

# Physician Behaviors and Hospital Influence

---

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

Johns Hopkins University

November 9, 2018

## 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

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

→ Incentives for hospitals to influence physicians

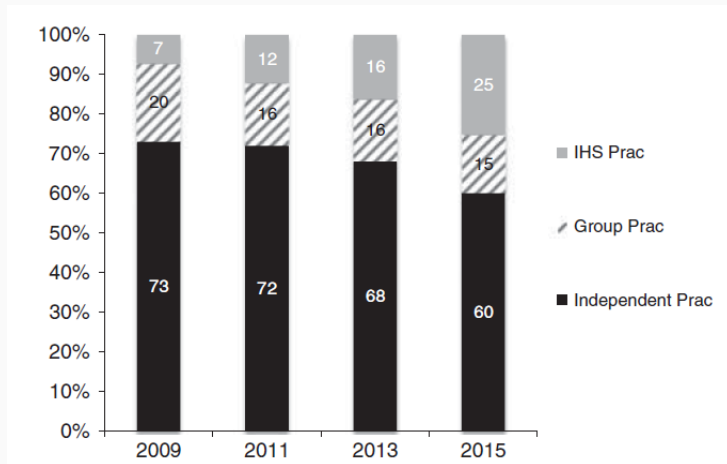
Differential financial incentives between physician and hospital

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

→ Incentives for hospitals to influence physicians

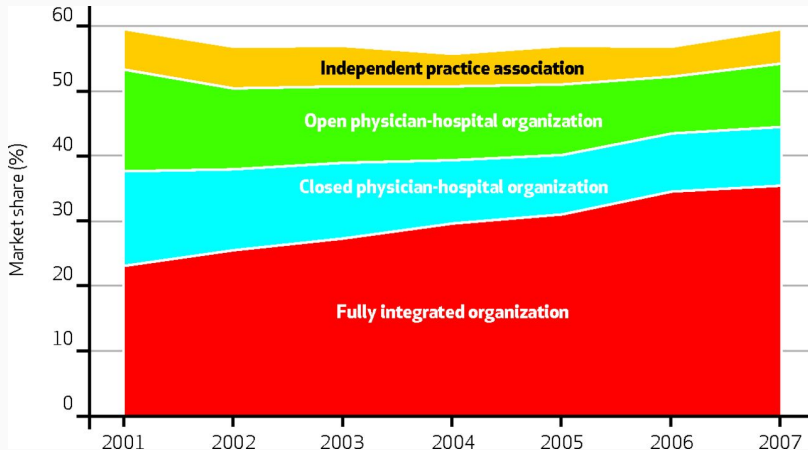
Most direct way (arguably) is to purchase physician practice

# Changing Physician Relationships



Richards *et al.*, Medical Care, 2016

# Changing Physician Relationships



Baker, Bundorf, and Kessler, Health Affairs, 2014



## What do we expect from integration?

- Hospitals claim efficiency gains, reduced fragmentation, increased coordination, etc.
- Financial incentives for cost increases and decreases
  - Lower costs with fixed payment
  - Substituting locations of care more efficiently
  - Spillovers from private insurance
  - More resources due to pay-for-performance

- Physician agency (Clemens & Gottlieb 2014, AER; Afendulis & Kessler 2007, AER; Gruber & Owings 1996, RAND; Iizuka 2012, AER)
- Vertical integration (Cuellar & Gertler 2006, JHE; Ciliberto & Dranove 2006, JHE; Baker *et al.* 2016, JHE; Koch *et al.* 2017, JHE)

## 1. Motivestimation

1. Motivestimation
2. Initial Results

# Outline

1. Motivestimation
2. Initial Results
3. Event Study

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

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

# Theoretical Framework

---



Observed care at time  $t$  is

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

Observed care at time  $t$  is

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

With linearity and separability assumptions in patient preferences:

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

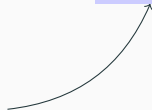
Observed care at time  $t$  is

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

With linearity and separability assumptions in patient preferences:

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

Patient Preferences



Observed care at time  $t$  is

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

With linearity and separability assumptions in patient preferences:

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

The diagram illustrates the components of the equation  $y_{ijk} = \alpha_i + x_i \beta + \Gamma_{jk} + \epsilon_{ijk}$ . A light blue box highlights the term  $\alpha_i + x_i \beta$ , and a light red circle highlights the term  $\Gamma_{jk}$ . An arrow points from the text "Patient Preferences" to the blue box, and another arrow points from the text "Physician and hospital characteristics" to the red circle.

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)

# 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)
2. Estimate  $\hat{\Gamma}_{jkt} = \gamma_j + \gamma_k + \tau_t + z_{jkt}\delta + \eta_{jkt}$  with physician-hospital panel

## 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)



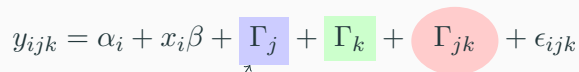
# Estimation Strategy

Traditional “match value” approach:

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

# Estimation Strategy

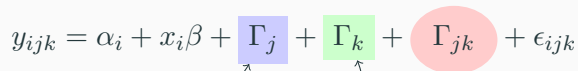
Traditional “match value” approach:

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


Physician effect

# Estimation Strategy

Traditional “match value” approach:

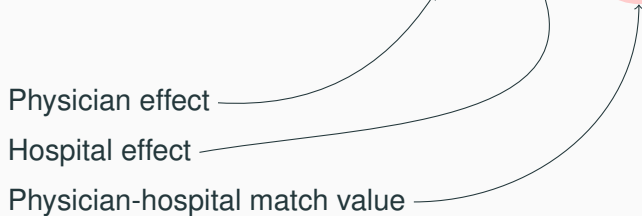
$$y_{ijk} = \alpha_i + x_i\beta + \Gamma_j + \Gamma_k + \Gamma_{jk} + \epsilon_{ijk}$$


Physician effect

Hospital effect

# Estimation Strategy

Traditional “match value” approach:

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


Physician effect

Hospital effect

Physician-hospital match value

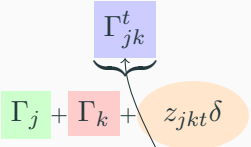
# Estimation Strategy

Our approach:

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

# Estimation Strategy

Our approach:

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


Physician, hospital, and match effect (jointly)

# Estimation Strategy

Our approach:

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

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

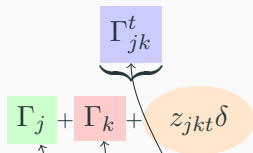
Physician, hospital, and match effect (jointly)

Physician effect

# Estimation Strategy

Our approach:

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



Physician, hospital, and match effect (jointly)

Physician effect

Hospital effect



# Estimation Strategy

Our approach:

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

Physician, hospital, and match effect (jointly)

Physician effect

Hospital effect

Physician-hospital integration

# Data

---

## Data Sources

- CMS: 100% inpatient and institutional outpatient Medicare claims data (2008-2015)
- SK&A: Hospital ownership of physician practices
- 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
- 518,398 unique observations at the physician/hospital/year
- 7.5mm inpatient stays (47% of total) and 24mm outpatient procedures



## 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

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

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

- 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

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

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

# 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)
- 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:

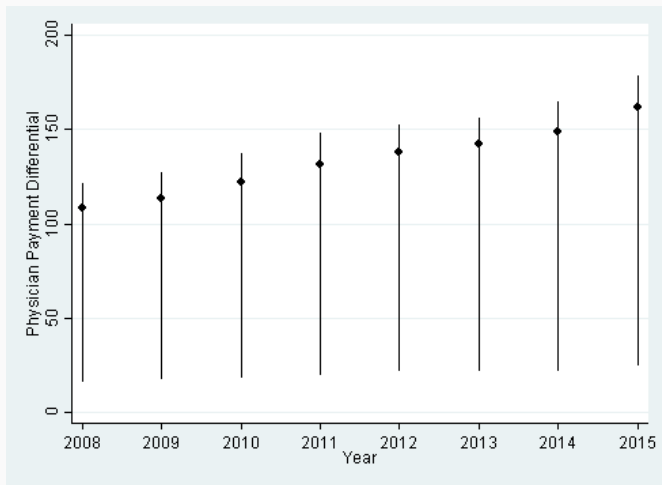
$$\begin{aligned}\Delta_k y_{ij} &= \hat{y}_{ijk} - \hat{y}_{ij\underline{k}} \\ &= \hat{\alpha}_i + x_i \hat{\beta} + \hat{\Gamma}_{jk} - \hat{\alpha}_i - x_i \hat{\beta} - \min \{ \Gamma_{j1}, \dots, \Gamma_{jK} \} \\ &= \hat{\Gamma}_{jk} - \min \{ \Gamma_{j1}, \dots, \Gamma_{jK} \} .\end{aligned}$$

## 2. Summarize

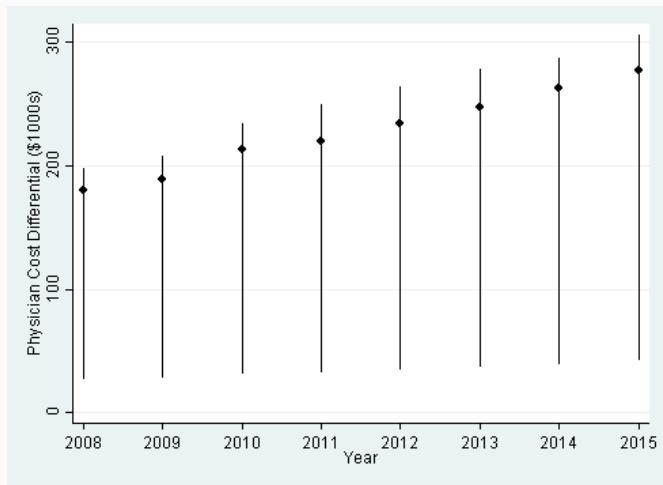
- Total cost differential for each physician
- Limit to pairs with 5 or more procedures
- Limit to physicians with 2 or more hospitals in a year
- Present interquartile range and mean



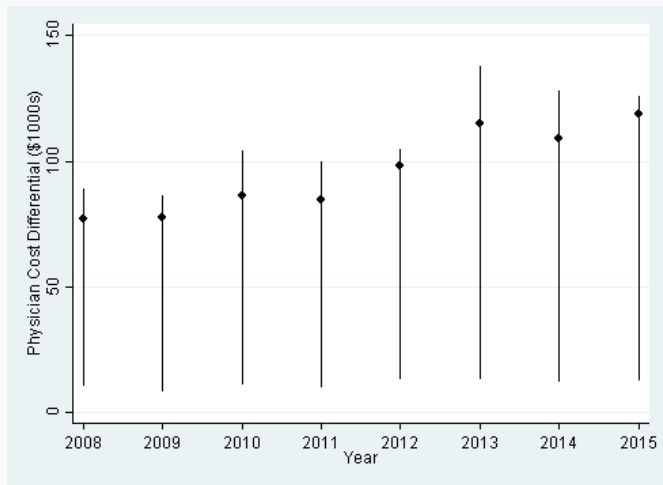
## Within-physician Variation in Payments



## Within-physician Variation in Payments



## Within-physician Variation in Payments



# **Estimation of Hospital Influence**

---

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

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

# 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 (7,595)	8,171 (8,472)	8,501 (8,290)	8,941 (8,724)	9,169 (8,755)	8,094 (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 (7,595)	8,171 (8,472)	8,501 (8,290)	8,941 (8,724)	9,169 (8,755)	8,094 (8,228)
Total Costs	9,387 (9,632)	11,323 (10,954)	11,756 (10,906)	12,237 (11,549)	12,736 (11,728)	10,965 (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 (7,595)	8,171 (8,472)	8,501 (8,290)	8,941 (8,724)	9,169 (8,755)	8,094 (8,228)
Total Costs	9,387 (9,632)	11,323 (10,954)	11,756 (10,906)	12,237 (11,549)	12,736 (11,728)	10,965 (10,626)
Inpatient Costs	13,655 (7,752)	16,958 (9,407)	17,711 (9,612)	18,367 (9,997)	19,081 (10,184)	16,294 (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 (7,595)	8,171 (8,472)	8,501 (8,290)	8,941 (8,724)	9,169 (8,755)	8,094 (8,228)
Total Costs	9,387 (9,632)	11,323 (10,954)	11,756 (10,906)	12,237 (11,549)	12,736 (11,728)	10,965 (10,626)
Inpatient Costs	13,655 (7,752)	16,958 (9,407)	17,711 (9,612)	18,367 (9,997)	19,081 (10,184)	16,294 (9,256)
Inpatient LOS	5.984 (2.427)	6.021 (2.493)	6.002 (2.494)	6.062 (2.513)	6.029 (2.492)	5.960 (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 (7,595)	8,171 (8,472)	8,501 (8,290)	8,941 (8,724)	9,169 (8,755)	8,094 (8,228)
Total Costs	9,387 (9,632)	11,323 (10,954)	11,756 (10,906)	12,237 (11,549)	12,736 (11,728)	10,965 (10,626)
Inpatient Costs	13,655 (7,752)	16,958 (9,407)	17,711 (9,612)	18,367 (9,997)	19,081 (10,184)	16,294 (9,256)
Inpatient LOS	5.984 (2.427)	6.021 (2.493)	6.002 (2.494)	6.062 (2.513)	6.029 (2.492)	5.960 (2.436)
Outpatient Costs	3,007 (2,135)	3,806 (2,782)	4,014 (2,925)	4,190 (3,096)	4,361 (3,195)	3,693 (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 (0.336)	0.206 (0.404)	0.233 (0.422)	0.255 (0.436)	0.332 (0.471)	0.196 (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 (0.336)	0.206 (0.404)	0.233 (0.422)	0.255 (0.436)	0.332 (0.471)	0.196 (0.397)
Physician FTE	24.23 (99.28)	28.59 (109.8)	31.14 (120.5)	31.74 (120.0)	33.13 (119.5)	28.43 (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 (0.336)	0.206 (0.404)	0.233 (0.422)	0.255 (0.436)	0.332 (0.471)	0.196 (0.397)
Physician FTE	24.23 (99.28)	28.59 (109.8)	31.14 (120.5)	31.74 (120.0)	33.13 (119.5)	28.43 (110.9)
Resident FTE	25.77 (108.2)	28.45 (120.4)	29.13 (121.4)	30.69 (125.9)	30.97 (127.8)	28.08 (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 (0.336)	0.206 (0.404)	0.233 (0.422)	0.255 (0.436)	0.332 (0.471)	0.196 (0.397)
Physician FTE	24.23 (99.28)	28.59 (109.8)	31.14 (120.5)	31.74 (120.0)	33.13 (119.5)	28.43 (110.9)
Resident FTE	25.77 (108.2)	28.45 (120.4)	29.13 (121.4)	30.69 (125.9)	30.97 (127.8)	28.08 (117.8)
Nurse FTE	340.8 (446.8)	365.7 (487.8)	369.1 (494.8)	384.9 (519.1)	402.7 (550.7)	364.8 (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 (0.336)	0.206 (0.404)	0.233 (0.422)	0.255 (0.436)	0.332 (0.471)	0.196 (0.397)
Physician FTE	24.23 (99.28)	28.59 (109.8)	31.14 (120.5)	31.74 (120.0)	33.13 (119.5)	28.43 (110.9)
Resident FTE	25.77 (108.2)	28.45 (120.4)	29.13 (121.4)	30.69 (125.9)	30.97 (127.8)	28.08 (117.8)
Nurse FTE	340.8 (446.8)	365.7 (487.8)	369.1 (494.8)	384.9 (519.1)	402.7 (550.7)	364.8 (487.3)
Other FTE	749.9 (975.5)	763.0 (1032.4)	761.8 (1076.2)	776.4 (1101.5)	806.0 (1157.2)	762.8 (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 (0.336)	0.206 (0.404)	0.233 (0.422)	0.255 (0.436)	0.332 (0.471)	0.196 (0.397)
Physician FTE	24.23 (99.28)	28.59 (109.8)	31.14 (120.5)	31.74 (120.0)	33.13 (119.5)	28.43 (110.9)
Resident FTE	25.77 (108.2)	28.45 (120.4)	29.13 (121.4)	30.69 (125.9)	30.97 (127.8)	28.08 (117.8)
Nurse FTE	340.8 (446.8)	365.7 (487.8)	369.1 (494.8)	384.9 (519.1)	402.7 (550.7)	364.8 (487.3)
Other FTE	749.9 (975.5)	763.0 (1032.4)	761.8 (1076.2)	776.4 (1101.5)	806.0 (1157.2)	762.8 (1037.4)
Beds (100s)	1.980 (2.160)	1.967 (2.142)	1.958 (2.137)	1.982 (2.172)	2.009 (2.235)	1.976 (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 (32.10)	17.31 (30.70)	17.31 (29.28)	17.82 (28.46)	18.41 (28.02)	16.10 (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 (32.10)	17.31 (30.70)	17.31 (29.28)	17.82 (28.46)	18.41 (28.02)	16.10 (30.05)
Experience	22.55 (6.496)	23.00 (6.703)	23.94 (6.950)	23.65 (6.902)	24.77 (6.989)	23.17 (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 (32.10)	17.31 (30.70)	17.31 (29.28)	17.82 (28.46)	18.41 (28.02)	16.10 (30.05)
Experience	22.55 (6.496)	23.00 (6.703)	23.94 (6.950)	23.65 (6.902)	24.77 (6.989)	23.17 (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	110.945**	(46.768)

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

## Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	110.945**	(46.768)
Total Hospital Costs	255.126***	(64.621)

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

## Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	110.945**	(46.768)
Total Hospital Costs	255.126***	(64.621)
Inpatient Hospital Costs	209.579***	(53.671)

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



## Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	110.945**	(46.768)
Total Hospital Costs	255.126***	(64.621)
Inpatient Hospital Costs	209.579***	(53.671)
Inpatient Length of Stay	-0.028	(0.019)

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

## Estimated Effects of Vertical Integration

Outcome	Estimate	St. Error
Total Medicare Payments	110.945**	(46.768)
Total Hospital Costs	255.126***	(64.621)
Inpatient Hospital Costs	209.579***	(53.671)
Inpatient Length of Stay	-0.028	(0.019)
Outpatient Hospital Costs	-58.581***	(20.320)

\* 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

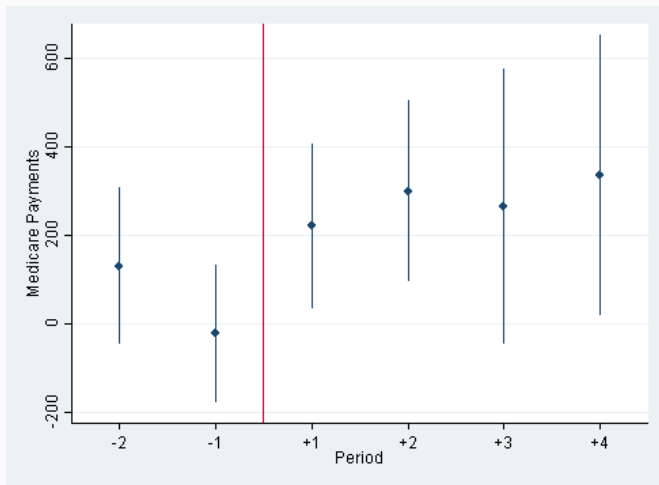
# Threats to Identification and Interpretation

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

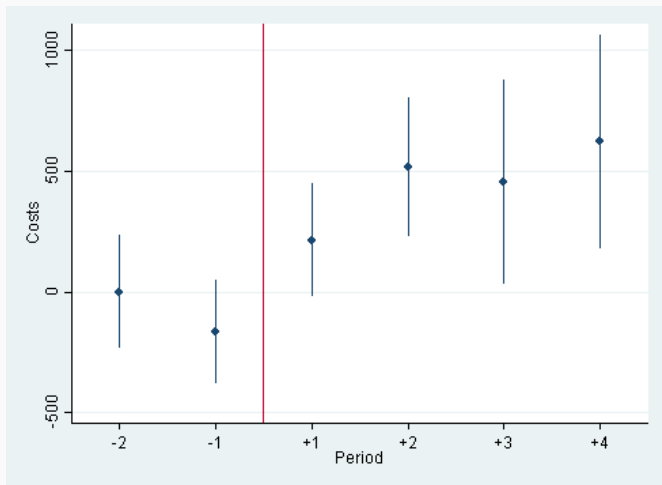
## Potential Problems

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

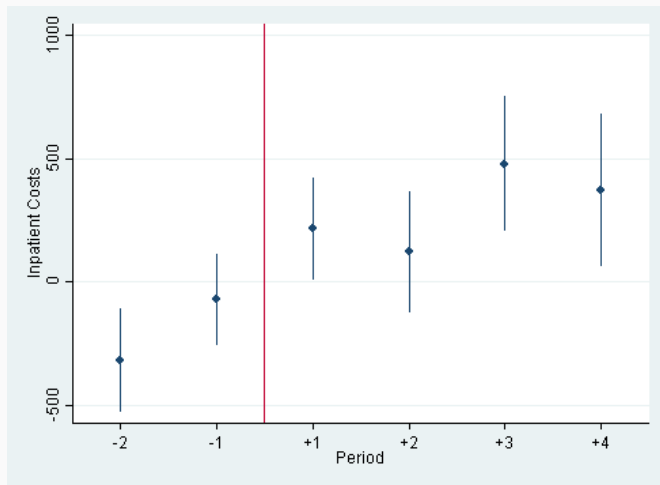
## Event Study: Total Medicare Payments



## Event Study: Total Hospital Costs



## Event Study: Inpatient Hospital Costs



# Takeaways

- Evidence of increase in payments and costs
- Evidence consistent with common trends assumption for total payments and costs
- Some concern about common trends for inpatient costs



# 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

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

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

## 2. Estimate probability of integration

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

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

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

# Endogeneity of physician-hospital integration

Outcome	Estimate	St. Error
---------	----------	-----------

---

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

## Endogeneity of physician-hospital integration

Outcome	Estimate	St. Error
Total Medicare Payments	1032.112**	(498.814)

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

# Endogeneity of physician-hospital integration

Outcome	Estimate	St. Error
Total Medicare Payments	1032.112**	(498.814)
Total Hospital Costs	3213.162***	(696.032)

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



## Endogeneity of physician-hospital integration

Outcome	Estimate	St. Error
Total Medicare Payments	1032.112**	(498.814)
Total Hospital Costs	3213.162***	(696.032)
Inpatient Hospital Costs	3081.788***	(533.495)

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

## Endogeneity of physician-hospital integration

Outcome	Estimate	St. Error
Total Medicare Payments	1032.112**	(498.814)
Total Hospital Costs	3213.162***	(696.032)
Inpatient Hospital Costs	3081.788***	(533.495)
Inpatient Length of Stay	0.108	(0.179)

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

## Endogeneity of physician-hospital integration

Outcome	Estimate	St. Error
Total Medicare Payments	1032.112**	(498.814)
Total Hospital Costs	3213.162***	(696.032)
Inpatient Hospital Costs	3081.788***	(533.495)
Inpatient Length of Stay	0.108	(0.179)
Outpatient Hospital Costs	-337.977*	(204.733)

\* 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

## 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	0.065***	(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	0.065***	(0.003)
Physician's outpatient share	0.047***	(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	0.065***	(0.003)
Physician's outpatient share	0.047***	(0.003)
Total patients	6.892***	(0.527)

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

## Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.065***	(0.003)
Physician's outpatient share	0.047***	(0.003)
Total patients	6.892***	(0.527)
Inpatient procedures	0.784***	(0.169)

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

## Results on Other Outcomes

Outcome	Estimate	St. Error
Physician's inpatient share	0.065***	(0.003)
Physician's outpatient share	0.047***	(0.003)
Total patients	6.892***	(0.527)
Inpatient procedures	0.784***	(0.169)
Outpatient procedures	9.929***	(1.087)

\* 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 (\$255-\$500)
- Extrapolates to between \$77 and \$210 million in added Medicare payments from vertical integration

# Summary of Results

## Sensitivity

- Event study consistent with common trends for Medicare payments and total hospital costs
- Calculation of  $2 \times 2$  DD weights suggests relatively small portion of negative weights (70% positive weights)
- As falsification test, no effects on payments or DRG weights per inpatient stay

# Summary of Results

## Effects on Total Patients and Allocation of Procedures

- More procedures going to acquiring hospital
- New procedures predominantly coming from outpatient side (13 new outpatient procedures per inpatient procedure)

# 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**

---