Supplemental Appendix for

Association Between Medicaid Expansion Under the Affordable Care Act and Preemptive Listings for Kidney Transplantation.

Table of Contents

Supplemental Methods

Test of Parallel Trends Assumption

Our difference-in-differences specification relies upon the assumption that there are parallel trends in the outcomes, across Medicaid expansion status. In other words, had the ACA not occurred, we would have expected the outcome measures to evolve similarly across early-expansion states, expansion states, and non-expansion states. As a robustness check, we tested the assumption of parallel trends in the outcome prior to full implementation of the ACA (2011-2013), by testing for preexisting trends in the outcomes, as in Wherry and Miller (2016)[1]. To do this, we grouped states by their expansion status (early-expansion [adopted 2011-2013], expansion [adopted 2014], non-expansion) and partitioned the data to the years prior to full implementation of the ACA (2011-2013). We then interacted expansion status (non-adopters are the reference) and quarter-year indicator variables (Q4 of 2013 is the reference). If there were no differential trends in the pre-ACA period, then the estimated coefficients on the interaction terms should not be statistically significantly different from zero. For all coefficients, we failed to reject the null hypothesis that they were significantly different from zero. We then conducted a Wald test of joint significance of the interaction terms and were unable to reject the null hypotheses that the coefficients were not jointly significantly different from zero. This was repeated using expansion states as the reference category, and no statistically significant differences in trends were observed. Thus, we collapsed the early-expansion and expansion states into one category for the main analyses in the manuscript.

Methods for making Figures 2-4, and Supplementary Figures 1-7

All figures display results from race-adjusted multinomial logistic regression models for insurance type used to attain preemptive listing. We used marginal standardization to calculate the adjusted proportions (predicted probabilities) of each type of insurance coverage (i.e.,

Medicaid, Medicare, and Private) in each year/quarter of the study period using the `margins` package in STATA, with confidence intervals estimated using the delta method.[2] In figure 2 and supplementary figures 1, 2, and 7, calendar dates are used to display trends in the adjusted proportions of each insurance type over time. In figure 4 and supplementary figures 3-6, to account for different dates of full implementation of Medicaid expansion among seven late expansion states, we standardized the date of full implementation and display results as a function of the number of quarters (3-month periods) before and after the calendar date of full implementation specific to each state.[3] The unadjusted proportions for each quarter would be calculated as:

$$\frac{Number\ of\ individuals\ listed\ between\ the\ start\ and\ end\ of\ the\ quarter\ with\ insurance\ coverage\ x}{Total\ number\ of\ individuals\ listed\ between\ the\ start\ and\ end\ of\ the\ quarter\ with\ all\ insurance\ types}$$

Thus, each figure shows changes in the proportion of insurance types used to attain preemptive listings over the course of the study period.

Supplementary Table 1. State Timelines of Medicaid Expansion under the Affordable Care Act[4]

Early Expansion States[1] 2010-2013	Expansion States January 1, 2014[2]	Late Expansion States (Date of Implementation)	Non-Expansion States
California Connecticut District of Columbia Minnesota New Jersey Washington	Arizona Arkansas Colorado Delaware Hawaii Illinois Iowa Kentucky Maryland Massachusetts Nevada New Mexico New York North Dakota Ohio Oregon Rhode Island Vermont West Virginia	Michigan (4/1/14) New Hampshire (8/15/14) Indiana (2/1/15) Pennsylvania (1/1/15) Alaska (9/1/15) Montana (1/1/16) Louisiana (7/1/16)	Alabama Florida Georgia Idaho Kansas Maine[3] Mississippi Missouri Nebraska North Carolina Oklahoma South Carolina South Dakota Tennessee Texas Utah Virginia Wisconsin Wyoming

[1] States that partially implemented Medicaid expansion under the Affordable Care Act between January 1, 2010-December 31, 2013.
[2] Early expansion states also fully implemented Medicaid expansion under the Affordable Care Act on January 1, 2014.
[3] Adopted expansion November 2017, not yet implemented.

Supplementary Table 2. Comparison of Characteristics among Preemptive Listings in Non-Expansion, Expansion, and Late-Expansion States

	Pre-Expansion January 1, 2011-December 31, 2013				Post-Expansion January 1, 2014-December 31, 2016			
	Non-Expansion States N=8427	Expansion on 1/1/14 N=15525	Expansion after 1/1/14 N=3847	p-value[1]	Non-Expansion States N=9702	Expansion on 1/1/14 N=17145	Expansion after 1/1/14 N=4460	p-value[1]
Age (Years)	55.0 (44.0, 63.0)	55.0 (45.0, 63.0)	55.0 (45.0, 63.0)	<0.001	54.0 (44.0, 63.0)	55.0 (45.0, 63.0)	56.0 (45.0, 64.0)	<0.001
Race/Ethnicity				<0.001				<0.001
White	5372 (63.7%)	9090 (58.6%)	2770 (72.0%)		5911 (60.9%)	9697 (56.6%)	3127 (70.1%)	
Black	1910 (22.7%)	2551 (16.4%)	823 (21.4%)		2192 (22.6%)	2794 (16.3%)	993 (22.3%)	
Hispanic	775 (9.2%)	1998 (12.9%)	110 (2.9%)		1017 (10.5%)	2358 (13.8%)	142 (3.2%)	
Other	370 (4.4%)	1886 (12.1%)	144 (3.7%)		582 (6.0%)	2296 (13.4%)	198 (4.4%)	
Male Sex	4730 (56.1%)	8964 (57.7%)	2216 (57.6%)	0.049	5399 (55.6%)	9975 (58.2%)	2597 (58.2%)	<0.001
BMI (kg/m^2)	28.8 (25.1, 32.9)	28.4 (24.8, 32.5)	29.0 (25.1, 33.5)	<0.001	28.7 (25.1, 32.7)	28.4 (24.7, 32.6)	29.4 (25.4, 33.6)	<0.001
Diabetes Status				0.034				<0.001
Non-Diabetic	5607 (66.5%)	10088 (65.0%)	2490 (64.7%)		6489 (66.9%)	11052 (64.5%)	2811 (63.0%)	
Diabetic	2810 (33.3%)	5417 (34.9%)	1352 (35.1%)		3208 (33.1%)	6088 (35.5%)	1645 (36.9%)	
Unknown	10 (0.1%)	20 (0.1%)	5 (0.1%)		5 (0.1%)	5 (<1%)	4 (0.1%)	
US Citizen	8259 (98.0%)	14785 (95.2%)	3798 (98.7%)	<0.001	9413 (97.0%)	16071 (93.7%)	4399 (98.6%)	<0.001
Education				<0.001				<0.001
< High School	223 (2.6%)	635 (4.1%)	60 (1.6%)		220 (2.3%)	706 (4.1%)	85 (1.9%)	
High School Graduate	4943 (58.7%)	8741 (56.3%)	2537 (65.9%)		5272 (54.3%)	9456 (55.2%)	2766 (62.0%)	
≥ College Graduate	2995 (35.5%)	5646 (36.4%)	1139 (29.6%)		3759 (38.7%)	6664 (38.9%)	1506 (33.8%)	
Unknown	266 (3.2%)	503 (3.2%)	111 (2.9%)		451 (4.6%)	319 (1.9%)	103 (2.3%)	
Insurance Type				<0.001				<0.001
Medicare	2448 (29.0%)	3961 (25.5%)	1106 (28.7%)		2700 (27.8%)	4415 (25.8%)	1285 (28.8%)	
Medicaid	325 (3.9%)	1094 (7.0%)	240 (6.2%)		356 (3.7%)	1737 (10.1%)	349 (7.8%)	
Private	5654 (67.1%)	10470 (67.4%)	2501 (65.0%)		6646 (68.5%)	10993 (64.1%)	2826 (63.4%)	
Prior Transplant	1116 (13.2%)	2056 (13.2%)	566 (14.7%)	0.046	247 (2.5%)	329 (1.9%)	30 (0.7%)	<0.001

Independent Function[2]				<0.001	247 (2.5%)	329 (1.9%)	30 (0.7%)	
No	1842 (21.9%)	2372 (15.3%)	755 (19.6%)					0.92
Yes	6465 (76.7%)	12508 (80.6%)	3069 (79.8%)		8517 (87.8%)	15023 (87.6%)	3908 (87.6%)	
Unknown	120 (1.4%)	645 (4.2%)	23 (0.6%)		1185 (12.2%)	2122 (12.4%)	552 (12.4%)	
Employed				<0.001				<0.001
No	3815 (45.3%)	7387 (47.6%)	1887 (49.1%)		4239 (43.7%)	7914 (46.2%)	2180 (48.9%)	
Yes	4405 (52.3%)	7884 (50.8%)	1811 (47.1%)		5270 (54.3%)	9061 (52.8%)	2201 (49.3%)	
Unknown	207 (2.5%)	254 (1.6%)	149 (3.9%)		193 (2.0%)	170 (1.0%)	79 (1.8%)	

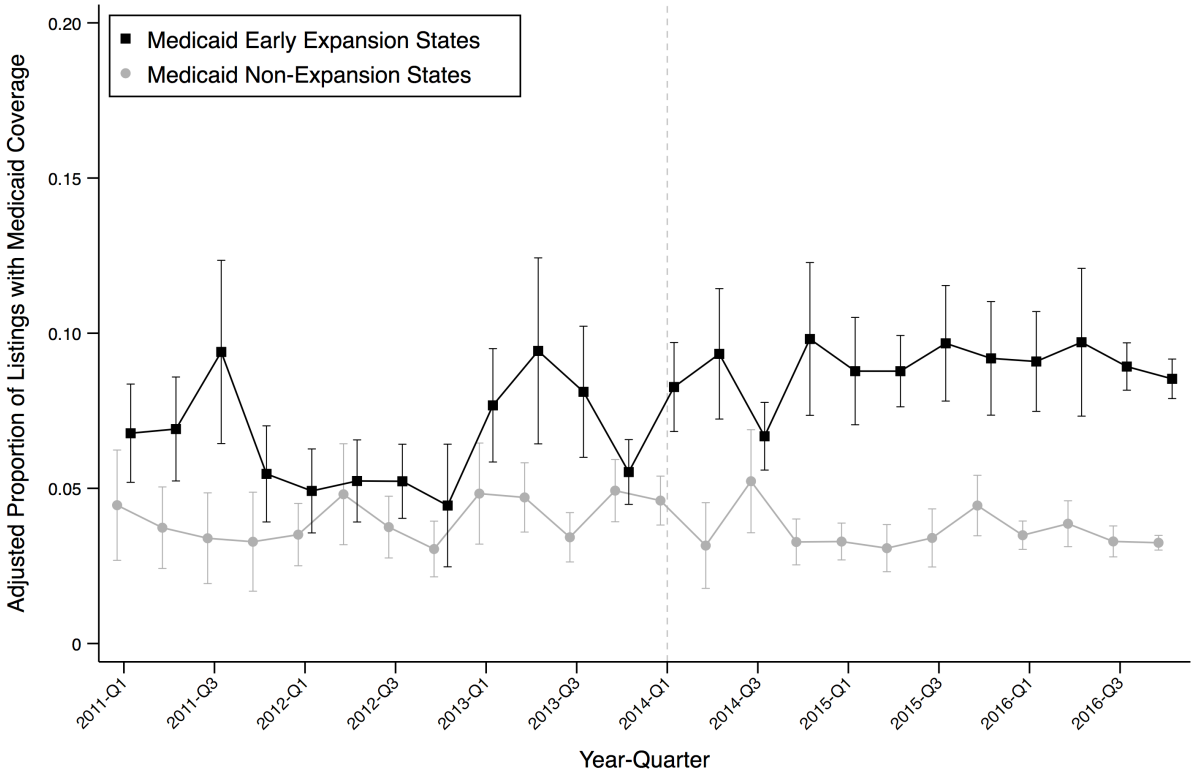
Values presented as median (interquartile range) and n (%)
Abbreviations: BMI-Body Mass Index, k—kg; m—meters
[1] *p*-values from χ^2 and Kruskal-Wallis Tests, as appropriate
[2] Defined as Karnofsky Performance Status Scale ≥ 80%[5]

Supplementary Table 3. Characteristics of Individuals Listed Between January 1, 2011-December 31, 2013 in Non-Expansion, Partial Implementation/Early Expansion States[6], Expansion States, and Late-Expansion States

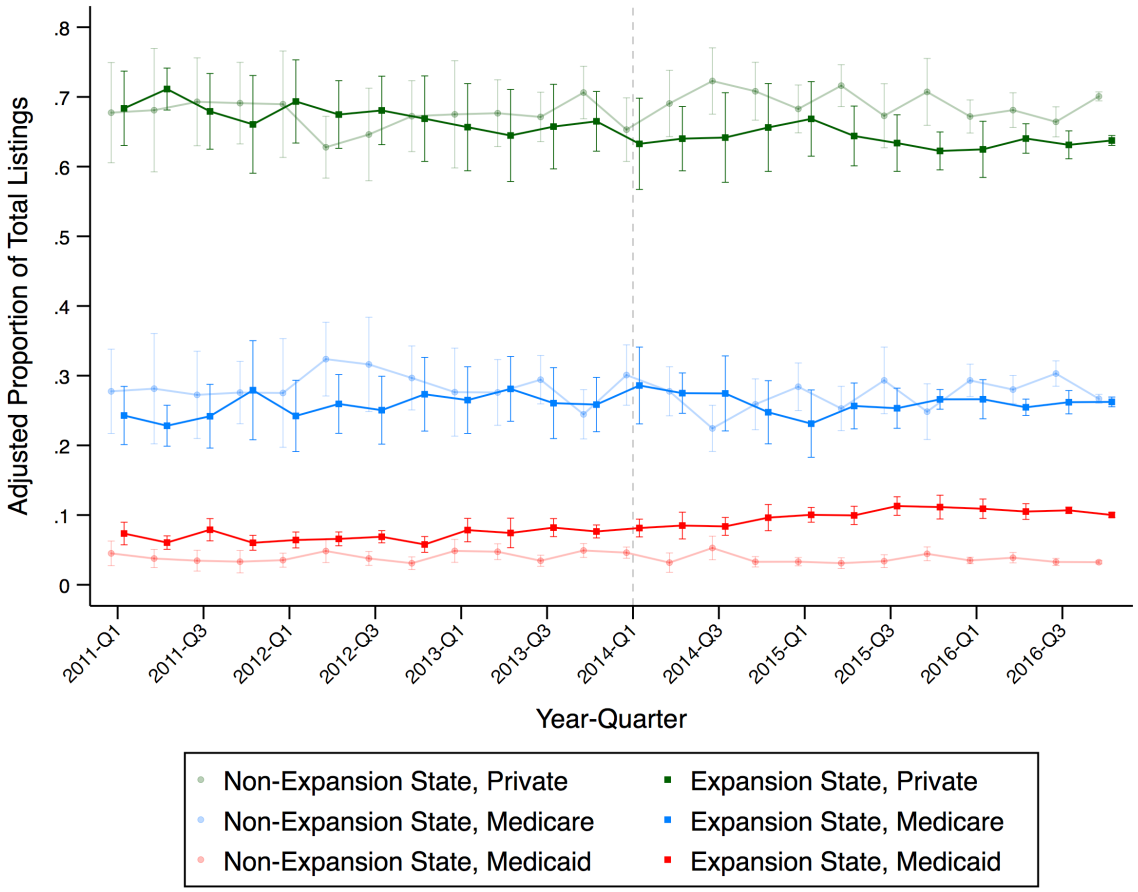
	Non-Expansion States (n=19) N=8487	Early Expansion States (n=5+DC) N=6197	Expansion on 1/1/14 (n=19) N=9328	Late Expansion States (n=7) N=3847	p-value[1]
Age	55.0 (44.0, 63.0)	55.0 (45.0, 64.0)	55.0 (46.0, 63.0)	55.0 (45.0, 63.0)	<0.001
Race/Ethnicity					<0.001
White	5429 (64.0%)	3333 (53.8%)	5757 (61.7%)	2770 (72.0%)	
Black	1910 (22.5%)	790 (12.7%)	1761 (18.9%)	823 (21.4%)	
Hispanic	775 (9.1%)	936 (15.1%)	1062 (11.4%)	110 (2.9%)	
Other	373 (4.4%)	1138 (18.4%)	748 (8.0%)	144 (3.7%)	
Male Sex	4762 (56.1%)	3590 (57.9%)	5374 (57.6%)	2216 (57.6%)	0.095
BMI (kg/m^2)	28.8 (25.1, 32.9)	28.0 (24.4, 31.9)	28.7 (25.0, 32.9)	29.0 (25.1, 33.5)	<0.001
Diabetes Status					0.093
Non-Diabetic	5651 (66.6%)	4016 (64.8%)	6072 (65.1%)	2490 (64.7%)	
Diabetic	2826 (33.3%)	2177 (35.1%)	3240 (34.7%)	1352 (35.1%)	
Missing	10 (0.1%)	4 (0.1%)	16 (0.2%)	5 (0.1%)	
US Citizen	8319 (98.0%)	5855 (94.5%)	8930 (95.7%)	3798 (98.7%)	<0.001
Education					<0.001
<High School	226 (2.7%)	251 (4.1%)	384 (4.1%)	60 (1.6%)	
High School	4971 (58.6%)	3412 (55.1%)	5329 (57.1%)	2537 (65.9%)	
≥ College Graduate	3020 (35.6%)	2255 (36.4%)	3391 (36.4%)	1139 (29.6%)	
Missing	270 (3.2%)	279 (4.5%)	224 (2.4%)	111 (2.9%)	
insurance					<0.001
Medicare	2463 (29.0%)	1382 (22.3%)	2579 (27.6%)	1106 (28.7%)	
Medicaid	330 (3.9%)	409 (6.6%)	685 (7.3%)	240 (6.2%)	
Private	5694 (67.1%)	4406 (71.1%)	6064 (65.0%)	2501 (65.0%)	
Prior Transplant	1121 (13.2%)	849 (13.7%)	1207 (12.9%)	566 (14.7%)	0.044
Independent Function[2]					<0.001
No	1849 (21.8%)	819 (13.2%)	1553 (16.6%)	755 (19.6%)	
Yes	6515 (76.8%)	4881 (78.8%)	7627 (81.8%)	3069 (79.8%)	
Unknown	123 (1.4%)	497 (8.0%)	148 (1.6%)	23 (0.6%)	
Employed					<0.001
No	3838 (45.2%)	2894 (46.7%)	4493 (48.2%)	1887 (49.1%)	
Yes	4435 (52.3%)	3194 (51.5%)	4690 (50.3%)	1811 (47.1%)	
Unknown	214 (2.5%)	109 (1.8%)	145 (1.6%)	149 (3.9%)	

Values presented as median (interquartile range) and n (%)
Abbreviations: BMI-Body Mass Index, k—kg; m—meters
[1] *p*-values from χ^2 Tests and Kruskal-Wallis Tests, as appropriate
[2] Defined as Karnofsky Performance Status Scale ≥ 80%

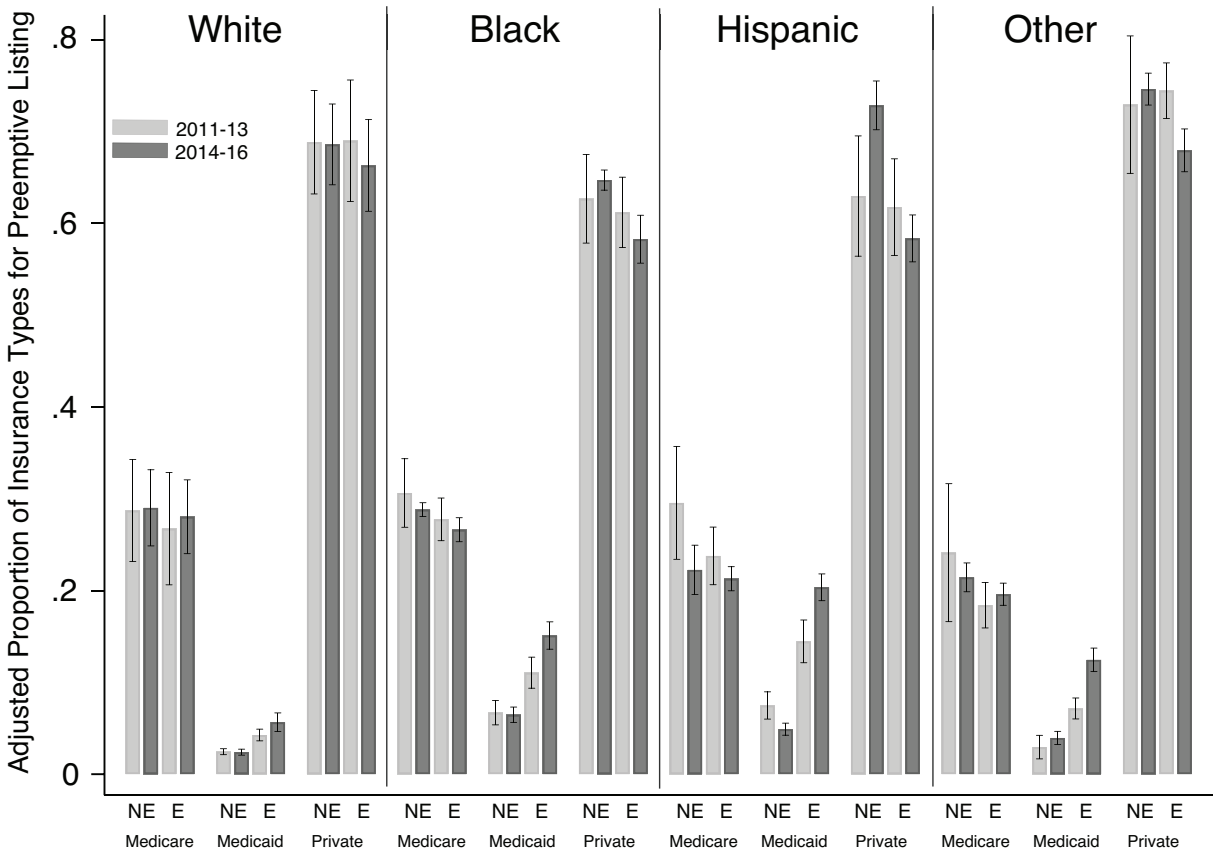
Supplementary Figure 1. Trends in the Proportion of Medicaid-Covered Preemptive Listings Comparing Only Early/Partial Medicaid Expansion to Non-Expansion States. We conducted a sensitivity analysis to determine if states that implemented partial Medicaid expansion prior to January 1, 2014 differed from other expansion states in the timing of divergent trends in the proportion of Medicaid-covered preemptive listings compared to non-expansion states. This figure displays results from a race-adjusted multinomial logistic regression model for insurance type at listing comparing 19 non-expansion states to 5 states and DC (i.e., "early expansion states"). Black squares represent proportions of Medicaid-covered listings in early expansion states, with 95% Confidence Intervals. Gray circles represent proportions of Medicaid-covered listings in non-expansion states, with 95% Confidence Intervals. The dashed line represents January 1, 2014.



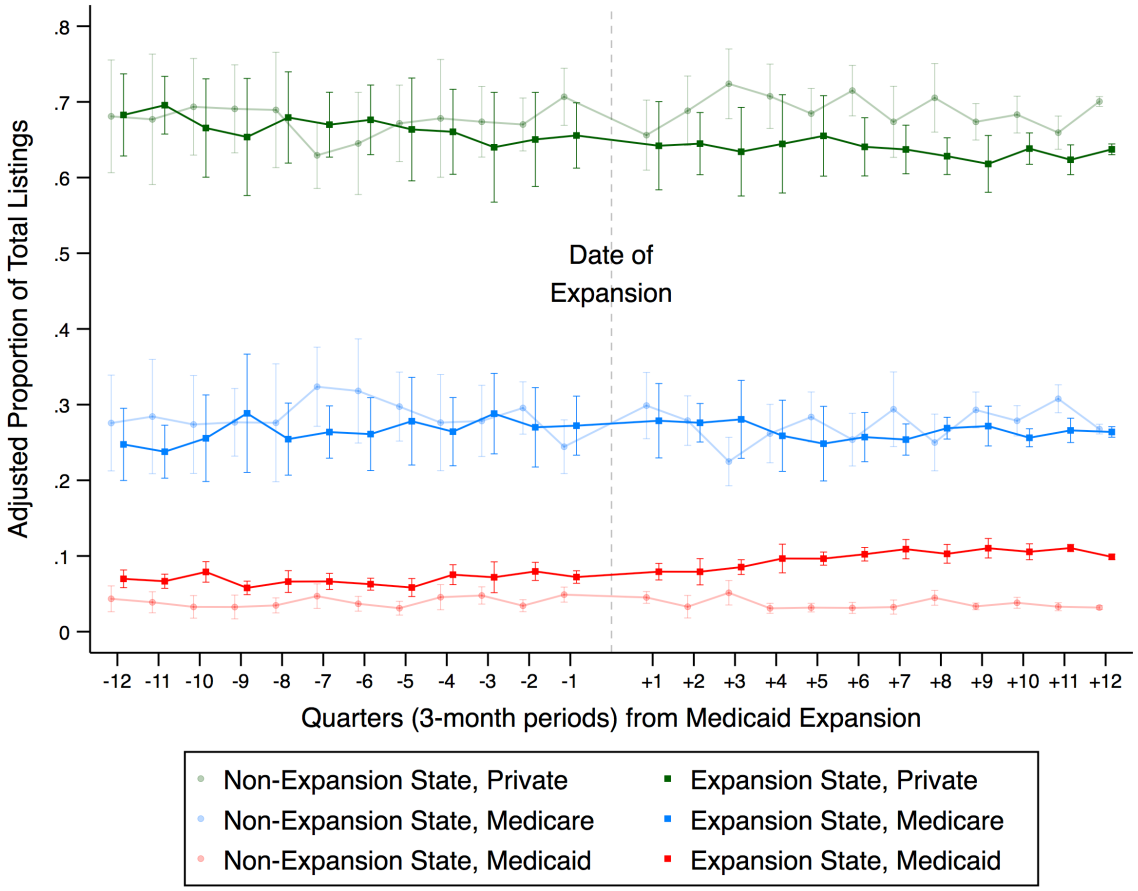
Supplementary Figure 2. Trends in all Insurance Types for Preemptive Listing in Medicaid Expansion and Non-Expansion States, Excluding States that Implemented Medicaid expansion after January 1, 2014. This figure displays results for all insurance types from the main manuscript primary analysis, as only trends in Medicaid listings are shown in main manuscript Figure 2. This figure displays results from a race-adjusted multinomial logistic regression model for insurance type at listing comparing 19 non-expansion states to 24 states and DC that fully implemented Medicaid expansion on January 1, 2014. The dashed line indicated the date of full implementation. All point estimates are presented with 95% Confidence Intervals. Dark green, blue, and red squares represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Expansion States. Light green, blue, and red circles represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Non-Expansion states.



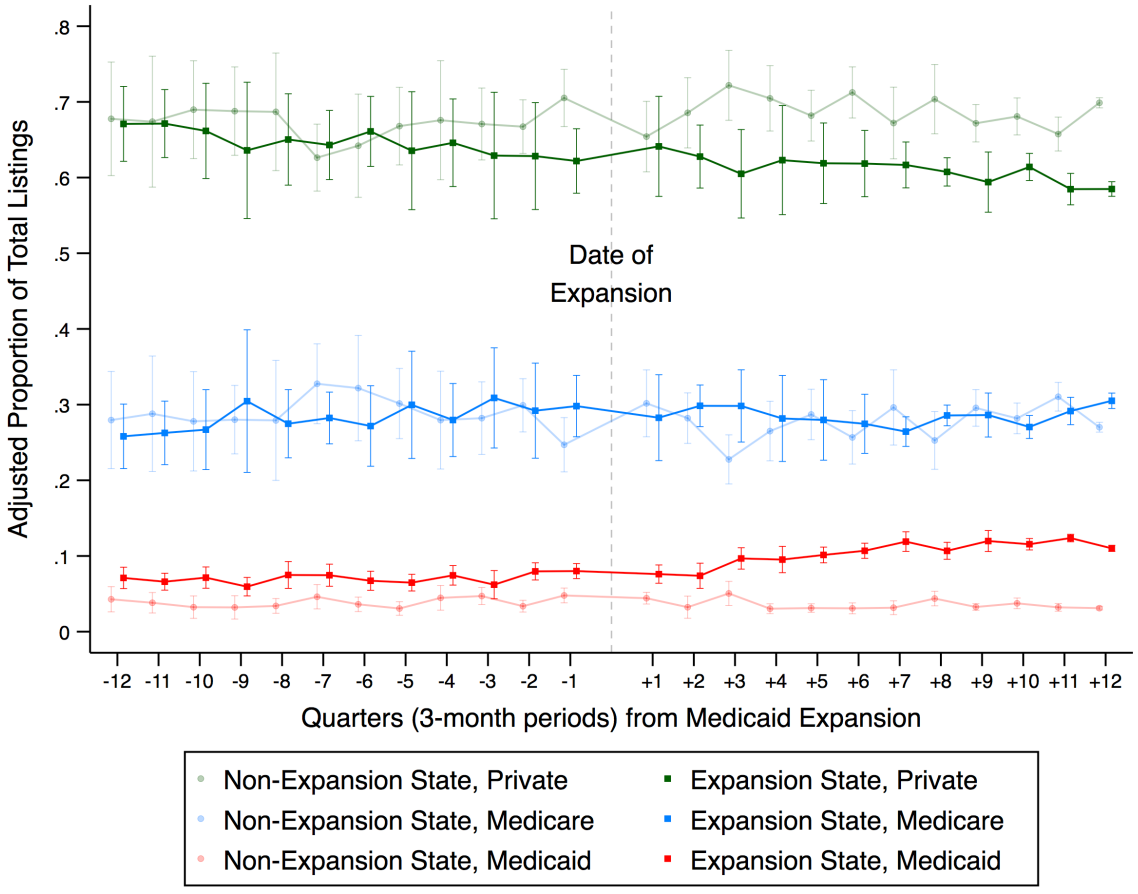
Supplementary Figure 3. Adjusted Proportion of Insurance Types Used for Preemptive Listing by Race/Ethnicity in Medicaid Expansion and Non-Expansion States, Pre- and Post-Expansion, with 95% Confidence Intervals. This figure displays full results from a race-adjusted multinomial logistic regression model for insurance type at listing comparing 19 non-expansion states to states that expanded Medicaid on January 1, 2014 (n=24+DC) (only Medicaid estimates are shown in manuscript Figure 3). The estimates were derived from the triple-interaction of race/ethnicity, Medicaid expansion state, and pre- and post-expansion period. Each bar represents the proportion of listings by insurance coverage within each listed race/ethnicity group in expansion states and non-expansion states, respectively. Light gray bars represent pre-expansion proportions, and dark gray bars represent post-expansion proportions.



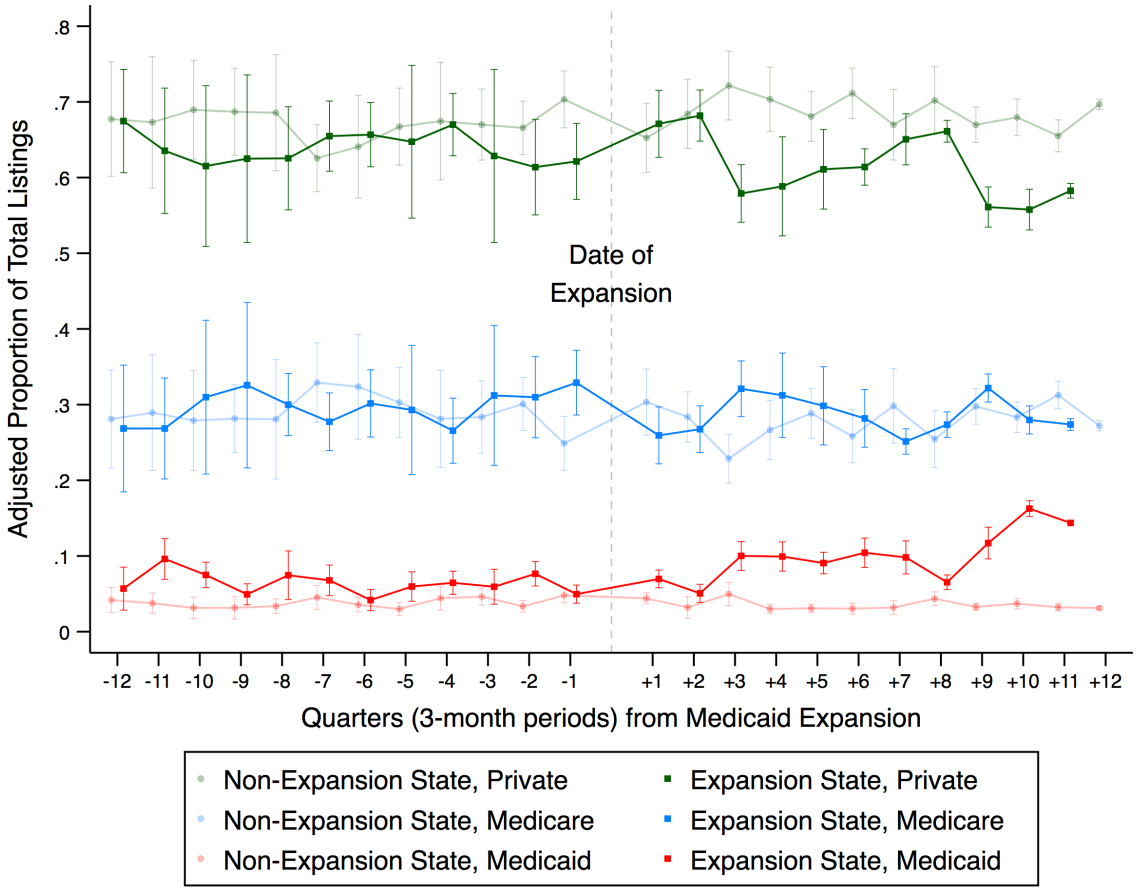
Supplementary Figure 4. Trends in all Insurance Types for Preemptive Listing in Medicaid Expansion and Non-Expansion States, Including all States. This figure displays results for all insurance types from the main manuscript secondary analysis, as only trends in Medicaid listings are shown in main manuscript Figure 4. We fit a race-adjusted multinomial logistic regression model comparing insurance types at listing among 19 non-expansion states to 31 expansion and late-expansion states, and DC. To account for different calendar dates of Medicaid expansion, results are presented as the number of quarters (3-month periods) away from a standardized Medicaid expansion date, where the calendar date of Medicaid expansion adoption is set to equal to zero. The dashed line indicates the calendar date of Medicaid expansion specific to each state. All point estimates are presented with 95% Confidence Intervals. Dark green, blue, and red squares represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Expansion States. Light green, blue, and red circles represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Non-Expansion states.



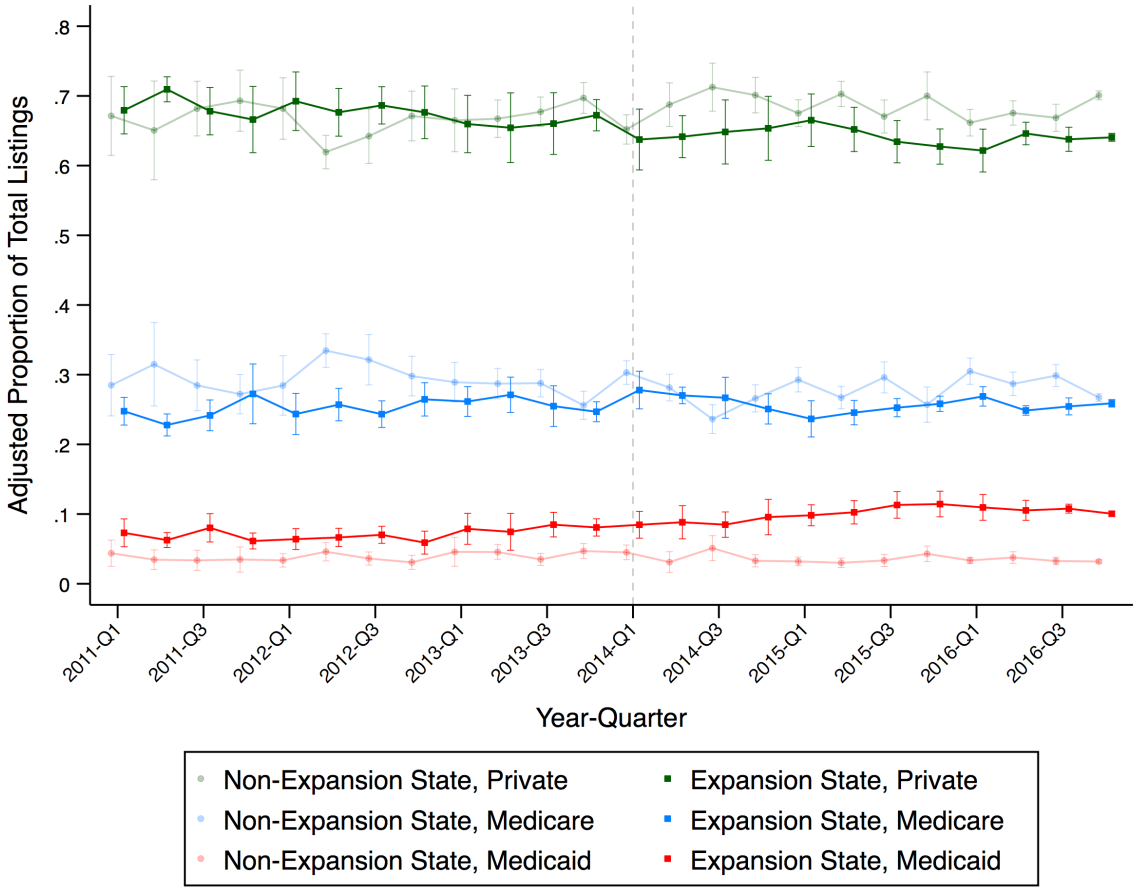
Supplementary Figure 5. Trends in Insurance Type for Preemptive Listing in Medicaid Expansion and Non-Expansion States, Excluding States that Partially Implemented Medicaid Expansion Before January 1, 2014. To determine if our findings were robust to the exclusion of early expansion states, this figure displays results from a sensitivity analysis in which we fit a race-adjusted multinomial logistic regression model for insurance type at listing comparing 19 non-expansion states to 16 expansion and late-expansion states, excluding the 5 states and the District of Columbia, that partially expanded Medicaid prior to January 1, 2014. To account for different calendar dates of Medicaid expansion, results are presented as the number of quarters away from a standardized Medicaid expansion date, where the calendar date of Medicaid expansion adoption is set to equal to zero. All point estimates are presented with 95% Confidence Intervals. The dashed line indicates the standardized date of Medicaid expansion. Dark green, blue, and red squares represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Expansion States. Light green, blue, and red circles represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Non-Expansion states.



Supplementary Figure 6. Trends in Insurance Type for Preemptive Listing Comparing States that Implemented Medicaid Expansion after January 1, 2014 (n=7) and Non-Expansion States (n=19). As states that expanded Medicaid after the initial January 1, 2014 start date may differ in meaningful ways from states that expanded Medicaid earlier, in this sensitivity analysis, we fit a race-adjusted multinomial logistic regression model for insurance type at listing comparing 19 non-expansion states to the 7 late-expansion states. To account for different calendar dates of Medicaid expansion, results are presented as the number of quarters away from a standardized Medicaid expansion date, where the calendar date of Medicaid expansion adoption is set to equal to zero. All point estimates are presented with 95% Confidence Intervals. The dashed line indicates the date of Medicaid expansion for each state. Dark green, blue, and red squares represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Expansion States. Light green, blue, and red circles represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Non-Expansion states.



Supplementary Figure 7. Trends in the Proportion of Medicaid-Covered Preemptive Listings Comparing States that Expanded Medicaid January 1, 2014 (24+DC) to Non-Expansion States (n=19) with Adjustment for Age, Race, and Sex. In the main manuscript, all trends and difference-in-differences analyses were derived from models that were adjusted for race/ethnicity, with transplant center cluster-robust standard errors. In this sensitivity analysis, we determined if the observed differences in insurance type were robust to additional adjustment for candidate age and sex. This figure displays results from an age-, sex-, and race-adjusted multinomial logistic regression model for insurance type at listing. All point estimates are presented with 95% Confidence Intervals. The dashed line indicates the onset of full implementation of Medicaid expansion (January 1, 2014). Dark green, blue, and red squares represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Expansion States. Light green, blue, and red circles represent proportions of Private, Medicare, and Medicaid-covered listings, respectively, in Non-Expansion states.



References

1. Wherry, LR, Miller, S: Early Coverage, Access, Utilization, and Health Effects Associated With the Affordable Care Act Medicaid Expansions: A Quasi-experimental Study. *Ann Intern Med,* 164**:** 795-803, 2016.
2. Muller, CJ, MacLehose, RF: Estimating predicted probabilities from logistic regression: different methods correspond to different target populations. *Int J Epidemiol,* 43**:** 962-970, 2014.
3. Sommers, BD, Baicker, K, Epstein, AM: Mortality and access to care among adults after state Medicaid expansions. *N Engl J Med,* 367**:** 1025-1034, 2012.
4. Henry J. Kaiser Family Foundation: Status of State Action on the Medicaid Expansion Decision. 2017.
5. Karnofsky D.A., BJH: The clinical evaluation of chemotherapeutic agents in cancer. In: *Evaluation of Chemotherapeutic Agents.* edited by MACLEOD, C. M., Columbia University Press, 1949.
6. Sommers, BD, Arntson, E, Kenney, GM, Epstein, AM: Lessons from early Medicaid expansions under health reform: interviews with Medicaid officials. *Medicare Medicaid Res Rev,* 3, 2013.