Market Size and Trade in Medical Services

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July 2022

Economies of scale and trade in medical services

Perpetual policy discussion of geographic variation in medical services:

- Less populous places have worse health outcomes...
- ...but US doctors are disproportionately in big cities (50% more per capita)

Evaluating this hypothesis hinges on returns to scale and tradability

- Increasing returns → geographic concentration of production yields benefits
- Trade costs for services → proximity-concentration trade-off
- If patients vary in willingness to travel, efficiency and equity considerations

How do local increasing returns and trade costs govern the geography of US healthcare production and consumption? (18% of US GDP)

Our approach

Context

- Setting: Medicare (regulated provider payments)
    - Consumers are insured—preferences over quality & travel cost
- Model: Logit demand and economies of scale
    - Gravity equation & home-market effect under price controls

Questions

- How much care is traded across regions?
- Are there home-market effects? In which services?
- How large are economies of scale?
- Do trade patterns reflect quality of service?
- Which patients are more amenable to travel?

Summary of findings and implications

Positive results:

- Domestic trade in medical services mimics trade in manufactures
- Home-market effects are stronger in less common services
- Geographic concentration $\rightarrow \uparrow$ service quality, $\uparrow$ specialization
- High-income patients are less sensitive to distance

Normative considerations:

- Proximity-concentration tradeoff interacts with equity-efficiency tradeoff
- Subsidize production in or travel from smaller markets?
- Defining relevant market for measuring concentration, place-based inequality

Contributions

Medical care: trade & increasing returns

- Distribution of physicians/rural access (Newhouse 1982a,b,c, 1990; Rosenthal, Zaslavsky & Newhouse, 2005; Buchmueller et al. 2006, Alexander & Richards, 2021; ...)
- Studies mostly treat markets as local (Dartmouth; Baumgardner 1988a,b; Bresnahan & Reiss 1991; Chandra & Staiger 2007; Finkelstein, Gentzkow & Williams 2016)

Home-market effect for trade in services

- Trade in services: Lipsey (2009) Eaton and Kortum (2019)
- Market size and goods: Davis and Weinstein (2003); Hanson and Xiang (2004); Dingel (2017); Bartelme et al. (2019) Acemoglu and Linn (2004); Costinot et al. (2019)
- Central place theory: Christaller (1933); Hsu, Holmes and Morgan (2014); Schiff (2015)

Roadmap

- Theoretical framework
- Data description
- Market-size effects
  - Larger markets are net exporters of medical services
  - Gravity-based empirics
- Rare procedures have stronger market-size effects
  - Population elasticities by procedure
  - Gravity-based empirics
- Mechanisms
  - Scale improves quality
  - The division of labor is limited by the extent of the market
- Tradeoffs and counterfactual scenarios

Theoretical framework

Model of a market for a medical procedure

- Partial-equilibrium competitive model of one procedure with a fixed price
- N_j potential patients in region j. Patient k choosing provider in region i gets

$$U_{ik} = \ln \delta_i + \ln \phi_{ij(k)} + \epsilon_{ik}$$

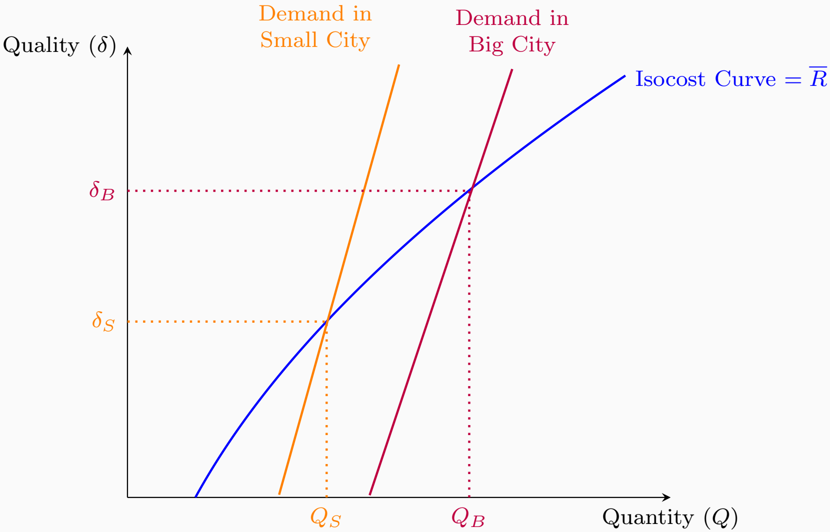
- Provider in region i chooses inputs L and quality δ to maximize profits, given input price w_i, reimbursement $\overline{R}$, productivity shifter A_i, regional output Q_i

$$\max_{L,\delta} \overline{R} A_i \frac{H(Q_i)}{K(\delta)} L - w_i L$$

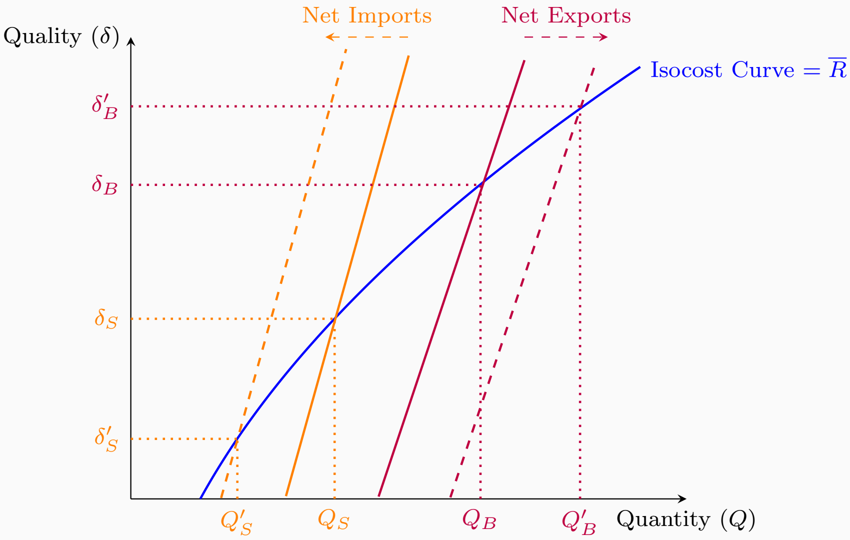
- Optimal quality and zero-profit conditions define isocost curve in (Q, δ) space:

$$\overline{R} = \frac{w_i K(\delta_i)}{A_i H(Q_i)} \equiv C(Q_i, \delta_i; w_i, A_i)$$

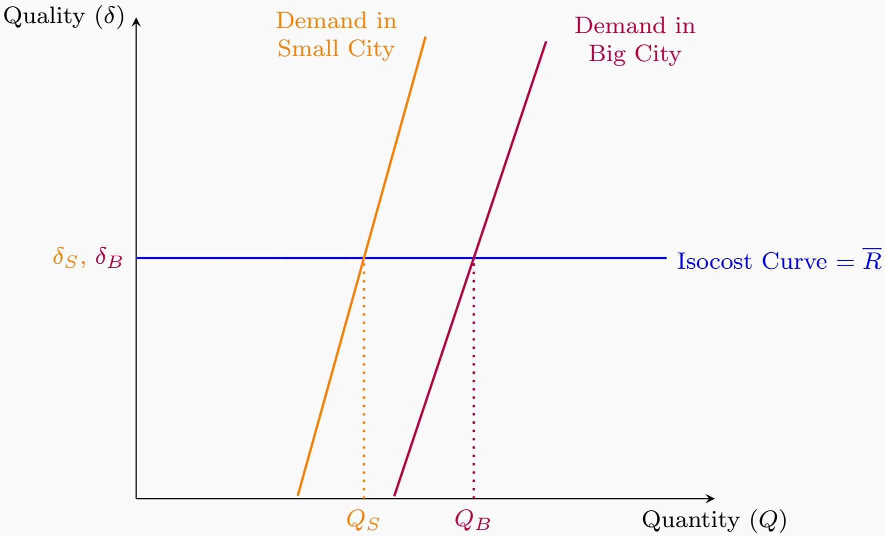
Equilibrium in autarky



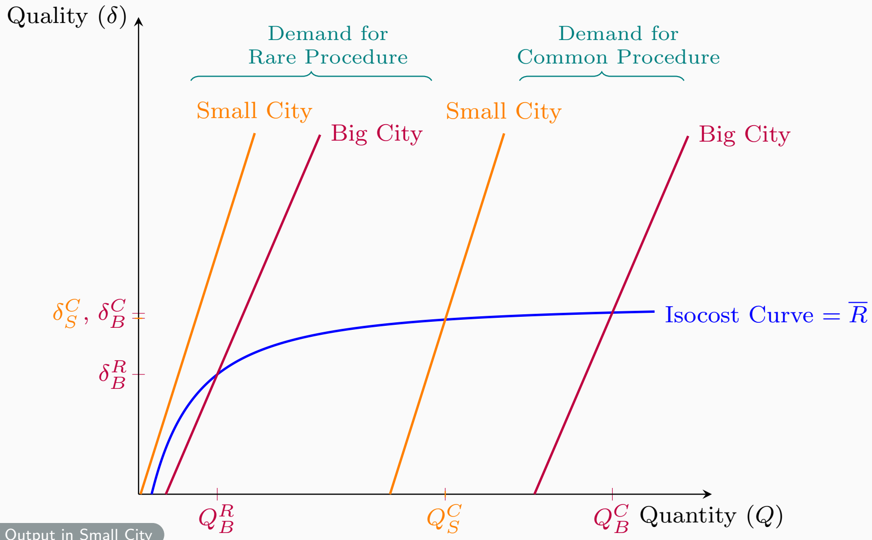
Equilibrium with trade



Equilibrium with constant returns to scale, $H'(Q_i) = 0$

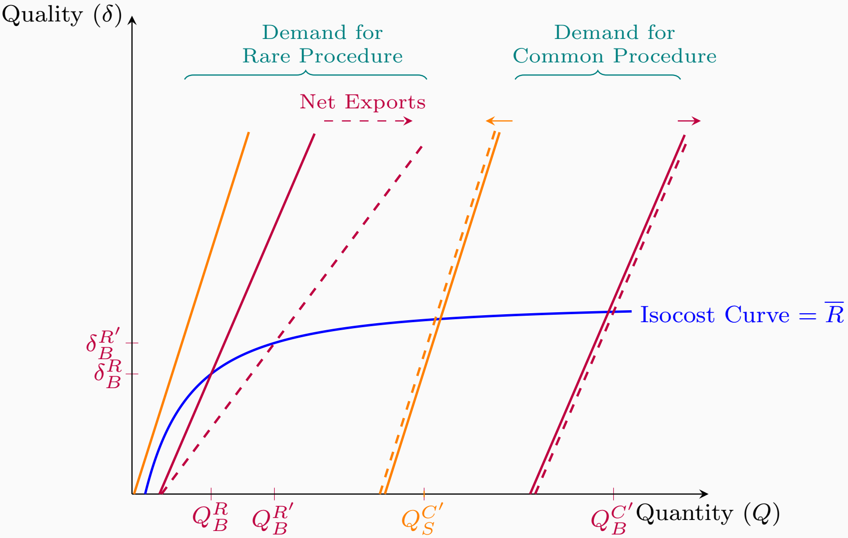


Rare vs common procedures: Autarky



▸ Non-Zero Output in Small City

Difference-in-differences prediction



Logit preferences and isoelastic external economies

$$U_{ik} = \ln \delta_i + \ln \phi_{ij(k)} + \epsilon_{ik}$$

- Preference shocks $\epsilon_{ik} \overset{\text{iid}}{\sim}$ T1EV $\implies$ Q_{ij} patients from j choosing i:

$$\mathbb{E}\left[Q_{ij}\right] = \frac{\delta_i \phi_{ij}}{\sum_{i'} \delta_{i'} \phi_{i'j}} N_j$$

$$\ln \mathbb{E}\left[Q_{ij}\right] = \ln \delta_i + \ln \left(\frac{N_j}{\Phi_j}\right) + \ln \phi_{ij}$$

- $H(Q_i) = Q_i^{\alpha}$ and $K(\delta) = \delta \rightarrow$ scale elasticity of quality is α:

$$\ln \delta_i = \alpha \ln Q_i + \ln \overline{R} - \ln w_i + \ln A_i$$

Home-market effects with many regions

Log-linearize around symmetric equilibrium: $N_i = \bar{N}\ \forall i, \phi_{ij} = \phi \in (0,1)\ \forall i \neq j$

With scale economies ($\alpha > 0$), $\uparrow$ region 1's size ($\mathrm{d}N_1 > 0$) $\rightarrow \uparrow$ quality

$$\frac{\mathrm{d}\ln\delta_1 - \mathrm{d}\ln\delta_{j\neq 1}}{\mathrm{d}\ln N_1} = \left[\frac{1-\alpha}{\alpha}\frac{(\bar{\Phi}-1)}{(1-\phi)\bar{\delta}} + \frac{(1-\phi)\bar{\delta}}{\bar{\Phi}}\right]^{-1} > 0$$

Higher quality raises gross exports (weak HME):

$$\frac{\mathrm{d}\ln Q_{1j}}{\mathrm{d}\ln N_1} = \left(\frac{\bar{N}-Q_{1j}}{\bar{N}}\right)\left[\frac{\mathrm{d}\ln\delta_1 - \mathrm{d}\ln\delta_j}{\mathrm{d}\ln N_1}\right] + \frac{Q_{0j}}{\bar{N}}\frac{\mathrm{d}\ln\delta_j}{\mathrm{d}\ln N_1} > 0$$

If α large enough and $\bar{N}$ small enough, net exports increase (strong HME):

$$\frac{\mathrm{d}\ln Q_{1,j\neq 1} - \mathrm{d}\ln Q_{j\neq 1,1}}{\mathrm{d}\ln N_1} = \frac{\frac{\alpha}{\bar{N}} - (1-\alpha)\frac{1+(\mathcal{I}-1)\phi}{1-\phi}}{\alpha\frac{(1-\phi)}{1+(\mathcal{I}-1)\phi}\frac{\bar{Q}}{\bar{N}} + (1-\alpha)\frac{1+(\mathcal{I}-1)\phi}{1-\phi}}$$

Data description

Medicare

- Medicare insures almost all Americans > 65 years old or disabled
  - 59 million beneficiaries and about 23% of healthcare expenditure (in 2017)
  - 39 million in Traditional Medicare (physicians & facilities bill Medicare)
- All willing providers covered; vast majority of doctors/hospitals
  - cf. private insurance: limited network, opaque pricing $\rightarrow$ patients have different choice sets
- Medicare regulates payment ("reimbursement") rates
  - Based on each procedure's estimated average cost
  - Constant across physicians within a region
  - Limited geographic variation (89 regions)
- Separate *professional* and *facility* fees
  - Professional fee $\rightarrow$ physician (we study these)
  - Facility fee $\rightarrow$ hospital (see appendix)

Data

Medicare professional claims data for 2017

- Carrier (fee-for-service claims) file reports procedure, provider, date, reimbursement
- Remove all Emergency Department care
- 20% representative sample of patients contains ∼230 million claims
- 13,000 5-digit procedures in Healthcare Common Procedure Coding System (HCPCS)
- ZIP codes of patient and place of service

National Plan and Provider Enumeration System (NPPES)

- Physician ID, name
- Physician specialization and location

We aggregate ZIP codes to hospital referral regions (HRRs)

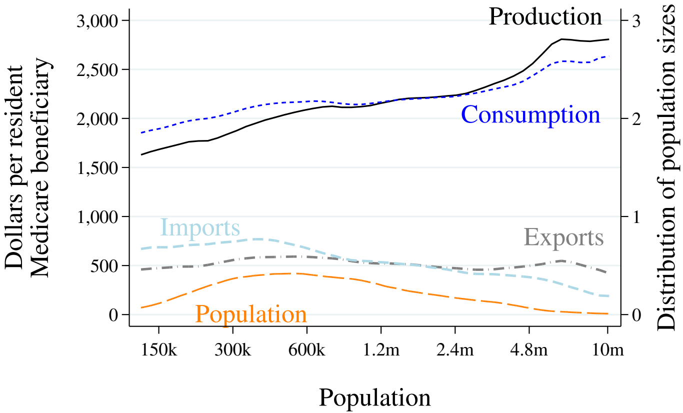
▸ HCPCS code examples ▸ Claim form ▸ HRR definition

Market-size effects

Market-size effects

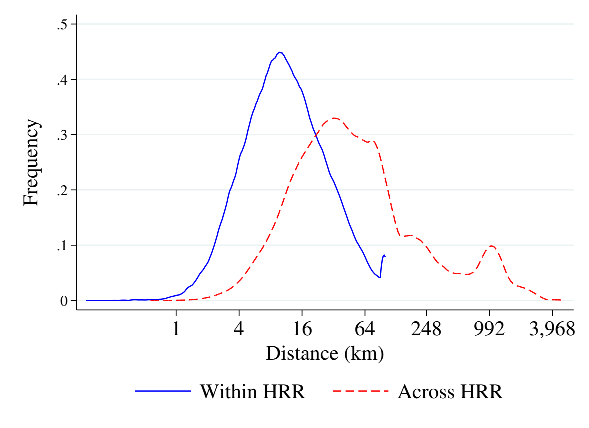
Larger markets are net exporters of medical services

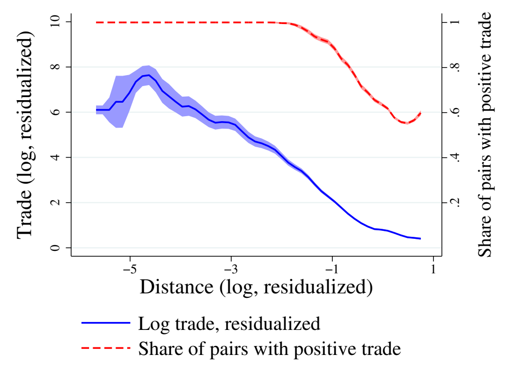
Production, consumption, trade, and market size



Population elasticity (log–log regression slope) of transactions per resident Medicare beneficiary:
Production: 0.13 (0.02), Consumption: 0.06 (0.01)
Exports: –0.00 (0.05), Imports: –0.25 (0.03)

Trade declines with distance





▸ CBSAs ▸ Intra-procedure trade ▸ By frequency

Market-size effects

Gravity-based empirics

Estimating home-market effect: 1-step gravity regression

$$\ln \mathbb{E}\left[Q_{ij}\right] = \ln \delta_i + \ln \left(\frac{N_j}{\Phi_j}\right) + \gamma \ln \text{distance}_{ij}$$

- Estimate HME by parameterizing gravity equation à la Costinot et al. 2019:

$$\ln \mathbb{E}\left(\overline{R} Q_{ij}\right) = \lambda_X \ln \text{population}_i + \lambda_M \ln \text{population}_j + \gamma \ln \text{distance}_{ij}$$

- $\lambda_X > 0$ is a weak home-market effect: $\uparrow N_i \implies \uparrow$ gross exports
- $\lambda_X > \lambda_M > 0$ is a *strong* home-market effect: $\uparrow N_i \implies \uparrow$ *net* exports

Two instruments:

- Population in 1940
- Depth to bedrock (Levy & Moscona, 2020)

Gravity regression: Strong HME for aggregate medical services

	(1)	(2)	(3)	(4)
Estimation method:	PPML	PPML	PPML	IV
Provider-market population (log)	0.636	0.641	0.643	0.594
	(0.0627)	(0.0603)	(0.0448)	(0.0719)
Patient-market population (log)	0.378	0.376	0.405	0.365
	(0.0608)	(0.0580)	(0.0417)	(0.0515)
Distance (log)	-1.656	0.0550		0.0362
	(0.0498)	(0.305)		(0.268)
Distance (log, squared)		-0.173		-0.171
		(0.0296)		(0.0262)
Observations	93,636	93,636	93,636	93,636
Distance elasticity at mean		-2.42		-2.42
Distance deciles			Yes	

Two-way clustered standard errors in parentheses

CBSAs | More FEs (HRR) | More FEs (CBSA) | Facility (HRR) | Facility (CBSA) | Labor costs by size | Bedrock IV

Rare procedures have stronger market-size effects

Rare procedures have stronger market-size effects

Population elasticities by procedure

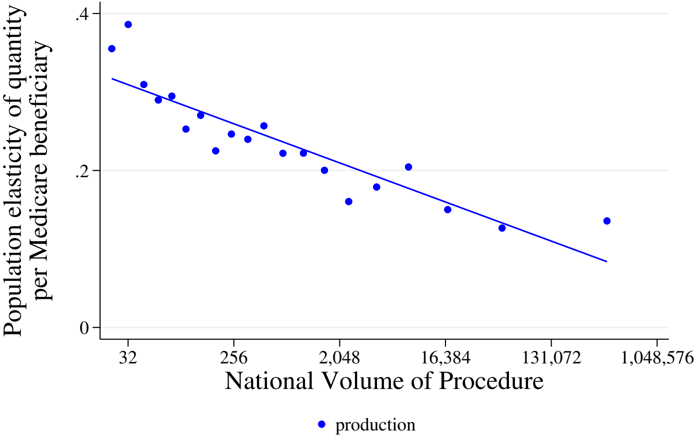
Estimating procedure-level population elasticities

- Q_{pi} is the count of procedure p produced in region i
- Q_{pi}/M_i is production per Medicare beneficiary residing in region i
- Use Poisson PML to estimate the population elasticity of economic activity

$$\ln \mathbb{E}\left[\frac{Q_{pi}}{M_i}\middle| \ln \text{population}_i\right] = \zeta_p + \beta_p \ln \text{population}_i$$

- We estimate elasticities for production and consumption
- Then relate estimated population elasticity $\widehat{\beta}_p$ to p's national frequency

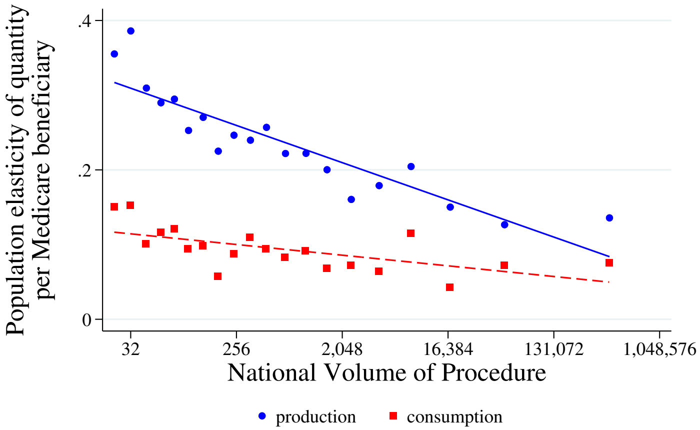
Population elasticity of production declines with frequency



Production fitted line: y = −0.024 (0.002) * x + 0.391 (0.016)
This plot depicts estimated population elasticities per Medicare beneficiary for 8,253 procedures produced at least 20 times nationally.

CBSAs

Population elasticity of consumption declines less with frequency

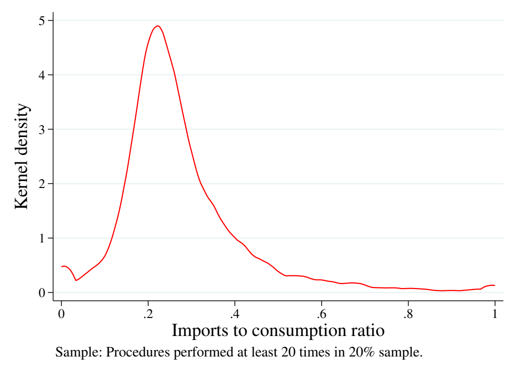


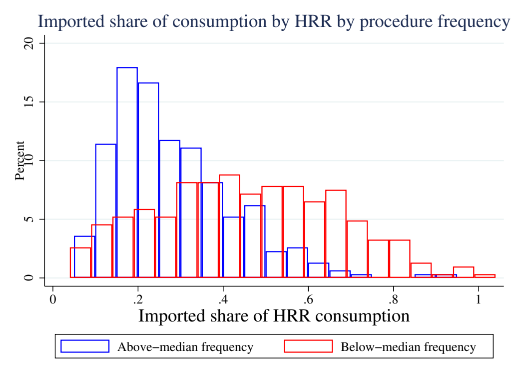
Production fitted line: y = −0.024 (0.002) * x + 0.391 (0.016)
Consumption fitted line: y = −0.007 (0.002) * x + 0.138 (0.014)
This plot depicts estimated population elasticities per Medicare beneficiary for 8,253 procedures produced at least 20 times nationally.

CBSAs
By diagnosis

Imports play a larger role in less-common procedures

- Imported share of consumption varies widely across procedures
- Imported share of consumption larger for less-common procedures





Rare procedures have stronger market-size effects

Gravity-based empirics

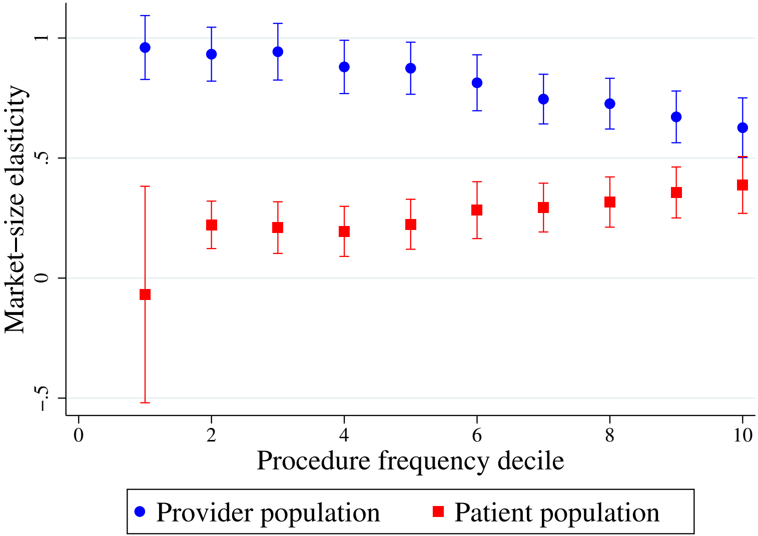
HME stronger for rarer procedures

	(1)	(2)	(3)	(4)	(5)	(6)
Provider-market population (log)	0.638	0.624	0.623		0.630	
	(0.0634)	(0.0613)	(0.0614)		(0.0598)	
Patient-market population (log)	0.377	0.379	0.380		0.379	
	(0.0615)	(0.0590)	(0.0591)		(0.0572)	
Provider-market population (log) $\times$ rare			0.306	0.291	0.316	0.287
			(0.0472)	(0.0455)	(0.0480)	(0.0458)
Patient-market population (log) $\times$ rare			-0.229	-0.219	-0.232	-0.211
			(0.0698)	(0.0671)	(0.0704)	(0.0658)
Observations	187,272	113,468	113,468	113,468	113,468	113,468
Distance controls	Yes	Yes	Yes	Yes		
Distance [quadratic] controls					Yes	Yes
Patient-provider-market-pair FEs				Yes		Yes

Two-way clustered standard errors in parentheses

Full table · Split by expenditures · CBSAs · By diagnosis · Bedrock IV · IV common-rare results · Specific procedures

HME stronger for rarer procedures



Mechanisms

Mechanisms

Scale improves quality

Estimating the scale elasticity: 2-step estimator

1. Estimate exporter fixed effects from gravity regression:

$$\ln \mathbb{E}\left(\overline{R}Q_{ij}\right) = \underbrace{\ln \delta_i}_{\text{exporter FE}} + \underbrace{\ln \theta_j}_{\text{importer FE}} + \gamma \ln \text{distance}_{ij}$$

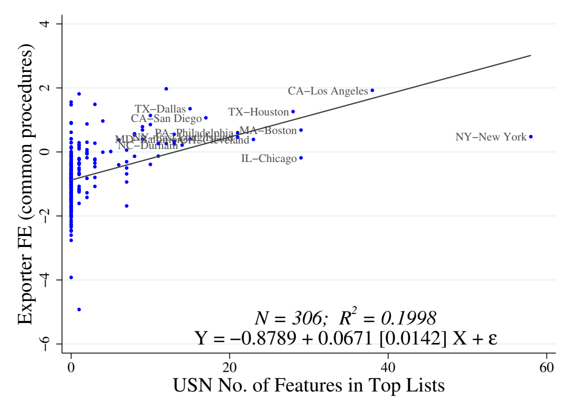
2. Regress them on output:

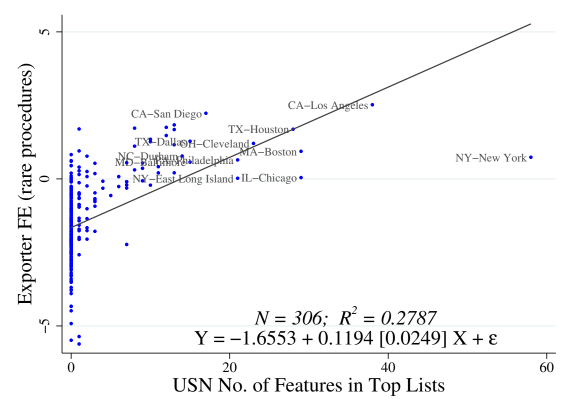
$$\widehat{\ln \delta_i} = \alpha \ln Q_i + \ln \overline{R} - \ln w_i + \ln A_i$$

- High-quality locations can be:
    - large ($Q_i \uparrow$),
    - cheap ($w_i \downarrow$),
    - or idiosyncratic ($A_i \uparrow$) [e.g., Mayo Clinic's historical investment in quality or reputation]
- 3 instruments for $\ln Q_i$: population, 1940 population, bedrock depth

Exporter fixed effects are correlated with other quality measures

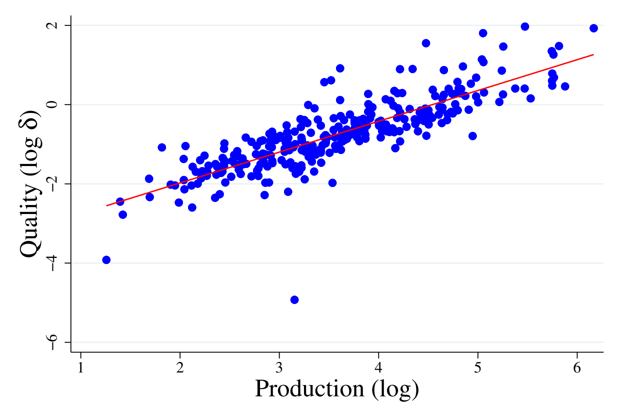
Hospital referral regions with more USNWR-ranked hospitals export more, especially rare procedures





▸ Dummy for ranked ▸ Leapfrog Safety Grades

Scale improves quality: $\alpha \approx 0.7$



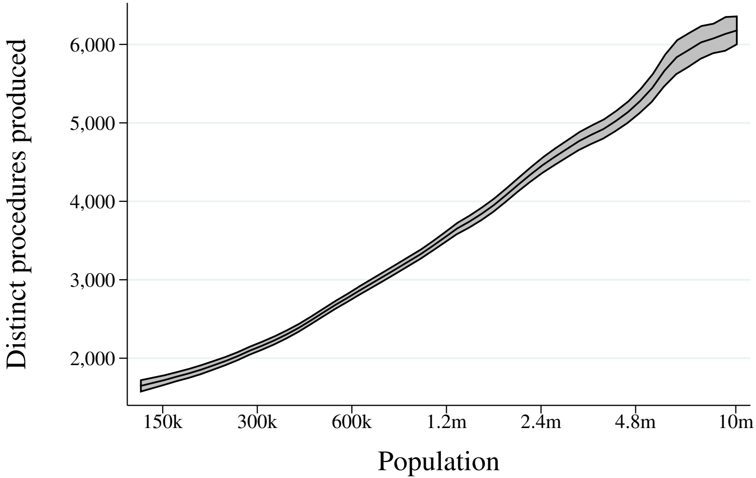
	No Controls		Controls	
	No Diag	Diag	No Diag	Diag
OLS	0.804	0.778	0.875	0.791
	(0.044)	(0.030)	(0.046)	(0.037)
2SLS: *pop*	0.799	0.716	0.861	0.720
	(0.049)	(0.030)	(0.052)	(0.036)
2SLS: *pop1940*	0.660	0.550	0.638	0.561
	(0.093)	(0.069)	(0.081)	(0.058)

▸ CBSAs ▸ By procedure

Mechanisms

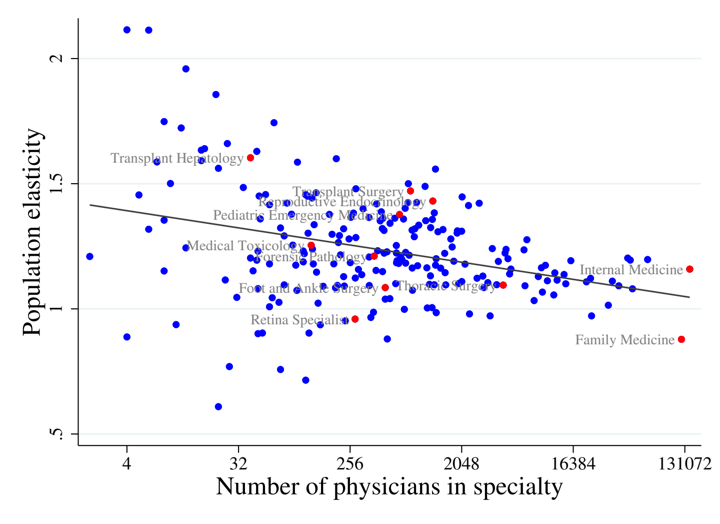
The division of labor is limited by the extent of the market

Larger markets produce greater set of procedures



Population elasticity (log–log regression slope) of number of distinct procedures: 0.37 (0.01).

Rare specialties have higher population elasticities

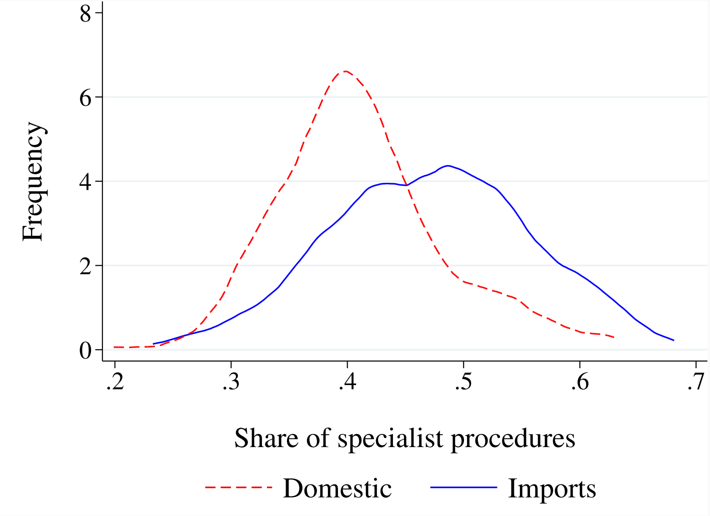


One source of increasing returns could be division of labor among physicians

Pearson correlation: -0.349.
Fitted line: $y = -0.039(0.007)\ln x + 1.484(0.046)$
Plot excludes 1 observation with elasticity greater than 2.12.

▸ CBSAs ▸ Earnings vs frequency ▸ Population elasticities of earnings ▸ Population elasticities of earnings by specialty

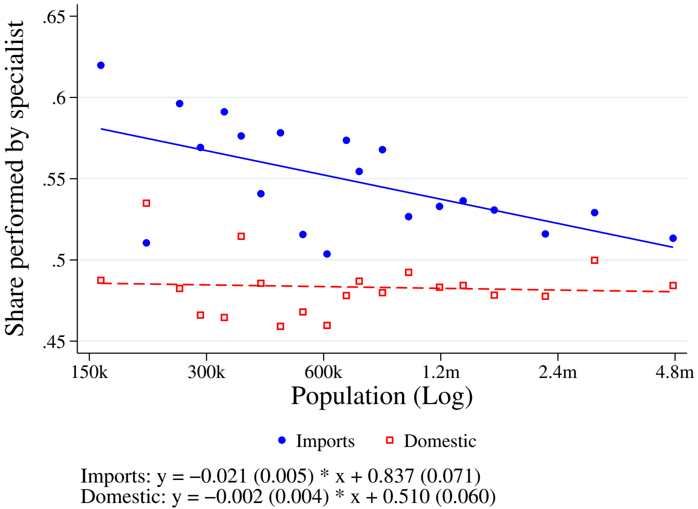
Traded procedures are specialist-intensive



- Classify a procedure as "generalist" if performed by Internal Medicine, Family Medicine, and General Practice $\geq 70\%$ (2,492 procedures)
- Classify as "specialist" if top two specializations do $\geq 70\%$ (7,533 procedures)
- Imports are more likely to be specialty care than locally produced consumption

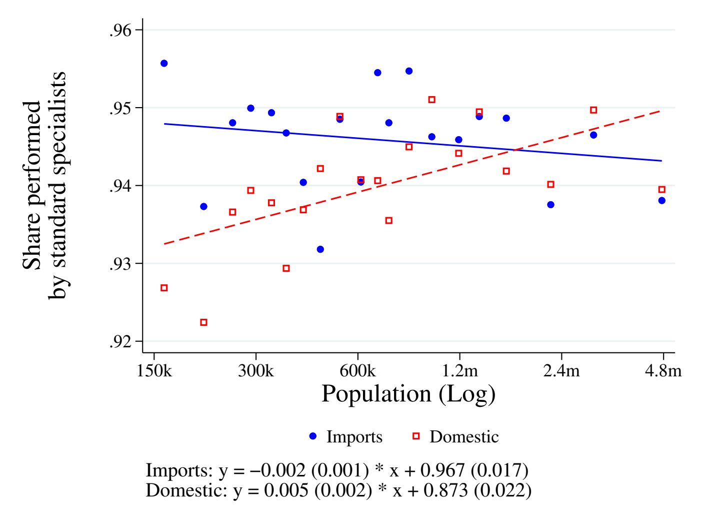
▸ CBSAs

Smaller places more likely to import specialty procedures



CBSAs

Care provided by "wrong" specialties in smaller places



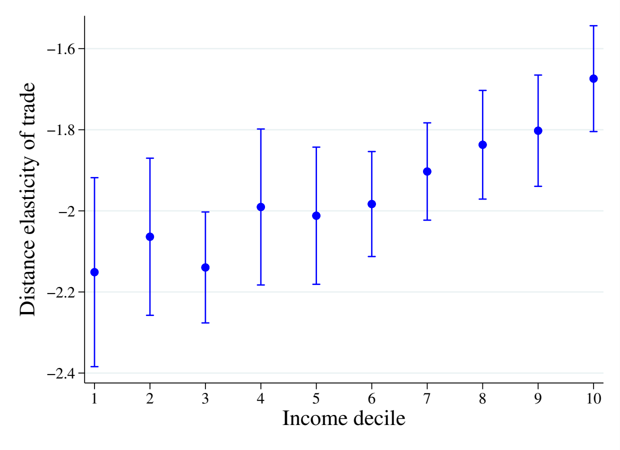
In smaller regions,

- domestically produced care less likely performed by "standard" specialist
- imports more likely performed by "standard" specialist

▸ CBSAs

Tradeoffs and counterfactual scenarios

Higher-SES patients are more willing to travel



Note: Coefficient on log distance estimated separately for each decile of the national ZIP-level median-household-income distribution. 95% CIs using standard errors clustered by both patient HRR and provider HRR.

By procedure

Counterfactual scenarios

1. Reallocate production to smaller markets ($\downarrow$ population elasticity 0.15)

$$Q_i' = Q_i \left(\text{population}_i \middle/ \overline{\text{population}} \right)^{-0.15}$$

$$\delta_i' = \delta_i \left(\frac{Q_i'}{Q_i} \right)^{\alpha}$$

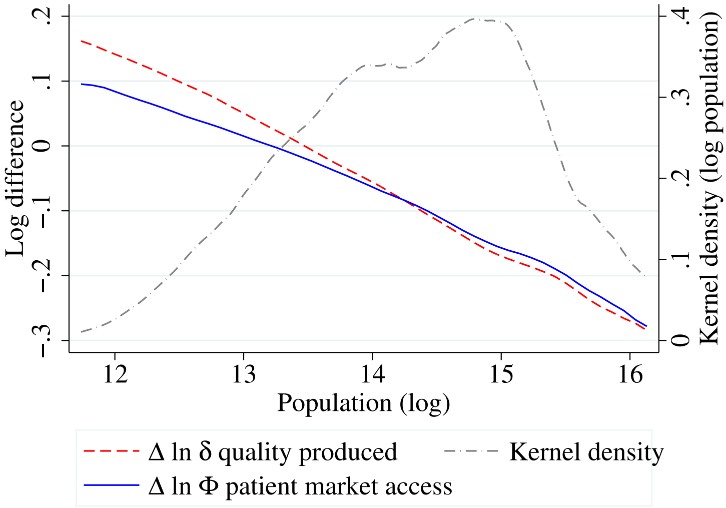
$$\Phi_i' - \delta_{0,i} = \sum_j \exp(\beta X_{ji}) \delta_j'$$

2. Increase patient willingness to travel ($\uparrow$ log distance coef to β') such that

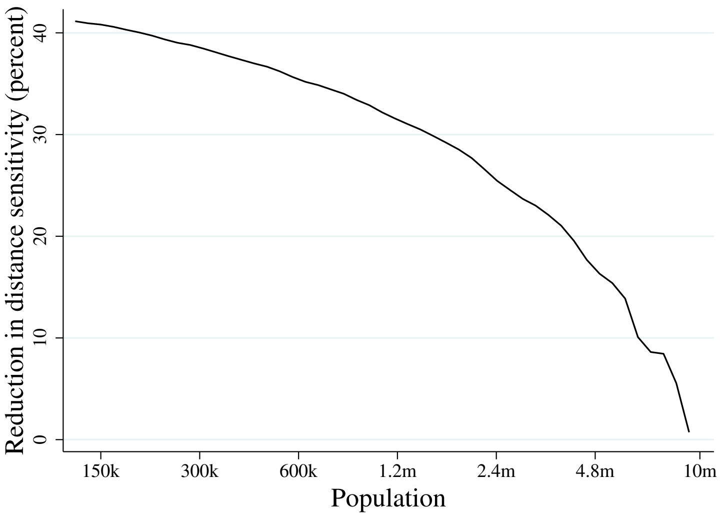
$$\Phi_i' - \delta_{0,i} \equiv \sum_j \exp(\beta' X_{ji}) \delta_j$$

$$= \Phi_{\text{biggest city}} - \delta_{0,\text{biggest city}}$$

Reallocation reduces average patient market access



How much cheaper travel would equalize patient market access?



Conclusions

Conclusions

Personal services are tradable:

- Interregional trade in medical care behaves like manufactures
  - But higher distance sensitivity
  - Distance sensitivity decreases in income
- Market size matters despite price controls
- Market size $\rightarrow$ quality & specialization

Implications:

- Proximity-concentration tradeoff interacts with equity-efficiency tradeoff
- Policy and research should account for trade
  - Impacts of location, access, concentration
  - Policies to improve access

Thank you