Spillovers and Redistribution through Intra-Firm Networks: The Product Replacement Channel

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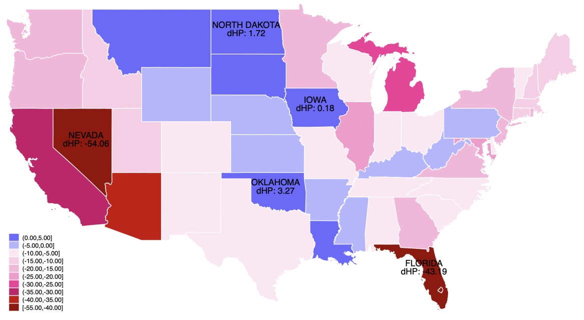
Motivation

Q. How do regional shocks spill over across regions & reshape regional welfare?

- A long-standing question in macro/trade, relevant in within-county contexts

  e.g., A sudden differential collapse in local housing markets in Great Recession



State-level Housing Price Growth in Great Recession

⇒ regional conditions spill over through various networks and reshape regional inequality

This Paper

Q. How do regional shocks spill over across regions & reshape regional welfare?

- A long-standing question in macro/trade, relevant in within-county contexts

  e.g., A sudden differential collapse in local housing markets in Great Recession

This Paper

- **Intra-firm networks** of producers who sell in multiple counties/states
  $\Rightarrow$ important firms, but ambiguous direction of spillovers

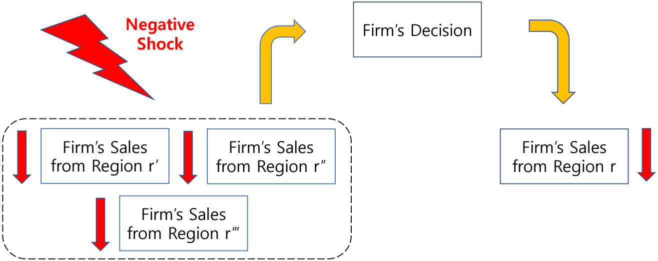
- **Empirics**: provide causal evidence of within-firm regional spillovers and identify a novel mechanism behind

- **Model**: formalize the mechanism & discuss aggregate implications

Summary: Empiric

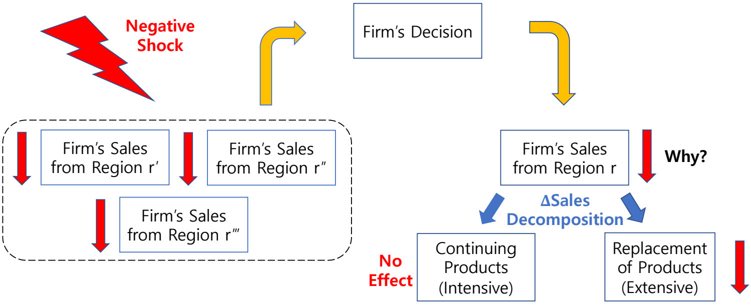
By exploiting a detailed micro-data & sudden *differential* $\Downarrow$ in local house prices in 07-09,

(1) Firm's local sales ***decrease*** w.r.t. not only *direct* local demand shock but also firm's average *indirect* local demand shock originating in its ***other markets***



Summary: Empiric

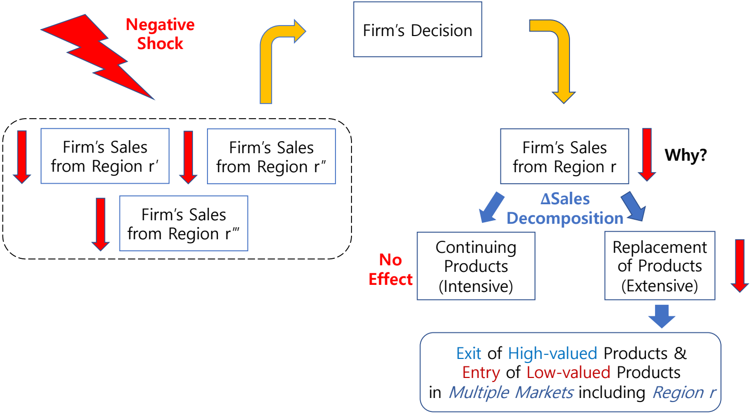
(2) **Why?** Such *spillover* driven by *extensive margin response* from product replacement (while *direct local shock* $\Rightarrow$ *intensive margin* from continuing products)



Summary: Empiric

(2) **Why?** Product replacements typically *synchronized* across many markets

- Shocks hitting other mkts induce product replacement even in "not hit" mkt
- Firms downgrade products (organic→non-organic, expensive→cheap etc.)



Summary: Empirical Results - Some Remarks

1. What are real world examples of synchronized product replacements?

- Kraft Foods Inc. produces both organic and non-organic cheese

(a) Organic Cheese

(b) Non-organic Cheese

- Organic: sold in 11 states in 2007, exited all the states in 2009
- Non-organic: uniformly entered in the same states
- Despite a large variation in regional shocks: -5% (PA) to -23% (MD)

2. We address potential endogeneity concerns in depth

Summary: Theory

Empiric: replacing high- to low- value products, which are synchronized across many markets

(2) **Mechanism**

A. producers facing negative demand shocks lower their product quality
- because of the (i) scale effect and (ii) non-homotheticity

B. in doing so, they do it in multiple markets simultaneously
- because of the local-firm-specific fixed cost of product replacement

(3) **Implication**: mitigates the regional consumption inequality

- many regions face the same quality goods: a novel redistribution mechanism
- std(consumption growth) $\Downarrow$ by 30% w/ our mechanism, $\approx$ \$400 per HH

Related Literature

Networks, Spillovers, and Macroeconomy

- Multi-Market: Berman et al. 15, Ahn & Mcquoid 17, Almunia et al. 18, Erbahar 18
- Multi-Establishment: Carvino & Levchenko 17, Gilbert 18, Giroud & Mueller 19
- Trade & Supply Chain: di Giovanni & Levchenko 10, Acemoglu et al. 16, Stumpner 17, Caliendo et al. 18, Arkolakis et al. 18, Auerbach et al. 19, Boehm et al. 19
- Banking Networks (Acemoglu et al. 15, Gilje et al. 16, Mitchener & Richardson 19); Migration (House et al. 18); Social Networks (Bailey et al. 18)

Housing Market Collapse and the Great Recession

- Mian et al. 13, Mian & Sufi 14, Stroebel & Vavra 19, Kaplan et al. 16, Giroud & Mueller 17, Beraja et al. 19

Variety/Quality Changes & Distributional Implications

- Broda & Weinstein 10, Schmitt-Grohe and Uribe 12, Nakamura & Steinsson 12, Hottman et al. 16 Dingel 17, Jaimovich et al. 17, Argente et al. 18, Jaravel 18, Medina 20, Faber & Fally 20

Business Cycle Comovement

- Backus et al. 92, Frankel & Rose 98, Kose & Yi 06, Johnson 14, Liao & Santacreu 15, Cravino & Levchenko 17, di Giovanni et al. 18

Regional Risk-Sharing/Redistribution

- Asdrubali et al. 96, Lustig & Van Nieuwerburgh 10, Hurst et al. 16

Uniform Pricing in Retail Sector

- DellaVigna and Gentzkow 17, Cavallo 18, Hitsch et al. 19

Outline

Data

Barcode-Region level Price and Quantity: ACNielsen Retail Scanner

- covers $\approx$ 2.6 million product prices and quantities,

  (e.g: cherry-flavored 500ml diet coke in New York county)

- from $\approx$ 35,000 participating stores

Producer Information: GS1, NETS

- producer name (e.g. Coca Cola), industry code, etablishment location, credit rating

Regional Housing Prices: Zillow database

- county- and state-level median housing prices

Variables

Dependent Variables

- $\tilde{\Delta} S_{rf} \equiv \left(\frac{\text{Sale}_{rf,09} - \text{Sale}_{rf,07}}{\overline{\text{Sale}}_{rf}}\right)$: region-firm level sales growth in 2007-09
- Sales Growth Exact Decomposition:

$$\tilde{\Delta} S_{rf} = \underbrace{\tilde{\Delta} S^{C}_{rf}}_{\text{intensive margin}} + \underbrace{\tilde{\Delta} S^{R}_{rf}}_{\text{extensive margin}}$$

Indirect Shock

- $\tilde{\Delta} HP_{r} \equiv \left(\frac{HP_{r,09} - HP_{r,07}}{\overline{HP}_{r}}\right)$: regional house price growth in 2007-09
- Indirect Shock: firm's average local demand shock from other regions

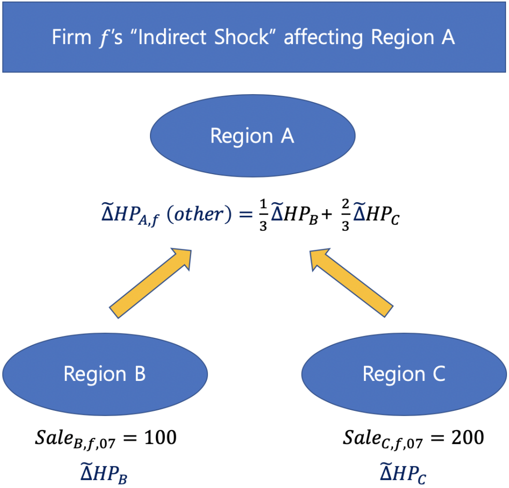
$$\tilde{\Delta} HP_{rf}\ (\text{other}) \equiv \sum_{r' \neq r} \omega_{r'f} \times \tilde{\Delta} HP_{r'}$$

where $\omega_{r'f} \equiv \frac{\text{Sale}_{r'f,07}}{\sum_{r' \neq r} \text{Sale}_{r'f,07}}$ is the leave-out initial sales share weight

- Also consider similarly constructed IVs

◂ data ◂ summary stat. ◂ dep.var extensive ◂ persistence ◂ sector list

Construction of Indirect Shock



Empirical Specification

$$\tilde{\Delta}\mathrm{S}_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta}\mathrm{HP}_r + \beta_2 \tilde{\Delta}\mathrm{HP}_{rf}\ (\mathrm{other}) + \mathrm{Controls}_{rf} + \varepsilon_{rf}$$

where r: region (county/state), f: firm, $\tilde{\Delta}X$: growth rate of X in 07-09

δ_s: primary sector FE

- β_2: the effect of regional shocks hitting other markets of firm f **conditional on direct local demand**
  - A priori $\beta_2 \lesseqgtr 0 \Rightarrow$ We get $\beta_2 > 0$
- β_1: the effect of direct regional shock in region r
  - Similar to Mian et al. (13), Kaplan et al. (16) $\Rightarrow$ We expect $\beta_1 > 0$

Empirical Specification

$$\tilde{\Delta}\text{S}_{rf} = \beta_0 + \delta_{rs} + \beta_2 \tilde{\Delta}\text{HP}_{rf}\ \text{(other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

where r: region (county/state), f: firm, $\tilde{\Delta}X$: growth rate of X in 07-09
δ_{rs}: region x sector FE

- β_2: the effect of regional shocks hitting other markets of firm f
  conditional on direct local demand
  - A priori $\beta_2 \lesseqgtr 0 \Rightarrow$ We get $\beta_2 > 0$
- β_1: the effect of direct regional shock in region r
  - Similar to Mian et al. (13), Kaplan et al. (16) $\Rightarrow$ We expect $\beta_1 > 0$
  - **Also consider region x sector FE instead of including $\tilde{\Delta}$HP$_r$**

Key Identifying Assumption

$$\tilde{\Delta}\mathsf{S}_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta}\mathsf{HP}_r + \beta_2 \tilde{\Delta}\mathsf{HP}_{rf}\ (\text{other}) + \text{Controls}_{rf} + \varepsilon_{rf}$$

Any confounding factor that affects firm's local sales growth does not simultaneously affect its other market house price growth

Key Identifying Assumption

$$\tilde{\Delta}S_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta}HP_r + \beta_2 \tilde{\Delta}HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

Any confounding factor that affects firm's local sales growth does not simultaneously affect its other market house price growth

Threats to identification

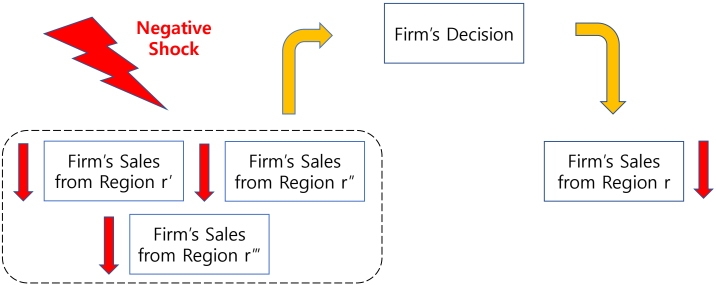
- **Common or clustered regional shocks?**
- **Alternative channels?**

Identification

Outline

Summary of Empirical Results

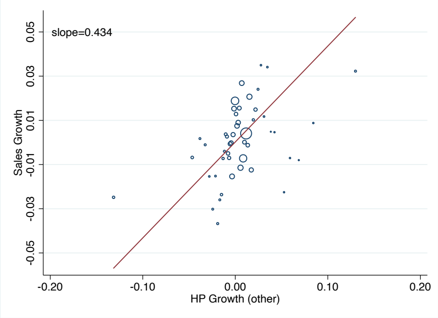
Overview of Empirical Results



Visualization

$$\tilde{\Delta} S_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta} HP_r + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

Local sales respond to both direct and indirect shocks



Scatter plots (25 bins based on ventiles) depicting the relationship between (residualized) $\tilde{\Delta} S_{rf}$ and either $\tilde{\Delta} HP_r$ or $\tilde{\Delta} HP_{rf}$ (other), where each point is the sales-weighted average across obs. within each bin. We use Frisch-Waugh theorem to tease out the effect.

Local sales respond to both direct and indirect shocks

$$\tilde{\Delta} S_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta} HP_r + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

	$\tilde{\Delta}$ S_{rf}, 2007-2009			
	(1)	(2)	(3)	(4)
	Ordinary Least Square			
$\tilde{\Delta}HP_r$	0.06**	0.06**		
	(0.03)	(0.03)		
$\tilde{\Delta}HP_{rf}$ (other)	0.35***		0.34***	0.40***
	(0.11)		(0.12)	(0.10)
Region-Firm Controls	✓		✓	✓
Region Controls		✓		
Firm FE		✓		
Sector FE	✓		✓	
Region FE			✓	
Sector x Region FE				✓
First-stage F statistics				
Hansen's J-stat p-value				
R^2	0.20	0.61	0.24	0.39
Observations	840,681	840,681	840,681	840,681

Display All Controls | Local Shock | Main (More)

Local sales respond to both direct and indirect shocks

$$\tilde{\Delta} S_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta} HP_r + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

	$\tilde{\Delta}$ S_{rf}, 2007-2009							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ordinary Least Square				IV Estimation using			
					elasticity	sensitivity	lending	all
$\tilde{\Delta} HP_r$	0.06**	0.06**						
	(0.03)	(0.03)						
$\tilde{\Delta} HP_{rf}$ (other)	0.35***		0.34***	0.40***	0.60***	0.72***	0.41**	0.44**
	(0.11)		(0.12)	(0.10)	(0.14)	(0.25)	(0.20)	(0.22)
Region-Firm Controls	✓		✓	✓	✓	✓	✓	✓
Region Controls		✓						
Firm FE		✓						
Sector FE	✓		✓					
Region FE			✓					
Sector x Region FE				✓	✓	✓	✓	✓
First-stage F statistics					541.20	231.20	540.50	254.70
Hansen's J-stat p-value								0.24
R^2	0.20	0.61	0.24	0.39				
Observations	840,681	840,681	840,681	840,681	448,604	587,436	658,607	417,869

Display All Controls | Local Shock | Main (More)

Placebo Test

Placebo Networks: (1) Alternative weights; (2) Alternative regions

Placebo Tests

	$\tilde{\Delta}$ S_{rf}, 2007-2009						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Alternative measures of $\tilde{\Delta}HP_{rf}$ (other) using						
	equal	pop.	inc.	debt	entry	plant	random
$\tilde{\Delta}HP_{rf}$ (other)	0.13	0.03	0.11	0.07	-0.03	-0.06	0.00
	(0.21)	(0.18)	(0.18)	(0.20)	(0.11)	(0.18)	(0.38)
Region-Firm Controls	✓	✓	✓	✓	✓	✓	✓
Sector x Region FE	✓	✓	✓	✓	✓	✓	✓
Observations	840,681	840,681	840,681	835,778	833,290	704,809	840,681

Note. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; We consider seven alternative constructions of the indirect demand shock. We use different initial weights: the equal is equal weight, the pop. is population weight, the inc. is household median income weight, and the debt is the household debt-to-income weight. The entry is the weight that still uses 2007 sales but replaces to zero if the 2006 sales are non-zero, and the plant weight is based on the firms' establishment network. In the random specification, we randomly allocate markets for each firm, measure the indirect demand shock, and estimate the coefficient; we repeat the procedure 1000 times and report the average estimates.

Go Back to Main Regression Identification Go Back to Robustness

Placebo Test

Placebo Networks: (1) Alternative weights; (2) Alternative regions

Placebo Tests

	$\tilde{\Delta}$ S_{rf}, 2007-2009						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Alternative measures of $\tilde{\Delta}HP_{rf}$ (other) using						
	equal	pop.	inc.	debt	entry	plant	random
$\tilde{\Delta}HP_{rf}$ (other)	0.13	0.03	0.11	0.07	-0.03	-0.06	0.00
	(0.21)	(0.18)	(0.18)	(0.20)	(0.11)	(0.18)	(0.38)
Region-Firm Controls	✓	✓	✓	✓	✓	✓	✓
Sector x Region FE	✓	✓	✓	✓	✓	✓	✓
Observations	840,681	840,681	840,681	835,778	833,290	704,809	840,681

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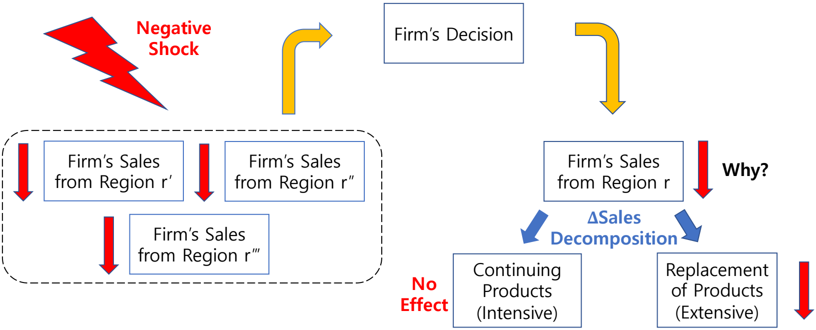
Go Back to Main Regression
Identification
Go Back to Robustness

Summary of Empirical Results

Overview of Empirical Results



Local sales respond to both direct and indirect shocks

$$\tilde{\Delta} S_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta} HP_r + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

	(1) $\tilde{\Delta} S_{rf}$	(2) $\tilde{\Delta} S^C_{rf}$	(3) $\tilde{\Delta} S^R_{rf}$	(4)	(5)
$\tilde{\Delta} HP_r$	0.059**	0.051**	0.009		
	(0.028)	(0.024)	(0.014)		
$\tilde{\Delta} HP_{rf}$ (other)	0.345***	0.025	0.320***		
	(0.110)	(0.067)	(0.093)		
sector FE	✓	✓	✓		
county controls	✓	✓	✓		
county-firm controls	✓	✓	✓		
R-squared	0.201	0.223	0.284		
Observations	840,681	840,681	840,681		

Note. County controls : all controls in Mian and Sufi 14. County-firm controls : log initial county-firm specific sales, log initial firm-level sales, log initial number of local markets, and log initial number of product groups. Regressions weighted by county-firm initial sales. Standard errors double clustered at state-sector level.

Visualize   Decomp. with group   Replace Pattern

Direct effect works through the intensive margin

$$\tilde{\Delta} S_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta} HP_r + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

	(1) $\tilde{\Delta} S_{rf}$	(2) $\tilde{\Delta} S^C_{rf}$	(3) $\tilde{\Delta} S^R_{rf}$	(4)	(5)
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$\tilde{\Delta} HP_{rf}$ (other)	0.345***	0.025	0.320***		
	(0.110)	(0.067)	(0.093)		
sector FE	✓	✓	✓		
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county-firm controls	✓	✓	✓		
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◂ Visualize ◂ Decomp. with group ◂ Replace Pattern

Spillover effect works through the extensive margin

$$\tilde{\Delta} S_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta} HP_r + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

	(1) $\tilde{\Delta} S_{rf}$	(2) $\tilde{\Delta} S^C_{rf}$	(3) $\tilde{\Delta} S^R_{rf}$	(4)	(5)
$\tilde{\Delta} HP_r$	0.059**	0.051**	0.009		
	(0.028)	(0.024)	(0.014)		
$\tilde{\Delta} HP_{rf}$ (other)	0.345***	0.025	0.320***		
	(0.110)	(0.067)	(0.093)		
sector FE	✓	✓	✓		
county controls	✓	✓	✓		
county-firm controls	✓	✓	✓		
R-squared	0.201	0.223	0.284		
Observations	840,681	840,681	840,681		

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◂ Visualize   ◂ Decomp. with group   ◂ Replace Pattern

Spillover effect works through the extensive margin $\Rightarrow$ robust to county x sector FE

$$\tilde{\Delta} S_{rf} = \beta_0 + \delta_{rs} + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

	(1) $\tilde{\Delta} S_{rf}$	(2) $\tilde{\Delta} S^C_{rf}$	(3) $\tilde{\Delta} S^R_{rf}$	(4)	(5)
$\tilde{\Delta} HP_{rf}$ (other)	0.398***	-0.021	0.419***		
	(0.105)	(0.045)	(0.102)		
county x sector FE	✓	✓	✓		
county-firm controls	✓	✓	✓		
R-squared	0.392	0.427	0.408		
Observations	840,681	840,681	840,681		

Note. County-firm controls : log initial county-firm specific sales, log initial firm-level sales, log initial number of local markets, and log initial number of product groups. Regressions weighted by county-firm initial sales. Standard errors double clustered at state-sector level.

Visualize
Decomp. with group
Replace Pattern

Spillover effect works through the extensive margin through products replaced in multiple markets

$$\tilde{\Delta} S_{rf} = \beta_0 + \delta_{rs} + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

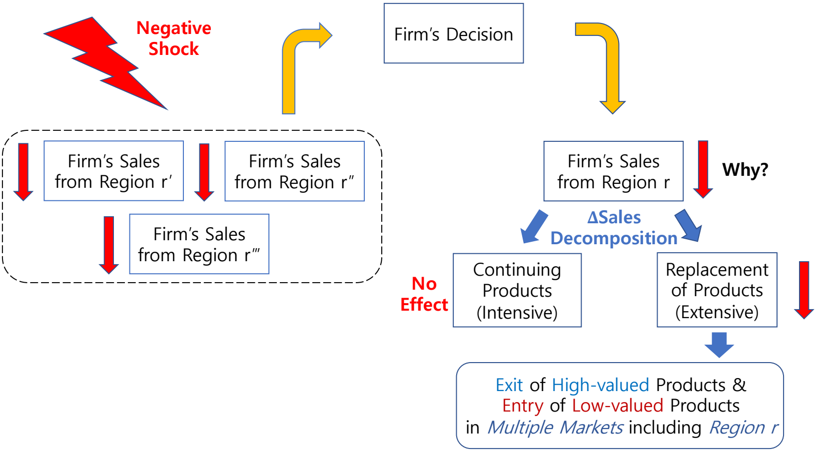
	(1) $\tilde{\Delta} S_{rf}$	(2) $\tilde{\Delta} S^{C}_{rf}$	(3) $\tilde{\Delta} S^{R}_{rf}$	(4) $\tilde{\Delta} S^{R,M}_{rf}$	(5) $\tilde{\Delta} S^{R,L}_{rf}$
$\tilde{\Delta} HP_{rf}$ (other)	0.398***	-0.021	0.419***	0.418***	0.000
	(0.105)	(0.045)	(0.102)	(0.101)	(0.000)
county x sector FE	✓	✓	✓	✓	✓
county-firm controls	✓	✓	✓	✓	✓
R-squared	0.392	0.427	0.408	0.408	0.216
Observations	840,681	840,681	840,681	840,681	840,681

Note. County-firm controls : log initial county-firm specific sales, log initial firm-level sales, log initial number of local markets, and log initial number of product groups. Regressions weighted by county-firm initial sales. Standard errors double clustered at state-sector level.

◀ Visualize ◀ Decomp. with group ◀ Replace Pattern

Summary of Empirical Results

Overview of Empirical Results



Spillover effect works through the extensive margin through products replaced in multiple markets from high- to low-valued products

$$\tilde{\Delta}v_{rf} = \beta_0 + \delta_{rs} + \beta_2 \tilde{\Delta}HP_{rf}\ (\text{other}) + \text{Controls}_{rf} + \varepsilon_{rf}$$

	(1)	(2)	(3)	(4)	(5)
			$\tilde{\Delta}v_{rf} \equiv \frac{v^{enter}_{rf,09} - v^{exit}_{rf,07}}{\bar{v}_{rf}}$		
where v_{rf} =	sale per upc	price	price$^{\text{group-adj.}}$	organic sale	# of upc
$\tilde{\Delta}HP_{rf}$ (other)	0.52**	0.92**	0.70**	43.78**	-0.06
	(0.21)	(0.44)	(0.34)	(17.88)	(0.17)
region x sector FE	✓	✓	✓	✓	✓
region-firm controls	✓	✓	✓	✓	✓
R-squared	0.40	0.41	0.42	0.38	0.40
Observations	464,423	461,672	461,672	27,930	464,423

Note. For organic share, we use state as a unit of region.

Group Level | Price Reg. (Replacement) | Quality Reg. (Replacement) | Price Reg. (Continue) | Equation

Spillover effect works through the extensive margin through products replaced in multiple markets $\Rightarrow$ not through simple reduction of variety

$$\tilde{\Delta} v_{rf} = \beta_0 + \delta_{rs} + \beta_2 \tilde{\Delta} HP_{rf} \text{ (other)} + \text{Controls}_{rf} + \varepsilon_{rf}$$

	(1)	(2)	(3)	(4)	(5)
	$\tilde{\Delta} v_{rf} \equiv \frac{v^{enter}_{rf,09} - v^{exit}_{rf,07}}{\bar{v}_{rf}}$				
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Note. For organic share, we use state as a unit of region.

Group Level   Price Reg. (Replacement)   Quality Reg. (Replacement)   Price Reg. (Continue)   Equation

Key Identifying Assumption: Further Robustness Check

$$\tilde{\Delta}S_{rf} = \beta_0 + \delta_s + \beta_1 \tilde{\Delta}HP_r + \beta_2 \tilde{\Delta}HP_{rf}\ (\text{other}) + \text{Controls}_{rf} + \varepsilon_{rf}$$

Any confounding factor that affects firm's local sales growth does not simultaneously affect its other market house price growth

Threats to identification Key Identifying Assumption

- **Common or clustered regional shocks?**
  - $\tilde{\Delta}HP_{rf}$(other): exclude nearby counties
  - state-firm-level regression
- **Alternative channels?**
  - supply-side/collateral channel? $\Rightarrow$ $\tilde{\Delta}HP_{rf}$(other): exclude regions with plants
  - not driven by retailer
  - not driven by clientele effect
  - and many others ... Robustness

Further Results

- **Heterogeneous treatment effect** interaction

Outline

Model Setup

Purpose: Formalize spillover mechanism & discuss aggregate implication

Multi-region model with endogenous quality-adjustments by firms

$\Rightarrow$ A parsimonious extension of Melitz 03 and Faber & Fally 20

- D: Each region $r \in R$ has representative HH with exogenous income
- S: Monopolistic competitive firms facing these HHs (multi-market) choose (i) price and (ii) product attribute or "quality"

Model Setup

Purpose: Formalize spillover mechanism & discuss aggregate implication

⇒ **Two key mechanisms** to match the empirical finding

(1) producers facing negative demand shocks lower their product quality

- scale effect : Firms' fixed cost increases with product quality
- nonhomotheticity : HHs switch from high- to low-quality if income decreases

(2) firms choose uniform product quality across markets

◂ Replacement Pattern

- can endogenize such assumption

⇒ **Empirics**

firms facing negative demand shocks decrease sales

by replacing high-valued products with low-valued products

in multiple markets simultaneously

Model Setup

Purpose: Formalize spillover mechanism & discuss aggregate implication

$\Rightarrow$ **Two key mechanisms** to match the empirical finding

(1) producers facing negative demand shocks lower their product quality

- scale effect : Firms' fixed cost increases with product quality
- nonhomotheticity : HHs switch from high- to low-quality if income decreases

(2) firms choose uniform product quality across markets

◂ Replacement Pattern

- can endogenize such assumption

$\Rightarrow$ **Further simplifying assumptions** to reduce "dimension" of the model

- Static model $\Rightarrow$ compare static equilibrium with pre- vs. post-shock periods
- Each firm produces a single product (i.e. product bundle) $\Rightarrow$ product attribute (intrinsic quality) change involves product replacement

Model Summary

(1) (Lower-tier) utility for CPG:

◂ Demand Details

$$U_r = \left[\int_{f \in G_r} (q_{rf} \zeta_{rf})^{\frac{\sigma-1}{\sigma}} df \right]^{\frac{\sigma}{\sigma-1}}$$

r: region, f: firm, G_r: set of firms selling in market r

$*$ $\zeta_{rf} \equiv (\phi_f)^{\gamma_r}$: "perceived" product quality of firm f in region r

◂ Intuition

$\Rightarrow$ ϕ_f: uniform intrinsic product quality & $\gamma_r \equiv \gamma(\text{Income}_r)$, $\gamma'(\cdot) > 0$: nonhomothetic

(2) Profit maximization problem under **uniform quality** :

◂ Production Details

$$\max_{\phi_f, \{p_{rf}\}_r} \pi_f = \sum_r [p_{rf} - mc(\phi_f; a_f)] \, Q_{rf} - [f(\phi_f) + f_0]$$

$$\text{s.t.} \quad S_{rf} = \phi_f^{\gamma_r(\sigma-1)} (p_{rf}/P_r)^{1-\sigma} \, \text{Sales}_r$$

$*$ scale effect in fixed cost: $f(\phi_f) \equiv b\beta\phi_f^{\frac{1}{\beta}}$; marginal cost $mc(\phi_f; a_f) \equiv \frac{\phi_f^{\xi}}{a_f}$

(c.f.) Profit maximization problem under **market-specific quality**:

$\max_{\{\phi_{rf}, p_{rf}\}_r} \pi_f^m = \sum_r \left[[p_{rf} - mc(\phi_{rf}; a_f)] \, Q_{rf} - [f^m(\phi_{rf}) + f_{0r}^m] \right]$

Structural Equation: Intra-Firm Market Inter-Dependency

Region-Firm Sales Growth: Scale Effect and Non-homotheticity

$$\tilde{\Delta} S_{rf} = \Upsilon_r \sum_{r'} \omega_{r'f} \left[\tilde{\Delta} S_{r'f} + \tilde{\Delta}(\gamma_{r'} - \xi) \right] + \text{other terms}_{rf}$$

where

$$\Upsilon_r \approx \underbrace{\beta}_{\text{sales or preference in r'} \Rightarrow \text{quality of f}} \times \underbrace{(\sigma - 1)(\gamma_r - \xi)}_{\text{quality of f} \Rightarrow \text{sales in r}}$$

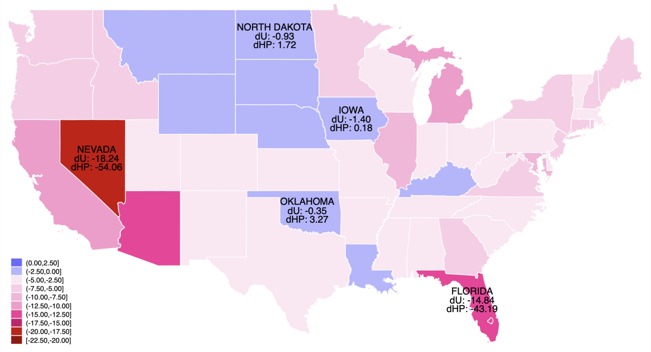
- β: inverse elasticity of fixed cost w.r.t. quality, $f(\phi_f) \equiv b\beta\phi_f^{\frac{1}{\beta}}$
- σ: demand elasticity
- γ_r: how much households value the quality, $\zeta_{rf} \equiv (\phi_f)^{\gamma_r}$
- ξ: elasticity of marginal cost w.r.t. quality (pass-through to price), $mc(\phi_f; a_f) = \frac{\phi_f^{\xi}}{a_f}$

Hetero-Effect | Equilibrium | Regression of Structural Equation | Exact formula | Estimation (Summary)

Real Consumption Growth

- **Benchmark**: uniform quality across markets, $\text{std}(\tilde{\Delta} U_r) = 4.0$

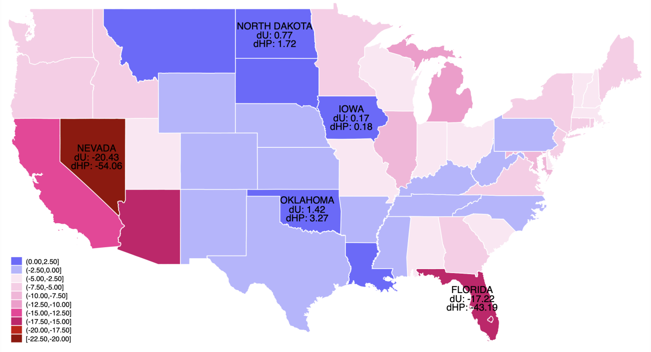
e.g. Florida: real consumption growth = **-14.8%**, house price growth = **-43.2%**
Oklahoma: real consumption growth = **-0.4%**, house price growth = **+3.3%**



Real Consumption Growth

- **Counterfactual**: state-specific quality, $\text{std}(\tilde{\Delta} U_r) = 5.2$
  - From counterfactual to benchmark: std $\Downarrow$ 30% $\approx$ \$400 per HH redistribution

e.g. Florida: real consumption growth = **-17.2%** (**-14.8%** in baseline)
Oklahoma: real consumption growth = **+1.4%** (**-0.4%** in baseline)



More

Conclusion

New Empirical Findings: Regional Spillovers and behind Mechanism

- regional shocks spill over through the intra-firm networks created by multi-market firms
- by replacing high-valued products with low-valued products in multiple markets simultaneously

Model and Implication: Regional Redistribution (Risk-Sharing)

- quality downgrading through product replacement
- mitigates the regional consumption inequality

Thank you!