Market Size and Trade in Medical Services

Jonathan I. Dingel Joshua D. Gottlieb Maya Lozinski Pauline Mourot

University of Chicago

October 2024

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 situation hinges on returns to scale and tradability

- \bullet Increasing returns \rightarrow productivity benefits from concentrating production
- Trade costs for services \rightarrow proximity-concentration trade-off
- Heterogeneity in patients' travel costs \rightarrow 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)

This paper

Approach:

- Setting: Medicare (regulated provider payments)
- $\bullet\,$ Model: Trade costs & scale economies $\rightarrow\,$ market-size effects
- \bullet Implementation: Logit demand \rightarrow gravity equation \rightarrow scale elasticity

Estimates:

- Domestic trade in medical services mimics trade in manufactures 19% of production is exported; distance elasticity is about -1.7
- Market-size effect makes larger regions net exporters of medical services; stronger effect in less common services
- Geographic concentration $\rightarrow \uparrow$ service quality, \uparrow specialization ($\alpha \approx 0.8$)

Simple model generates rich depiction of proximity-concentration tradeoffs:

- Changes in output quality ≠ changes in patient market access: improving access need not mean subsidizing *output* in the region
- Production subsidies and travel subsidies can impose contrasting spillovers ("agglomeration shadows") on neighboring regions
- Production may be too dispersed: marginal return is higher in larger regions
- Production subsidies in smaller regions benefit lower-income patients more
- Lower-SES patients need larger travel subsidies to equalize access
- Size of the United States contributes to inequality in access

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services
- Mechanisms
 - How market-size effects vary with procedure characteristics
 - Sources of increasing returns: Division of labor and lumpy capital
 - Travel to access specialized services
- Health policy with trade and increasing returns

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services
- Mechanisms
 - How market-size effects vary with procedure characteristics
 - Sources of increasing returns: Division of labor and lumpy capital
 - Travel to access specialized services
- Health policy with trade and increasing returns

Claims data from Traditional Medicare, 2013–2017

- Vast majority of providers serve Medicare patients (65+ and disabled)
- All claims for hospitals and 20% random sample of 39 million FFS patients

Medical services:

- Claims use 12,000+ procedure codes
- We study all care provided by MD/DO outside Emergency Department Inpatient & outpatient claims show similar patterns

Geography:

- Claims report ZIP code of patient and ZIP code of place of service
- Main geographic unit of analysis: Hospital referral region (HRR)
 Similar results for metropolitan statistical areas (MSAs) and other units

Production, consumption, trade, and market size



Trade declines with distance



Understanding these patterns

The geography of US medical services:

- Large markets are net exporters
- Traveling for care is costly

Are large markets net exporters because they have more patients?

- Are there regional increasing returns to scale in medicine?
- Are they so large that higher demand generates net exports?

How might policies change these geographic patterns?

- Where is the marginal return to subsidizing production highest?
- What happens if government subsidizes travel?

• Empirical setting and geographic patterns

• Theoretical framework

- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services
- Mechanisms
 - How market-size effects vary with procedure characteristics
 - Sources of increasing returns: Division of labor and lumpy capital
 - Travel to access specialized services

• Health policy with trade and increasing returns

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 care in region i gets

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

• Provider in region *i* hiring *L* inputs to produce quality δ takes productivity shifter A_i and regional output Q_i as given. Output quantity is

$$A_i \frac{H(Q_i)}{K(\delta)} L$$

 Given government-set reimbursement rate R and factor price w_i, the free-entry condition defines an isocost curve in (Q, δ) space:

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

Autarky



10/37

Trade

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

$$\mathbb{E}\left[Q_{ij}\right] = \frac{\delta_i \rho_{ij}}{\Phi_j} N_j \quad \text{where } \Phi_j \equiv \sum_{i'} \delta_{i'} \rho_{i'j} \text{ is patient market access in } j$$

Trade follows gravity equation:

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

Market size and trade: N_j , δ_i , Φ_j

- Larger population (larger N_j) raises import demand
- With increasing returns ($\alpha > 0$): $\uparrow N_i \rightarrow \uparrow \delta_i \rightarrow \uparrow$ gross exports & $\uparrow \Phi_i$
- With sufficiently strong increasing returns ($\alpha \gg 0$):
 - $\uparrow N_i \rightarrow \ln \delta_i$ increases faster than $\ln \left(\frac{N_i}{\Phi_i} \right)$: region *i* is net exporter
 - This effect is larger for rare services

- Empirical setting and geographic patterns
- Theoretical framework

• Regional increasing returns in medical services

- Estimating the scale elasticity
- Strong home-market effect for aggregate medical services
- Mechanisms
 - How market-size effects vary with procedure characteristics
 - Sources of increasing returns: Division of labor and lumpy capital
 - Travel to access specialized services

• Health policy with trade and increasing returns

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services
- Mechanisms
 - How market-size effects vary with procedure characteristics
 - Sources of increasing returns: Division of labor and lumpy capital
 - Travel to access specialized services
- Health policy with trade and increasing returns

Estimating regional quality and the scale elasticity

1. Exporter fixed effects from gravity regression reveal regional quality:

$$\ln \mathbb{E} \left(S_{ij} \right) = \underbrace{\ln \delta_i}_{\text{exporter FE}} + \underbrace{\ln \theta_j}_{\text{importer FE}} + \gamma \ln \text{distance}_{ij}$$
$$= \frac{N_i}{\Phi_i}$$

2. Isocost curve implies estimating equation for α :

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

Higher-quality output can reflect:

- larger scale $(Q_i \uparrow)$,
- cheaper inputs $(w_i \downarrow)$,
- exogenous productivity $(A_i \uparrow)$ [e.g., sunk investments in quality]

Estimated HRR quality positively correlated with health outcomes



• Further support for clinical quality: Fischer et al., 2022; Battaglia, 2022; Petek, 2022

13/37

Quality \sim isoelastic with respect to scale



Scale elasticity estimate $\hat{\alpha}$

All services	Baseline	No Diagonal	Controls
OLS: 2017	0.806	0.961	0.786
	(0.031)	(0.047)	(0.041)
OLS: 2013-2017 difference	0.999	1.045	1.018
	(0.079)	(0.083)	(0.082)
2SLS: population (log)	0.800	0.905	0.777
	(0.037)	(0.057)	(0.050)
	[2141]	[2141]	[1621]
2SLS: population (1940, log)	0.697	0.924	0.633
	(0.063)	(0.093)	(0.070)
	[163]	[163]	[206]

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services
- Mechanisms
 - How market-size effects vary with procedure characteristics
 - Sources of increasing returns: Division of labor and lumpy capital
 - Travel to access specialized services
- Health policy with trade and increasing returns

Estimating home-market effects using gravity regressions

Test for HME using the gravity equation à la Costinot et al. (2019):

$$\ln \mathbb{E} \left[Q_{ij} \right] = \ln \delta_i + \ln \left(\frac{N_j}{\Phi_j} \right) + \gamma \ln \text{distance}_{ij}$$
$$\ln \mathbb{E} \left(Q_{ij} \right) = \lambda_{\mathbf{X}} \ln \text{population}_i + \lambda_{\mathbf{M}} \ln \text{population}_j + \gamma \ln \text{distance}_{ij}$$

- $\lambda_{\mathbf{X}} > 0$ is a weak home-market effect: $\uparrow N_i \implies \uparrow$ gross exports
- $\lambda_{\mathbf{X}} > \lambda_{\mathbf{M}}$ is a *strong* home-market effect: $\uparrow N_i \implies \uparrow$ *net* exports

Panel estimation using 2013-2017 population changes:

 $\ln \mathbb{E} \left(Q_{ijt} \right) = \mu_{\mathbf{X}} \ln \text{population}_{it} + \mu_{\mathbf{M}} \ln \text{population}_{jt} + \phi_{ij} + \gamma_t \ln \text{distance}_{ij}$

Gravity regression: Strong HME for aggregate medical services

	Cross-sectional PPML			IV: 1940 population	2013–2017 panel
$\lambda_{\mathbf{X}}$ Provider-market population (log)	0.671	0.681	0.671	0.757	0.939
	(0.0543)	(0.0505)	(0.0366)	(0.0547)	(0.151)
$\lambda_{\mathbf{M}}$ Patient-market population (log)	0.260	0.252	0.286	0.284	-0.205
	(0.0547)	(0.0501)	(0.0346)	(0.0467)	(0.148)
Distance (log)	-1.627	0.344		0.377	
	(0.0489)	(0.304)		(0.250)	
Distance (log, squared)		-0.199		-0.201	
		(0.0305)		(0.0247)	
Distance (log) $ imes$ 2017					-0.00117
					(0.00667)
p-value for H_0 : $\lambda_X \leq \lambda_M$	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Observations	93,636	93,636	93,636	93,636	162,678
Fixed effects					ij
Distance elasticity at mean		-1.59		-1.57	
Distance deciles	Yes				

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services

Mechanisms

- How market-size effects vary with procedure characteristics
- Sources of increasing returns: Division of labor and lumpy capital
- Travel to access specialized services
- Health policy with trade and increasing returns

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services
- Mechanisms
 - How market-size effects vary with procedure characteristics
 - Sources of increasing returns: Division of labor and lumpy capital
 - Travel to access specialized services
- Health policy with trade and increasing returns

Larger markets produce greater set of procedures



Stronger home-market effect for rarer procedures

 $\ln \mathbb{E}(S_{ij}) = \lambda_{\mathbf{X}} \ln \text{population}_i + \lambda_{\mathbf{M}} \ln \text{population}_j + \gamma \ln \text{distance}_{ij}$



Scale elasticity estimates $\hat{\alpha}$ for rare procedures

Rare services	Baseline	No Diagonal	Controls
OLS: 2017	0.972	1.119	0.938
	(0.035)	(0.048)	(0.041)
OLS: 2013-2017 difference	1.326	0.859	1.348
	(0.264)	(0.542)	(0.278)
2SLS: population (log)	0.941	1.074	0.897
	(0.041)	(0.053)	(0.053)
	[1581]	[1575]	[1143]
2SLS: population (1940, log)	0.857	1.078	0.797
	(0.065)	(0.089)	(0.072)
	[129]	[128]	[164]

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services

Mechanisms

- How market-size effects vary with procedure characteristics
- Sources of increasing returns: Division of labor and lumpy capital
- Travel to access specialized services

• Health policy with trade and increasing returns

Rare specialties are concentrated in larger markets



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

Pearson correlation: -0.446. Fitted line: $y = -0.072(0.010) \ln x + 0.798(0.065)$ Plot excludes 2 observations with elasticity greater than 1.60.

Rarely used equipment is concentrated in larger markets



Another mechanism could be lumpy capital, namely expensive medical equipment

Pearson correlation: -0.450. Fitted line: $y = -0.056(0.006) \ln x + 0.946(0.076)$ Plot excludes 11 observation with elasticity greater than 2.29.

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services

Mechanisms

- How market-size effects vary with procedure characteristics
- Sources of increasing returns: Division of labor and lumpy capital
- Travel to access specialized services

• Health policy with trade and increasing returns

Trade expands access to specialists, experience, and equipment

- Traded procedures are specialist-intensive. . .
- ... especially smaller markets' imports
- Small markets' locally-produced care uses "non-standard" specialties more
- Larger regions & imported care have more experienced physicians
- Larger regions & imported care use rare equipment more

Traded procedures are specialist-intensive



- Classify a procedure as "generalist" if performed by Internal Medicine, Family Medicine, and General Practice ≥ 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

Smaller places more likely to import specialty procedures



25 / 37

Care provided by "non-standard" specialties in smaller places



In smaller regions,

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

Larger regions & imported care have more experienced physicians



- Physician experience: number of times billing the service code over past year (scaled by code's mean)
- Average experience across codes, weighted by spending (scaled by mean across HRRs)
- Imported care provided by more experienced physicians than locally provided care, at any population size 27 / 37

Larger regions & imported care use rare equipment more



- Imports are more likely performed with rare equipment
- Larger regions more likely to use rare equipment for locally produced care

- Empirical setting and geographic patterns
- Theoretical framework
- Regional increasing returns in medical services
 - Estimating the scale elasticity
 - Strong home-market effect for aggregate medical services
- Mechanisms
 - How market-size effects vary with procedure characteristics
 - Sources of increasing returns: Division of labor and lumpy capital
 - Travel to access specialized services

• Health policy with trade and increasing returns

Health policy with trade and increasing returns

Three counterfactual scenarios:

- 1. Increase reimbursements in one region
 - Spatial impacts on quality and access
 - Spillovers on neighbors
 - Heterogeneity by income
- 2. Subsidize imported care in one region
 - Spillovers on neighbors
 - Differences by population size
 - Subsidies required by income
- 3. Increase proximity to make US geography \sim Germany
 - Reduces market access-income gradient

Change (%) in output quality δ_i

Change (%) in patient market access Φ_i



Counterfactual: Increase reimbursements in Paducah, KY

Change (%) in output quality δ_i Change (%) in patient market access Φ_i



- Spillover negative with exports to Paducah
- Net spillovers depend on whether market is net exporter

Higher-SES patients are more willing to travel



Counterfactual scenarios: Raise reimbursements in one region



- Two sources of contrast:
 - Lower-income patients disproportionately live in smaller markets
 - Higher-income patients
 travel more to high-quality
 providers

Boston example:

- Tercile 3 gains 70% more than tercile 1
- Difference due to share imported from Boston

Counterfactual: Subsidize imports for Paducah residents



- Paducahans' imports \rightarrow agglomeration benefits in neigboring regions
- Positive spillovers correlated with baseline exports to Paducah

Could geography explain US's steeper health-income gradient?



- United States has a steeper health-income gradient across regions than other OECD countries (e.g. Germany)
- Does USA's large size
 → costs of
 remoteness?

Counterfactual: Match German market-potential distribution



- Transforming the US geography to that of Germany (equivalent to broad travel subsidy)...
- ... reduces the Φ_i -income elasticity by 21%
- Rural areas have lower incomes
- Rural areas gain most in this counterfactual

Conclusions

Market Size and Trade in Medical Services

Findings:

- Domestic trade in medical services mimics trade in manufactures
 - But larger distance elasticity
 - Low-SES patients more sensitive to distance
- \bullet Scale economies \rightarrow large markets are net exporters
- Market-size effects largest in lower-volume services

Counterfactual outcomes:

- Spillovers of production subsidies depend on net trade flows
- For net importers, travel subsidies have opposite spillovers
- Aggregate return highest in larger regions, but lower-income patients benefit from subsidizing smaller regions

