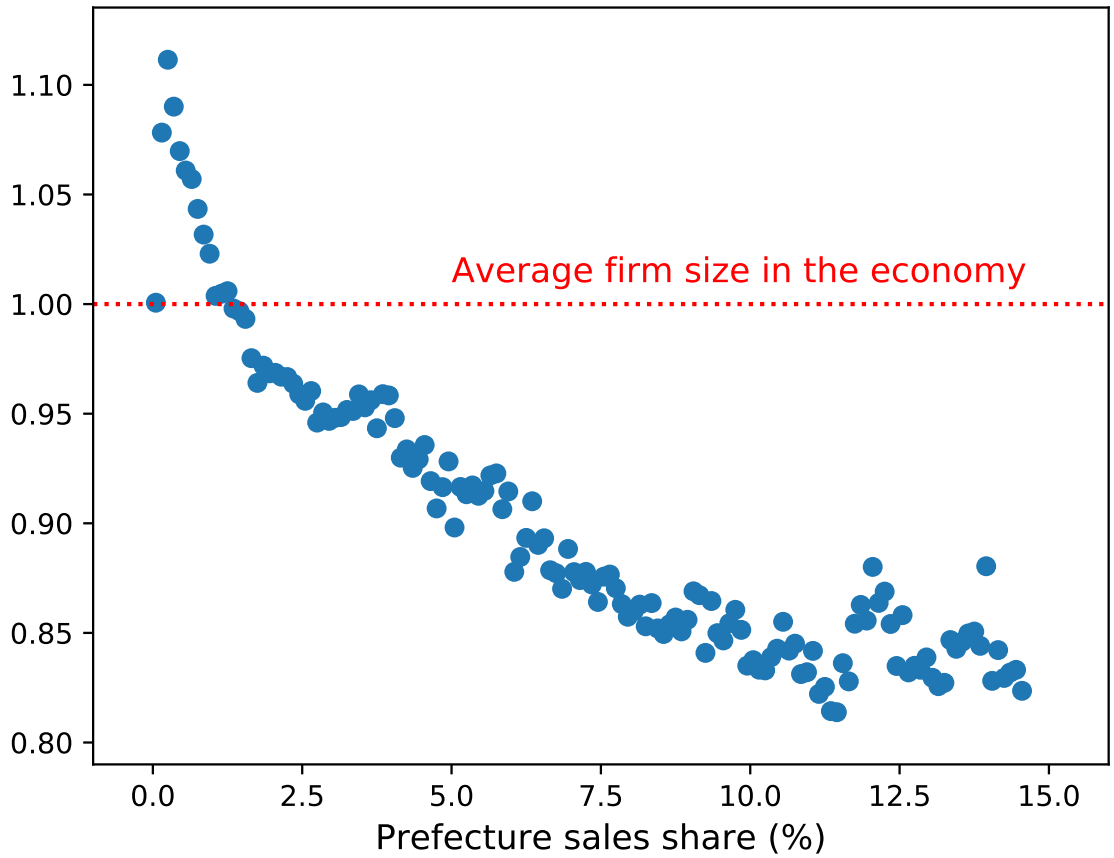
Fact 2: More goods in larger markets

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



Outline of the talk

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
- Three fixed costs: of developing products, entering a market, and selling a product in a market

Preference

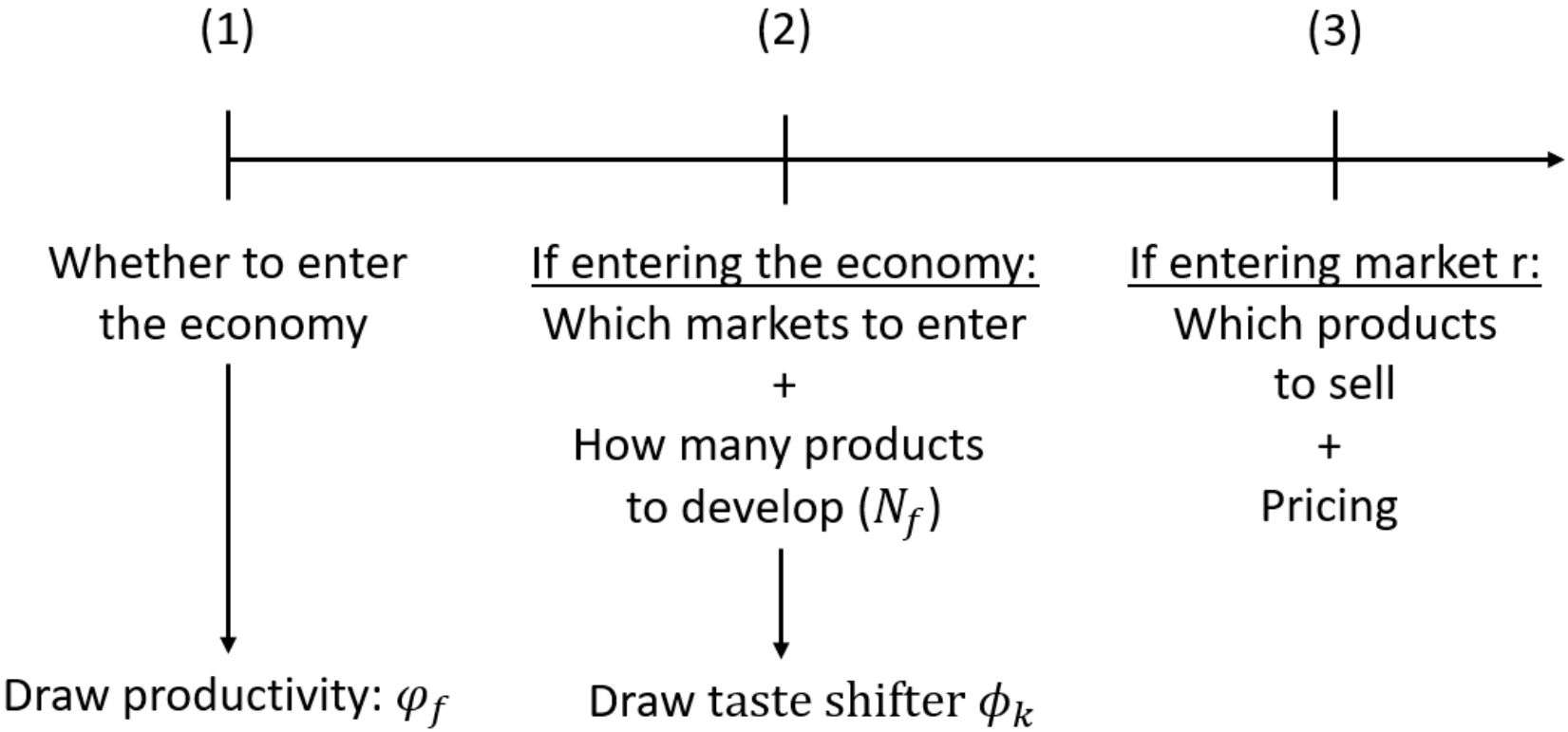
- Representative consumer in market r:

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

  - 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 & regions:

$$\mathrm{MC}_{kr} = \mathrm{MC}_f = w\varphi_f^{-1}$$

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

- Monopolistic competition $\Longrightarrow$ $p_{kr} = p_f = \frac{\sigma}{\sigma-1}\mathrm{MC}_f$

- **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

$$\pi_{kr}(\phi^*_{fr}) \equiv (p_f - \text{MC}_f)C_{kr}(\phi^*_{fr}) = F_p$$

2. How many products to develop & which markets to enter

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

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

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Two sources of complementarity

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

1. Develop more products → 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 → develop more products

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Parameter values

Parameter	Definition	Value	Target
R	Number of regions	43	Data (number of prefectures)
L_r	Labor endowment for each region		Data (sales in each prefecture)
$\log(\phi) \sim N(\mu, \sigma^2)$	Distribution of common component	$\mu = 0.47, \sigma = 0.92$	Estimated from the data
$\varphi \sim$ Pareto$(\alpha, \bar{\varphi})$	Distribution of productivity	$\alpha = 2.3, \bar{\varphi} = 1(set)$	Estimated from the data (SMM)
σ	Elasticity of substitution in CES	2.4	Estimated from the data (SMM)
θ	Parameter in the fixed costs of developing products	2.6	Estimated from the data (SMM)
F_d	Fixed cost of developing products	0.079	Parameters to fit top10/median stats
F	Fixed cost of entering a region	0.05	
F_p	Fixed cost of selling per product in each region	0.35	
F_e	Fixed cost of entering the production economy	1.25	Fit the # of firms in the economy

- Estimation using SMM
  - Elasticity: σ
  - Productivity distribution: φ_f
  - Parameter in the fixed costs of developing products: θ
- Targeted moments: top10% vs median firm's stats in
  - firm size, product scope, and geographic scope distributions
  - Three fixed costs: F_d, F, and F_p

Qualitative fit: Facts 1-3

1. In a given market, threshold taste shifter decreases with productivity
   - Fact 1: Larger firms sell more products in a market
2. Given productivity, threshold taste shifter decreases with market size
   - Fact 2: Same firms sell more products in larger markets
3. Threshold productivity decreases with market size
   - Fact 3: Larger firms penetrate smaller markets

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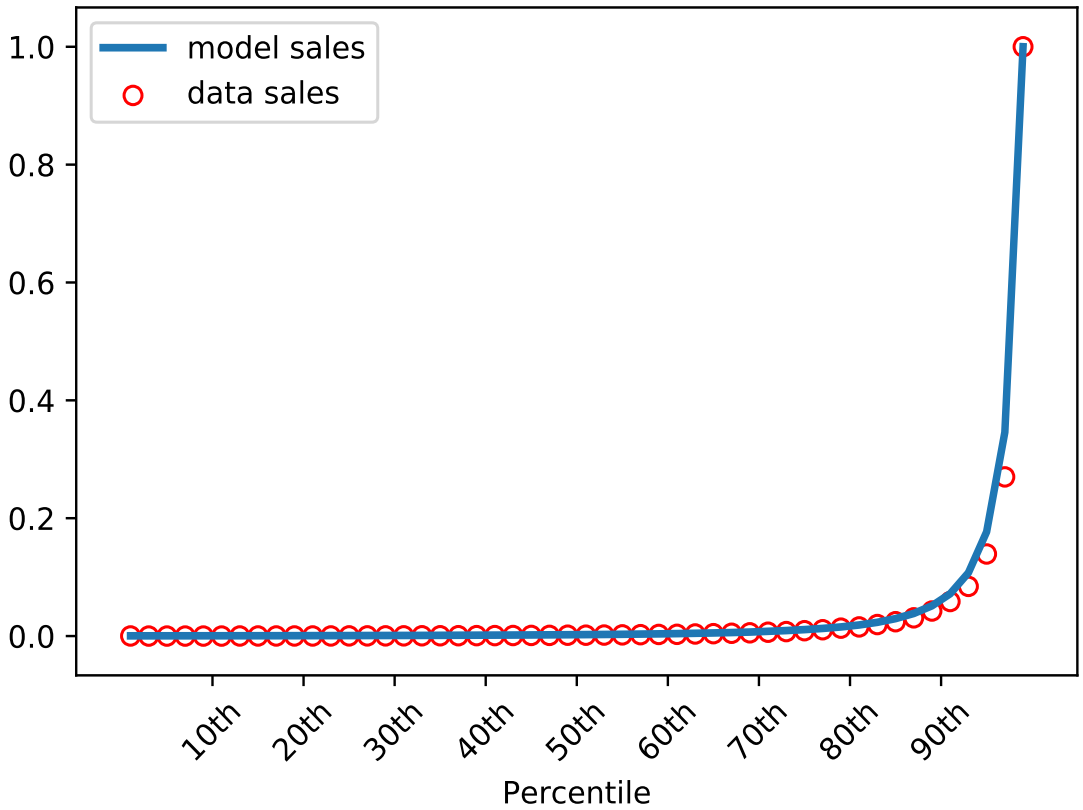
Quantitative fit: Non-targeted moments

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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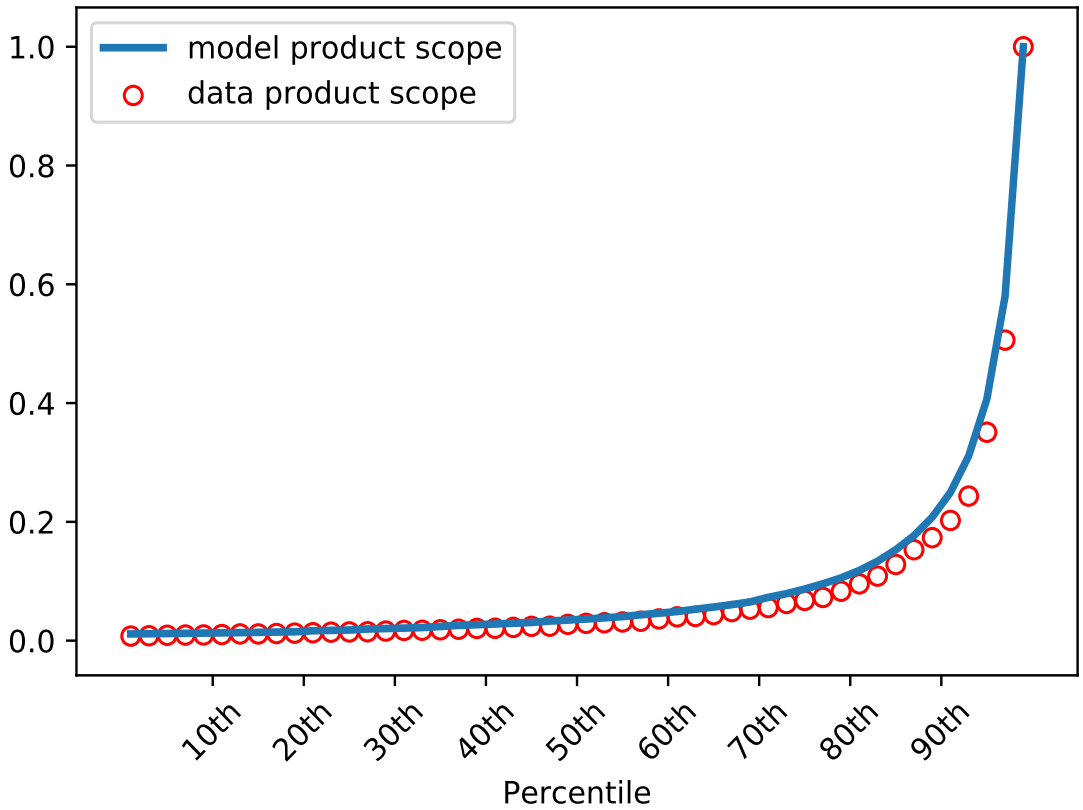

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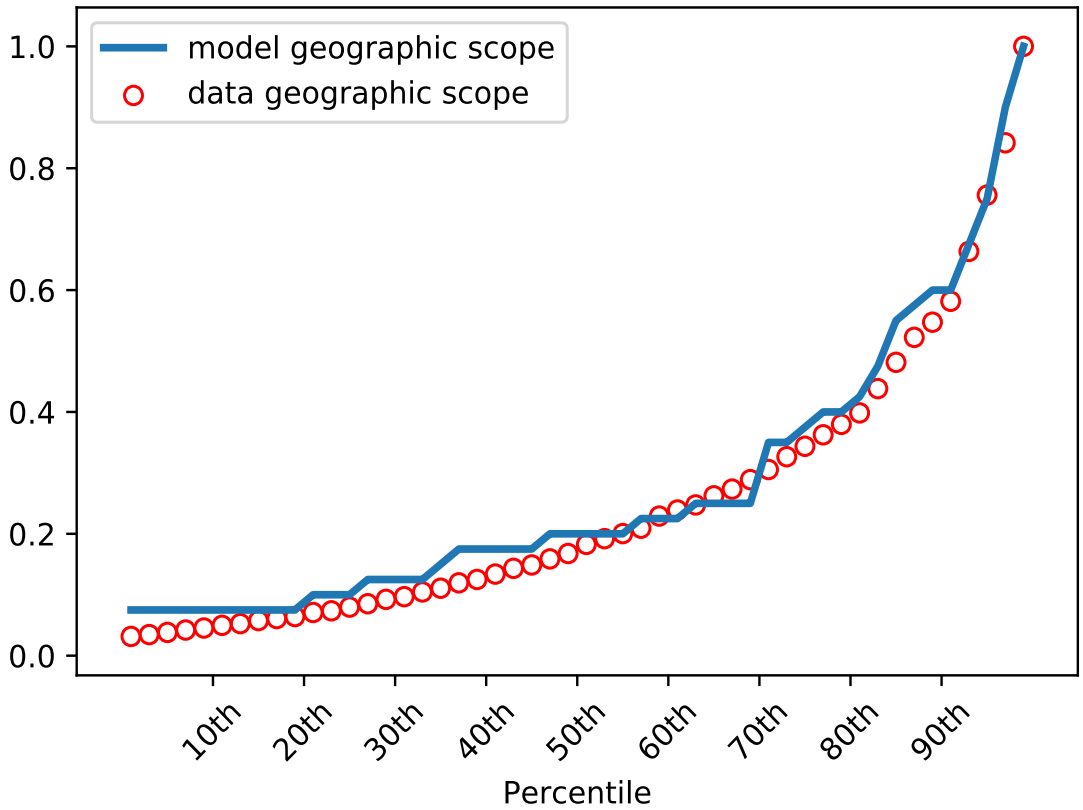

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- How important is complementarity?

My model = Heterogeneous productivity firms
+ multiple markets (CF1)
+ multiple products (CF2)

CF1: Eliminate geographic scope

- **Baseline**

	Sales		Product		Geographic	
	Data	Model	Data	Model	Data	Model
Top 10% / Median	139.2	139.0	15.9	15.1	4.5	4.5

- **CF1**: Single market economy

	Sales		Product		Geographic	
	Data	CF2	Data	CF1	Data	CF2
Top 10% / Median	139.2	49.8	15.9	8.7	4.5	1

CF2: 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

Welfare effect of 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
- Results: welfare costs of the subsidy
  - Baseline model: 2.19%
  - Single-market model: 1.47%
  - Welfare costs underestimated with single-market model

Outline of the talk

Conclusion

1. The importance of geographic and product scope in explaining firm size distribution
2. Complementarity between geographic and product scope is an important amplifier of firm size heterogeneity
3. Micro-foundation for the models of firm size heterogeneity
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   - Policies that have different effects on firms with different sizes

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