Minimum Nurse-to-Patient Ratios in Hospitals: Evidence from California

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- Low quality hospitals are a source of regulatory concern
  - Large gaps in clinical outcomes between lowest vs. highest rated hospitals
  - *How* to regulate hospitals to improve quality of medical care?

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- Question 1: What are the effects of ratio regulation on hospitals? Raja (2023, *JHE*)
- Question 2: Could we improve quality more **efficiently**: achieve larger quality gains by spending the same amount on something else?

Policy Timeline

- (1990s) Several failed attempts at nurse staffing legislation
- (Dec. 1999) AB 394 instructs CA Dept. of Health Services to establish ratios by unit
- (July 2003) DHS announces ratios after public comment period
- (Jan. 2004 / Jan. 2005) Hospitals implement intermediate/final ratios

Policy Context

Figure 1: Mandated Minimum Nurse-to-Patient Ratios
Source: National Nurses United

- Distinction made between RNs and LVNs (up to 50% share)
- 34 eligible small and rural hospitals received exemptions
- Inspection once in three years + financial penalty for non-compliance

Data: Hospital Annual Disclosure Report

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- Hospital level:
  - Active medical staff physicians by specialty and type
  - Expenditures on capital including leases and equipment
  - Case Mix Index of severity
  - Hospital characteristics (non-profit, teaching, rural)

Data: Patient Discharge Data + Death Master Statistical File

- Inpatient discharge records for each non-federal hospital (1995-2008)
- Used to construct quality measures:
  - AMI in-hospital mortality rate
  - AMI 30-day readmission rate
  - Hospital-wide 30-day readmission rate
  - [in progress] AMI + hospital-wide 30-day mortality rate + other clinical outcomes
- Risk-adjustment of quality measures:
  - Gender, race, age
  - One-year history of inpatient care
- Universal coverage relative to Medicare or administrative claims data

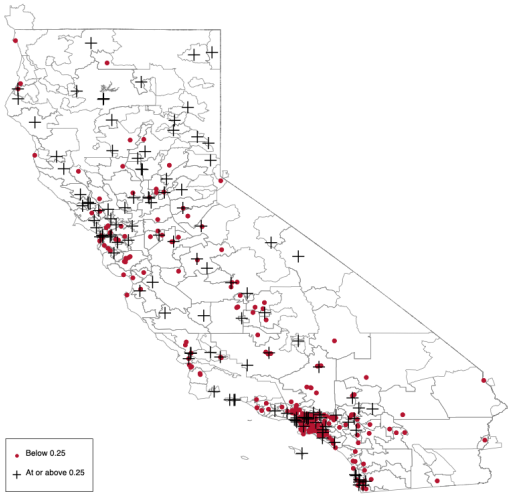
Table 1: Descriptive Statistics for California Hospitals from 1996-2002

	Nurse-to-Patient Ratio Distribution			
	Bottom 25	25-50	50-75	Top 25
Hospitals	52	52	52	52
Annual discharges	9,367	10,368	10,993	9,433
Annual inpatient revenue ($)	60,769,720	78,174,402	77,836,713	77,893,051
Acute share of revenue	0.366	0.401	0.417	0.448
Case Mix Index	1.03	1.08	1.10	1.14
Hospital-wide discharges				
Hospital-wide 30-day non-readmission rate	0.902	0.897	0.887	0.897
Hospital-wide risk-residualized rate	0.970	0.968	0.966	0.973
Hospital-wide length of stay	3.407	3.510	3.496	3.544
Inputs in Med/Surg Acute Care Unit				
Nurses per 1,000 patient days	2.196	2.443	2.725	3.230
Physicians per 1,000 patient days	1.091	1.289	1.295	1.233
Materials expenditures per 1,000 patient days ($)	4,403	3,531	3,872	4,120
Capital expenditures per 1,000 patient days ($)	433,019	468,360	541,930	580,107
Patient care costs per 1,000 patient days ($)	399,171	473,644	547,243	626,019
Hospital characteristics				
Share church or non-profit	0.654	0.596	0.692	0.731
Share investor-owned	0.115	0.192	0.154	0.096
Share teaching hospitals	0.038	0.096	0.115	0.154
Share small/rural hospitals	0.173	0.115	0.135	0.212

Correlation vs. Causation: Nurse Staffing and Outcomes

- Higher staffing hospitals have other characteristics that may *also* affect outcomes
- Need to isolate the effect of staffing from *other* hospital characteristics (use of other inputs, managerial talent, treatment choices)
- *How?*
  - Use 1999 CA nurse staffing mandate as a shock to Med/Surg Acute Care Unit staffing
  - Mandate only affected low staffing hospitals
  - Variation in nurse staffing on both time and cross-sectional dimensions

Hospitals by Pre-Mandate Staffing Level



Notes: This figure shows the locations of hospitals in the balanced panel based on their pre-mandate nurse staffing levels in the Med/Surg Acute Care Unit.

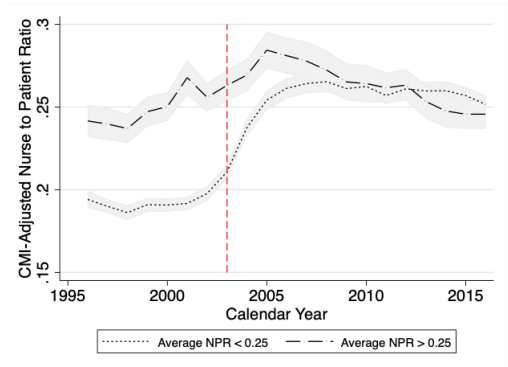
Difference-in-Differences Research Methodology

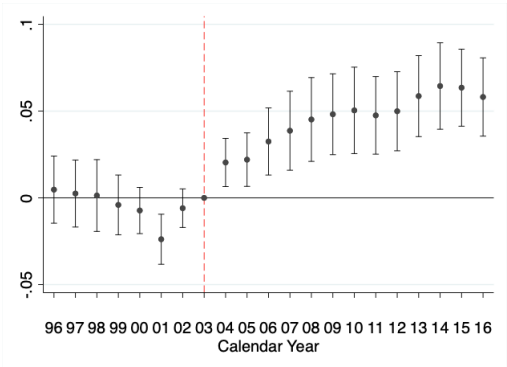
$$y_{it} = \alpha + \sum_{t \in T} \beta_t * \mathbb{1}\{\text{YEAR} = t\} * \mathbb{1}\{\text{2000-2002 Staffing Ratio} < 0.25\}_{it} + \xi_i + \gamma_t + \epsilon_{it}$$

- y_{it} = nurse-to-patient ratio; bed capacity; bed utilization rate; clinical outcomes
- β_t = treatment effect for low staffing hospital in year t
- $\mathbb{1}\{\text{YEAR} = t\}$ = indicator variable for year
- $\mathbb{1}\{\text{2000-2002 Staffing Ratio} < 0.25\}_{it}$ = indicator variable for treated

- Differential effect of the mandate on treated hospitals' outcomes in the post vs. pre period
- Requires parallel trends in outcomes between treated + control groups absent mandate

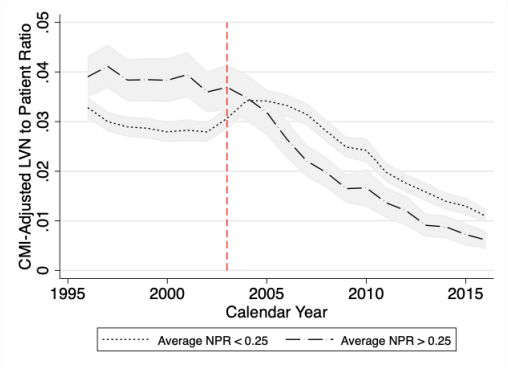
Results: 12% Increase in Nurse Staffing

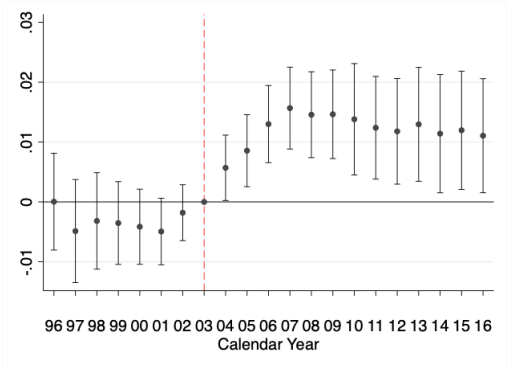




Note: Nurse-to-patient ratio is equal to nursing hours provided by RNs, LVNs, and registry nurses divided by the number of patient days times 24 hours per day.

Results: Increase in Lower-Licensed Nurses (LVNs)

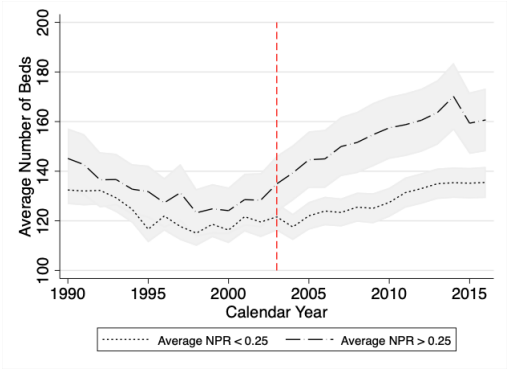


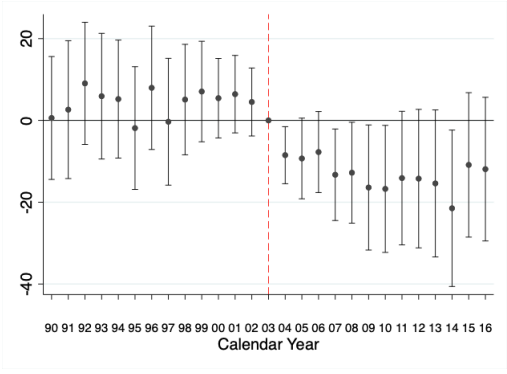


Results: Where Did the Nurses Come From?

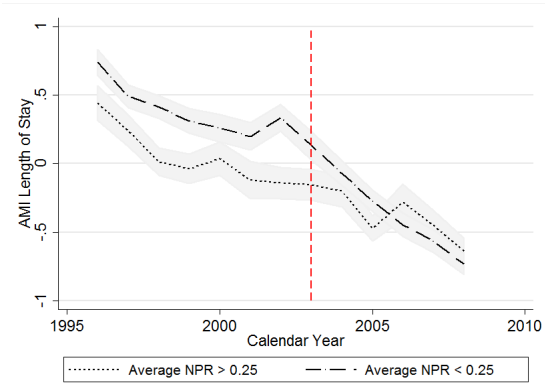
- Combination of nursing graduates + out-of-state licensees
- Increase in the graduates of nursing programs by 25% in the early 2000s (CA Legislative Analyst's Office, 2007)
  - Between 2000 and 2007, CA added 26 nursing programs
  - Enrollment in new + existing programs increased by 25%
- Suggestive evidence of compositional changes to the RN workforce:
  - I show that the average RN wage at treated hospitals declined relative to control
  - I use NSSRN to show average age of the hospital RN declined in CA relative to other states
  - I use NCSBN licensing data to show increase in out-of-state licensees relative to other states
- Lessons for a larger scale mandate (e.g. federal)

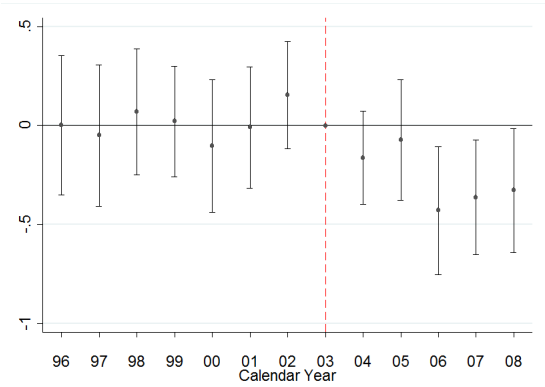
Results: 14% Decline in Excess Capacity + 8% Increase in Utilization



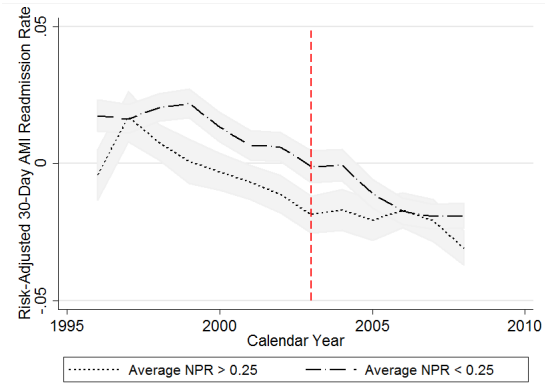


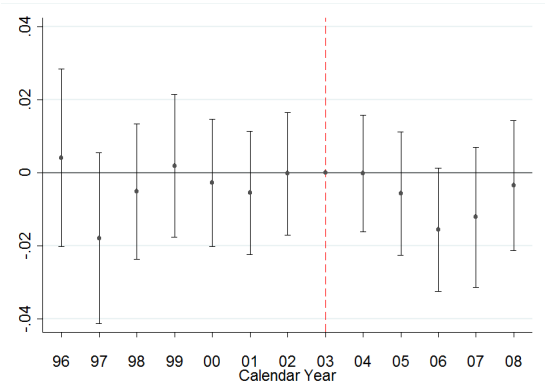
Results: Improvement (5% decline) in AMI Length of Stay



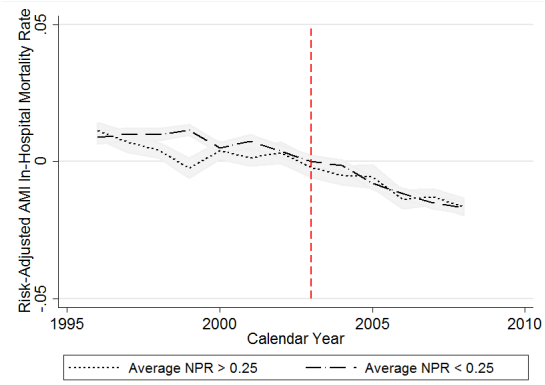


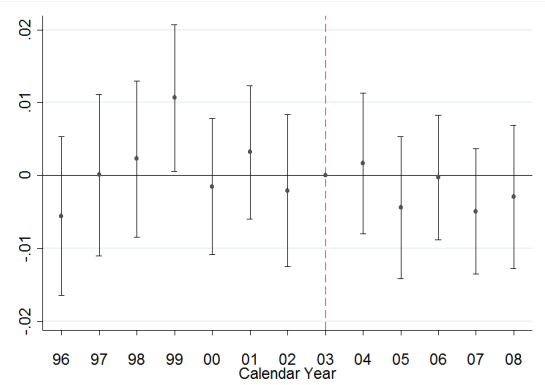
Results: No Significant Effect on AMI Readmission



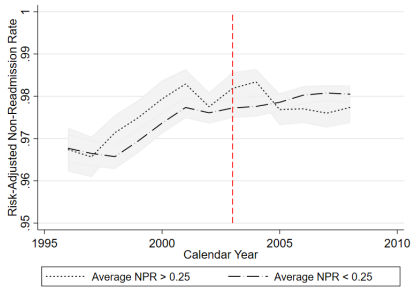


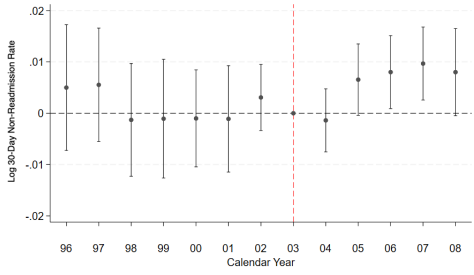
Results: No Significant Effect on AMI In-Hospital Mortality





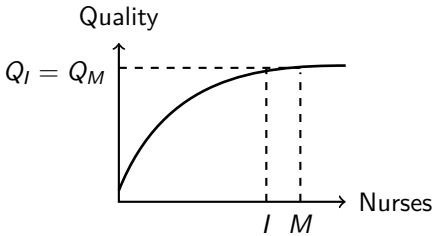
Results: Improvement (0.7% increase) in Hospital-Wide Non-Readmission



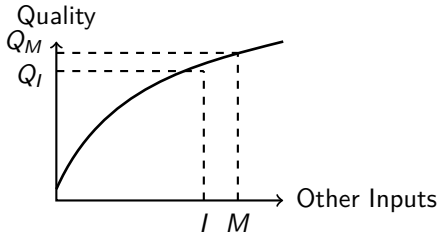


Are We Spending Money on the "Right" Inputs?

We want to target *other* inputs if the curve for nurses looks like this ("flat of the curve")...



Or if the curve for the other inputs looks like this...



Results: Are We Spending Money on the "Right" Inputs?

- I estimate the curvature of this function: readmission rate is the measure of quality as a function of inputs (nurses, physicians, materials, capital)
- I find that quality improvements require addition of *both* nurses + physicians:
  - Nurses + physicians work together by design (licensing restrictions)
  - Adding nurses without adding physicians (to diagnose, assign tasks, and supervise) has limited returns in terms of reducing readmission
- On average:
  - Salary costs of the mandate ($54m) + cost of unmeasured complements
  - Benefits from voided readmissions ($89m)
- But some hospitals benefit and some do not:
  - Inner-city, rural hospitals need physicians

Results: Are Nurses Being Allocated to the "Right" Places?

- Intuitively, I find nurses more valuable when patients are severe
- CA staffing mandate sets single ratio mandate across hospitals
- Valuable to account for patient severity when allocating nurses across space:
  - High severity hospitals in densely populated counties need higher staffing
  - Lessons for any setting where there are fewer nurses to pull from

In Progress

- Share data sets that I have compiled:
  - 1988-2016 Hospital Annual Disclosure Report in Stata/SAS files
  - Nurse licensing data in Stata/SAS files
- Knowledge sharing on risk-adjustment for healthcare quality indicators:
  - 30-day readmission and mortality construction from PDD + DSMF data
  - Other clinical outcomes?
- How the roles of nurses vary across units (Intensive Care, ER)
- How the roles of healthcare workforce vary across procedures