Technology Adoption and Market Allocation: The Case of Robotic Surgery

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Motivation

- Technology key driver of productivity in health care, economy in general
- Information frictions, insurance may distort adoption in health care
- Patients may have a preference for technology, use as proxy for quality
- "Medical arms race": hospitals compete over same patients
  $\Longrightarrow$ service duplication, increased cost

- How does tech adoption impact care utilization?
- Does adoption prompt market expansion? Business stealing?
- Who does adoption draw into treatment?

Overview

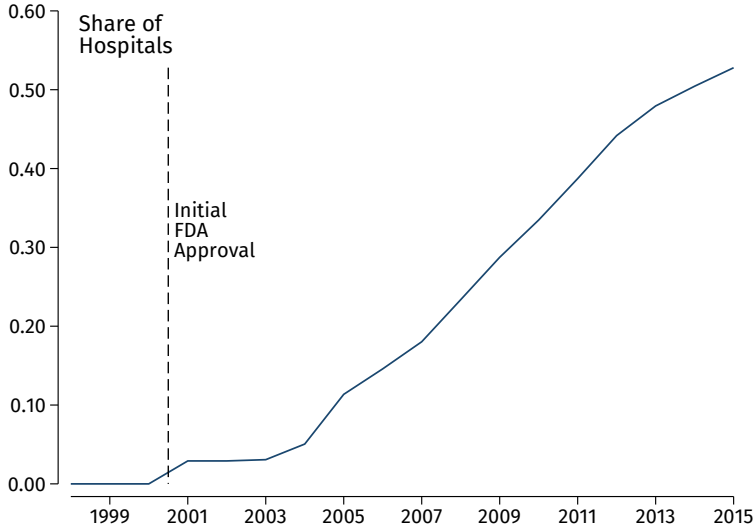
Study effect of adopting robotic surgery on prostate cancer hospitalizations

- Robot: intermediate cost (vs. cardiac cath, β blockers)
- Leverage rapid, staggered, adoption of robot
- Assess effects at market & hospital levels
- Characterize marginal patients (Gruber et al. 1999)

Key findings

- Adoption drives large increase in volume (80-99%)
- Smaller effects at market level (market expansion **and** business stealing)
- Marginals relatively healthy (adoption not broadening eligibility criteria)

Robotic Adoption Over Time

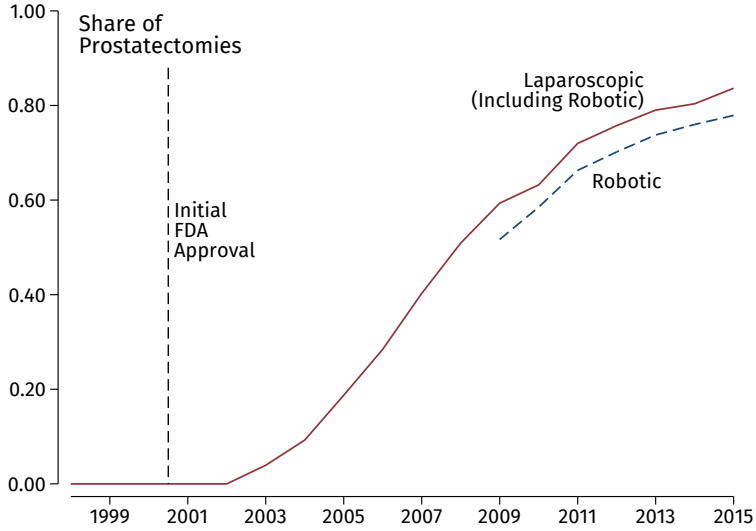


Background: Surgical Robotics

- Intuitive Surgical da Vinci robot (only device during analysis period)
- FDA approved in 2000
- Dramatically changed prostate cancer intervention
- Relatively low barriers to entry
- Not pivotal for Medicare payment
- No RCT evidence of benefit vs. alternatives (laparoscopic, open)
- Focus of hospital advertising

Hospital Advertising

Use of Robotic Surgery for Prostatectomy Over Time



Background: Prostate Cancer

- Second most common cancer in men, 33k deaths/year
- Key surgical treatment: prostatectomy
- Slow-growing, often not fatal (competing risks)
- Mid-2000s shift to “watch & wait” (avoid unnecessary treatment)
- 32% drop in prostatectomies during analysis period
- Rapid adoption of robots during this shift, offsetting some of decline

Data

100% Medicare hospitalization data (MEDPAR), 1998-2015

- Measure prostate cancer, prostatectomy patients
- Hospitals in “risk set” for intensive treatment (50+ patients, 5+ cancer patients annually)
- Sample: 2,261 hospitals (1,091 adopters)

Robotic Adoption

- Archives of Intuitive Surgical website, 2002-2005
- AHA survey data, 2005-2015

Methodology

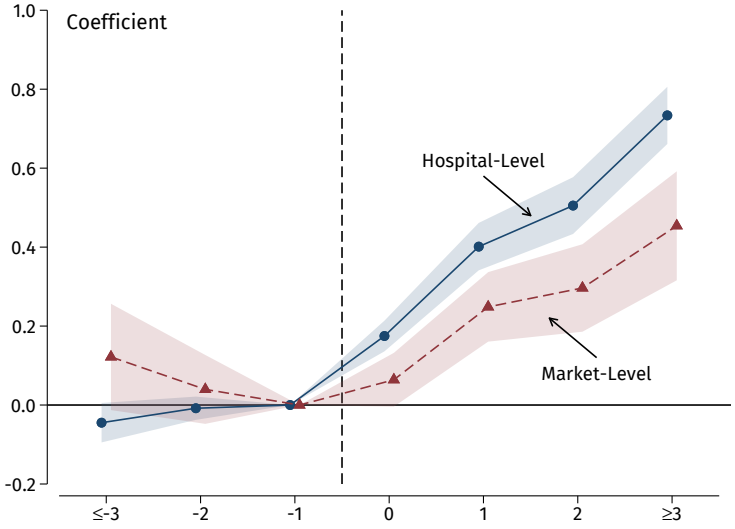
$$N_{ht} = \exp\left(\alpha_t + \alpha_h + \beta \cdot interim_{ht} + \gamma \cdot post_{ht}\right) + \varepsilon_{ht}$$

- $N_{h,t}$ - admissions for hospital h, time t
- α_t - year FE, α_h - hospital FE
- $interim_{h,t}$ - adopted in t
- $post_{h,t}$ - adopted in $t-1$ or before

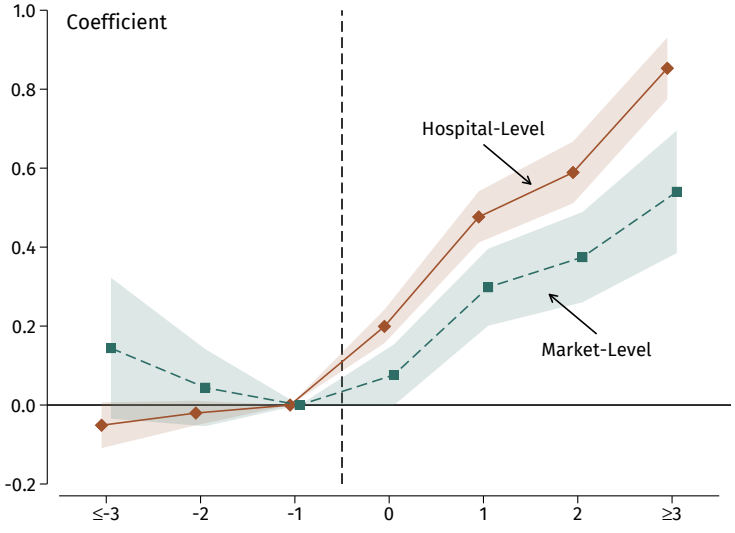
Also run analyses at market (HRR) level r

- $interim_{r,t}$ - beds-weighted share adopting in t
- $post_{r,t}$ - beds-weighted share adopting in $t-1$ or before

Effects on Prostate Cancer Patient Volume



Effects on Prostatectomy Patient Volume



Estimates of Effect of Adoption on Volume

	(1)	(2)	(3)	(4)
	Hospital-Level		Market-Level	
Patients:	Prostate Cancer	Prostatectomy	Prostate Cancer	Prostatectomy
Post	0.59	0.69	0.28	0.34
	(0.04)	(0.04)	(0.07)	(0.08)
Marginal Effect	7.8	7.6	27.8	27.8
DV Average	11.5	9.5	90.2	73.1
Hospitals/Markets	2,255	2,212	306	306
Observations	40,590	39,816	5,508	5,508

Robust standard errors clustered at the market level in parentheses.

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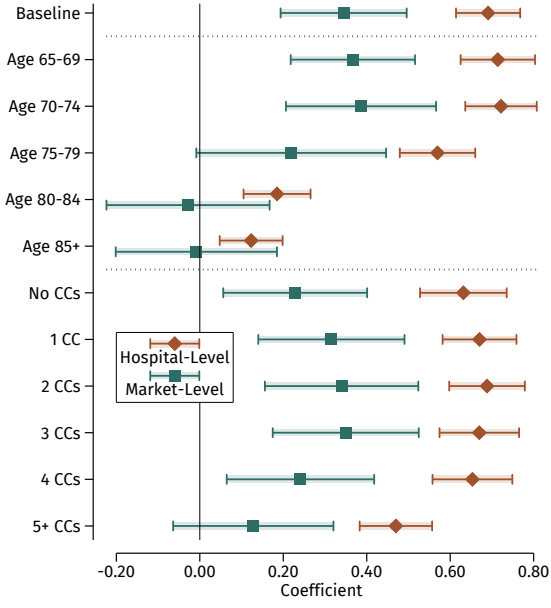
Identifying Characteristics of Marginal Patients

Study *who* robots bring into treatment:

- Patient Age
- Chronic conditions (22 conditions from pre-admit diagnoses)

First approach: use DD to measure volume effects for subgroups


Baseline
Age 65-69
Age 70-74
Age 75-79
Age 80-84
Age 85+
No CCs
1 CC
2 CCs
3 CCs
4 CCs
5+ CCs
Hospital-Level
Market-Level
-0.20
0.00
0.20
0.40
0.60
0.80
Coefficient

Identifying Characteristics of Marginal Patients

Second approach: estimate characteristics of marginals (c.f. Gruber et al. 1999)

$$N_{ht} = \exp\left(\alpha_t^{1S} + \alpha_h^{1S} + \beta^{1S} \cdot interim_{ht} + \gamma^{1S} \cdot post_{ht}\right) + \varepsilon_{ht}^{1S}$$

"First stage" - same DD regression as before

$$C_{ht} = \exp\left(\alpha_t^{RF} + \alpha_h^{RF} + \beta^{RF} \cdot interim_{ht} + \gamma^{RF} \cdot post_{ht}\right) + \varepsilon_{ht}^{RF}$$

"Reduced form" - use average characteristic C_{ht} as outcome

$$\eta = \gamma^{RF}/\gamma^{1S}$$

"Elasticity" - ratio of reduced form to first stage
$\approx$ % effect on average characteristic from 100% increase in volume
$\approx$ % diff between marginal & average patient (under no defiers)

Characteristics of Marginal Patients After Adoption

	Hospital-Level		Market-Level				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Characteristic:	Age	CCs	Age	CCs	Beds	Volume	Teaching
Elasticity	-0.054	-0.277	-0.067	-0.248	0.061	0.107	0.245
	(0.004)	(0.033)	(0.020)	(0.149)	(0.075)	(0.088)	(0.191)
Average Char	73.32	2.68	72.24	2.50	413.08	22.02	0.46
Hosps/Markets	2,191	2,164	306	306	306	306	306
Observations	62,046	53,808	10,956	9,732	10,956	10,942	8,925

CCs: chronic conditions count. Beds & volume measured at baseline (1998) levels.

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Findings

Robotic surgery expands market *and* moves patients across hospitals

- Gap between the market- & hospital-level: business stealing
- Marginal patients are younger and healthier
- No detected expansion of treatment to older patients (low-value)
- Signs that adoption brings patients to larger & teaching hospitals

Implications for Welfare

A socially wasteful “medical arms race”?

- Traditional view: unconstrained adoption, fixed costs, business stealing $\implies$ welfare-damaging arms race
- Assumes common quality or quality uncorrelated with adoption
- Adoption that reallocates to better hospitals can be welfare-improving
- Signs patients move to bigger & teaching hospitals are encouraging

Implications for Welfare Cont'd

Does finding of market expansion mean welfare improved?

- Market imperfections, behavioral patients (or agents) complicate story
- Moral hazard - insurance distorts decisions
- Behavioral hazard - biased beliefs distort decisions (Baicker et al. 2015)
- But don't find welfare-damaging expansion to poor matches to surgery
- Detailed clinical data (e.g. SEER) could give the last word

Conclusion

- Study intermediate-cost, rapidly-adopted tech in prostate cancer context
- Find adoption drives large increases in patient volume
- Effects due to market expansion and business stealing
- Small to no volume effects for poor patient matches
- Results inconsistent with most welfare-damaging stories

- Thank you for attending!