

Owning the Agent: Hospital Influence on Physician Behaviors

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September 6, 2019

Background

Physician Agency

Physician with decision-making authority for treatment

- Information asymmetry
- Regulatory restrictions

Differential financial incentives between physician and hospital

- More procedures = more revenue, but location of procedure may matter to hospital
- Hospital wants less cost with fixed payment, but physician dictates resource use
- Hospital as residual claimant on billable physician services

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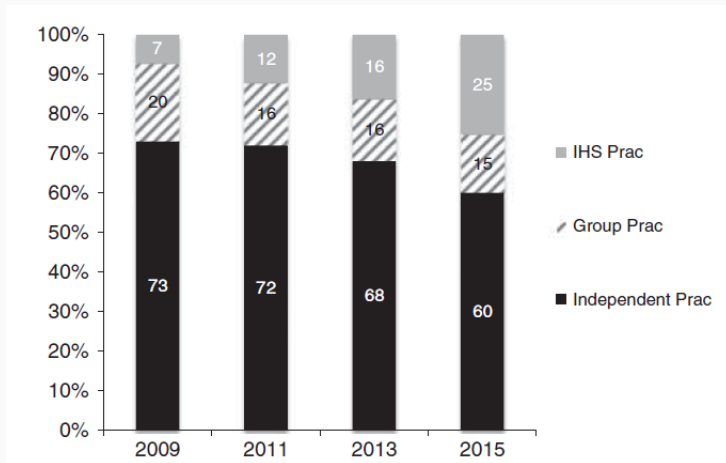
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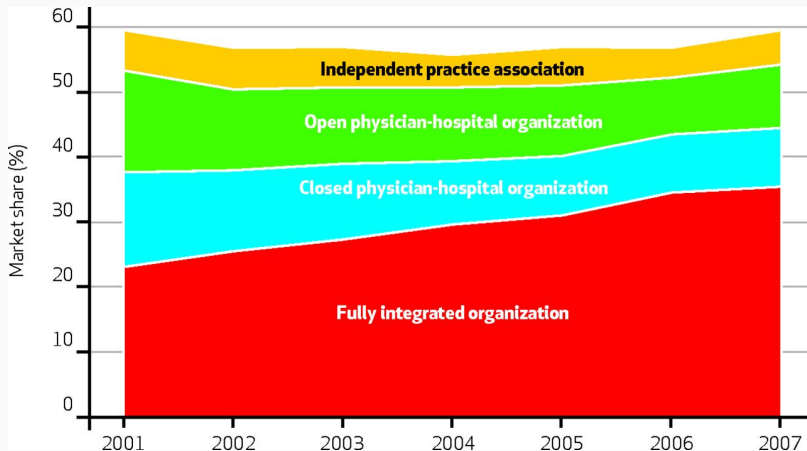
Most direct way (arguably) is to purchase physician practice

Changing Physician Relationships



Richards *et al.*, Medical Care, 2016

Changing Physician Relationships



Baker, Bundorf, and Kessler, Health Affairs, 2014

- Physician agency (Clemens & Gottlieb 2014, AER; Afendulis & Kessler 2007, AER; Gruber & Owings 1996, RAND; Iizuka 2012, AER)
- Supply-side variation (Finkelstein *et al.* 2016, QJE; Molitor 2018, AEJ: Policy)
- Vertical integration (Cuellar & Gertler 2006, JHE; Ciliberto & Dranove 2006, JHE; Baker *et al.* 2016, JHE; Koch *et al.* 2017, JHE)

1. Conceptual Framework
2. Initial Results
3. Event Study
4. Instrumental Variables
5. Other Outcomes

Conceptual Framework

Observed care at time t is

$$y_{ijk} = \arg \max_y \theta_u \tilde{u}(y; \Gamma_k, \Gamma_j, \kappa_i) + \theta_\pi \pi(y; \Gamma_k, \Gamma_j, \kappa_i).$$

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With assumptions on linearity and separability in patient preferences:

$$y_{ijk} = \alpha_i + x_i \beta + \Gamma_{jk} + \epsilon_{ijk}$$

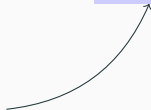
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Patient Preferences

Physician and hospital characteristics

Estimation Strategy

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1. Estimate $y_{ijk} = \alpha_i + x_i\beta + \Gamma_{jk} + \epsilon_{ijk}$ at patient level (separately by year). This isolates variation in care to physicians and hospitals (not patients).
2. Estimate $\hat{\Gamma}_{jkt} = \gamma_j + \gamma_k + \tau_t + z_{jkt}\delta + \eta_{jkt}$ with physician-hospital panel. This further isolates variation to physician-hospital interaction.

Estimation Strategy

- Draws from “match values” in labor literature (Abowd *et al.*, 2002; Card *et al.*, 2013, QJE)
- Exploits variation across inpatient stays and splits the separation of match value into two steps
- Identifies effects on match value from within-physician variation across hospitals (e.g., patient movers in Finkelstein *et al.*, 2016, QJE)

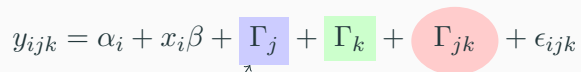
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Traditional “match value” approach:

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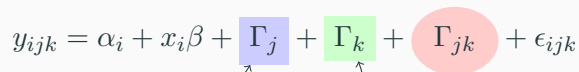
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Physician effect

Estimation Strategy

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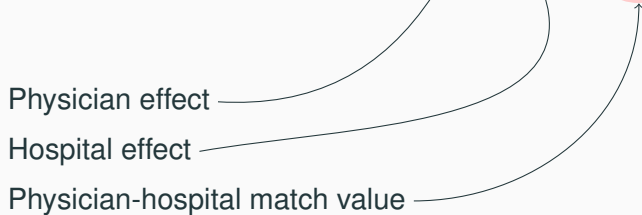
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Physician effect

Hospital effect

Physician-hospital match value

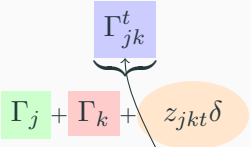
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Our approach:

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Physician, hospital, and match effect (jointly)

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The diagram illustrates the decomposition of the treatment effect term Γ_{jk}^t in the equation. A bracket under Γ_{jk}^t points to the sum $\Gamma_j + \Gamma_k + z_{jkt}\delta$. The term Γ_j is highlighted in a green box, Γ_k in a red box, and $z_{jkt}\delta$ in an orange oval. Arrows from the text labels below point to these components: 'Physician, hospital, and match effect (jointly)' points to the entire sum, and 'Physician effect' points specifically to Γ_j .

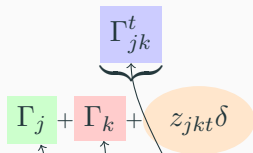
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Physician, hospital, and match effect (jointly)

Physician effect

Hospital effect

Physician-hospital integration

- Hospital influence on physicians is an interaction effect
- Potential influence should be net of patient preference
- Why not estimate in single step?
 - Treatment assignment should be at physician/hospital level
 - Weights by number of patients
 - Computationally infeasible with same specification

Data

Data Sources

- CMS: 100% inpatient and institutional outpatient Medicare claims data (2008-2015)
- SK&A: Hospital ownership of physician practices and practice characteristics
- AHA, HCRIS, POS: Hospital characteristics
- Annual IPPS Impact Files: Hospital cost-to-charge ratios (CCR)
- ACS: County-level demographics, education, income, and employment

Sample Construction

- Planned inpatient stays (elective admissions initiated by a physician, clinic, or HMO referral) and outpatient procedures with observed NPI for the operating physician

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 - Drop physicians with NPIs not matched in the SK&A data
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- 518,398 unique observations at the physician/hospital/year
- 7.5mm inpatient stays (47% of total) and 24mm outpatient procedures

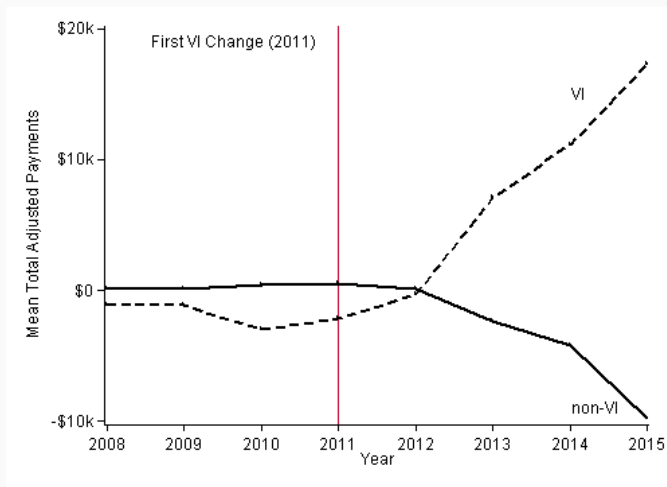
Preliminary Evidence

Total Spending by Integration Status

Estimate and plot residual from:

$$y_{jkt} = \beta x_{jt} + \delta z_{kt} + \lambda_k + \lambda_j + \lambda_t + \varepsilon_{jkt}$$

Total Spending by Integration Status



Estimation of Match Values

Two-step estimation strategy:

1. Estimate $y_{ijk} = \alpha_i + x_i\beta + \Gamma_{jk} + \epsilon_{ijk}$ at patient level (separately by year)
2. Estimate $\hat{\Gamma}_{jkt} = \gamma_j + \gamma_k + \tau_t + z_{jkt}\delta + \eta_{jkt}$ with physician-hospital panel

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- Total inpatient and outpatient Medicare payments
- Total inpatient and outpatient hospital costs (from cost-to-charge ratios)
- Total number of procedures

$$y_{ijk} = \alpha_i + x_i\beta + \Gamma_{jk} + \epsilon_{ijk},$$

- Quartiles of total prior Medicare payments and procedures
- Covers all payments/procedures (not just elective)
- Beneficiary-specific ranking of health care utilization up to time t

Independent Variables

$$y_{ijk} = \alpha_i + \textcolor{red}{x}_i\beta + \Gamma_{jk} + \epsilon_{ijk},$$

- Age, gender, race
- Indicators for ICD9 diagnosis code groups (18 diagnosis groups per variable plus missing group)

Summary of Match Values

1. Calculate Cost Differential

Apply minimum cost physician-hospital combination to all of physician j 's patients:

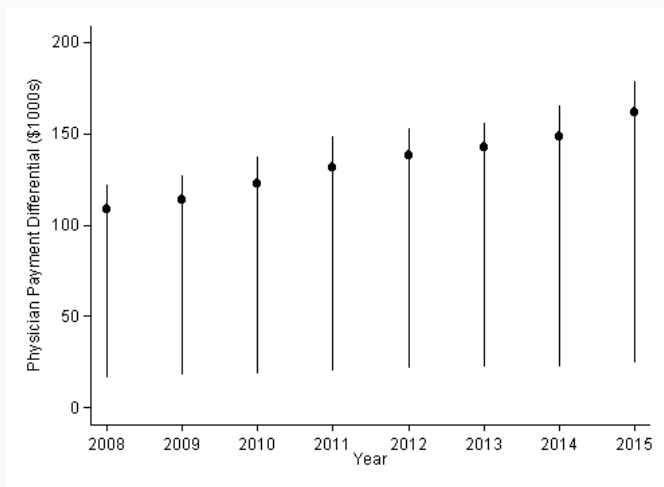
$$\begin{aligned}\Delta_k y_{ij} &= \hat{y}_{ijk} - \hat{y}_{ij\underline{k}} \\ &= \hat{\alpha}_i + x_i \hat{\beta} + \hat{\Gamma}_{jk} - \hat{\alpha}_i - x_i \hat{\beta} - \min \{ \Gamma_{j1}, \dots, \Gamma_{jK} \} \\ &= \hat{\Gamma}_{jk} - \min \{ \Gamma_{j1}, \dots, \Gamma_{jK} \} .\end{aligned}$$

Summary of Match Values

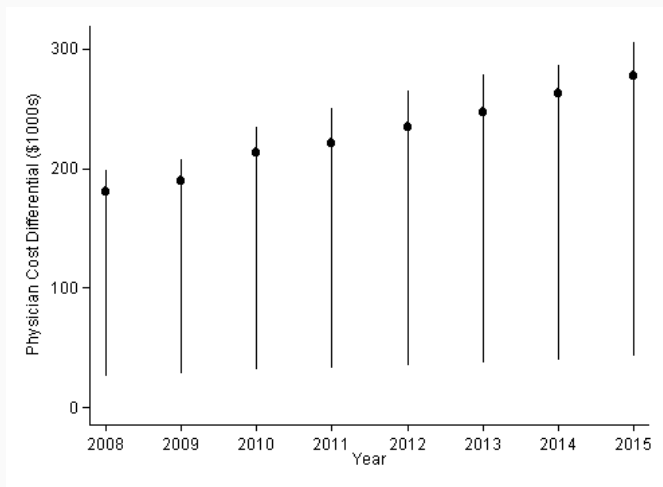
2. Summarize

- Total cost differential for each physician
- Limit to pairs with 5 or more procedures
- Limit to physicians with 2 or more hospitals in a year
- Present interquartile range and mean

Within-physician Variation in Payments



Within-physician Variation in Payments



Estimation of Hospital Influence

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Main Outcomes

$$\hat{\Gamma}_{jkt} = \gamma_j + \gamma_k + \tau_t + z_{jkt}\delta + \eta_{jkt},$$

	2008	2012	2013	2014	2015	Overall
Total Payments	6,367.7 (5,454.5)	7,301.9 (6,385.4)	7,644.3 (6,562.7)	8,021.9 (6,658.9)	8,234.8 (6,822.7)	7,238.4 (6,219.2)

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Total Costs	8,384.5 (6,822.1)	10,168.8 (8,165.1)	10,600.5 (8,410.1)	11,029.3 (8,754.5)	11,466.5 (8,935.2)	9,851.9 (7,994.5)

Independent Variables

$$\hat{\Gamma}_{jkt} = \gamma_j + \gamma_k + \tau_t + z_{jkt}\delta + \eta_{jkt},$$

	2008	2012	2013	2014	2015	Overall
Integrated	0.129 (0.336)	0.205 (0.404)	0.232 (0.422)	0.254 (0.435)	0.327 (0.469)	0.196 (0.397)

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Beds (100s)	1.979 (2.160)	1.963 (2.141)	1.950 (2.135)	1.977 (2.177)	1.995 (2.231)	1.971 (2.153)

Independent Variables

$$\hat{\Gamma}_{jkt} = \gamma_j + \gamma_k + \tau_t + z_{jkt}\delta + \eta_{jkt},$$

	2008	2012	2013	2014	2015	Overall
Practice Size	13.81 (32.27)	17.39 (30.83)	17.40 (29.42)	17.96 (28.68)	18.65 (28.43)	16.21 (30.24)

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Experience	22.55 (6.498)	23.00 (6.704)	23.93 (6.953)	23.65 (6.901)	24.76 (6.999)	23.16 (6.748)

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Experience	22.55 (6.498)	23.00 (6.704)	23.93 (6.953)	23.65 (6.901)	24.76 (6.999)	23.16 (6.748)
% Multi-Specialty	0.249	0.248	0.266	0.284	0.344	0.264
% Surgery Center	0.452	0.500	0.506	0.507	0.452	0.479

Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
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* p-value <0.1, ** p-value <0.05, *** p-value <0.01

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Outcome	Estimate	St. Error
Total Medicare Payments	75.121**	(30.902)

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Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	75.121**	(30.902)
Total Hospital Costs	132.466***	(42.026)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	75.121**	(30.902)
Total Hospital Costs	132.466***	(42.026)
Total Procedures	0.015***	(0.004)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Threats to Identification and Interpretation

Estimator is effectively a two-way fixed effects DD with time varying treatment

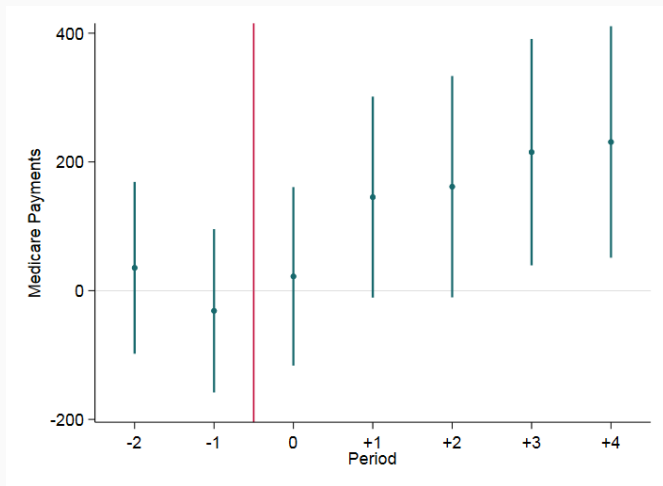
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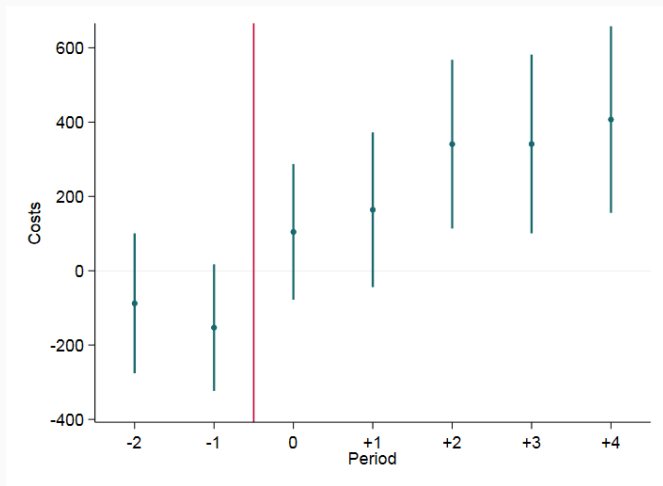
Potential Problems

1. Vertical integration due to time-varying unobservables & outcomes (standard DD concern)
2. Weighted average of all 2×2 DD estimates, with some potentially negative weights

Event Study: Total Medicare Payments



Event Study: Total Hospital (IP & OP) Costs



Takeaways

- Increase in payments and costs
- Evidence consistent with common trends assumption for total payments and costs
- Concerns about limited pre-period data

Endogeneity of physician-hospital integration

Integration could be driven by:

- Unobserved, time-varying practice characteristics
- Existing costs and treatment patterns

Endogeneity of physician-hospital integration

1. Set of possible physician-hospital pairs

Form set of all hospitals where physician operates from 2008-2015

2. Estimate probability of integration

$$\Pr(I_{jk} = 1) = \frac{\exp(\lambda z_{jk})}{1 + \exp(\lambda z_{jk})}$$

- Hospital and practice characteristics
- Average differential distance (relative to nearest hospital in patient choice set)
- Differential distance interacted with hospital and practice characteristics

2. Estimate probability of integration

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Intuition: Physicians less likely to seek/allow acquisition if patients live further away

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$$\hat{\Gamma}_{jkt} = \gamma_j + \gamma_k + \tau_t + \underbrace{I_{jkt}}_{\hat{I}_{jkt} = \hat{\Pr}(I_{jkt}=1)} \delta_1 + \tilde{z}_{jkt} \delta_2 + \eta_{jkt},$$

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
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* p-value <0.1, ** p-value <0.05, *** p-value <0.01

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
Total Medicare Payments	870.4**	(340.41)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
Total Medicare Payments	870.4**	(340.41)
Total Hospital Costs	2,546***	(454.70)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

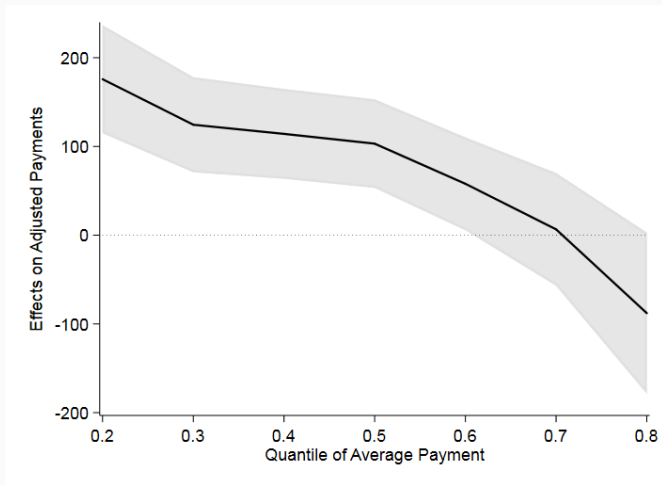
IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
Total Medicare Payments	870.4**	(340.41)
Total Hospital Costs	2,546***	(454.70)
Total Procedures	0.271***	(0.042)

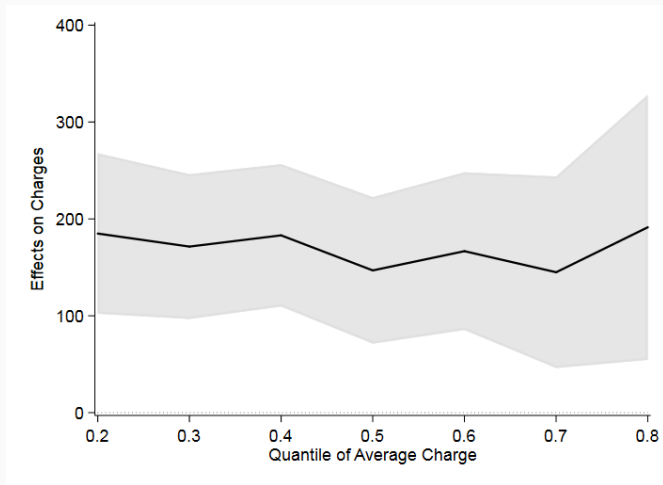
* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Heterogeneities in Effects

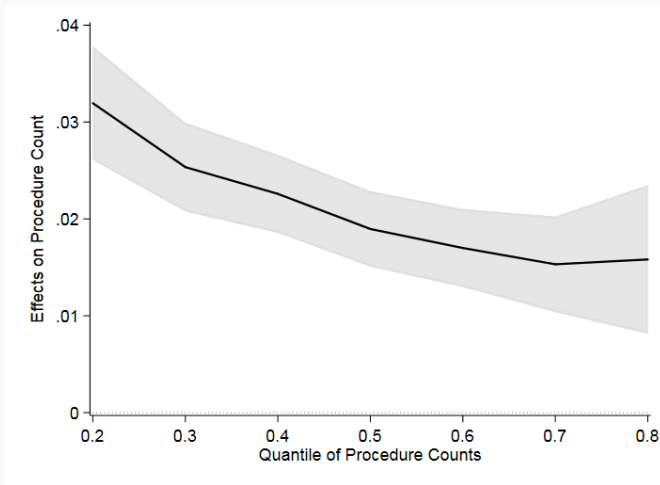
Unconditional Quantile Results: Payments



Unconditional Quantile Results: Hospital Costs



Unconditional Quantile Results: Procedures



Treatment Intensity vs Reallocation

Want to isolate treatment intensity effect

1. Focus on patients with no change in physician/hospital pairs over time
2. Examine outcomes within an inpatient stay

Aggregate Outcomes without Reallocation

Outcome	Estimate	St. Error
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* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Aggregate Outcomes without Reallocation

Outcome	Estimate	St. Error
Total Medicare Payments	63.291**	(30.853)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Aggregate Outcomes without Reallocation

Outcome	Estimate	St. Error
Total Medicare Payments	63.291**	(30.853)
Total Hospital Costs	124.830***	(42.073)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Aggregate Outcomes without Reallocation

Outcome	Estimate	St. Error
Total Medicare Payments	63.291**	(30.853)
Total Hospital Costs	124.830***	(42.073)
Total Procedures	0.014**	(0.004)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Effects on Components of Inpatient Stay

Outcome	Estimate	St. Error
Charges for:		
Total Inpatient	165.441***	(50.165)
Medical Supplies	40.413	(30.299)
Operating Room	-1.780	(22.996)
Anesthesia	6.504	(4.970)
Labs	14.006	(8.782)
Radiology	-2.366	(5.971)
MRI	-0.073	(1.386)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Effects on Components of Inpatient Stay

Outcome	Estimate	St. Error
Counts of:		
ICU Days	0.022*	(0.013)
Procedures	0.030***	(0.009)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Allocation of Procedures and Patients

Other ways integration posited to affect physician behavior:

- More procedures overall (not per patient)
- Reallocating procedures from other hospitals
- Reallocating procedures across inpatient and outpatient settings
- Changing patient profile

Results on Other Outcomes

Outcome	Estimate	St. Error
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* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.083***	(0.003)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.083***	(0.003)
Physician's outpatient share	0.063***	(0.003)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.083***	(0.003)
Physician's outpatient share	0.063***	(0.003)
Total patients	7.304***	(0.500)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.083***	(0.003)
Physician's outpatient share	0.063***	(0.003)
Total patients	7.304***	(0.500)
Inpatient procedures	1.124***	(0.161)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.083***	(0.003)
Physician's outpatient share	0.063***	(0.003)
Total patients	7.304***	(0.500)
Inpatient procedures	1.124***	(0.161)
Outpatient procedures	10.375***	(1.001)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.083***	(0.003)
Physician's outpatient share	0.063***	(0.003)
Total patients	7.304***	(0.500)
Inpatient procedures	1.124***	(0.161)
Outpatient procedures	10.375***	(1.001)
Patient Claims	0.013	(0.058)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.083***	(0.003)
Physician's outpatient share	0.063***	(0.003)
Total patients	7.304***	(0.500)
Inpatient procedures	1.124***	(0.161)
Outpatient procedures	10.375***	(1.001)
Patient Claims	0.013	(0.058)
Patient Payments	-156.713	(136.992)

* p-value <0.1, ** p-value <0.05, *** p-value <0.01

Summary of Results

Overall Results

- Increase in Medicare payments (\$75-\$200) and hospital costs (\$130-\$350)
- Extrapolates to between \$52mm and \$140mm in additional Medicare payments per year
- 4-10% of within-physician variation explained by vertical integration

Summary of Results

Sensitivity

- Event study consistent with common pre-trends but limited pre-period data
- IV results suggest conservative estimates
- No improvement in quality (mortality)
- As falsification test, no effects on payments or DRG weights per inpatient stay

Thank You
