Owning the Agent: Hospital Influence on Physician Behaviors

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

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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

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$\longrightarrow$ Incentives for hospitals to influence physicians

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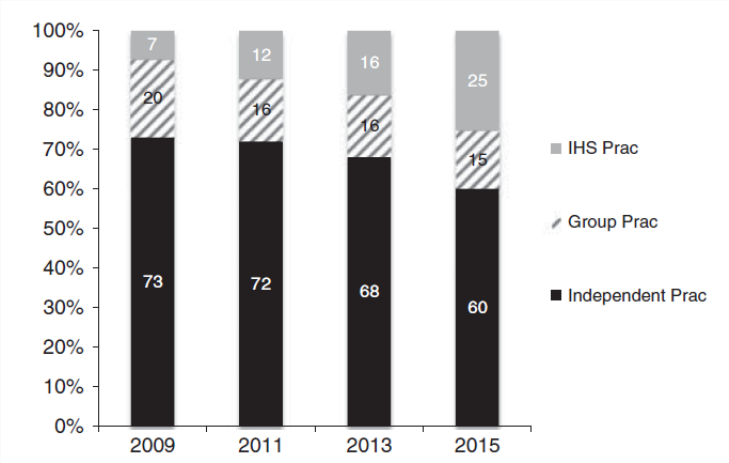
$\longrightarrow$ Incentives for hospitals to influence physicians

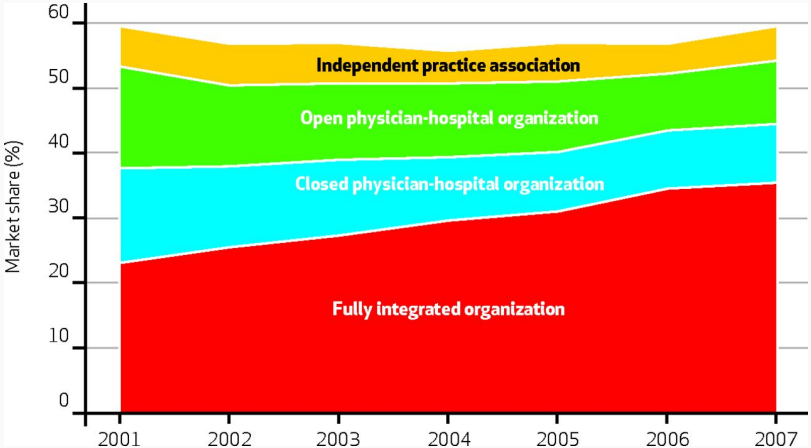
Most direct way (arguably) is to purchase physician practice

Changing Physician Relationships



Richards *et al.*, Medical Care, 2016

Changing Physician Relationships



Baker, Bundorf, and Kessler, Health Affairs, 2014

This Paper

Our question: Does a hospital's acquisition of a physician practice change the amount, location, and types of services provided by the physician (per episode and in aggregate)?

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- 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; Koch *et al.* 2021, ReStat; Post *et al.* 2022, HE)

This Paper

Our question: Does a hospital's acquisition of a physician practice change the amount, location, and types of services provided by the physician (per episode and in aggregate)?

Contribution:

- *Synthesis:* We consider several outcomes collectively, many of which (but not all) have been studied in isolation
- *Identification:* Instrumental variables strategy to help address endogeneity from two-sided matching problem between hospital and physician

Outline

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

Conceptual Framework

Physician Agency without Integration

- Profits to non-integrated physician: $\pi_{j,NI} = R_j\left(y_{ijk}\right) - c_{j,NI}\left(y_{ijk}\right)$
  - R_j, net revenue to the physician (reimbursement net direct costs of patient care)
  - $c_{j,NI}$, other indirect costs not reimbursed by insurers
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- Perceived patient utility: $\tilde{u}(y_{ijk})$

With assumptions on linearity and separability in patient preferences:

$$y_{ijk}^{NI} = \arg\max_{y} \left\{ \theta_u \tilde{u}(y_{ijk}) + \theta_\pi^j \left(R_j\left(y_{ijk}\right) - c_{j,NI}\left(y_{ijk}\right)\right) \right\}$$

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Patient Preferences

Physician profit

Physician Agency without Integration

Solution to the non-integrated physician's optimization problem therefore satisfies:

$$\theta_u \tilde{u}' \left(y_{ijk}^{NI}\right) = \theta_\pi^j \left(c'_{j,NI}(y_{ijk}^{NI}) - R'_j(y_{ijk}^{NI})\right)$$

Physician Agency with Integration

- Profits to integrated physician: $\pi_{j,VI} = \bar{R} - c_{j,VI}\left(y_{ijk}\right)$
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Solution to the integrated physician's optimization problem therefore satisfies:

$$\theta_u \tilde{u}'\left(y_{ijk}^{VI}\right) = \theta_\pi^j c'_{j,VI}(y_{ijk}^{VI}) + \theta_\pi^k \left(c'_k(y_{ijk}^{VI}) - R'_k(y_{ijk}^{VI})\right).$$

Comparison with and without Integration

$$\theta_u \tilde{u}' \left(y_{ijk}^{VI}\right) = \theta_\pi^j c'_{j,VI}(y_{ijk}^{VI}) + \theta_\pi^k \left(c'_k(y_{ijk}^{VI}) - R'_k(y_{ijk}^{VI})\right)$$
$$\theta_u \tilde{u}' \left(y_{ijk}^{NI}\right) = \theta_\pi^j \left(c'_{j,NI}(y_{ijk}^{NI}) - R'_j(y_{ijk}^{NI})\right)$$

- VI implies marginal revenue for own-profits drops to zero. Will tend to reduce care
- VI introduces the hospital's profit function into physician/patient optimization problem. Effects depend on the relative size of θ_π^k versus θ_π^j and $\pi_{j,NI}$ versus π_k.
- Implications for episode-level treatment and aggregate physician "effort"

Reduced-form Analog

- Assume $\tilde{u}$, π_j, and π_k are additively separable in i and (j, k, t)
- Reduced-form analog:

$$y_{ijkt} = x_{it}\beta_x + w_{jkt}\beta_w + \mathsf{VI}_{jkt}\delta + \gamma_{jk} + \lambda_t + \epsilon_{ijkt}$$

- x_{it}: patient characteristics
- w_{jkt}: hospital and county characteristics
- VI_{jkt}: hospital k owns the practice of physician j at time t;
- γ_{jk}: time-invariant physician-hospital fixed effects;
- λ_t: time fixed effects

Estimation Strategy

Case 1: Integration is unrelated to unobserved physician or patient characteristics

Estimation Strategy

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1. DD with staggered treatment
2. Estimate following Callaway and Sant'Anna (2021)

Estimation Strategy

Case 2: Endogenous integration

Estimation Strategy

Case 2: Endogenous integration

- Exploit plausibly exogenous change to physician fee schedule in 2010-2013 following Dranove and Ody (2019)
- Shift-share instrument using fee schedule change and initial (pre-policy) physician services

Intuition

- Treatment assignment is at physician/hospital level
- Requires the same physician/hospital pairs to interact before and after integration
- In data...
  - $\sim$ 84,000 physician-hospital-year combinations among integrated pairs
  - $\sim$ 52,000 with pre-integration episodes ($\sim$ 12,000 unique pairs)

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- Treatment assignment is at physician/hospital level
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- In data...
  - $\sim$ 84,000 physician-hospital-year combinations among integrated pairs
  - $\sim$ 52,000 with pre-integration episodes ($\sim$ 12,000 unique pairs)
  - Majority of integrated pairs have pre and post integration data

Preview of Results

General Findings

- Increase in spending per episode, largely from outpatient services (mechanical result from site-of-care payment differentials)
- Large reduction in services provided, particularly in labs and imaging
- Substantial “reallocation” toward integrated providers and away from non-integrated providers
- Increase in overall IP and OP services provided by the physician, preliminary results suggest shift to more intensive services

Data

Data Sources

- CMS: Complete Parts A and B Medicare claims for 20% sample of beneficiaries (2010-2015)
- SK&A: Hospital ownership of physician practices and practice characteristics
- AHA: Hospital characteristics
- ACS: County-level demographics, education, income, and employment

Sample Construction

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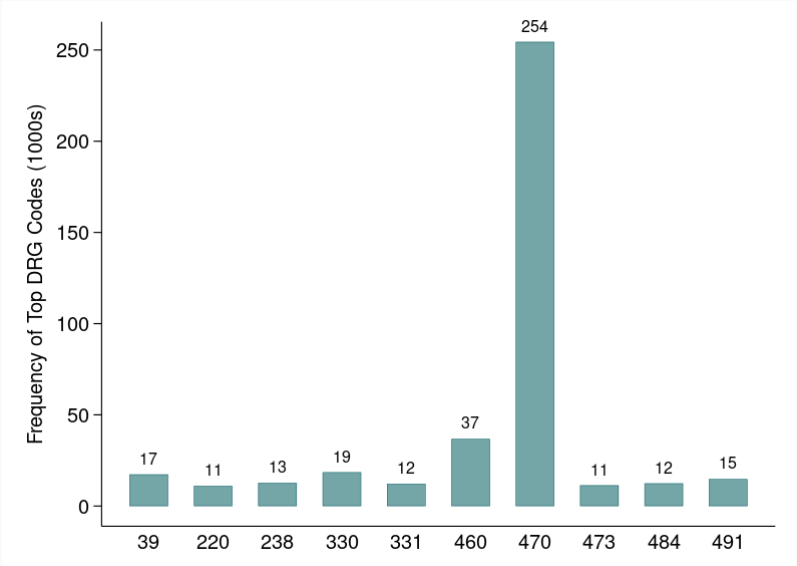
Final Data:

- 1,090,312 episodes
- 104,117 unique physician/hospital pairs
- 5,451 unique hospital NPIs
- 76,831 unique physician NPIs

Outcomes

- Construct episodes of care initiated by planned and elective inpatient stay (predominately hip and knee replacements, DRG 470)
- Episodes include physician services up to 30 days prior to focal inpatient stay and all inpatient, outpatient, physician, SNF, and HHA claims up to 90 days after discharge
- **Primary outcomes:** Spending, RVUs, service counts, events
- **Secondary outcomes:** Mortality, readmission, complications (incidence of sepsis and SSI)

Summary Statistics: Top Episode DRGs

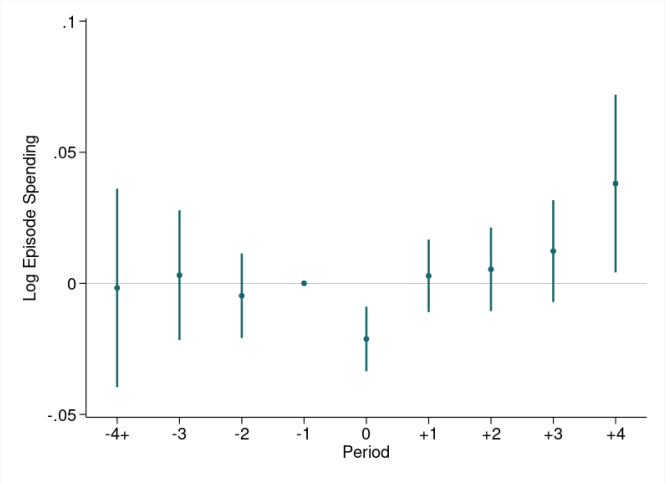


Summary Statistics: Episodes

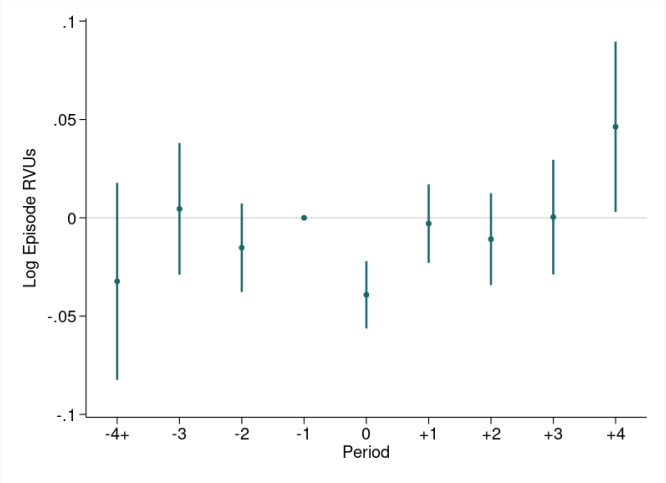
	Overall	Not Integrated	Integrated
Spending	30,561	29,420	33,807
	(21,573)	(20,513)	(24,042)
Total Events	22.786	22.589	23.345
	(13.893)	(13.684)	(14.457)
RVUs	86.853	87.360	85.410
	(68.120)	(67.805)	(68.986)
Service Count	109.495	111.947	102.522
	(626.160)	(448.490)	(966.998)
Mortality	0.040	0.040	0.042
	(0.197)	(0.196)	(0.200)
Readmission	0.185	0.181	0.198
	(0.388)	(0.385)	(0.399)
Any Complication	0.060	0.059	0.063
	(0.237)	(0.235)	(0.243)
Observations	1,090,312	806,694	283,618

Difference in Differences

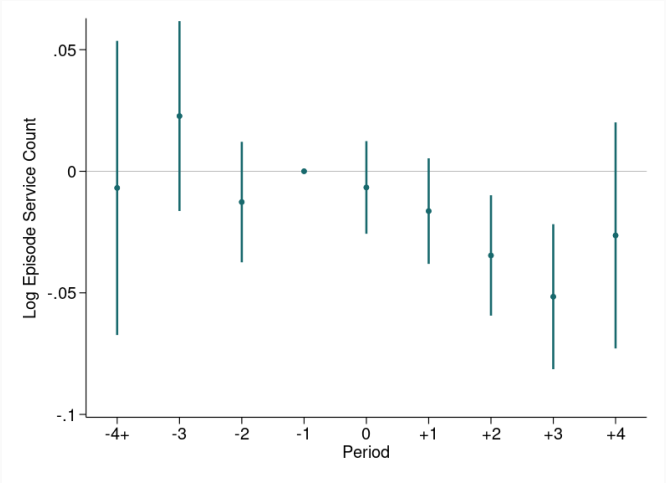
Event Study: Episode Spending



Event Study: Episode RVUs



Event Study: Episode Service Count



Takeaways

- Apparent increase in spending, maybe also in RVUs
- Potential reduction in service counts
- Likely violation of parallel trends due to endogenous matching between physician-hospital pairs

Instrumental Variables

Instrument

1. Site-of-care Payment Differentials

- For non-integrated practice, Medicare pays physician fee as per the physician fee schedule
- For integrated practice, Medicare pays physician fee $+$ facility fee
- For *identical service*, total payment for service from integrated physician exceeds payment for non-integrated physician due to added facility fee

Instrument

2. **PPIS Shock** Quick Physician Fee Schedule Review:
   - Work RVU (estimate of cost of the physician's work)
   - Malpractice RVU
   - Practice expense RVU (split into indirect vs direct expenses)

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- Work RVU (estimate of cost of the physician's work)
- Malpractice RVU
- Practice expense RVU (split into indirect vs direct expenses)

CMS introduced the **Physician Practice Information Survey** in 2007-2008 to update the calculation of indirect vs direct practice expense

- Phased in from 2010-2014
- Acts as shock to facility versus office site-of-care payment differential

Instrument Construction

1. Construct PPIS price change

- Calculate the PPIS price change relative to the baseline 2009 price, separately for facility and non-facility (e.g., office-based) payments and separately for each HCPCS code, c
- Denote price changes by $\Delta p^c_{f,t} = p^c_{f,t} - p^c_{f,2009}$ for facility payments and $\Delta p^c_{nf,t} = p^c_{nf,t} - p^c_{nf,2009}$ for non-facility payments

Instrument Construction

2. Construct relative price differential

- Calculate the difference in price changes between facility and non-facility payments, $\Delta p^c_{r,t} = \Delta p^c_{f,t} - \Delta p^c_{nf,t}$
- Reflects the additional distortion in facility versus non-facility payments introduced by the PPIS

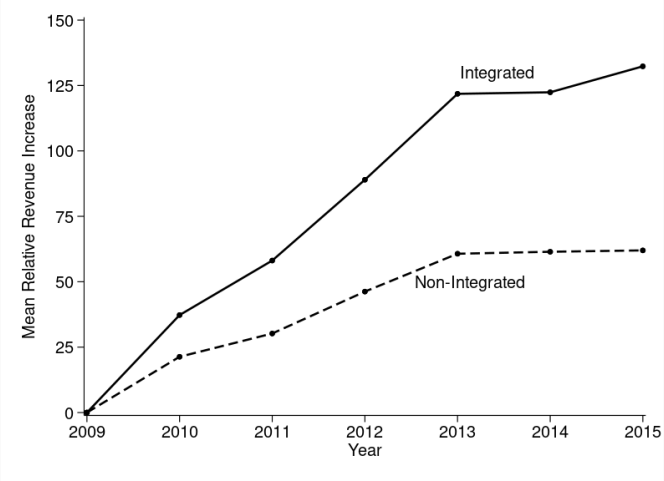
Instrument Construction

3. Aggregate price changes

- Aggregate $\Delta p^c_{r,t}$ to the practice level based on the count of office-based claims for HCPCS code c
- Use 2008 claims to avoid anticipatory responses to PPIS update, $q_{j(c),2008}$
- Weight by 2008 non-facility prices
- Normalize by 2008 non-facility revenue

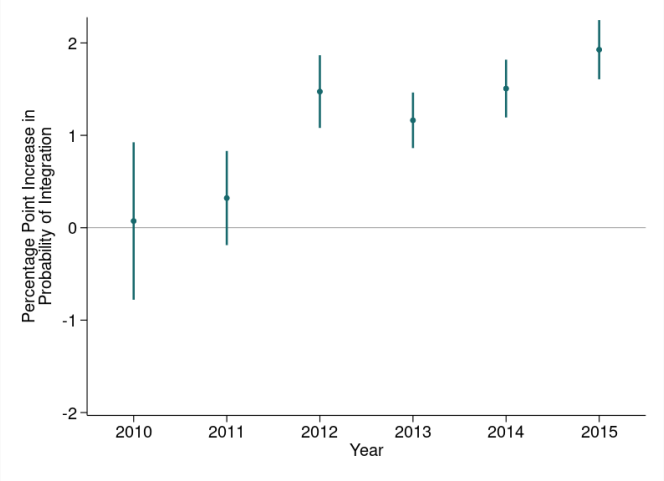
$$\Delta\text{Revenue}_{j,t} = \frac{\sum_c \Delta p^c_{r,t} \times q_{j(c),2008} \times p^c_{nf,2008}}{\sum_c q_{j(c),2008} \times p^c_{nf,2008}}$$

Revenue from PPIS and Integration Status



Assessment of Instrument

Integration LPM, analogous to Dranove and Ody (2019)



Instrumental Variables Analysis

$$y_{ijkt} = x_{it}\beta_x + w_{jkt}\beta_w + \underbrace{\hat{\mathsf{VI}}_{jkt}}_{f\left(x_{it}, w_{jkt}, \tilde{\gamma}_{jk}, \tilde{\lambda}_t, \Delta\mathsf{Revenue}_{j,t}\right)}\delta + \gamma_{jk} + \lambda_t + \epsilon_{ijkt}$$

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Episode outcomes (30 days prior and 90 days after discharge)

- spending
- work RVUs
- service count

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Patient characteristics...

- *Demographics:* Age, gender, race
- *Prior healthcare:* Quartiles of total prior spending and procedures
- *Current episode variables:* Indicators for ICD9 diagnosis code groups (18 diagnosis groups per variable plus missing group) and DRG codes

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County and hospital characteristics...

- *Demographics:* Distribution of county age, income, gender, education, and race
- *Market:* Indicators for whether the county hospital market is a monopoly, duopoly, or triopoly
- *Hospital:* Nurse and other medical staff FTEs, system membership, profit status, and teaching status; indicator for any hospital-level vertical integration

Instrumental Variables Analysis

Specifications Considered

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Instrumental Variables Analysis

1. Individual FE Only

$$y_{ijkt} = \cancel{x_{it}\beta_x} + \cancel{w_{jkt}\beta_w} + \underbrace{\hat{\mathsf{VI}}_{jkt}}_{f\left(\cancel{x_{it}}, \cancel{w_{jkt}}, \cancel{\tilde{\gamma}_{jk}}, \tilde{\lambda}_t, \Delta\text{Revenue}_{j,t}\right)} \delta + \cancel{\gamma_{jk}} + \overset{\tilde{\gamma}_j, \tilde{\gamma}_k}{\lambda_t} + \gamma_j + \gamma_k + \epsilon_{ijkt}$$

- Split physician-hospital pairwise FE into separate physician and hospital FE
- Time FE, λ_t
- Patient covariates
- Exclude hospital and county covariates

2. Pairwise FE Only

$$y_{ijkt} = \cancel{x_{it}\beta_x} + \cancel{w_{jkt}\beta_w} + \underbrace{\hat{\mathsf{VI}}_{jkt}}_{f(\cancel{x_{it}}, \cancel{w_{jkt}}, \tilde{\gamma}_{jk}, \tilde{\lambda}_t, \Delta\mathsf{Revenue}_{j,t})} \delta + \gamma_{jk} + \lambda_t + \epsilon_{ijkt}$$

- Pairwise FE, γ_{jk}, and time FE, λ_t
- Patient covariates
- Exclude hospital and county covariates

3. Pairwise FE with County Variables

$$y_{ijkt} = x_{it}\beta_x + w_{jkt}\beta_w + \underbrace{\hat{\text{VI}}_{jkt}}_{f(x_{it}, w_{jkt}, \tilde{\gamma}_{jk}, \tilde{\lambda}_t, \Delta\text{Revenue}_{j,t})}\delta + \gamma_{jk} + \lambda_t + \epsilon_{ijkt}$$

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4. Pairwise FE with County and Hospital Variables

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- Patient, county, and hospital covariates

5. Pairwise FE with County, Hospital, and Quality Variables

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- Pairwise FE, γ_{jk}, and time FE, λ_t
- Patient, county, and hospital covariates
- Include controls for incidence of mortality, readmission, and complication

Estimated Effects on Episode Outcomes

Outcome (Logs)	(1)	(2)	(3)	(4)	(5)
Observations	1,072,316	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X	X
γ_j, γ_k	X				
γ_{jk}		X	X	X	X
Patient Vars	X	X	X	X	X
County Vars			X	X	X
Hospital Vars				X	X
Quality Vars					X

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

** First-stage F-stat > 300

Estimated Effects on Episode Outcomes

Outcome (Logs)	(1)	(2)	(3)	(4)	(5)
Spending	0.042**	0.042**	0.044**	0.049**	0.052***
[$30,561]	(0.018)	(0.018)	(0.019)	(0.020)	(0.018)
Observations	1,072,316	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X	X
γ_j, γ_k	X				
γ_{jk}		X	X	X	X
Patient Vars	X	X	X	X	X
County Vars			X	X	X
Hospital Vars				X	X
Quality Vars					X

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

** First-stage F-stat > 300

Estimated Effects on Episode Outcomes

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[$30,561]	(0.018)	(0.018)	(0.019)	(0.020)	(0.018)
Work RVUs	0.045	0.052	0.063*	0.059	0.062
[86.853]	(0.039)	(0.039)	(0.038)	(0.042)	(0.040)
Observations	1,072,316	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X	X
γ_j, γ_k	X				
γ_{jk}		X	X	X	X
Patient Vars	X	X	X	X	X
County Vars			X	X	X
Hospital Vars				X	X
Quality Vars					X

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

** First-stage F-stat > 300

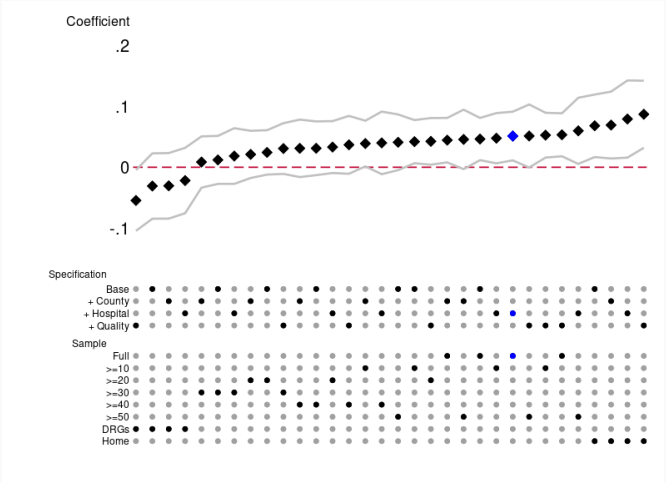
Estimated Effects on Episode Outcomes

Outcome (Logs)	(1)	(2)	(3)	(4)	(5)
Spending	0.042**	0.042**	0.044**	0.049**	0.052***
[$30,561]	(0.018)	(0.018)	(0.019)	(0.020)	(0.018)
Work RVUs	0.045	0.052	0.063*	0.059	0.062
[86.853]	(0.039)	(0.039)	(0.038)	(0.042)	(0.040)
Service Count	-0.244***	-0.225***	-0.165***	-0.161***	-0.159***
[109.495]	(0.043)	(0.042)	(0.042)	(0.046)	(0.044)
Observations	1,072,316	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X	X
γ_j, γ_k	X				
γ_{jk}		X	X	X	X
Patient Vars	X	X	X	X	X
County Vars			X	X	X
Hospital Vars				X	X
Quality Vars					X

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

** First-stage F-stat > 300

Specification Chart



Composition within an Episode

Components of Episode

Split episode outcomes into individual components:

- Inpatient
- Outpatient
- Office
- Labs
- E&M visits
- Imaging
- Limited results for HHA and SNF (data processing in VRDC)

Components of Episode

Split episode outcomes into individual components:

- Inpatient
- Outpatient
- Office
- Labs
- E&M visits
- Imaging
- Limited results for HHA and SNF (data processing in VRDC)

Carrier claims separated based on place of service or BETOS codes

Estimated Effects on Spending

Outcome	(1)	(2)	(3)	(4)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Spending

Outcome	(1)	(2)	(3)	(4)
Inpatient	174.078	456.913	559.100	641.984**
[$6,135]	(389.668)	(415.230)	(451.255)	(323.684)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Spending

Outcome	(1)	(2)	(3)	(4)
Inpatient	174.078	456.913	559.100	641.984**
[$6,135]	(389.668)	(415.230)	(451.255)	(323.684)
Outpatient	618.347***	601.020***	475.969***	461.451***
[$2,539]	(162.649)	(170.345)	(183.165)	(182.050)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Spending

Outcome	(1)	(2)	(3)	(4)
Inpatient	174.078	456.913	559.100	641.984**
[$6,135]	(389.668)	(415.230)	(451.255)	(323.684)
Outpatient	618.347***	601.020***	475.969***	461.451***
[$2,539]	(162.649)	(170.345)	(183.165)	(182.050)
HHA	135.677**	105.020**	103.077	93.749
[$1,122]	(57.884)	(60.587)	(66.822)	(66.301)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Spending

Outcome	(1)	(2)	(3)	(4)
Inpatient	174.078	456.913	559.100	641.984**
[$6,135]	(389.668)	(415.230)	(451.255)	(323.684)
Outpatient	618.347***	601.020***	475.969***	461.451***
[$2,539]	(162.649)	(170.345)	(183.165)	(182.050)
HHA	135.677**	105.020**	103.077	93.749
[$1,122]	(57.884)	(60.587)	(66.822)	(66.301)
SNF	-285.041	-298.230	-288.433	-304.623
[$2,746]	(218.798)	(230.909)	(253.243)	(249.010)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Spending: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** "Office" denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Spending: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	76.149	167.125	249.707	261.349
[$2,414]	(191.158)	(198.915)	(218.402)	(218.463)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Spending: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	76.149	167.125	249.707	261.349
[$2,414]	(191.158)	(198.915)	(218.402)	(218.463)
Lab	-67.837	-41.758	-36.454	-30.836
[$1,766]	(54.228)	(57.402)	(63.233)	(63.060)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Spending: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	76.149	167.125	249.707	261.349
[$2,414]	(191.158)	(198.915)	(218.402)	(218.463)
Lab	-67.837	-41.758	-36.454	-30.836
[$1,766]	(54.228)	(57.402)	(63.233)	(63.060)
E&M	174.358***	213.717***	250.801***	263.336***
[$1,508]	(58.135)	(62.00)	(68.593)	(60.787)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Spending: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	76.149	167.125	249.707	261.349
[$2,414]	(191.158)	(198.915)	(218.402)	(218.463)
Lab	-67.837	-41.758	-36.454	-30.836
[$1,766]	(54.228)	(57.402)	(63.233)	(63.060)
E&M	174.358***	213.717***	250.801***	263.336***
[$1,508]	(58.135)	(62.00)	(68.593)	(60.787)
Imaging	-53.063***	-28.186	-33.204	-32.684
[$366]	(18.222)	(18.448)	(20.375)	(19.878)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Work RVUs

Outcome	(1)	(2)	(3)	(4)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Work RVUs

Outcome	(1)	(2)	(3)	(4)
Inpatient	-0.785	-3.736	-2.653	-2.312
[75.24]	(3.193)	(3.190)	(3.517)	(3.446)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Work RVUs

Outcome	(1)	(2)	(3)	(4)
Inpatient	-0.785	-3.736	-2.653	-2.312
[75.24]	(3.193)	(3.190)	(3.517)	(3.446)
Outpatient	0.556	0.559	1.208	1.153
[21.48]	(1.057)	(1.100)	(1.221)	(1.220)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Work RVUs: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Work RVUs: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	-0.603	-0.418	-0.135	-0.140
[15.45]	(0.651)	(0.679)	(0.744)	(0.744)

Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Work RVUs: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	-0.603	-0.418	-0.135	-0.140
[15.45]	(0.651)	(0.679)	(0.744)	(0.744)
Lab	-0.064	-0.025	-0.040	-0.028
[3.36]	(0.104)	(0.111)	(0.122)	(0.122)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Work RVUs: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	-0.603	-0.418	-0.135	-0.140
[15.45]	(0.651)	(0.679)	(0.744)	(0.744)
Lab	-0.064	-0.025	-0.040	-0.028
[3.36]	(0.104)	(0.111)	(0.122)	(0.122)
E&M	4.211***	4.934***	5.778***	6.060***
[27.95]	(1.173)	(1.250)	(1.381)	(1.226)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Work RVUs: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	-0.603	-0.418	-0.135	-0.140
[15.45]	(0.651)	(0.679)	(0.744)	(0.744)
Lab	-0.064	-0.025	-0.040	-0.028
[3.36]	(0.104)	(0.111)	(0.122)	(0.122)
E&M	4.211***	4.934***	5.778***	6.060***
[27.95]	(1.173)	(1.250)	(1.381)	(1.226)
Imaging	-0.226	-0.063	-0.141	-0.115
[4.41]	(0.202)	(0.212)	(0.231)	(0.216)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Service Counts

Outcome	(1)	(2)	(3)	(4)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Service Counts

Outcome	(1)	(2)	(3)	(4)
Inpatient	-7.381***	-7.969***	-7.432***	-7.205***
[30.31]	(1.735)	(1.675)	(1.844)	(1.780)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Service Counts

Outcome	(1)	(2)	(3)	(4)
Inpatient	-7.381***	-7.969***	-7.432***	-7.205***
[30.31]	(1.735)	(1.675)	(1.844)	(1.780)
Outpatient	-3.200	-2.842	-0.623	-0.574
[40.19]	(2.361)	(2.445)	(2.704)	(2.705)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Inpatient” excludes focal inpatient stay.

Estimated Effects on Service Counts: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Service Counts: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	6.999	11.686	16.467	17.333
[65.14]	(10.675)	(11.096)	(12.192)	(12.187)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Service Counts: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	6.999	11.686	16.467	17.333
[65.14]	(10.675)	(11.096)	(12.192)	(12.187)
Lab	-2.566**	-1.747	-1.457	-1.342
[47.69]	(1.302)	(1.374)	(1.514)	(1.511)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Service Counts: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	6.999	11.686	16.467	17.333
[65.14]	(10.675)	(11.096)	(12.192)	(12.187)
Lab	-2.566**	-1.747	-1.457	-1.342
[47.69]	(1.302)	(1.374)	(1.514)	(1.511)
E&M	-4.449***	-3.307***	-3.181***	-3.092***
[19.86]	(0.723)	(0.739)	(0.820)	(0.732)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Estimated Effects on Service Counts: Physician Services Only

Outcome	(1)	(2)	(3)	(4)
Office	6.999	11.686	16.467	17.333
[65.14]	(10.675)	(11.096)	(12.192)	(12.187)
Lab	-2.566**	-1.747	-1.457	-1.342
[47.69]	(1.302)	(1.374)	(1.514)	(1.511)
E&M	-4.449***	-3.307***	-3.181***	-3.092***
[19.86]	(0.723)	(0.739)	(0.820)	(0.732)
Imaging	0.251	0.551	0.403	0.442
[11.82]	(0.858)	(0.859)	(0.938)	(0.927)
Observations	1,058,196	872,841	872,522	872,522
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

** “Office” denotes POS 1, 11, 15, 20, 49, 50, 60, 71, and 72.

Referral Decisions

Components of Episode

Identify claims as billed by other vertically integrated providers or non-integrated providers

- Spending
- RVUs
- Service Counts

Estimated Effects on Spending

Outcome	(1)	(2)	(3)	(4)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Estimated Effects on Spending

Outcome	(1)	(2)	(3)	(4)
Other VI	3,890***	4,089***	4,245***	4,229***
	(405.768)	(432.524)	(472.629)	(456.012)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Estimated Effects on Spending

Outcome	(1)	(2)	(3)	(4)
Other VI	3,890***	4,089***	4,245***	4,229***
	(405.768)	(432.524)	(472.629)	(456.012)
Other Non-VI	-3,957***	-3,896***	-3,691***	-3,664***
	(415.412)	(439.485)	(469.119)	(441.070)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Estimated Effects on RVUs

Outcome	(1)	(2)	(3)	(4)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Estimated Effects on RVUs

Outcome	(1)	(2)	(3)	(4)
Other VI	14.307***	15.739***	16.859***	16.890***
	(1.664)	(1.773)	(1.953)	(1.925)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Estimated Effects on RVUs

Outcome	(1)	(2)	(3)	(4)
Other VI	14.307***	15.739***	16.859***	16.890***
	(1.664)	(1.773)	(1.953)	(1.925)
Other Non-VI	-11.202***	-10.974***	-9.845***	-9.701***
	(1.698)	(1.798)	(1.963)	(1.850)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Estimated Effects on Service Counts

Outcome	(1)	(2)	(3)	(4)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Estimated Effects on Service Counts

Outcome	(1)	(2)	(3)	(4)
Other VI	13.024***	12.283***	14.992***	14.805***
	(4.255)	(4.237)	(4.563)	(4.566)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Estimated Effects on Service Counts

Outcome	(1)	(2)	(3)	(4)
Other VI	13.024***	12.283***	14.992***	14.805***
	(4.255)	(4.237)	(4.563)	(4.566)
Other Non-VI	-8.010	-9.123	-1.374	-1.894
	(10.184)	(10.681)	(11.599)	(11.582)
Observations	1,036,767	855,674	855,359	855,359
λ_t	X	X	X	X
γ_{jk}	X	X	X	X
Patient Vars	X	X	X	X
County Vars		X	X	X
Hospital Vars			X	X
Quality Vars				X

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

Physician “Effort”

Total Physician Activity

Form aggregate physician measures using 100% carrier claims for each physician

- Spending
- RVUs
- Patients
- Split between inpatient and outpatient

Estimated Effects on Aggregate Physician Behaviors

Outcome (Logs)	(1)	(2)	(3)
Observations	209,972	174,566	174,543
λ_t	X	X	X
γ_j	X	X	X
County Vars		X	X
Physician Vars			X

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

Estimated Effects on Aggregate Physician Behaviors

Outcome (Logs)	(1)	(2)	(3)
Spending	0.180***	0.159***	0.159***
	(0.034)	(0.033)	(0.033)
Observations	209,972	174,566	174,543
λ_t	X	X	X
γ_j	X	X	X
County Vars		X	X
Physician Vars			X

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

Estimated Effects on Aggregate Physician Behaviors

Outcome (Logs)	(1)	(2)	(3)
Spending	0.180***	0.159***	0.159***
	(0.034)	(0.033)	(0.033)
RVUs	0.234***	0.229***	0.230***
	(0.029)	(0.029)	(0.029)
Observations	209,972	174,566	174,543
λ_t	X	X	X
γ_j	X	X	X
County Vars		X	X
Physician Vars			X

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

Estimated Effects on Aggregate Physician Behaviors

Outcome (Logs)	(1)	(2)	(3)
Spending	0.180***	0.159***	0.159***
	(0.034)	(0.033)	(0.033)
RVUs	0.234***	0.229***	0.230***
	(0.029)	(0.029)	(0.029)
Total Patients	0.238***	0.229***	0.230***
	(0.027)	(0.027)	(0.027)
Observations	209,972	174,566	174,543
λ_t	X	X	X
γ_j	X	X	X
County Vars		X	X
Physician Vars			X

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

Estimated Effects on Aggregate Physician Behaviors by Setting

Outcome (Logs)	(1)	(2)	(3)
Observations	209,972	174,566	174,543
λ_t	X	X	X
γ_j	X	X	X
County Vars		X	X
Physician Vars			X

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

Estimated Effects on Aggregate Physician Behaviors by Setting

Outcome (Logs)	(1)	(2)	(3)
IP Spending	0.100***	0.098***	0.098***
	(0.038)	(0.039)	(0.039)
IP Patients	0.132***	0.121***	0.121***
	(0.033)	(0.033)	(0.033)
Observations	209,972	174,566	174,543
λ_t	X	X	X
γ_j	X	X	X
County Vars		X	X
Physician Vars			X

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

Estimated Effects on Aggregate Physician Behaviors by Setting

Outcome (Logs)	(1)	(2)	(3)
IP Spending	0.100***	0.098***	0.098***
	(0.038)	(0.039)	(0.039)
IP Patients	0.132***	0.121***	0.121***
	(0.033)	(0.033)	(0.033)
OP Spending	0.206***	0.181***	0.184***
	(0.081)	(0.081)	(0.081)
OP Patients	0.190***	0.125***	0.124***
	(0.070)	(0.069)	(0.069)
OP RVUs	0.422***	0.405***	0.408***
	(0.082)	(0.083)	(0.083)
Observations	209,972	174,566	174,543
λ_t	X	X	X
γ_j	X	X	X
County Vars		X	X
Physician Vars			X

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

Summary of Results

Episode Utilization

- Increase in spending per episode of 4-5% (about $1,500)
- Largest relative spending increases coming from outpatient setting (as expected)
- Little change in RVUs per episode
- Large reduction in service count for IP and HHA, mainly from imaging and labs

Summary of Results

Episode Referrals

- Substantial shift to other integrated providers
- Shown in spending, RVUs, and service counts

Summary of Results

Total Physician Effort

- Large increase in spending, RVUs, and patients
- Particularly in outpatient setting

Summary of Results

What does vertical integration do to treatment decisions?

- Shifts location of care from office to outpatient setting (mechanical)
- Concentrates treatment “team” to integrated providers
- Reduces quantity of services provided but without realized cost savings

What does employment do to overall physician “effort”?

- More patients in the inpatient (and outpatient) settings
- Reduction in E&M visits, reallocation toward more intensive services

Thank You!