

**ONLINE APPENDIX:**

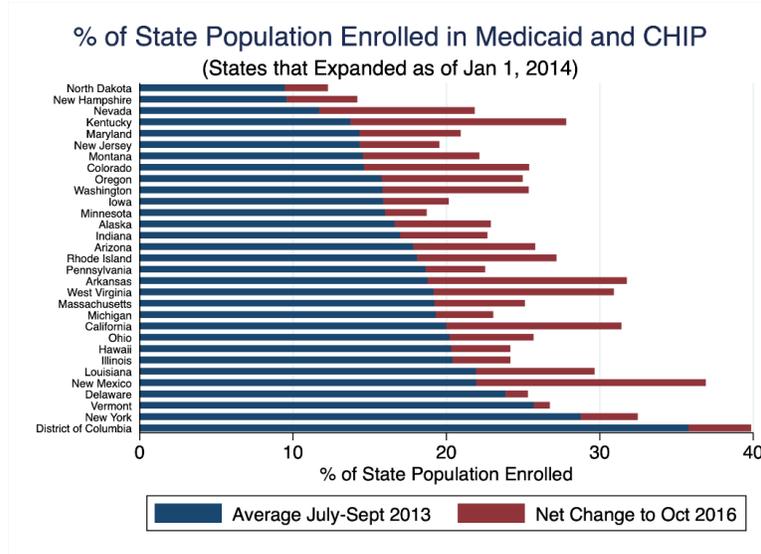
The Impact of the Affordable Care Act:  
Evidence from California's Hospital Sector

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## Appendix A. ADDITIONAL FIGURES AND TABLES

(a): Medicaid enrollment in expansion states



(b): California relative to other expansion states

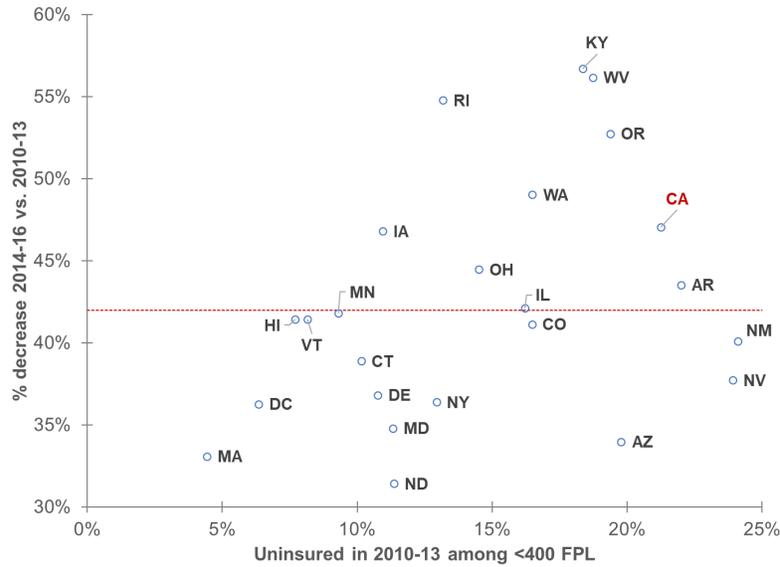


FIGURE A. 1: MEDICAID ENROLLMENT AND DECLINE IN UNINSURANCE

*Notes:* Panel (a) presents Medicaid enrollment as a share of a state's population for states that expanded Medicaid under the ACA on January 1, 2014. Medicaid share as of July–Sept 2013 (i.e., pre-ACA) is depicted in blue and the change through October 2016 is plotted in red. States are sorted in ascending order by Medicaid's share of population as in 2013. Comparable baseline data was not available for Connecticut. Source: <https://www.medicaid.gov/medicaid/downloads/october-2016-enrollmentdata.zip>. Panel (b) presents the % decline in proportion of uninsured individuals among those less than 400% of Federal Poverty Level. Source: American Community Survey microdata.

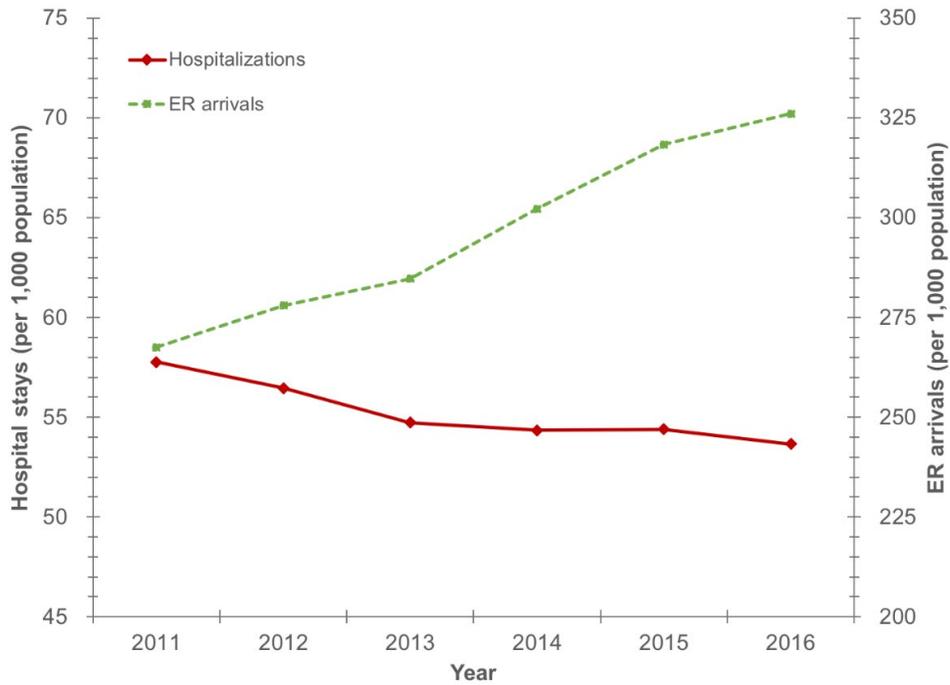
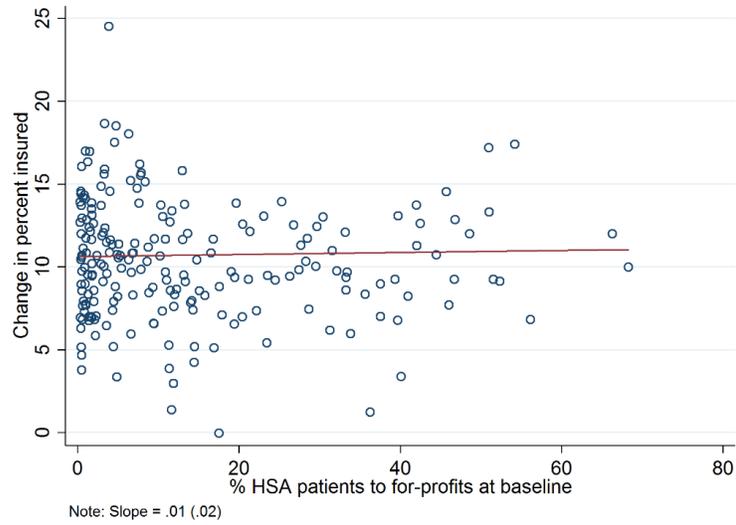


FIGURE A. 2: HOSPITAL UTILIZATION BY PATIENTS AGED 21–64 (PER 1,000 PEOPLE)

*Notes:* This figure presents the number of hospital stays (Panel a) and arrivals at Emergency rooms (Panel b) by patients aged 21–64 in California over 2011–16. The sample contains about 7.5 million discharges. ER arrivals include ER visits and those who were subsequently discharged as inpatients; the sample contains about 40.3 million arrivals. The raw discharges are normalized by population estimates from the National Cancer Institute for each age-year cell. These population estimates were also used in the RD-DD analysis for the same purpose. The figure makes use of the same sample restrictions as in our main analysis—limit to general acute care hospitals, exclude childbirth related cases, and exclude cases for individuals with zip codes missing or located outside California.

(a): Change in percent insured vs. for-profit share of HSA patients



(b): Differential change in insured by baseline for-profit share of HSA

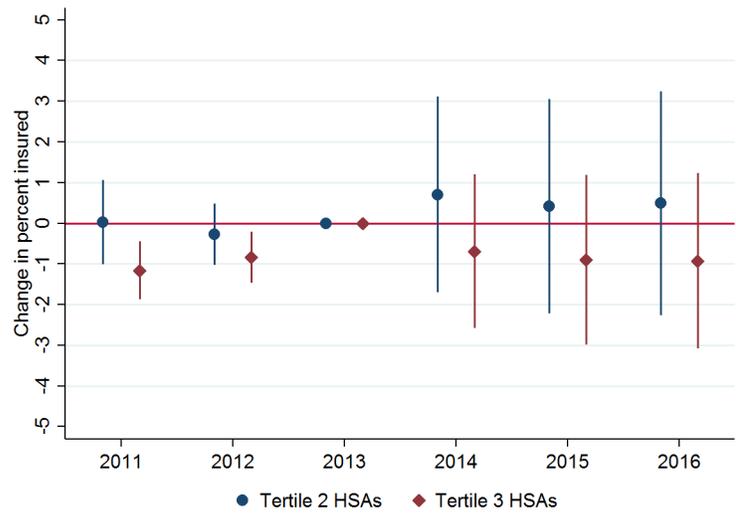


FIGURE A. 3: CHANGE IN INSURANCE VS. BASELINE SHARE OF FOR-PROFIT HOSPITALS

Notes: This figure presents evidence on whether for-profit hospitals were located in HSAs that differentially benefited from insurance expansion under the ACA. Panel (a) presents a scatter plot of the 209 HSAs of the raw change in percent insured post-ACA on the Y-axis versus the share of HSA patients admitted at for-profit hospitals in 2008–10. It also plots the fitted line in red and mentions the slope. Panel (b) formalizes this raw data by presenting event study coefficients showing differential change in percent insured post-ACA at HSAs in the top and middle tertile relative to those in the bottom tertile.

TABLE A. 1: POPULATION ATTRIBUTES AT AGE THRESHOLDS (NATIONAL HEALTH INTERVIEW SURVEY)

	(1) Insured mean	(2) Uninsured mean	(3) Difference	(4) Mean value at threshold	(5) RD estimate at threshold
<b>Panel A: Ages 20-21</b>					
Married	0.08	0.13	0.044 (0.008)	0.08	-0.012 (0.012)
Employed	0.62	0.66	0.040 (0.011)	0.60	0.013 (0.022)
In school	0.23	0.07	-0.156 (0.010)	0.21	-0.031 (0.017)
Percent days alcohol	0.12	0.10	-0.013 (0.008)	0.09	0.030 (0.013)
Smoker	0.22	0.35	0.135 (0.018)	0.23	0.067 (0.038)
Flu shot past 12 months	0.14	0.09	-0.054 (0.013)	0.13	0.008 (0.023)
No insurance coverage	-	-	-	0.29	0.050 (0.020)
<b>Panel B: Ages 64-65</b>					
Married	0.69	0.51	-0.181 (0.023)	0.67	0.025 (0.025)
Employed	0.37	0.34	-0.028 (0.024)	0.34	0.002 (0.027)
In school	0.00	0.00	-0.001 (0.000)	0.00	0.001 (0.001)
Percent days alcohol	0.16	0.09	-0.068 (0.017)	0.15	-0.018 (0.024)
Smoker	0.17	0.29	0.128 (0.032)	0.17	-0.009 (0.027)
Flu shot past 12 months	0.51	0.24	-0.269 (0.029)	0.51	-0.067 (0.039)
No insurance coverage	-	-	-	0.03	0.065 (0.014)

*Notes:* This table presents population weighted descriptive statistics and regression discontinuity estimates at ages 21 and 65 using data from the National Health Interview Survey (NHIS) person and sample adult files from 2004–2009. Data is limited to individuals within 12 months of their 21<sup>st</sup> and 65<sup>th</sup> birth month, excluding individuals interviewed in their month of birth. There are 11,321 and 6,883 such individuals in the person files. The outcomes percent days alcohol in past 12 months, smoking status, and flu shot in past 12 months are taken from the sample adult files which have 4,375 and 3,587 individuals, respectively. Standard errors (in brackets) are adjusted to account for sampling stratification as recommended by NHIS documentation. Mean value at threshold pertains to the mean value for individuals aged 20 and 65, respectively. RD estimate indicates difference in mean for individuals aged 21 and 64 (the treatment group), respectively. RD estimates are obtained using OLS including linear polynomial in age and year fixed effects.

TABLE A. 2: RD-DD RESULTS ON INSURANCE COVERAGE USING ACS

	(1)	(2)	(3)	(4)	(5)	(6)
<b>Panel A: Elderly</b>						
<i>A1. BW = 2 years</i>						
	Medicaid	Employer	Individual	Private	Miscellaneous	Insured
Linear	6.5 (0.29)	-1.48 (0.52)	1.65 (0.33)	0.18 (0.53)	-0.09 (0.46)	6.59 (0.32)
Linear, flexible	5.76 (0.70)	-1.18 (1.26)	1.03 (0.80)	-0.15 (1.27)	-1.35 (1.11)	4.26 (0.77)
2011-13 mean (63-64)	8.37	46.04	12.91	58.95	17.46	84.78
Observations	101,710					
<i>A2. BW = 5 years</i>						
Linear	6.85 (0.20)	-1.09 (0.33)	1.66 (0.21)	0.57 (0.33)	-0.09 (0.26)	7.33 (0.21)
Linear, flexible	6.34 (0.40)	-0.93 (0.66)	1.65 (0.43)	0.73 (0.65)	-0.83 (0.53)	6.24 (0.42)
2011-13 mean (60-64)	8.82	48.52	12.71	61.23	13.96	84.01
Observations	250,832					
<b>Panel B: Young</b>						
<i>B1. BW = 2 years</i>						
Linear	1.28 (0.44)	1.47 (0.57)	0.52 (0.37)	1.99 (0.57)	-0.04 (0.23)	3.23 (0.47)
Linear, flexible	2.12 (1.08)	1.12 (1.37)	-1.32 (0.90)	-0.21 (1.38)	1.63 (0.55)	3.54 (1.13)
2011-13 mean (21-22)	11.12	41.17	10.90	52.07	4.14	67.33
Observations	122,093					
<i>B2. BW = 5 years</i>						
Linear	2.50 (0.29)	3.17 (0.36)	1.55 (0.22)	4.72 (0.36)	-0.18 (0.13)	7.04 (0.28)
Linear, flexible	0.17 (0.60)	0.40 (0.73)	-0.26 (0.45)	0.15 (0.73)	0.34 (0.27)	0.66 (0.57)
2011-13 mean (21-25)	11.22	42.52	9.78	52.30	4.20	67.72
Observations	306,672					

*Notes:* This table presents regression results on changes in insurance coverage using RD-DD models on ACS survey data from California. Coefficients presented are on the interaction of the indicator for being in the treated group (age 21 or 64) and post-ACA period in equation 2a. Regressions were estimated on the sample of elderly (Panel A) and young (Panel B) respondents, respectively, as described in Section III.A. The dependent variable is coverage by specific payer type. Miscellaneous includes Medicare, Government employees, and workers' compensation. All models control for age and include a full set of year fixed effects. Standard errors are clustered by age cell.

TABLE A. 3: HEALTH OUTCOMES (ELDERLY)

	(1)	(2)	(3)	(4)
	<b>Mortality</b>		<b>Potentially Avoidable Hospitalization</b>	
	All cases	Non-discretionary	All cases	Non-discretionary
<b>Panel A: Hospital Stays</b>				
Age 64 * Post	-0.121 (0.085)	-0.551 (0.322)	-0.152 (0.306)	N/A
IV estimate	-0.020 (0.014)	-0.068 (0.040)	-0.021 (0.043)	
Observations	558,220	50,988	241,995	
2011-13 mean (age 64)	2.63	3.62	20.84	
<b>Panel B: ER Arrivals</b>				
Age 64 * Post	-0.073 (0.035)	-0.240 (0.168)	0.108 (0.181)	N/A
IV estimate	-0.008 (0.004)	-0.030 (0.021)	0.012 (0.020)	
Observations	1,340,968	92,546	631,191	
2011-13 mean (age 64)	1.18	1.90	20.45	

*Notes:* This table presents estimated effects on two health outcomes—in-hospital mortality and share of stays/visits that were potentially avoidable—for elderly patients. Panels A and B present results for hospital stays and ER arrivals, respectively. The dependent variables are indicators for in-hospital death (Columns 1 and 2) and potentially avoidable stay/ER visit (Columns 3 and 4). Columns 1 and 3 use the entire sample, while columns 2 and 4 use only the sample of patients discharged with a non-discretionary condition. Intuitively, a negligible fraction of non-discretionary visits were tagged as potentially avoidable. The estimated change in discontinuity post-ACA is the coefficient on  $d_i \cdot T_t$  in equation 2b. All models control linearly for patient age, year fixed effects, and observable differences in patient sickness, i.e., diagnosis category and gender. Standard errors are clustered by day-of-age cell. Table B. 2 presents results on patient health at age 21 threshold.

TABLE A. 4: ROBUSTNESS CHECKS

	(1)	(2)	(3)	(4)	(5)	(6)
	<i>Payer share</i>					
	Medicaid	Private	Miscellaneous	Insured	County	Self-Pay
<b>Panel A: BW = 1 year</b>						
<b>A1. Main spec.</b>						
Age 64 * Post	8.66 (0.18)	-2.61 (0.24)	-0.09 (0.24)	5.95 (0.09)	-3.32 (0.05)	-2.64 (0.08)
<b>A2. Flexible spec.</b>						
Age 64 * Post	8.21 (0.35)	-3.16 (0.52)	0.49 (0.52)	5.55 (0.20)	-3.04 (0.12)	-2.51 (0.17)
2011-13 mean (Age 64)	18.87	43.01	30.02	91.90	3.56	4.54
Observations	558,220					
<b>Panel B: BW = 2 years</b>						
<b>B1. Main spec</b>						
Age 64 * Post	8.83 (0.13)	-2.37 (0.16)	-0.34 (0.17)	6.12 (0.06)	-3.42 (0.04)	-2.70 (0.05)
<b>B2. Flexible spec</b>						
Age 64 * Post	8.34 (0.25)	-2.70 (0.35)	0.14 (0.35)	5.78 (0.13)	-3.21 (0.08)	-2.57 (0.11)
2011-13 mean (Age 63-64)	19.34	42.72	29.69	91.74	3.67	4.59
Observations	1,132,896					

TABLE A. 4: ROBUSTNESS CHECKS (CONTD.)

	(1)	(2)	(3)	(4)	(5)	(6)
	<i>Utilization</i>		<i>Hospital choice</i>		<i>Health</i>	
	Stays	ER Arrivals	Govt.	For-Profit	RA Mort.	Mort (ND)
<b>Panel C: BW = 1 year</b>						
<b>C1. Main spec.</b>						
Age 64 * Post	8.17 (0.72)	12.80 (1.12)	-1.15 (0.16)	0.76 (0.19)	-2.23 (0.60)	-0.55 (0.32)
<b>C2. Flexible spec.</b>						
Age 64 * Post	8.72 (1.50)	17.74 (2.41)	-0.37 (0.34)	1.10 (0.40)	-2.26 (1.25)	-0.98 (0.69)
2011-13 mean (Age 64)	127	287	12.73	15.68	5.73	3.62
Observations		4,200	558,220	558,220	461,070	50,988
<b>Panel D: BW = 2 years</b>						
<b>D1. Main spec</b>						
Age 64 * Post	9.63 (0.53)	15.80 (0.79)	-1.46 (0.12)	0.78 (0.14)	-1.51 (0.41)	-0.21 (0.22)
<b>D2. Flexible spec</b>						
Age 64 * Post	9.00 (1.04)	12.69 (1.64)	-0.88 (0.24)	0.74 (0.27)	-3.23 (0.86)	-0.77 (0.46)
2011-13 mean (Age 63-64)	125	286	12.92	15.87	5.55	3.54
Observations		8,580	1,132,896	1,132,896	954,902	103,501

*Notes:* This table presents robustness checks of the main RD-DD results presented earlier. In the interest of brevity, we present results for key outcomes only. Panels A and B present results on changes in payer shares (Table 2), Panels C and D: Columns 1–2 present results on utilization (Table 3), Columns 3–5 present results on hospital choice (Table 4), and Column 6 presents results on in-hospital mortality for patients with non-discretionary conditions (Table A. 3). Within each panel, the top row presents estimates using the main specification which constrains slopes w.r.t. age to remain unchanged pre- and post-ACA. The bottom row in each panel presents results using a flexible specification allowing slopes w.r.t age to change post-ACA. Panels B and D are equivalent to panels A and C, respectively, except they use a larger sample with a 2-year bandwidth. The baseline estimates are available in the top row of Panels A and C. The estimated change in the discontinuity post-ACA is the coefficient on  $d_s \cdot T_t$  in equation 2b. All models also include a full set of year fixed effects. Panels C and D column 6 also include controls for observable differences in patient sickness, i.e., diagnosis category and gender. Standard errors are clustered by day-of-age cell.

TABLE A. 5: HOSPITAL FACTOR INPUTS

<i>Panel A: Labor inputs</i>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Payroll per bed (‘000 \$)	FT staff per bed	PT staff per bed	FTE per bed	FTE docs per bed	FTE nurses per bed	Pay per FTE (‘000 \$)
Uninsured * Post	-118.8 (75.2)	0.38 (0.75)	0.19 (0.33)	0.70 (0.66)	0.04 (0.12)	-0.31 (0.25)	-26.50 (10.2)
Observations	1,865	1,865	1,865	1,865	1,865	1,865	1,865
Dep. Var. mean (11-13)	376	4	2	5.0	0.1	1.5	81
<i>Panel B: Capital inputs</i>							
	Fixed assets per bed (‘000 \$)	Capital exp. per bed (‘000 \$)	Number of Beds				
Uninsured * Post	-332.78 (245.27)	29.3 (68.6)	-26.0 (40.2)				
Observations	1,923	1,923	1,923				
Dep. Var. mean (11-13)	517	82.0	234				

*Notes:* This table presents regression results examining effects on hospital factor inputs by exploiting baseline (2008–10) variation in hospitals’ uninsured patient shares, as discussed in Section IV.A. Coefficients presented are for the interaction of baseline uninsurance and an indicator for the post-ACA period in equation 3a. Panels A and B present estimated effects on labor and capital inputs, respectively. All dollar values are expressed in thousands deflated to 2016 using the CPI-U. We winsorize values for labor and capital variables at the 99<sup>th</sup> percentile. The bottom rows present the number of observations (about 320 hospitals x 6 years) and mean value of each dependent variable pre-ACA, i.e., 2011–13. Data on labor inputs was sourced from the American Hospital Association (AHA) survey, matched to about 310 of the 320 hospitals in the main sample. All models include a full set of hospital and year fixed effects. Hospital observations are weighted by their number of discharges in 2008–10. Standard errors are clustered by hospital. The weighted mean baseline share of uninsured patients across hospitals was 0.14.

TABLE A. 6: HOSPITAL FINANCES BY OWNER TYPE

	(1)	(2)	(3)	(4)	(5)
	Total rev. per bed (‘000 \$)	Medicaid per bed (‘000 \$)	Private per bed (‘000 \$)	All Other per bed (‘000 \$)	Net Medicaid per bed (‘000 \$)
<b><i>Panel A: Average Effects</i></b>					
Uninsured * Post	471.3 (198.0)	508.3 (147.8)	39.9 (89.1)	-77.0 (104.8)	317.7 (174.1)
<b><i>Panel B: Triple Difference</i></b>					
Uninsured * Post	1,024 (408.2)	533.9 (168.8)	265.6 (252.7)	224.1 (184.9)	366.2 (190.8)
Uninsured * Post * For-Profit	-1,428 (789.8)	-665.2 (290.0)	-371.0 (413.4)	-391.4 (338.9)	-510.0 (319.6)
Uninsured * Post * Govt	-356.4 (485.4)	-32.20 (299.2)	-56.3 (280.6)	-267.9 (239.0)	46.8 (336.3)
Observations	1,923	1,923	1,923	1,923	1,923
Dep. Var. mean (11-13)					
All hospitals	968	192	411	365	229
Non-profit	1154	206	543	406	243
For-profit	722	124	258	339	142
Government	797	259	254	284	322

TABLE A. 6: HOSPITAL FINANCES BY OWNER TYPE (CONTD.)

	(1)	(2)	(3)	(4)	(5)
	Inpatient Discharges per bed	Outpatient Visits per bed	Mean IP rev. per discharge (‘000 \$)	Mean OP rev. per visit (‘000 \$)	Op. margin per bed (‘000 \$)
<b>Panel C: Average Effects</b>					
Uninsured * Post	-5.8 (3.6)	-58.2 (132.8)	10.0 (3.4)	0.07 (0.2)	326.0 (133.2)
<b>Panel D: Triple Difference</b>					
Uninsured * Post	7.2 (6.5)	415.9 (229.6)	7.5 (5.9)	0.08 (0.3)	318.6 (149.4)
Uninsured * Post * For-Profit	-23.6 (23.9)	-525.9 (349.0)	-13.5 (8.6)	-0.61 (0.9)	-438.1 (185.5)
Uninsured * Post * Govt	-17.5 (9.6)	-577.2 (275.9)	8.3 (7.6)	0.13 (0.4)	45.9 (239.3)
Observations	1,923	1,923	1,923	1,845	1,923
Dep. Var. mean (11-13)					
All hospitals	36	645	18.7	0.8	39
Non-profit	41	767	17.5	0.8	56.2
For-profit	33	242	23.0	1.0	73.3
Government	28	914	15.6	0.5	-65.5

*Notes:* This table presents regression results examining effects on hospital finances by exploiting baseline (2008–10) variation in hospitals’ uninsured patient shares, as discussed in Section IV.A. Coefficients presented are for the interaction of baseline uninsurance and an indicator for the post-ACA period in equation 3a. Panels A and C reproduce the average effects for all hospitals first presented in Table 6, while Panels B and D present effects by hospital owner type, with non-profit hospitals forming the reference group. All revenue variables are expressed in thousands of dollars deflated to 2016 using the CPI-U. “Net Medicaid” refers to the sum of Medicaid, Self-pay, and County revenue. We winsorize values for revenue, volume, labor, and capital variables at the 99<sup>th</sup> percentile, and operating margin at the 1<sup>st</sup> and 99<sup>th</sup> percentile (more details in footnote 33). Operating margin is reported by hospitals to California as a percentage and is calculated as the ratio of the difference between operating revenue and costs over operating revenue. The bottom rows present the number of observations (about 320 hospitals x 6 years) and mean value of each dependent variable pre-ACA, i.e., 2011–13. 78 hospitals have no outpatient visits or revenue and hence drop out when examining mean revenue per outpatient visit. All models include a full set of hospital and year fixed effects. Hospital observations are weighted by their number of discharges in 2008–10. Standard errors are clustered by hospital. The weighted mean baseline share of uninsured patients across all hospitals was 0.14. It was 0.29, 0.09, and 0.11 at public, for-profit, and non-profit hospitals, respectively.

## Appendix B. RD-DD ANALYSIS FOR PATIENTS AGED 20-21

This section presents results obtained using a RD-DD research design on changes in payer mix, utilization, and health outcomes for patients aged 20-21 (henceforth, the young). The research design and estimation procedure are analogous to the approach used for elderly patients, as described in Section III.

Table B. 1 presents descriptive statistics on the hospital and ER discharge samples used. The samples were constructed using the same algorithm as for the sample of elderly patients (aged 64-65). This table follows the same format used in Table 1 Panel A. We observe about 150,000 (1.9 million) hospital stays (ER arrivals) for patients in this younger age group over 2011–16.

### A. Estimating equations

For the reader's convenience, we reproduce below the estimating equations 2a and 2b used to generate these results. Note that  $d_i$  is defined to take value one for patients aged 21,  $T_t$  takes value one for the years 2014–16. We report the reduced form coefficients  $\theta_{x2}$  in the figures and Table B. 2 below. The table also reports the IV coefficients obtained as  $\theta_{RD-DD} = \theta_{22}/\theta_{12}$  for each outcome of interest.

$$\text{Ins}_{it} = \alpha_{10} + \delta_{1t} + \theta_{11}d_i + \theta_{12}d_i \cdot T_t + \lambda_{11}\bar{a}_i + \lambda_{12}\bar{a}_i \cdot d_i + [\mathbf{X}'_i\psi_1 +] \epsilon_{1it}$$

$$Y_{it} = \alpha_{20} + \delta_{2t} + \theta_{21}d_i + \theta_{22}d_i \cdot T_t + \lambda_{21}\bar{a}_i + \lambda_{22}\bar{a}_i \cdot d_i + [\mathbf{X}'_i\psi_2 +] \epsilon_{2it}$$

### B. Payer mix

Figure B. 1 is identical in format to Figure 2 and summarizes changes in the share of insured hospital stays for patients aged 21, relative to those aged 20. The figure

indicates a large increase in the share of insured patients post-ACA. In contrast, there is a small decrease in the share insured in the falsification analysis. Table B. 2 columns 1–6 present reduced form coefficients on changes for different payers, obtained by estimating equation 2. Panel A presents results on payer shares, Panel B presents results on utilization, and Panel C presents results on health. Qualitatively, these results follow the same pattern as found in the case of elderly patients. The only deviation is that we find a small and statistically insignificant change in the share of privately insured patients.

### *C. Utilization*

Figure B. 2 presents corresponding plots on changes in the rate of use of hospital stays (panel a) and ER arrivals (panel b) per 1,000 population per year. These figures follow the same format as corresponding panels of Figure 3 in the main paper. The patterns are qualitatively similar to those for elderly patients, with sharp discontinuities exactly at the threshold. 21-year-old patients experience an increase in utilization relative to 20-year-old patients post-ACA. In case of ER arrivals, the base utilization rate was actually similar in the samples of young and elderly patients prior to the ACA (277 per 1,000 for young vs. 287 per 1,000 for the elderly, see respective summary statistics tables). Interestingly, the estimated effect on ER arrivals is also similar in magnitude—9.8 (12.8) per 1,000 for the young (elderly). Table B. 2 Panel B columns 1-2 present the corresponding regression coefficients.

Next, we investigate changes in hospital choice post-ACA. Consistent with our results for elderly patients, we find that utilization for young patients also shifted away from publicly-owned hospitals, and specifically toward for-profit hospitals. Figure B. 3a presents the corresponding figure, in which the discontinuity is plainly visible. Table B. 2 Panel B columns 4-6 present the corresponding regression coefficients. These results imply that for-profit owned hospitals gained

share from both government and non-profit hospitals, though the coefficient on the latter (not presented) is small and statistically insignificant. Relative to the base share of local hospitals, we find similar shifts in the young (1.5/20 ~ 7.5%) and elderly (1.2/12.7 ~ 9%) patient samples.

Are young patients also more likely to receive care at higher quality hospitals? Although our estimated point coefficient is negative—implying that patients are indeed receiving care at hospitals with lower mortality scores—the coefficient is not precisely estimated. Figure B. 3b presents the corresponding plot, and the patterns are quite diffuse. Table B. 2 Panel C presents the corresponding regression coefficient.

#### *D. Patient health outcomes*

Finally, we also examine the same two health outcomes that we studied in other sections of the paper—in-hospital mortality and the rate of potentially avoidable hospital stays. On both, we find small and statistically insignificant effects. Mortality is a very rare outcome for young patients, and may not be as sensitive to quality of care (for example, if it is largely due to accidents and trauma).

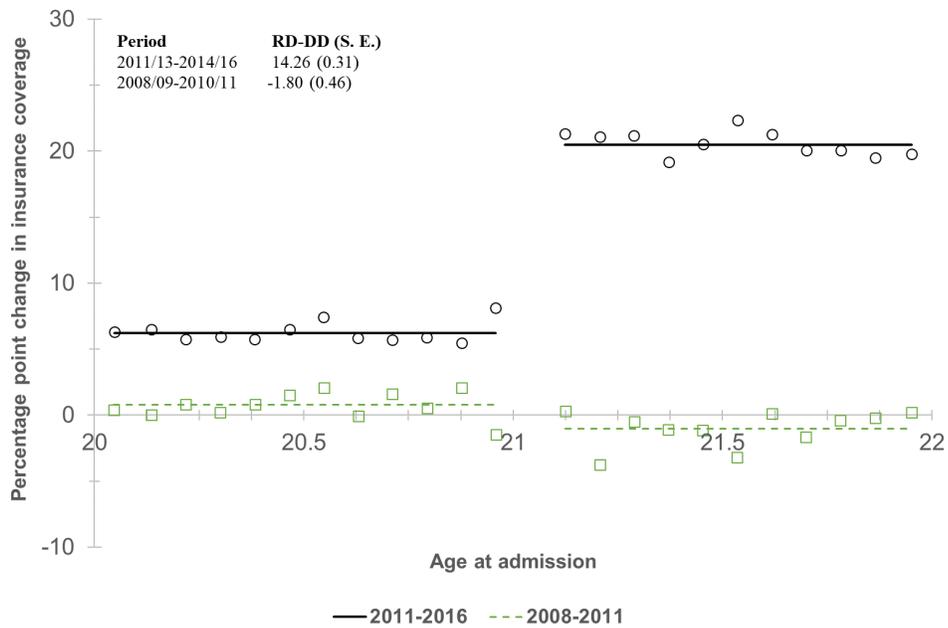


FIGURE B. 1: INSURANCE CHANGE

*Notes:* This figure presents the percentage point change in insurance coverage among hospital patients and corresponding fitted values by month-of-age. These were obtained by estimating equation 2a on discharge level data as described in Section III.A for the sample of patients aged 20-21. The treated groups are those aged 21. The figure presents results for 2011–16 (circles, solid line), and results from 2008–11 (squares, dashed line), which serves as a falsification exercise. The dependent variable—insurance coverage—is defined by the patient not being Self-pay or County indigent care and values are either 0 or 100. All models control linearly for age and include year fixed effects. To improve presentation, we collapse the data to month-of-age cells. We also note the estimated change in discontinuity, which is the coefficient on  $d_i \cdot T_t$  in Equation 2a. Standard errors are clustered by day-of-age cell. Figure 2 presents corresponding results for elderly patients.

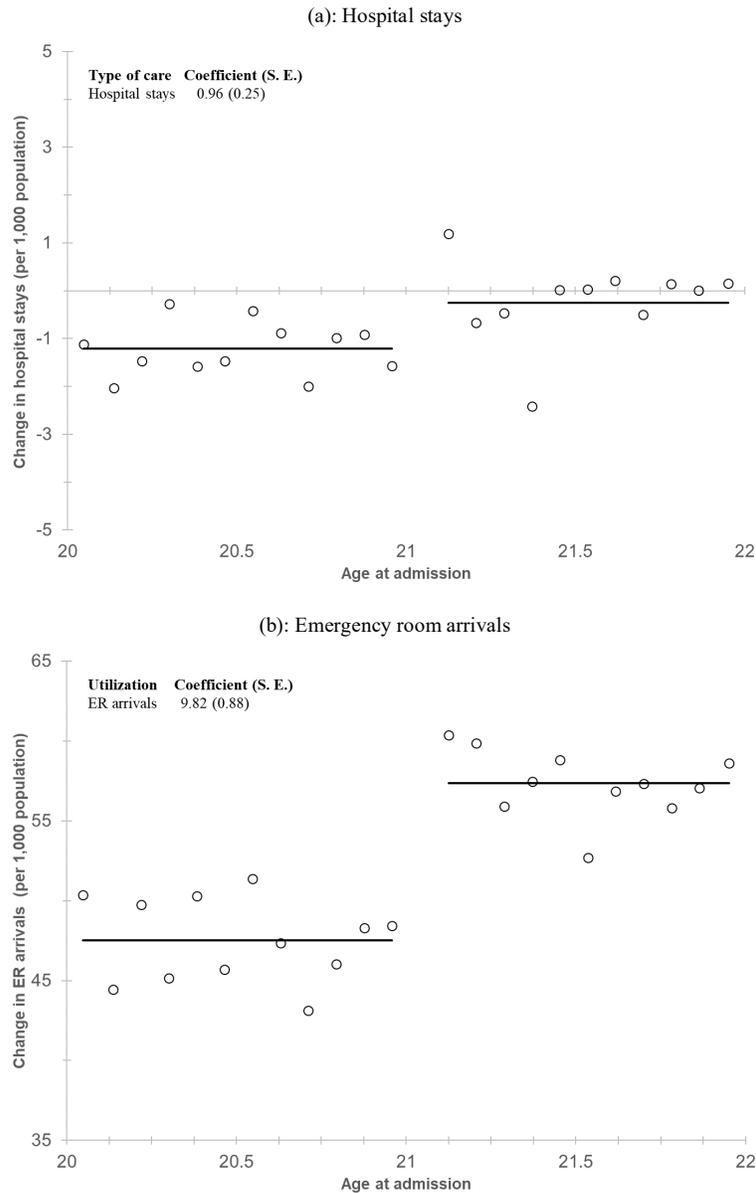


FIGURE B. 2: RATE OF UTILIZATION (PER 1,000 PEOPLE PER YEAR)

*Notes:* This figure presents the mean post-ACA change in number of hospital stays (Panel a) and ER arrivals (Panel b), i.e., including those patients who were eventually admitted as inpatients, per 1,000 CA residents in each month-of-age cell. Raw discharges were converted to utilization rates using California population estimates, obtained from the National Cancer Institute. The regressions were estimated on data at day-of-age - year level, but for presentation clarity we collapse data to month-of-age level. Patients aged 21 constitute the treated group. We also plot corresponding fitted values (dashed lines) obtained as described in Section III.C models control linearly for age and include a full set of year fixed effects. We also note the estimated change in discontinuity, which is the coefficient on  $d_i \cdot T_t$  in a collapsed version of equation 2b. Standard errors are clustered by day-of-age cell. Figure 3 presents corresponding results for elderly patients.

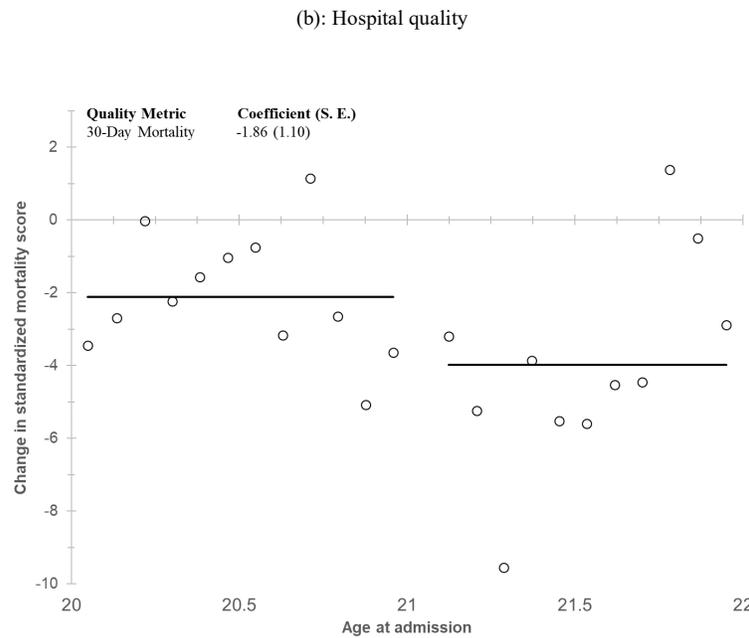
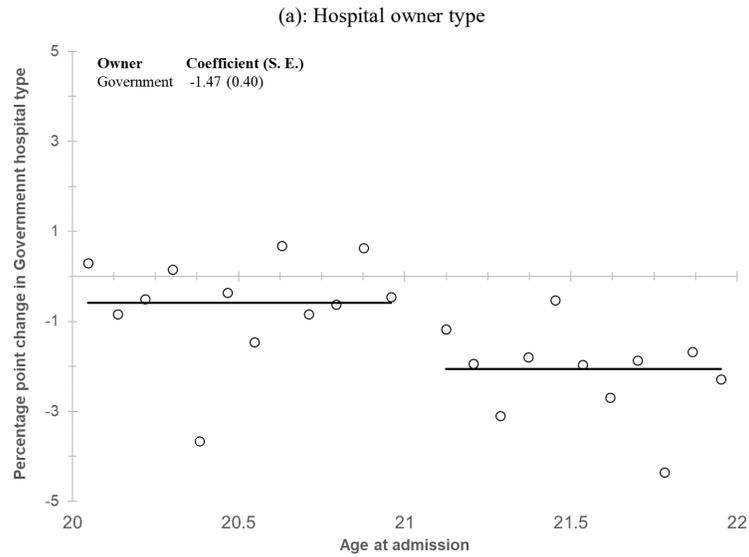


FIGURE B. 3: HOSPITAL CHOICE: OWNER TYPE AND QUALITY

*Notes:* This figure presents the post-ACA percentage point change in the percentage of hospital stays at government hospitals (Panel a) and in mean standardized mortality score for patients, a variable with mean 0 and SD of 100 (Panel b). We also plot fitted values obtained by estimating equation 2b on case level data as described in Section III.A. Patients aged 21 constitute the treated group. Regressions were estimated at the day-of-age - year level but for presentation clarity the data is collapsed to month-of-age level. Regressions control linearly for age and include year fixed effects. The estimated change in discontinuity, which is the coefficient on  $d_t \cdot T_t$  in 2b is also presented. Standard errors are clustered by day-of-age cell. Figure 4 presents corresponding results for elderly patients.

TABLE B. 1: DESCRIPTIVE STATISTICS

	Hospital stays		ER arrivals	
	2011-13	2014-16	2011-13	2014-16
All observations	78,386	71,766	928,441	1,040,696
Admitted through ER	53,984	49,946	N/A	N/A
Medicaid	34.0	51.1	28.0	46.4
Private	39.8	37.3	35.8	33.5
Uninsured	17.7	4.4	30.1	14.8
County	5.1	0.4	2.9	0.7
Self-pay	12.6	4.0	27.2	14.1
Utilization per 1,000 pop.	24	23	282	334
Government hospital	18.4	17.1	17.0	15.4
In-hospital mortality	0.6	0.6	0.1	0.1
In-hospital mortality (non-disc.)	1.2	1.1	0.4	0.3

*Notes:* This table presents descriptive statistics on the RD-DD sample of young patients aged 20-21. It follows the same format as Table 1 Panel A does for elderly patients. Fraction uninsured includes patients coded as Self-pay or County indigent coverage. ER arrivals include ER visits and hospital stays that originated in the ER. To calculate utilization, we normalize number of annual stays/ER arrivals by the population in relevant age-year cell obtained from the National Cancer Institute, hence these are measures of utilization per 1,000 people per year. Government hospitals include city, county, and district but not federally owned hospitals. We present in-hospital mortality for the full sample as well as for the sample of patients discharged with non-discretionary cases (i.e., conditions like heart attack, fractures, etc.), for which patients cannot avoid hospital care.

TABLE B. 2: RD-DD RESULTS FOR YOUNG PATIENTS

	(1)	(2)	(3)	(4)	(5)	(6)
<b>Panel A: Payer shares</b>	Medicaid	Private	Misc	Insured	County	Self-Pay
Age 21 * Post	15.77 (0.50)	-0.01 (0.50)	-1.50 (0.28)	14.26 (0.31)	-7.93 (0.16)	-6.33 (0.28)
2011-13 mean (Age 21)	26.95	39.75	7.89	74.59	9.15	16.27
Observations			150,152			
<b>Panel B: Utilization</b>	Stays	ER arrivals		Govt.	For-Profit	RA Mort.
Age 21 * Post	0.96 (0.25)	9.82 (0.88)		-1.47 (0.40)	1.66 (0.38)	-1.86 (1.10)
IV estimate	0.07 (0.02)	0.96 (0.09)		-0.10 (0.03)	0.12 (0.03)	-0.12 (0.07)
2011-13 mean (Age 21)	24	277		19.68	14.40	8.73
Observations		4,200		150,152	150,152	127,518
<b>Panel C: Health</b>	Mortality	PAH				
Age 21 * Post	-0.02 (0.08)	0.34 (0.78)				
IV estimate	-0.001 (0.006)	0.032 (0.039)				
2011-13 mean (Age 21)	0.65	22.41				
Observations	150,152	51,656				

*Notes:* This table summarizes regression results on all key outcomes for young patients using the RD-DD analysis. Panel A presents results on changes in payer shares, Panel B columns 1–2 present results on utilization, Panel B columns 4–6 present results on hospital choice, and Panel C columns 1–2 present results on patient health. Coefficients presented are on the interaction of indicator for being aged 21 and post-ACA period in equation 2b and the corresponding IV estimate. These estimates replicate the same approach as used for results presented for elderly patients in Table 2 (payer share), Table 3 (utilization), Table 4 (hospital choice), and Table A. 3 (health outcomes). All models control linearly for age and include a full set of year fixed effects. Standard errors are clustered by day-of-age cell.

## Appendix C. ANALYSIS USING PATIENTS AGED 21–64

This section describes a supplementary analysis on the same outcomes investigated in the RD-DD analysis, but utilizing the entire sample of non-elderly adults and exploiting a different source of variation.

### A. Empirical strategy

We deploy a differences-in-differences research design exploiting cross-sectional variation in poverty rates (the share of the population below 125% of the federal poverty level) across HSAs in 2007–11. High-poverty areas would, all else equal, have a higher share of individuals directly affected by the ACA’s Medicaid expansion, which covered individuals with family incomes up to 133 percent of the federal poverty line. We use data from the ACS 2007–11 5-year estimates to calculate the poverty variation just prior to the ACA. Figure C. 1 presents a histogram of the estimated poverty rates among non-elderly adults across HSAs. There was substantial variation in poverty—the difference in poverty between the top and bottom quintile markets was 18%. In addition, we leverage within-HSA time-series variation created due to the implementation of the ACA in 2014. We estimate econometric models at the HSA-year level, presented in equation 4a.

$$(4a) \quad Y_{jt} = \alpha_j + \gamma_t + \xi \cdot Poverty\ rate_j \cdot T_t + [X'_{jt}\psi +] \epsilon_{ijt}$$

$Y_{jt}$  is the mean outcome value for HSA  $j$  in year  $t$ .  $T_t$  is an indicator that turns on in 2014. The coefficient of interest is  $\xi$ , which estimates the change in outcome  $Y$  post-ACA (2014–16) versus pre-ACA (2011–13) for a market with a baseline poverty rate of one hundred percent compared to a market with no poverty. We maintain the sample period 2011–16 in order to be consistent with the RD-DD analysis. We include a full set of HSA and year fixed effects,  $\alpha_j$  and  $\gamma_t$ ,

respectively. Some specifications account for observable differences in patient characteristics (age group, gender, and category of principal diagnosis) by including vector  $\mathbf{X}_{jt}$ . To mitigate the influence of small outlier units, we weight each HSA by pre-ACA non-elderly population estimates obtained from the ACS.

Identification of the causal effect of the ACA relies on the standard parallel trends assumption, i.e., outcomes for HSA markets at different poverty levels would evolve along similar paths in the absence of the ACA. To assess the validity of this assumption, we estimate and present results from models allowing effects  $\xi_s$  to vary flexibly by year from 2011 through 2016, omitting 2013 as the reference year, as depicted in equation 4b.

$$(4b) \quad Y_{jt} = \alpha_j + \gamma_t + \sum_{\substack{s=2011, \\ \neq 2013}}^{s=2016} \xi_s \cdot \text{Poverty rate}_j \cdot I(t = s) + \epsilon_{jt}$$

Note that this approach uses a different source of identifying variation relative to the RD-DD analysis. Estimates from the geographic analysis inform us about changes for patients residing in high poverty areas *relative* to changes for patients of the same age group living in more affluent markets.

### B. Hospital payer share

Figure C. 2a plots event studies of changes in Medicaid and Self-pay, using coefficients from equation 4b. It shows there were no differential pre-trends across markets, providing reassuring support for the identification assumption. Table C. 1 Panel A columns 1–6 present point estimates on changes in payer shares for hospital stays. These results lead to similar conclusions as in the RD-DD approach. First, there was a large increase in insurance coverage, driven primarily by Medicaid. The mean poverty rate in the pre-ACA period was 18%, hence the coefficient of 29

implies an average increase in Medicaid coverage of 5.2 percentage points ( $29 \times 0.18$ ). Correspondingly, the results imply an average increase of 4.8 pp in the share of insured patients ( $26.4 \times 0.18$ ), which would entirely eliminate the pre-ACA disparity in coverage between patients from the least and most affluent market quintiles (-4.7 pp). In contrast, we estimate a small and statistically insignificant increase in private coverage, implying an increase of 0.6 percentage points ( $3.4 \times 0.18$ ) on average. In fact, we can rule out an increase of greater than 1.5 pp ( $8 \times 0.18$ ) in private coverage, relatively small compared to the mean level.

Second, about 40% of the increase in Medicaid offsets the decline of County indigent programs, strikingly similar to the estimate in the RD-DD approach. We estimate a larger decline in Self-pay relative to the RD-DD analysis (nearly 50% vs. 30% of the estimated increase in Medicaid). These proportions remain relatively similar when we focus on the non-discretionary sample (see **Error! Reference source not found.**).

### *C. Utilization (volume and hospital choice)*

Table C. 1 Panel B columns 1–6 present estimated effects on hospital volume. Unlike in the RD-DD analysis, we are unable to normalize the raw discharges by HSA-year population estimates since we do not have annual estimates of population by HSA. However, the concern of spurious results due to the baby boom is diminished in this case since the variation in age profile across markets is likely very small relative to the variation in baseline poverty across markets. The estimates imply that aggregate hospital stays and ER arrivals increased by 4-5% on average ( $0.2 \times 0.18$ ,  $0.25 \times 0.18$ ). These estimates imply that 64-year-olds experienced an increase in utilization (discussed in the previous section) that was only slightly greater than that for all non-elderly adults (6% vs. 4%). Figure C. 2b presents the corresponding event study plot and indicates a sharp

increase in volume in 2014, followed by further increases in subsequent years. The plot suggests no differential trends in utilization across markets as a function of poverty rates prior to the ACA.

Table C. 1 Panel C columns 1–3 present corresponding results on changes in hospital shares, by owner type. The point estimates indicate a decline in the share of public hospitals (0.7 pp, relative to 1.1 pp estimated for 64-year-old patients). In a departure from the RD-DD estimates, we find that volume shifted away from both public and for-profit hospitals and moved toward non-profit facilities. Figure C. 2c presents the corresponding event study plot on the share of hospital stays at private hospitals. It shows a slight increase post-ACA, with an upward trend. However, these point estimates are statistically insignificant, implying these shifts were sharper for the near-elderly. The estimated effects on mean hospital quality (Cols. 4-5) are particularly noisy. This could partly reflect the limited relevance of these quality metrics for younger patients.

#### *D. Health*

Table C. 1 Panel D column 1 presents the estimated effect on in-hospital mortality for the non-elderly patient group. Again, we primarily focus on effects for the subset of patients discharged with a non-discretionary condition (Table C. 2). The results are suggestive of mortality reductions in areas with larger increases in coverage, though the point estimate is not statistically significant, as in the RD-DD analysis. The estimate implies an average decrease in mortality of 0.14 pp ( $0.76 \times 0.18$ ), sufficient to eliminate a quarter of the pre-ACA mortality gap between the poorest and most affluent market quintiles (0.48 pp).

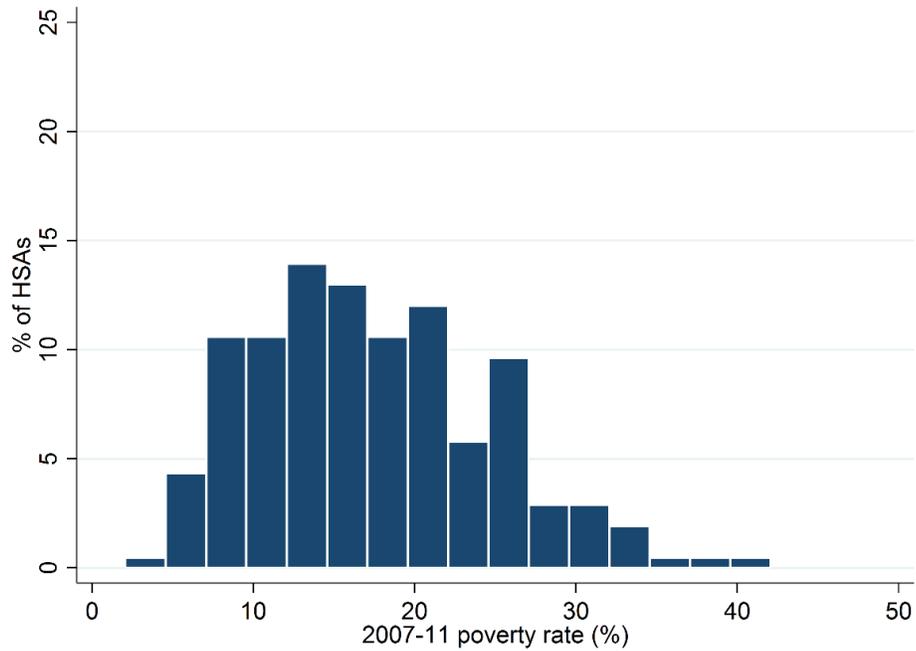


FIGURE C. 1: DISTRIBUTION OF POVERTY RATES ACROSS HOSPITAL SERVICE AREAS

*Notes:* This figure presents a histogram of poverty percentage across Hospital Service Areas (HSAs). Poverty share is defined as the share of population < 125% of federal poverty level, as estimated by the 2007–11 five-year American Community Survey. There are 209 HSAs in California, and they are defined to approximate local markets for hospital care and typically contain only one hospital. For more details on HSAs refer to <http://www.dartmouthatlas.org/tools/faq/researchmethods.aspx>. The San Francisco bay area has a disproportionate concentration of low poverty markets, for example, San Ramon (2%), Pleasanton (5%), Walnut Creek (6%), Burlingame, San Mateo and Fremont (7%), Mountain View and Livermore (8%). High poverty markets are distributed across the state with some concentration in central California along Interstate 5—Lindsay (41%), Delano (38%), Corcoran (35%), Lake Isabella (33%), Dinuba, Porterville (31%), and Merced (27%). The difference in poverty rates across HSAs was 18.3 between the least and most affluent quintiles, and coincidentally the mean across markets was also 18.4. We exploit this variation in poverty across markets to identify the effects of the ACA on non-elderly adult hospital use.

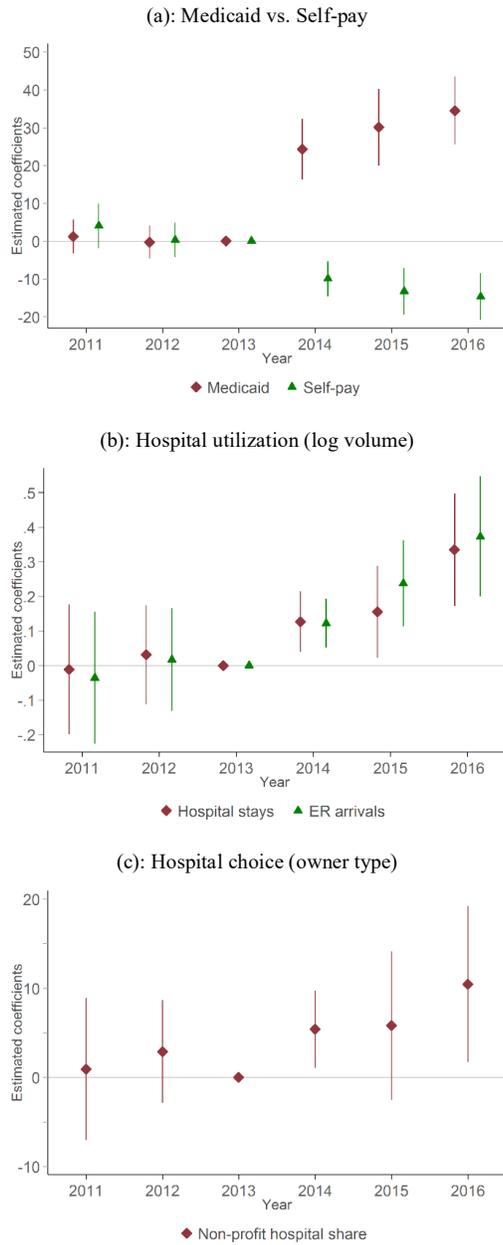


FIGURE C. 2: RESULTS USING POVERTY VARIATION

*Notes:* This figure presents event studies from the geographic analysis. Each panel plots coefficients on the interaction of  $Pov_j$  and indicator for each year  $s$  from 2011–16 (relative to 2013), obtained by estimating equation 4b with Medicaid or Self-pay status (Panel a), log of stays or ER arrivals (Panel b), and share of stays at non-profit hospitals (Panel c) as outcome variables. Bars indicate confidence intervals at the 95% level.  $Pov_j$  is the estimated share of people in HSA  $j$  with income below 125% of the federal poverty level as reported by the ACS 2007–11 5-year estimates. These models are estimated using data from the sample of all patients aged 21–64 over 2011–16, about 7.5 million stays and 40.3 million ER arrivals. All models are estimated with data collapsed to the HSA-year level and include HSA and year fixed effects. HSAs are weighted by pre-ACA non-elderly population. Mean poverty rate was 0.183.

TABLE C. I: ESTIMATED EFFECTS ON FULL SAMPLE

	(1)	(2)	(3)	(4)	(5)	(6)
<b>Panel A: Payer share</b>	Medicaid	Private	Misc.	Insured	Self	County
Pov. rate * Post	29.33 (4.21)	3.39 (3.88)	-6.35 (4.31)	26.37 (4.82)	-14.08 (2.19)	-12.29 (4.47)
Mean value (2011-13)	24.03	40.74	21.04	85.82	8.43	5.75
<b>Panel B: Utilization</b>	All stays	Medicaid	Private	Self	County	ER arrivals
Pov. rate * Post	785 (313.1)	3,529 (1,994.9)	155 (258.0)	-1,305 (770.1)	-1,195 (656.7)	17,047 (8,937)
Mean value (2011-13)	6,047	1,528	2353	518	352	29,632
<b>Panel C: Hospital choice</b>	Govt.	Non-profit	For-profit	Adj. Mort	Adj. Readm	
Pov. rate * Post	-3.54 (3.14)	5.90 (4.25)	-2.36 (2.84)	4.41 (11.47)	1.68 (4.91)	
Mean value (2011-13)	15.6	68.0	16.4	1.95	-1.99	
<b>Panel D: Health</b>	(1) Mortality	(2) Health Outcomes PAH				
Pov. rate * Post	-0.29 (0.20)	-1.69 (1.20)				
Mean value (2011-13)	1.60	17.89				

*Notes:* This table presents results from the geographic analysis exploiting the variation in poverty rate across hospital service markets (HSAs). This table provides estimates on all key outcomes discussed in the paper, in each case presenting the DD coefficient on the interaction of *poverty rate* ·  $T_t$  from Equation 4a, where poverty rate is the share of non-elderly population below 125% of federal poverty level as reported by 2007–11 ACS 5-year estimates. There are approximately 7.5 million stays and 40.3 million ER arrivals, collapsed to the HSA-year level (209 HSAs x 6 years). The volume regressions use numbers of discharges as the outcome. All models include a full set of HSA and year fixed effects. HSAs are weighted by pre-ACA non-elderly population. Standard errors are clustered by HSA. The bottom row in each panel presents the pre-ACA mean values for outcomes. The difference in poverty rates between top and bottom quintile HSAs was 0.183, and coincidentally the mean was 0.184.

TABLE C. 2: ESTIMATED EFFECTS ON NON-DISCRETIONARY SAMPLE

	(1)	(2)	(3)	(4)	(5)	(6)
<b>Panel A: Payer share</b>	Medicaid	Private	Misc.	Insured	Self	County
Pov. rate * Post	51.55 (5.74)	3.92 (2.96)	-9.01 (4.09)	46.46 (4.93)	-28.38 (4.62)	-18.08 (5.06)
Mean value (2011-13)	18.32	44	16.61	78.93	14.07	7
<b>Panel B: Utilization</b>	All stays	Medicaid	Private	Self	County	ER arrivals
Pov. rate * Post	118 (46.0)	443 (270.5)	72 (35.1)	-208 (135.1)	-143 (88.1)	581 (258)
Mean value (2011-13)	644	122	275	91	46	1,714
<b>Panel C: Hospital choice</b>	(1) Govt.	(2) Non-profit	(3) For-profit	(4) Adj. Mort	(5) Adj. Readm	
Pov. rate * Post	0.79 (4.78)	0.55 (5.28)	-1.34 (2.56)	-4.15 (9.50)	-8.56 (5.87)	
Mean value (2011-13)	16.6	68.8	14.6	5.27	-2.92	
<b>Panel D: Health</b>	(1) Mortality					
Pov. rate * Post	-0.76 (0.63)					
Mean value (2011-13)	2.22					

*Notes:* This table presents results exploiting variation in poverty across hospital markets, limiting the sample to Non-Discretionary cases among the 21–64 non-elderly adult sample. The format of the table is identical to that used for Table C. 1. There are approximately 0.8 million hospital stays and 2.2 million ER arrivals, collapsed to the HSA-year level (209 HSAs x 6 years). These cases were identified using ICD-9/10 diagnosis codes, following Garthwaite et al. (2017). The volume regressions use number of discharges as the outcome. Since these cases are highly acute and urgent, there are virtually no “potentially avoidable” cases in this sample. All models include a full set of HSA and year fixed effects. HSAs are weighted by pre-ACA non-elderly population. Standard errors are clustered by HSA. The bottom row in each panel presents the pre-ACA mean values for outcomes. The difference in poverty rates between top and bottom quintile HSAs was 0.183, and coincidentally the mean across all markets was 0.184.