Physician Behaviors and Hospital Influence

Haizhen Lin & **Ian McCarthy** & Michael Richards

February 8, 2019

Background

Physician Agency

Physician with decision-making authority for treatment

- Information asymmetry
- Regulatory restrictions

Physician Agency

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

Physician Agency

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

$\longrightarrow$ Incentives for hospitals to influence physicians

Physician Agency

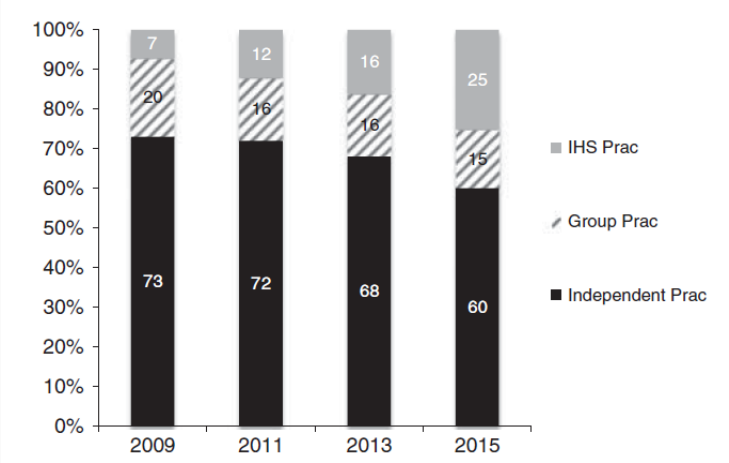
Differential financial incentives between physician and hospital

- 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

$\longrightarrow$ Incentives for hospitals to influence physicians

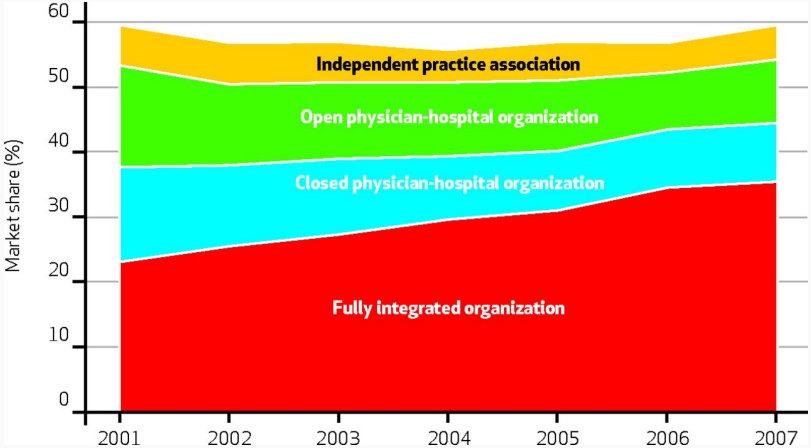
Most direct way (arguably) is to purchase physician practice

Changing Physician Relationships



Richards *et al.*, Medical Care, 2016

Changing Physician Relationships



Baker, Bundorf, and Kessler, Health Affairs, 2014

In context

- 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)

Outline

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

Theoretical Framework

Physician Agency

Observed care at time t is

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

Physician Agency

Observed care at time t is

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

With assumptions on linearity and separability in patient preferences:

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

Physician Agency

Observed care at time t is

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

With assumptions on linearity and separability in patient preferences:

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

Patient Preferences

Physician Agency

Observed care at time t is

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

With assumptions on linearity and separability in patient preferences:

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

Patient Preferences

Physician and hospital characteristics

Estimation Strategy

Suggests two-step estimation strategy:

Estimation Strategy

Suggests two-step estimation strategy:

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).

Estimation Strategy

Suggests two-step estimation strategy:

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)

Estimation Strategy

Traditional “match value” approach:

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

Estimation Strategy

Traditional “match value” approach:

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

Physician effect

Estimation Strategy

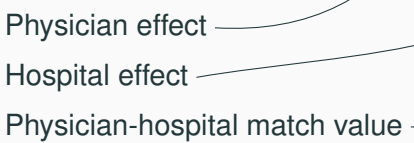
Traditional “match value” approach:

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

Estimation Strategy

Traditional “match value” approach:

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



Estimation Strategy

Our approach:

$$y_{ijk} = \alpha_i + x_i\beta + \underbrace{\Gamma^t_{jk}}_{\Gamma_j + \Gamma_k + z_{jkt}\delta} + \epsilon_{ijk}$$

Estimation Strategy

Our approach:

$$y_{ijk} = \alpha_i + x_i\beta + \Gamma^t_{jk} + \epsilon_{ijk}$$

$$\Gamma^t_{jk} = \Gamma_j + \Gamma_k + z_{jkt}\delta$$

Physician, hospital, and match effect (jointly)

Estimation Strategy

Our approach:

$$y_{ijk} = \alpha_i + x_i\beta + \Gamma^t_{jk} + \epsilon_{ijk}$$

$$\Gamma^t_{jk} = \Gamma_j + \Gamma_k + z_{jkt}\delta$$

Physician, hospital, and match effect (jointly)

Physician effect

Estimation Strategy

Our approach:

$$y_{ijk} = \alpha_i + x_i\beta + \Gamma^t_{jk} + \epsilon_{ijk}$$

$$\Gamma^t_{jk} = \Gamma_j + \Gamma_k + z_{jkt}\delta$$

Physician, hospital, and match effect (jointly)

Physician effect

Hospital effect

Estimation Strategy

Our approach:

$$y_{ijk} = \alpha_i + x_i\beta + \Gamma^t_{jk} + \epsilon_{ijk}$$

$$\Gamma^t_{jk} = \Gamma_j + \Gamma_k + z_{jkt}\delta$$

Physician, hospital, and match effect (jointly)

Physician effect

Hospital effect

Physician-hospital integration

Intuition

- Hospital influence on physicians is an interaction effect
- Potential influence should be net of patient preference

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

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
- Drop physicians operating in hospitals more than 120 miles from primary office or outside of contiguous U.S.

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
- Drop physicians operating in hospitals more than 120 miles from primary office or outside of contiguous U.S.
- Drop physicians with NPIs not matched in the SK&A data

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
- Drop physicians operating in hospitals more than 120 miles from primary office or outside of contiguous U.S.
- Drop physicians with NPIs not matched in the SK&A data
- Drop lowest/highest 1% of charges and patients $<$ 65 years old

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
- Drop physicians operating in hospitals more than 120 miles from primary office or outside of contiguous U.S.
- Drop physicians with NPIs not matched in the SK&A data
- Drop lowest/highest 1% of charges and patients $<$ 65 years old

$\longrightarrow$ 518,398 unique observations at the physician/hospital/year
$\longrightarrow$ 7.5mm inpatient stays (47% of total) and 24mm outpatient procedures

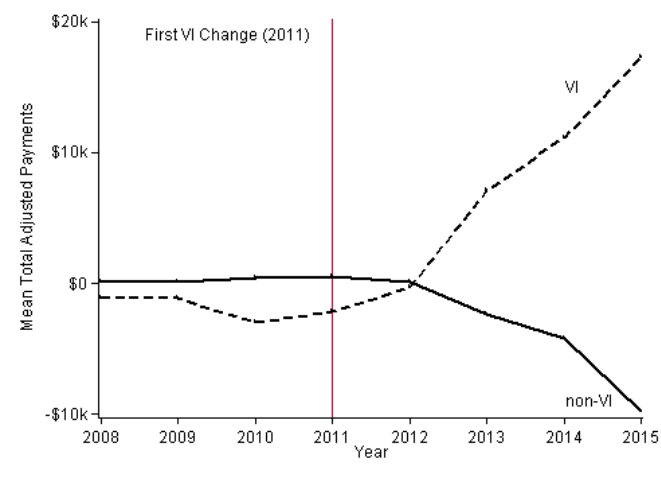
Preliminary Evidence

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

Specification

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

Specification

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

Outcomes

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

- Total inpatient and outpatient Medicare payments
- Total inpatient and outpatient hospital costs (from cost-to-charge ratios)
- Inpatient hospital costs
- Inpatient length of stay
- Outpatient hospital costs

Independent Variables

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

- Quartiles of total “other” Medicare payments and procedures
- Covers 2008 through 2015 period
- Beneficiary-specific ranking of health care utilization

Independent Variables

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

- Age, gender, race
- Indicators for ICD9 diagnosis code groups (18 diagnosis groups per variable plus missing group)
- Indicators for primary DRGs (with at least 1000 observations in a given year)
- Minor differences between total, inpatient, and outpatient specifications

Summary of Match Values

1. Calculate Cost Differential

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

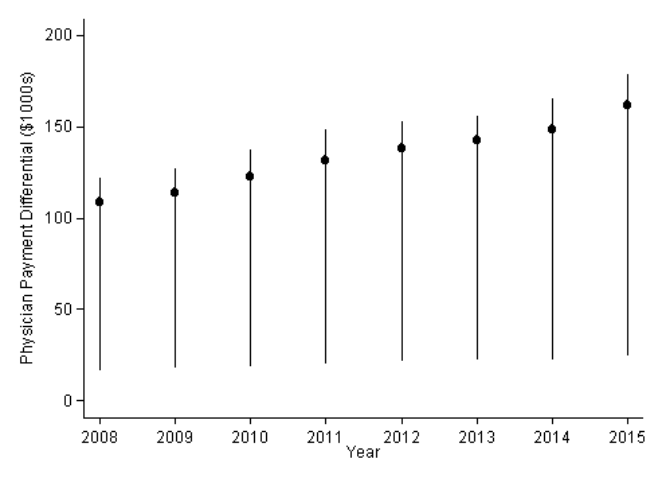
$$\begin{aligned}\Delta_k y_{ij} &= \hat{y}_{ijk} - \hat{y}_{ij\underline{\mathbf{k}}} \\ &= \hat{\alpha}_i + x_i\hat{\beta} + \hat{\Gamma}_{jk} - \hat{\alpha}_i - x_i\hat{\beta} - \min\left\{\Gamma_{j1}, ..., \Gamma_{jK}\right\} \\ &= \hat{\Gamma}_{jk} - \min\left\{\Gamma_{j1}, ..., \Gamma_{jK}\right\}.\end{aligned}$$

Summary of Match Values

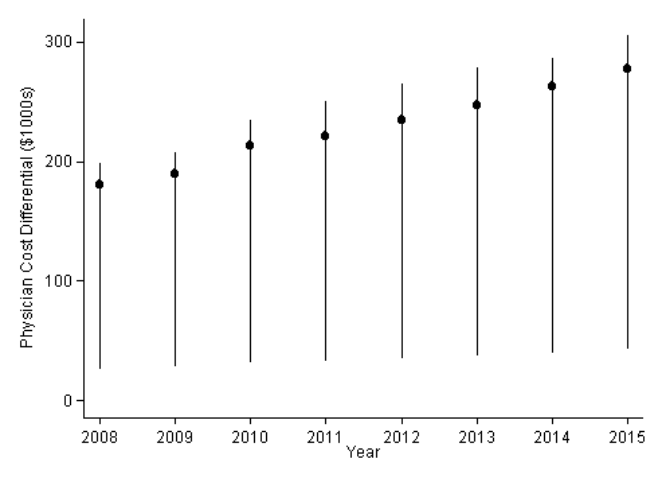
2. Summarize

- 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

Specification

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

Specification

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

Main Outcomes

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

	2008	2012	2013	2014	2015	Overall
Total Payments	7,152	8,171	8,501	8,941	9,169	8,094
	(7,595)	(8,472)	(8,290)	(8,724)	(8,755)	(8,228)

Main Outcomes

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

	2008	2012	2013	2014	2015	Overall
Total Payments	7,152	8,171	8,501	8,941	9,169	8,094
	(7,595)	(8,472)	(8,290)	(8,724)	(8,755)	(8,228)
Total Costs	9,387	11,323	11,756	12,237	12,736	10,965
	(9,632)	(10,954)	(10,906)	(11,549)	(11,728)	(10,626)

Main Outcomes

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

	2008	2012	2013	2014	2015	Overall
Total Payments	7,152	8,171	8,501	8,941	9,169	8,094
	(7,595)	(8,472)	(8,290)	(8,724)	(8,755)	(8,228)
Total Costs	9,387	11,323	11,756	12,237	12,736	10,965
	(9,632)	(10,954)	(10,906)	(11,549)	(11,728)	(10,626)
Inpatient Costs	13,655	16,958	17,711	18,367	19,081	16,294
	(7,752)	(9,407)	(9,612)	(9,997)	(10,184)	(9,256)

Main Outcomes

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

	2008	2012	2013	2014	2015	Overall
Total Payments	7,152	8,171	8,501	8,941	9,169	8,094
	(7,595)	(8,472)	(8,290)	(8,724)	(8,755)	(8,228)
Total Costs	9,387	11,323	11,756	12,237	12,736	10,965
	(9,632)	(10,954)	(10,906)	(11,549)	(11,728)	(10,626)
Inpatient Costs	13,655	16,958	17,711	18,367	19,081	16,294
	(7,752)	(9,407)	(9,612)	(9,997)	(10,184)	(9,256)
Inpatient LOS	5.984	6.021	6.002	6.062	6.029	5.960
	(2.427)	(2.493)	(2.494)	(2.513)	(2.492)	(2.436)

Main Outcomes

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

	2008	2012	2013	2014	2015	Overall
Total Payments	7,152	8,171	8,501	8,941	9,169	8,094
	(7,595)	(8,472)	(8,290)	(8,724)	(8,755)	(8,228)
Total Costs	9,387	11,323	11,756	12,237	12,736	10,965
	(9,632)	(10,954)	(10,906)	(11,549)	(11,728)	(10,626)
Inpatient Costs	13,655	16,958	17,711	18,367	19,081	16,294
	(7,752)	(9,407)	(9,612)	(9,997)	(10,184)	(9,256)
Inpatient LOS	5.984	6.021	6.002	6.062	6.029	5.960
	(2.427)	(2.493)	(2.494)	(2.513)	(2.492)	(2.436)
Outpatient Costs	3,007	3,806	4,014	4,190	4,361	3,693
	(2,135)	(2,782)	(2,925)	(3,096)	(3,195)	(2,749)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Integrated	0.130	0.206	0.233	0.255	0.332	0.196
	(0.336)	(0.404)	(0.422)	(0.436)	(0.471)	(0.397)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Integrated	0.130	0.206	0.233	0.255	0.332	0.196
	(0.336)	(0.404)	(0.422)	(0.436)	(0.471)	(0.397)
Physician FTE	24.23	28.59	31.14	31.74	33.13	28.43
	(99.28)	(109.8)	(120.5)	(120.0)	(119.5)	(110.9)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Integrated	0.130	0.206	0.233	0.255	0.332	0.196
	(0.336)	(0.404)	(0.422)	(0.436)	(0.471)	(0.397)
Physician FTE	24.23	28.59	31.14	31.74	33.13	28.43
	(99.28)	(109.8)	(120.5)	(120.0)	(119.5)	(110.9)
Resident FTE	25.77	28.45	29.13	30.69	30.97	28.08
	(108.2)	(120.4)	(121.4)	(125.9)	(127.8)	(117.8)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Integrated	0.130	0.206	0.233	0.255	0.332	0.196
	(0.336)	(0.404)	(0.422)	(0.436)	(0.471)	(0.397)
Physician FTE	24.23	28.59	31.14	31.74	33.13	28.43
	(99.28)	(109.8)	(120.5)	(120.0)	(119.5)	(110.9)
Resident FTE	25.77	28.45	29.13	30.69	30.97	28.08
	(108.2)	(120.4)	(121.4)	(125.9)	(127.8)	(117.8)
Nurse FTE	340.8	365.7	369.1	384.9	402.7	364.8
	(446.8)	(487.8)	(494.8)	(519.1)	(550.7)	(487.3)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Integrated	0.130	0.206	0.233	0.255	0.332	0.196
	(0.336)	(0.404)	(0.422)	(0.436)	(0.471)	(0.397)
Physician FTE	24.23	28.59	31.14	31.74	33.13	28.43
	(99.28)	(109.8)	(120.5)	(120.0)	(119.5)	(110.9)
Resident FTE	25.77	28.45	29.13	30.69	30.97	28.08
	(108.2)	(120.4)	(121.4)	(125.9)	(127.8)	(117.8)
Nurse FTE	340.8	365.7	369.1	384.9	402.7	364.8
	(446.8)	(487.8)	(494.8)	(519.1)	(550.7)	(487.3)
Other FTE	749.9	763.0	761.8	776.4	806.0	762.8
	(975.5)	(1032.4)	(1076.2)	(1101.5)	(1157.2)	(1037.4)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Integrated	0.130	0.206	0.233	0.255	0.332	0.196
	(0.336)	(0.404)	(0.422)	(0.436)	(0.471)	(0.397)
Physician FTE	24.23	28.59	31.14	31.74	33.13	28.43
	(99.28)	(109.8)	(120.5)	(120.0)	(119.5)	(110.9)
Resident FTE	25.77	28.45	29.13	30.69	30.97	28.08
	(108.2)	(120.4)	(121.4)	(125.9)	(127.8)	(117.8)
Nurse FTE	340.8	365.7	369.1	384.9	402.7	364.8
	(446.8)	(487.8)	(494.8)	(519.1)	(550.7)	(487.3)
Other FTE	749.9	763.0	761.8	776.4	806.0	762.8
	(975.5)	(1032.4)	(1076.2)	(1101.5)	(1157.2)	(1037.4)
Beds (100s)	1.980	1.967	1.958	1.982	2.009	1.976
	(2.160)	(2.142)	(2.137)	(2.172)	(2.235)	(2.154)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Practice Size	13.73	17.31	17.31	17.82	18.41	16.10
	(32.10)	(30.70)	(29.28)	(28.46)	(28.02)	(30.05)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Practice Size	13.73	17.31	17.31	17.82	18.41	16.10
	(32.10)	(30.70)	(29.28)	(28.46)	(28.02)	(30.05)
Experience	22.55	23.00	23.94	23.65	24.77	23.17
	(6.496)	(6.703)	(6.950)	(6.902)	(6.989)	(6.746)

Independent Variables

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

	2008	2012	2013	2014	2015	Overall
Practice Size	13.73	17.31	17.31	17.82	18.41	16.10
	(32.10)	(30.70)	(29.28)	(28.46)	(28.02)	(30.05)
Experience	22.55	23.00	23.94	23.65	24.77	23.17
	(6.496)	(6.703)	(6.950)	(6.902)	(6.989)	(6.746)
% Multi-Specialty	0.249	0.248	0.266	0.284	0.344	0.264
% with Surgery	0.452	0.501	0.507	0.508	0.454	0.480

Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error

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

Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	108.293**	(43.335)

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

Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	108.293**	(43.335)
Total Hospital Costs	235.404***	(60.717)

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

Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	108.293**	(43.335)
Total Hospital Costs	235.404***	(60.717)
Inpatient Hospital Costs	157.018***	(49.787)

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

Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	108.293**	(43.335)
Total Hospital Costs	235.404***	(60.717)
Inpatient Hospital Costs	157.018***	(49.787)
Inpatient Length of Stay	-0.014	(0.017)

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

Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	108.293**	(43.335)
Total Hospital Costs	235.404***	(60.717)
Inpatient Hospital Costs	157.018***	(49.787)
Inpatient Length of Stay	-0.014	(0.017)
Outpatient Hospital Costs	-47.940***	(18.892)

* 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

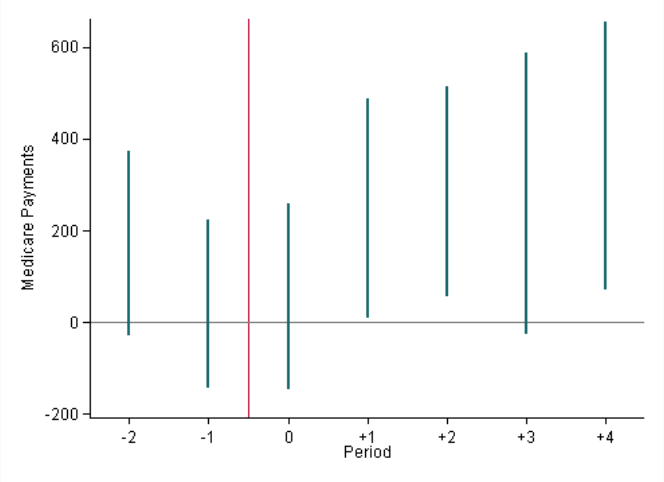
Threats to Identification and Interpretation

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

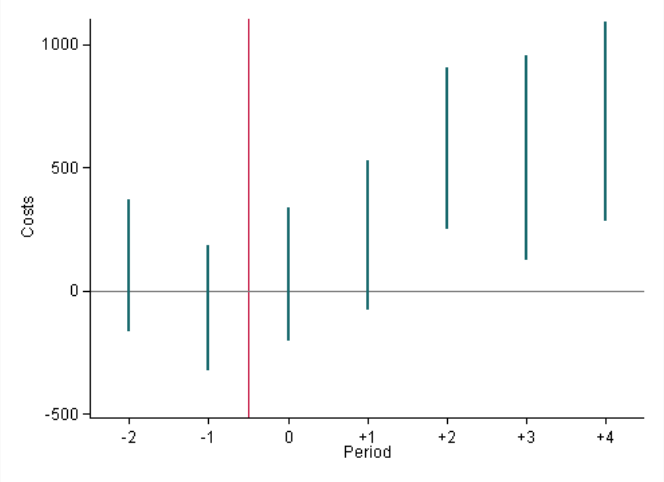
Potential Problems

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

Endogeneity of physician-hospital integration

2. Estimate probability of integration

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

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

Endogeneity of physician-hospital integration

2. Estimate probability of integration

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

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

Endogeneity of physician-hospital integration

2. Estimate probability of integration

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

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

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

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error

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

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
Total Medicare Payments	1028.994**	(498.917)

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

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
Total Medicare Payments	1028.994**	(498.917)
Total Hospital Costs	3238.716***	(697.512)

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

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
Total Medicare Payments	1028.994**	(498.917)
Total Hospital Costs	3238.716***	(697.512)
Inpatient Hospital Costs	2922.754***	(532.646)

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

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
Total Medicare Payments	1028.994**	(498.917)
Total Hospital Costs	3238.716***	(697.512)
Inpatient Hospital Costs	2922.754***	(532.646)
Inpatient Length of Stay	0.322*	(0.181)

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

IV Results: Aggregate Outcomes

Outcome	Estimate	St. Error
Total Medicare Payments	1028.994**	(498.917)
Total Hospital Costs	3238.716***	(697.512)
Inpatient Hospital Costs	2922.754***	(532.646)
Inpatient Length of Stay	0.322*	(0.181)
Outpatient Hospital Costs	-240.470	(200.800)

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

Does this Reflect Hospital Influence?

Areas with most incentives...

1. If hospital is residual claimant on billable procedures, should see more procedures within inpatient stays
2. If marginal revenue higher for commercial insurance, should see larger changes for larger private shares

Effects on Components of Inpatient Stay

Outcome	Estimate	St. Error
Charges for:		
Medical Supplies	32.969	(30.076)
Operating Room	-7.492	(23.023)
Anesthesia	5.715	(5.044)
Labs	10.324	(8.767)
Radiology	-3.843	(6.035)
MRI	-0.207	(1.355)

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

Effects on Components of Inpatient Stay

Outcome	Estimate	St. Error
Counts of:		
Private Days	-0.003	(0.012)
ICU Days	0.023*	(0.013)
Radiology	-0.00	(0.00)
Procedures	0.028***	(0.009)

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

Estimates by Public share

Outcome	VI	× Public Share

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

Estimates by Public share

Outcome	VI	× Public Share
Total Medicare Payments	88.093	26.638
	(113.638)	(223.408)

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

Estimates by Public share

Outcome	VI	× Public Share
Total Medicare Payments	88.093	26.638
	(113.638)	(223.408)
Total Hospital Costs	520.925***	-655.699**
	(165.879)	(324.061)

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

Estimates by Public share

Outcome	VI	× Public Share
Total Medicare Payments	88.093	26.638
	(113.638)	(223.408)
Total Hospital Costs	520.925***	-655.699**
	(165.879)	(324.061)
Inpatient Hospital Costs	252.181*	-191.168
	(131.999)	(264.319)

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

Estimates by Public share

Outcome	VI	× Public Share
Total Medicare Payments	88.093	26.638
	(113.638)	(223.408)
Total Hospital Costs	520.925***	-655.699**
	(165.879)	(324.061)
Inpatient Hospital Costs	252.181*	-191.168
	(131.999)	(264.319)
Inpatient Length of Stay	0.013	-0.062
	(0.045)	(0.089)

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

Estimates by Public share

Outcome	VI	× Public Share
Total Medicare Payments	88.093	26.638
	(113.638)	(223.408)
Total Hospital Costs	520.925***	-655.699**
	(165.879)	(324.061)
Inpatient Hospital Costs	252.181*	-191.168
	(131.999)	(264.319)
Inpatient Length of Stay	0.013	-0.062
	(0.045)	(0.089)
Outpatient Hospital Costs	-73.150	57.086
	(49.911)	(98.901)

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

Allocation of Procedures and Patients

Other Effects

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

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

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.081***	(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	0.081***	(0.003)
Physician's outpatient share	0.057***	(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	0.081***	(0.003)
Physician's outpatient share	0.057***	(0.003)
Total patients	7.079***	(0.505)

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

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.081***	(0.003)
Physician's outpatient share	0.057***	(0.003)
Total patients	7.079***	(0.505)
Inpatient procedures	1.102***	(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	0.081***	(0.003)
Physician's outpatient share	0.057***	(0.003)
Total patients	7.079***	(0.505)
Inpatient procedures	1.102***	(0.161)
Outpatient procedures	10.069***	(1.015)

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

Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.081***	(0.003)
Physician's outpatient share	0.057***	(0.003)
Total patients	7.079***	(0.505)
Inpatient procedures	1.102***	(0.161)
Outpatient procedures	10.069***	(1.015)
Patient Procedures	-0.004	(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	0.081***	(0.003)
Physician's outpatient share	0.057***	(0.003)
Total patients	7.079***	(0.505)
Inpatient procedures	1.102***	(0.161)
Outpatient procedures	10.069***	(1.015)
Patient Procedures	-0.004	(0.058)
Patient Payments	-180.101	(130.470)

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

Summary of Results

Effects per Patient

- Increase in Medicare payments ($110 to $300) and hospital costs ($235-$500)
- Extrapolates to between $77 and $210 million in added Medicare payments from 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

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

Summary of Results

Evidence of Hospital Influence

- Inpatient increases coming from more procedures
- Effects larger for hospitals with higher share of commercial payers

Summary of Results

Interpreting Main Results

- Total within-physician variation in Medicare payments of around $140,000 per physician per year
- Increases due to vertical integration of between $110 and $300 per patient per year
- 5-13% of within-physician variation explained by vertical integration

Thank You