High Housing Cost Vulnerable Groups and Health Insurance Coverage Effect under Affordable Care Act, 2010-19

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Selected Paper prepared for presentation at the 2022 Agricultural & Applied Economics Association Annual Meeting, Anaheim, CA; July 31-August 2

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First Version: May, 2022

Abstract

Housing Burdens might affect people's willingness to purchase health insurance. Obtaining health insurance is crucial for those who suffer from housing affordability problems. In this paper, we examine the changes in health insurance coverage since the 2014 ACA implementation among individuals with different level of rent burdens. Using a difference-in-difference and triple differences approach, we find that household with high rent burden (i.e. rent-to-income (RTI) ratio is above 30 percent) in the expansion states benefit most from ACA implementation. On average, the medicaid coverage rate increase by 8.30% and the uninsured rate decreased by 3.44% in expansion states. Within the expansion states, medicaid coverage rate improved by an additional 1.5% among high rent-burden household, comparing to low rent-burden household. Medicaid expansion may have provided a unique mechanism for high rent burden populations to gain access to health insurance.

Keywords: ACA, Medicaid expansion, High housing costs

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1 Introduction

The Affordable Care Act has made a notable impact on improving insurance coverage among vulnerable populations such as low-income individuals (Kominski, Nonzee, and Sorensen 2017) of the ACA on housing affordability heterogeneity. Housing, one of the key social determinants of health, Housing stability, quality, safety, and affordability all affect health outcomes, as do physical and social characteristics of neighborhoods (Taylor 2018). Housing related cost generally represents each family's biggest portion of expenditure as well. Given its importance, it is not surprising that factors related to housing can either benefit or harm our health in major ways. Specifically, low-income earners are more likely to suffer a financial burden related to housing costs. Medicaid expansion was designed to make affordable health insurance available to more people and has already made remarkable improvements. However, how closely the rate of Medicaid expansion enrollment is linked to individuals' different levels of housing affordability is still unknown. This paper examines how the level of coverage changes after implementation of the ACA for those individuals living in households with different RTI ratios.

We estimate the impact of the ACA Medicaid expansion on health insurance coverage among households that pay different portions of their income on rent by using publicly available data from the American Community Survey (ACS), the largest household survey administered by the U.S. Census Bureau. The ACS data provides detailed information on demographic, health insurance and housing characteristics of over 3 million respondents each year. Our sample focuses on ages 18 to 64 with incomes up to 400% of the federal poverty level (FPL) from 2010 to 2019. We choose gross rent as a percent of income to represent the level of households' housing affordability. We segment it into 2 levels of housing affordability: (1) no more than 30 percent of income spent on rent and (2) between 30 percent and 100 percent. The 30 percent threshold is a conventional standard for housing rental affordability since 1981, which gradually increased from 20% and was first introduced by the National Housing Act of 1937 that created the public housing program for low-income families (Linneman and Megbolugbe 1992). In 2019, 37.1 million American households (30.2 percent) spent more than 30 percent of their income on housing (Center 2020). The United States Department of Housing and Urban Development (HUD) defines cost-burdened families as those "who pay more than 30 percent of their income for housing" and "may have difficulty affording necessities such as food, clothing, transportation, and medical care (Edge 2018)." In this paper, we define those families whose RTI ratio arrives between 30 percent and 100 percent as high rent

burden households, respectively, families' RTI ratio lower than 30 percent were considered as low rent burden households. We count cost as the first important issue to them and assume that the Medicaid enrollment rate of high rent burden households will increase in the expansion states compare to non-expansion states after the ACA, since they are eligible to Medicaid for the first time.

To estimate the impact of the ACA regarding the portion of income spent solely on housing, we use a difference-in-differences approach to compare insurance coverage in 2010-13 with 2015-19 to determine how individuals with various levels of households' rent to income ratios gained health insurance coverage in states that adopted the ACA Medicaid expansion and non-adopted states. In addition, we utilize an interacted difference-in-difference-in-differences model, comparing those who have high RTI ratio to other RTI ratio groups, before and after the ACA went into effect, in expansion and non-expansion states. We use 2014 as a transition year to compare differences in percentage of insurance coverage from before and after the ACA took effect.

We find that the percentage of insurance coverage increased notably for individuals in both levels of household housing affordability in expansion and non-expansion states after the ACA implementation. For individuals whose gross rent falls between 30 percent and 100 percent, the rate of Medicaid increases by 9.22 percentage points (pp) in expansion states. Similarly, the uninsured rate increased by 3.29 pp after the ACA was implemented. In contrast, for individuals whose gross rent is less than 30 percent of their income, Medicaid coverage and uninsured rate improves by 7.68 and 3.61 pp respectively. Compared to expansion states, Medicaid and insurance rate improves by a smaller magnitude in non-expansion states.

Furthermore, we adjust age, sex, race, income, employment status, marital status, education and citizenship to test coverage changes in response to the Medicaid expansion. We find that adjusted Medicaid coverage increases 11.496 pp more in Medicaid expansion states than in non-expansion states among those whose gross rent is between 30 percent and 100 percent of their income. In addition, adjusted difference increases 5.699 pp more in expansion states than in non-expansion states for total insurance coverage after the ACA went into effect. By comparison, there is a 5.96 pp greater adjusted increase in private coverage in non-expansion states than in expansion states. To analyze the differential impacts of the ACA Medicaid expansion on health insurance coverage for low-income individuals with varying housing affordability levels, we further utilize difference-in-difference-in-difference (DDD). There is no evidence that shows a differential change in households

with a higher portion of income spending on rent versus those who spend less than 30 percent for overall insurance, Medicaid and any private insurance coverage.

In sum, we provide evidence of an increase in insurance coverage for Medicaid, employer sponsored, directly purchased and any type of insurance in response to the Medicaid eligibility expansion. However, disparities in coverage persist between households spending between 30 percent and 100 percent gross rent of income and those paying less than 30 percent.

Our paper proceeds as follows. Section 2 describes the background. Section 3 and 4 describe the data source and empirical strategy. Section 5 presents the results, and section 6 concludes.

2 Background

It is natural to take cost into account first because the ACA was designed for low-income populations with affordable access. Several analyses have found declines in cost-related barriers to care under the ACA (Sommers et al. 2014; Collins et al. 2015). Frean, Gruber and Sommers (2017) found that the percentage of net premium subside is much more relevant to the insured rate gains compared to net premiums (Frean, Gruber, and Sommers 2017). Their analysis shows that of the ACA's increase in the insurance rate in 2014 and 2015, roughly 40 percent because of the premium subsidies. However, besides health related costs, all living expenses account for cost. Especially for low-income individuals, guaranteeing basic living needs is their overriding aim. Among all living expenses, housing related costs are no doubt the largest. Based on the 2020 U.S. Bureau of Labor Statistics (BLS) Consumer Expenditure Surveys (CE), housing, transportation, food, personal insurance and pensions, and healthcare were the top five categories consumers spend the most (BLS 2021). The lack of housing affordability affects individual's ability to meet other essential expenses, placing many individuals and families under tremendous and constant financial strain. Contrarily, health insurance is a higher-level social security cost, which is not a basic living need for low-income populations. Based on a 2019 National Health Interview Survey (NHIS) data brief, among uninsured adults aged 18–64, the three most common reasons for being currently uninsured was that coverage was not affordable, not eligible, and did not want or need it (Cha and Cohen 2020). So, it's reasonable to assume, even just a small change in their housing cost, it will affect their health insurance enrollment. There is at least another factor that could affect all these ACA targeted people's choices, fluke mentality. Some people just think the probability of the cost to be sick

is lower than the health insurance premium is higher than the other way. It can be explained in the following points. First, health insurance premium is fixed and visible, but the cost to be sick is unknown, which gives them this illusion. Second, because of the sympathy and friendly of social systems to low-income populations, people are still able to substantially reduce their expenses through all kinds of financial and charity programs even if they are getting sick.

The cost of housing not only alters individuals and families stability and safety, but also affects their overall ability to make healthy choices (Gibson et al. 2011). Unaffordable housing is a particular economic burden which forces individuals to make trade-offs between either paying the rent or spending money on fresh food, health care services and other basic needs. The high cost of housing may also cause individuals to move frequently, which not only leads to residential instability, but compels them to live far from work. The result is more time and money commuting and less time engaging in health-promoting activities such as adequate exercise and proper sleep patterns. Specifically, low-income earners are more likely to suffer a financial burden related to housing costs. For example, having 50 percent of a $\$19,000$ annual salary left to spend after covering housing costs, provides a much more limited set of options than someone earning even twice as much (Pollack et al. 2008). Therefore, they presumably have restricted health resources which increases the risk of health issues. Because of their potential high healthcare needs, obtaining insurance coverage is crucial. The health impacts of lacking affordability of housing have yet to be studied. It may harm health through increased stress, loss of financial resources. These impacts in turn can have longer-term health consequences (Krieger and Higgins 2002). While Medicaid expansion tends to protect more people financially from a health shock. It is important to find out the relations between housing affordability and health insurance enrollment rate. Nevertheless, this prevention tool is easily considered as a non-urgent and unnecessary expense by some people, especially low-income individuals and families. Based on this, we assume the enrollment rate in health insurance will decrease if they have a relatively high housing cost. This paper examines the degree of improvement of coverage since the ACA went into effect among individuals living in different rent to income ratio households.

3 Data

The data used in this analysis comes from the American Community Survey (ACS), the largest household survey administered by the U.S. Census Bureau. The survey is a pooled cross-sectional

data and have over 3 million respondent each year. The ACS benefits our study in two major ways. First, the response rate is high. The sample covers 1% of the US population and intended to be nationally representative. Second, it collects a broad rage of household-level information such as: health insurance coverage, demographic characteristics, housing status, income and other socioeconomic factors. In this study, we utilize these household-level information to examines the effectiveness of Medicaid expansion policy across different subgroups. The ACS has been used extensively in previous studies to estimate ACA's impact on health insurance coverage (Buchmueller, Ham, and Shore-Sheppard 2016, Courtemanche et al. 2017, and Agarwal, Goldman, and Sommers 2019). However, none of them examines whether the effectiveness of Medicaid expansion could be influenced by housing affordability heterogeneity. That is, the changes in Medicaid coverage after Medicaid expansion could be different among household facing different RTI ratio. In this study, we use the year 2014 as a transition year to compare changes in insurance coverage across different RTI groups before and after Medicaid expansion took effect. Our sample focus on household with members from age 18 to 64 and the sample year is from the year 2010 to the year 2019. Households whose annual income is above 400% of FPL are excluded from our study. We also drop individuals who are not U.S. citizens, or whose rent to income ratio is above 100 percent, which includes 747,902 observations for the original data (or 207,070 observations for the cleaned data). In addition, those who do not have rent payment were not taken into consideration in our analysis. A cleaned data set includes 1,055,772 individuals who are defined as with a low RTI ratio, and 913,327 individuals who are defined as high RTI ratio.

Descriptive statistics for the sample is reported in Table C1 in Appendix. Our primary interests is to evaluate the difference in Medicaid expansion's impact on insurance coverage across different RTI group. In the sample, the median RTI ratio is around 30 percent. Hence, we group household into high RTI group (or low RTI group) if their annual rent payment is above (or below) 30 percent of their annual income. Table 1 compares key statistics between two RTI group in the period before the Medicaid expansion implemented.

For the majority of the demographic characteristics, individuals in high RTI group (column (3)) are at a notable disadvantage compared to those whose in low RTI group (column (2)). For example, household in low RTI group receives 2 times higher annual income than those in high RTI group. The unemployment rate in high RTI group is 12.63% and is significantly higher, compared to low RTI group, which is only 7.67%. The difference in marital status and percent of white population

Table 1: Summary Statistic pre ACA

Variables	Full Sample	Rent-to-income Ratio	
		below 30%	above 30%
Household Income (in dollars)	37,222.29	54,156.17	23,539.04
	(27,911.32)	(30,180.61)	(15,924.16)
Age	36.43	36.25	36.56
	(12.8)	(12.43)	(13.09)
Number of Children	0.80	0.75	0.84
	(1.17)	(1.12)	(1.21)
Family Size	3.62	3.70	3.55
	(1.61)	(1.67)	(1.56)
Number of Bedrooms	2.32	2.36	2.29
	(1.11)	(1.11)	(1.11)
Unemployment Rate	10.41%	7.67%	12.63 %
Percent of Married Household	33.76%	37.43%	30.78%
Female respondent	45.08%	48.24%	42.54%
Race:			
White	64.42%	67.6%	61.84%
Black	18.49%	16.19%	20.35%
Asian	5.26%	4.84%	5.61%
Muti-racial	2.88%	2.64%	3.08%
Other	8.72%	8.53%	8.82%
Insurance Coverage:			
Medicaid	22.90%	15.58%	28.81%
Employer-sponsored	37.12%	48.53%	27.91%
Direct Purchase	7.30%	6.37%	8.05%
Uninsured Rate	33.22%	30.55%	35.37%
No. Of Observations	1,552,942	694,033	858,909

Note: Calculations based on ACS 2010-13. Sample is restricted to those who are between 18 and 65, below 400% FPL, and not covered by VA Health Care or India Health Service. Other racial including American Indian, Native Hawiian and other pacific islander and alaska native. All variables are binary except for Age, Household income and Family size, which are continuous. Calculations account for ACS sample weights.

are also large between these two groups. The marriage rate is 7% higher in low RTI group and this group has 6% more white population. The differences in age and family size are small. This table also depicts the rate of coverage for each subgroup before the ACA went into effect. Those who have a higher housing cost burden are more likely to be covered by Medicaid (a 13.23 percentage point difference), less likely to be covered by employer-sponsored insurance (a 20.62 percentage point difference), and more likely to be uninsured (a 4.82 percentage point difference).

4 Empirical Approach

The primary outcome variable of interest is defined as a binary variable which equals 1 if a respondent is enrolled in Medicaid program in a given year. We use a DID analysis to evaluate the impact from ACA's expansion on Medicaid coverage across different RTI groups. In addition, we also extend our analysis to uninsured rate, and other health insurance coverage including directly purchased and employer-sponsored private insurance.

In our benchmark analysis, we first estimate the impact of ACA expansion in 2014 on different health insurance coverage, regardless of household RTI ratio. That is, we exclude states that implement ACA expansion different from the year 2014. The benchmark analysis, therefore include 37 states and 23 of them implement ACA expansion in the year 2014. We estimate:

$$Y_{ist}^{f} = \beta Expanded_s \times Post_t + \psi_1 Expanded_s + \psi_2 Post_t + \gamma' X_{ist} + \eta_s + \eta_t + \varepsilon_{ist} \tag{1}$$

where Y_{ist} is a dummy variable that equals 1 if the household has enrolled in type f insurance. Here, we consider *Medicaid*, *employer-sponsored*, *directly purchased*, and *uninsured*. $Expanded_s$ is a state-level dummy variable which equals 1 if the household live in the state that implemented ACA expansion in 2014. $Post_t$ is a year dummy variable takes value of 1 if the year is greater than 2014. X_i is a vector of covariates that might affect household's insurance enrollment decision. Particularly, we include household income, age, sex, education level, race, employment status, citizenship and marital status. η_s is the state fixed effect and η_t is the calendar year fixed effect. β represents the estimated average changes in type f health insurance coverage rates in expanded states, relative to non-expanded states.

To evaluate ACA expansion on health insurance coverage across different RTI group, we use an

interacted difference-in-difference-in-difference model. We estimate:

$$\begin{aligned} Y_{ist}^{f} =& \tilde{\beta} HighRent_{ist} \times Expanded_s \times Post_t + \psi_1 Post_t + \psi_2 Expanded_s + \psi_3 HighRent_{ist} \\ &+ \psi_4 HighRent_{ist} \times Expanded_s + \psi_5 Highrent_{ist} \times Post_t + \psi_6 Expanded_s \times Post_t \\ &+ \gamma' X_{ist} + \eta_s + \eta_t + \varepsilon_{ist} \end{aligned} \tag{2}$$

$HighRent_{ist}$ is a dummy variables takes value of 1 if the household annual rent payment is above 30 percent of his annual income. Other controls are the same as equation (1). ψ_6 measures the average changes in coverage rate after Medicaid expansion. $\tilde{\beta}$ is our triple difference estimator for the treatment effect on high RTI group. It captures the additional changes in coverage rate among high RTI group after Medicaid expansion. We can use estimated $\tilde{\beta}$ to calculate the average treatment effect of Medicaid expansion on different RTI groups.

In addition to DID and DDD analysis, we also conduct event study further estimate the evolution of health insurance coverage after Medicaid expansion. We replace the dummy variable $Post_t$ with a set of year dummies and estimate:

$$\begin{aligned} Y_{ist}^{f} =& Expanded_s \times \sum_{y=2010}^{y=2012} \phi_y \mathbb{I}(t=y) + Expanded_s \times \sum_{y=2014}^{y=2018} \beta_y \times \mathbb{I}(t=y) \\ &+ \psi_1 Expanded_s + \gamma' X_{ist} + \eta_s + \eta_t + \varepsilon_{ist} \end{aligned} \tag{3}$$

Here, $\mathbb{I}$ is an indicator variable which equals 1 if time equals to year y. ϕ_y with$y \in [2010, 2012]$ is the estimated pre-trend of the difference in insurance coverage f between expansion and non-expansion states. β_y with $y \in [2014, 2018]$ is the estimated average treatment effect on insurance coverage f in expansion states. Similarly, we replace $Post_t$ in equation (2) with a sequence of indicator variables $\mathbb{I}$ to estimate the evolution of the average treatment effect of Medicaid expansion on different RTI groups. As an extension we also evaluate the effect of Medicaid expansion which are implemented in the year 2015 and the year 2016.

5 Results

5.1 Benchmark Results

Regression results for equation (1) are presented in Table 2. The key identifying assumptions of our DID analysis is that the insurance coverage in both expansion and non-expansion states follow the same trend in the absence of Medicaid expansion. The test of this parallel trend assumption in shown in Appendix Table C4. In general, we do not find supporting evidence that the trend of Medicaid take-up rates or other insurance coverage rate is different between expansion and non-expansion states before ACA went into effect. Column (1) and (3) of Table 2 show the average coverage rate of different type of insurance in the pre-expansion period in non-expansion states and expansion states, respectively. Column (2) and (4) display the average coverage rate of different type of insurance in the post-expansion period in non-expansion states and expansion states, respectively. Before 2014, the average Medicaid take-up rate is 18.89% in non-expansion states and 26.15% in expansion states. The Medicaid take-up rates increased only 0.5% in non-expansion states after 2014. However, among expansion states, the Medicaid take-up rates is increased to 34.73% after 2014, 8% higher than the take-up rates before Medicaid expansion implemented.

Following Sommers et al. (2014), we use the DID model to estimate the treatment effect of Medicaid expansion on insurance coverage rate. The estimated coefficient β in equation (1) is shown in (6) of Table 2. Column (5) lists the estimated treatment effect without household level controls X_{ist}. The estimates in panel A show that treatment effect of Medicaid expansion is statistically significant and economically large in expansion states. It shows that adjusted Medicaid coverage increased by 8.30 percentage points more in expansion states than in non-expansion states after the ACA went into effect. We find quantitatively similar results in column (5) when we do not control for household level demographic characteristics. In contrast to the positive treatment effects of the expansion on the Medicaid take-up, the employer-sponsored insurance rate and directly purchased insurance rate significantly increased by 2.96 and 1.86 percentage points more in non-expansion states, respectively. The treatment effect on the overall insurance coverage is still positive among expansion states. The uninsured rate significantly went down by 3.44%. Our results suggest that Medicaid expansion has a positive impact on health insurance coverage, and the enrollment in Medicaid might slightly drives down the enrollment in other privately-purchased insurance. Individuals who used to purchase health insurance by themselves could then benefit from enrolling in Medicaid

if they are eligible.

Table 2: Average Estimated Treatment Effect of 2014 Medicaid Expansion

	States %							
	Non-Expansion		Expansion		Unadjusted Difference-in-Differences (standard error)		Adjusted Difference-in-Differences (standard error)	
	Pre-ACA 2008-2013 (1)	Post-ACA 2015-2019 (2)	Pre-ACA 2008-2013 (3)	Post-ACA 2015-2019 (4)	(5)		(6)	
Panel A: Total Sample								
Uninsured	32.30	22.10	24.70	11.35	-3.40^{***}	(0.35)	-3.44^{***}	(0.33)
Medicaid	18.89	19.49	26.15	34.73	8.28^{***}	(0.35)	8.30^{***}	(0.34)
Private								
Employer sponsored	40.28	46.35	42.49	45.86	-2.99^{***}	(0.31)	-2.96^{***}	(0.27)
Directly purchased	6.64	11.04	6.94	9.40	-1.88^{***}	(0.22)	-1.86^{***}	(0.22)
(Observations = 1,969,099)								
Panel B: Different Income Group								
low rent-burden group: rent-to-income ratio below 30%								
Uninsured	29.01	20.64	22.96	11.38	-3.68^{***}	(0.34)	-3.61^{***}	(0.33)
Medicaid	13.48	14.59	18.84	26.63	7.49^{***}	(0.36)	7.68^{***}	(0.35)
Private								
Employer sponsored	49.97	54.32	52.74	55.22	-2.40^{***}	(0.35)	-2.60^{***}	(0.33)
Directly purchased	6.34	10.04	6.49	8.78	-1.43^{***}	(0.22)	-1.42^{***}	(0.22)
(Observations = 1,055,772)								
high rent-burden group: rent-to-income ratio above 30%								
Uninsured	35.96	23.95	26.56	11.30	-3.13^{***}	(0.45)	-3.29^{***}	(0.44)
Medicaid	24.91	25.72	33.93	44.46	9.44^{***}	(0.46)	9.22^{***}	(0.43)
Private								
Employer sponsored	29.48	36.22	31.59	34.62	-3.81^{***}	(0.46)	-3.50^{***}	(0.38)
Directly purchased	6.97	12.32	7.42	10.15	-2.44^{***}	(0.29)	-2.39^{***}	(0.29)
(Observations = 913,327)								

Notes: The sample used in this analysis exclude any states that implement Medicaid expansion before 2014 or later than 2014. That is, we exclude 5 early expansion states: CA, DC, MA, MN, WA; and 6 late expansion states. Column (5) presents the unadjusted DID estimates without any household-level controls. Column (6) presents the adjusted DID estimates, by controlling for respondents' age, sex, race, level of education, household income, citizenship status, marriage status, and employment status. We controlled for both year and state fixed effect in column (5) and (6). The standard errors clustered at CPUMA level are in the parentheses. $***$, $**$ and $*$ indicate significance at levels 1%, 5%, and 10%.

In Panel B of Table 2, we re-estimate equation (1) on different RTI group. We use RTI ratio of 30 percent as a threshold to separate household into high rent-burden group (those above 30 percent) and low rent-burden group. The treatment effect on Medicaid take up rate is significantly higher among high rent-burden group, compared to those in low rent-burden group. Adjusted Medicaid coverage increased by 7.68 percentage points (95% confidence interval is $[6.99\%, 8.36\%]$) in expansion states than in non-expansion states after the ACA implementation among those whose gross rent is below 30 percent, whereas it increased by 9.22 percentage points (95% confidence interval is $[8.38\%, 10.07\%]$). The higher Medicaid take up rate in high rent-burden group cause a larger crowding out effect on directly purchased insurance. The coverage rate of directly purchased insurance dropped by 2.39% in high rent-burden group; whereas it only dropped by 1.42% in low

rent-burden group. However, we do not observe a statistically significant difference in changes of employer sponsored insurance coverage rate between these two rent-burden groups. The estimation results suggests that in expansion state, individuals in high rent-burden group benefit more from Medicaid expansion. Individuals who are eligible for Medicaid under the expansion no longer need to purchase health insurance by themselves. This, at some extension, can relief their financial burdens, especially for those in high rent-burden group.

5.2 Difference-in-difference-in-difference Results

The estimation results for the triple difference model (2) are presented in column (1) to column (4) in Table 3. The second row measures the average treatment effect on insurance coverage for those in low rent-burden group. The first row is the estimated $\tilde{\beta}$. It captures the additional changes in insurance coverage after Medicaid expansion for those in high rent-burden group. The treatment effect on Medicaid take up rate is positive and statistically significant. Compared to non-expansion state, Medicaid take up rate increased by 7.5% in low rent-burden group and 9.0% in high-burden group in expansion states after the year 2014. Similar to our DID results, the increase in Medicaid enrollment drives down the enrollment in self-purchased insurance (see column (2)) and employer-sponsored insurance (see column (3)). This crowds out effect is slightly larger among those in high rent-burden groups. Though there's significant difference in treatment effect on Medicaid take up rate between high rent-burden and low rent-burden group, we do not observe any significant difference in treatment effect on uninsured rate between these two groups.

The Medicaid expansion expanded Medicaid coverage to those with annual income above 100 federal poverty line. We re-run equation 2 based on a sub-sample for those with annual income between 100 and 400 federal poverty line. The estimation results is presented in column (5) to column (8) in Table 3. The estimated coefficients are qualitatively and quantitatively similar to those based on full sample. The treatment effects we observe in our full sample analysis are mostly driven by the treatment effects among household whose annual income is above the 100 federal poverty line, who are the benefit of Medicaid expansion.

Table 3: Triple Difference regression results

	All Income Level				Income Above 100 FPL			
	Medicaid	Direct	Employer	Uninsured	Medicaid	Direct	Employer	Uninsured
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$HighRent \times Expanded \times Post$	0.015***	−0.010**	−0.008*	0.002	0.015***	−0.015**	−0.008	0.007
	(0.004)	(0.003)	(0.005)	(0.004)	(0.004)	(0.003)	(0.005)	(0.004)
$Expanded \times Post$	0.075***	−0.014**	−0.024**	−0.037**	0.071***	−0.013**	−0.025**	−0.033***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
No. of Observations	1,969,099	1,969,099	1,969,099	1,969,099	1,490,705	1,490,705	1,490,705	1,490,705
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The sample used in this analysis exclude any states that implement Medicaid expansion before 2014 or later than 2014. That is, we exclude 5 early expansion states: CA, DC, MA, MN, WA; and 6 late expansion states. Column (1) to (4) are estimated coefficients based on full samples. Column (5) to (8) are estimated coefficients based on subsample with annual income above 100 federal poverty line. Other controls in equation (2) are included but not reported. Complete DDD results can be found in Table C5 in the Appendix. The standard errors clustered at CPUMA level are in the parentheses. $***$, $**$ and $*$ indicate significance at levels 1%, 5%, and 10%.

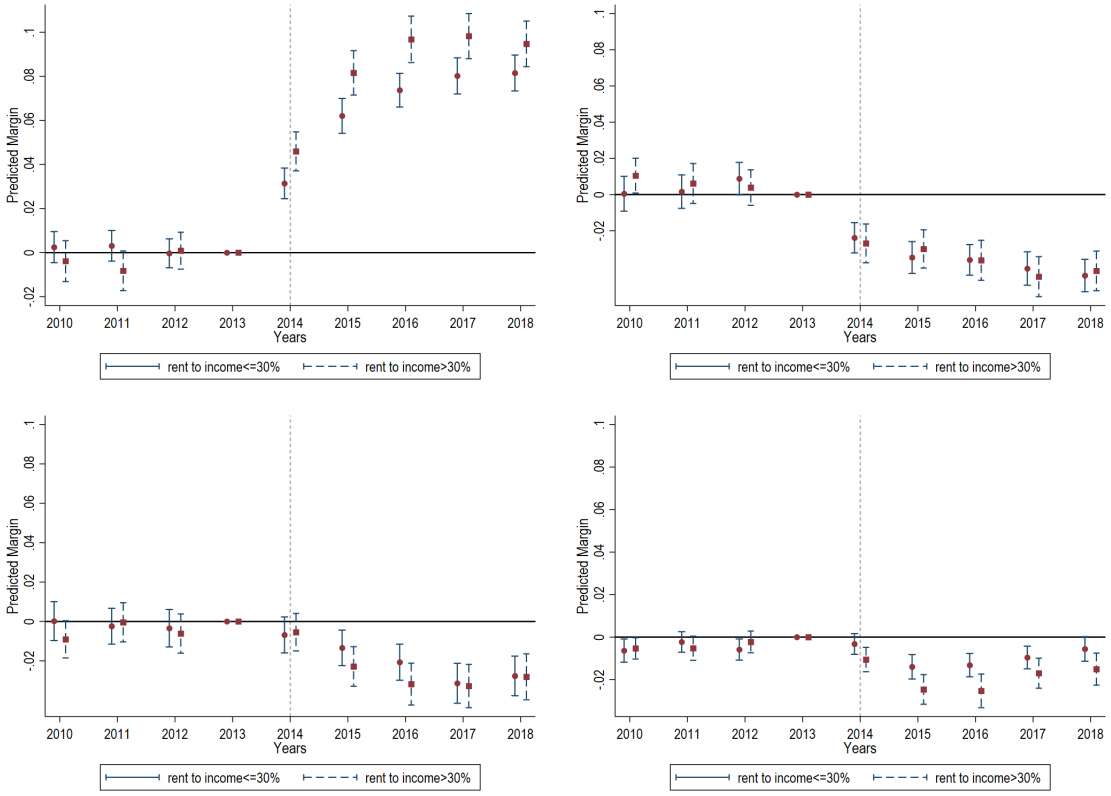
5.3 Event Study Results

Similar to the methodology used in Miller, Johnson, and Wherry (2021), we present the estimated evolution of treatment effect after Medicaid expansion in figure 1.[1] A parallel testing results suggest the fixed effects from years before 2014 do not affect individuals' take-up rates (p-value = 0.56). Similar to our previous findings, in figure 1 we show that for the transition year 2014, its effect is larger than zero, but it is smaller than that of the later years. The average effect for the year 2015 to 2018 is 8.34 percentage points, which is 8.30 percentage points as shown in the table 2) of our DID findings. For the later expansion states, we find that the average effects are 5.18 percentage points for the year 2015 expansion and 13.70 percentage points for the year 2016, respectively. In particular, these effects calculated through an event study approach are close to our findings (5.17 and 13.87 percentage points) in linear probability model (see Table 2).

In addition, we separate the groups into low rent-burden individuals and high rent-burden individuals and discuss the event study results in figure 1. Our findings suggest that, consistent with linear probability model, for those who have high rent burden, the Medicaid expansion's effects on their take-up rates are higher than that of the low rent burden. The results are held for the expansion years of 2014, 2015, and 2016, and moreover, the results are held for each year's effect within each expansion year (although the differences are not statistically significant for all years' comparisons between low and high rent individuals). For example, the effects of expansion year 2014 on the take-up rates are 3.27%, 6.46%, 7.57%, 8.24%, 8.46% (years 2014 – 2018) for the

[1]Figure 1 represents the changes in outcomes for the Medicaid expansion in 2014, while the results of expansion in 2015 and 2016 can be found in figure B2 and figure B3 in the Appendix.

Figure 1: Estimated Treatment Effect Across Year



Notes: The figure is based on a sample that exclude any early or late expansion states. The estimation is based on states implement Medicaid expansion in 2014 and those without expansion. The red dots (or red squared) is the estimated average treatment effect on low rent-burden group (or high rent-burden group). The Solid line (or dash lien) is the 95% confidence interval for estimated average treatment effect on low rent-burden group (or high rent-burden group) Upper Left: Medicaid coverage rate. Upper Right: Uninsured rate. Lower Left: employer-sponsored rate. Lower Right: directly-purchased rate. For state implement Medicaid expansion in 2014.

low rent burden-individuals with the average of 7.68%, while the effects are 4.61%, 8.16%, 9.68%, 9.86%, 9.51% (years 2014 – 2018) for the high rent-burden individuals with the average of 9.30%. Moreover, both findings are close to the findings of 7.68%, 9.22% that we show in Table 2 using the DID approaches.

6 Discussion

In this paper, we use DD and interact DDD approaches to compare individuals with high housing costs to those with normal RTI ratio, before and after the ACA Medicaid expansion implementation. In both Medicaid expansion and non-expansion states, rate of coverage gained significantly from 2010–13 to 2015–19. The rate of Medicaid increased significantly in expansion states, while

employer-sponsored insurance and directly purchased insurance rose significantly in non-expansion states. For example, adjusted uninsured rates decreased by 5.56 percentage points (pp) more in expansion states than in non-expansion states after the ACA went into effect among those whose gross rent is between 30 percent and 100 percent of their income for individuals with incomes below 100% FPL. We also find the effects on Medicaid coverage improved by 10.28 and 11.16 pp more in expansion states for those whose gross rent is below and above 30 percent of their income among individuals with incomes up to 100% FPL. The Medicaid increases in expansion states were of a larger magnitude as the private coverage increases in non-expansion states. Ample number of studies have shown that Medicaid increases in expansion states were of a higher degree as the private coverage increases in non-expansion states ().

These results are consistent with the ACA studies that focus on other vulnerable populations. However, virtually none of those studies examined whether differential changes for housing costs subgroups were statistically meaningful. This paper observed a significantly higher increase in Medicaid coverage among those with a higher RTI ratio. Reasons for the differential benefit may be related to the housing costs present prior to expansion. These prior costs indicate greater unmet needs for individuals who have a higher housing cost that could be uniquely met by the expansion. Unmet need is evidenced by lower rates of insurance among individuals with high cost burden and greater financial burdens due to out-of-pocket costs. To the extent that private coverage was less affordable among high housing costs individuals, Medicaid expansion may have provided a unique mechanism for high cost populations to gain access to health insurance. Furthermore, it may have allowed a high burden population to discontinue individually purchasing insurance in place of Medicaid.

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Appendix

A Descriptive Statistics

Table C1: Summary Statistic

Variables	Full Sample	Rent-to-income Ratio	
		below 30%	above 30%
Household Income (in FPL)			
0-100% FPL	30.20%	11.22%	46.75%
101-400% FPL	69.80%	88.78%	61.11%
Age	36.52	36.22	36.78
	(12.89)	(12.50)	(13.22)
Unemployment Rate	7.94%	5.93%	0.73 %
Percent of Married Household	33.32%	36.53%	30.52%
Female respondent	45.19%	48.20%	42.56%
Race:			
White	64.43%	67.69%	61.97%
Black or African Native	17.87%	15.93%	19.56%
Asian	5.34%	4.70%	5.90%
Muti-racial	2.88%	2.64%	3.08%
Other	11.13%	10.61%	11.58%
Insurance Coverage:			
Medicaid	25.08%	17.73%	31.49%
Employer-sponsored	39.84%	50.69%	30.37%
Direct Purchase	9.00%	7.95%	9.92%
Uninsured Rate	26.94%	25.01%	28.63%
No. Of Observations	4,526,550	2,107,801	2,418,550

Source: Authors' analysis of American Community Survey data

B DID and Income-to-poverty Ratio

We could separate our data by individuals' income-to-poverty ratio to control for the effects of individuals' wealth, which highly influences their decision-making in rent and Medicaid take-up. Following the definition of income-to-poverty ratio, individuals could be separated into less or equal to 100 percent (henceforth *Below100*) or higher than 100 percent but less or equal to 400 percent (henceforth *Above100*). In Table C2, we separately present the summary statistics and regression results of low rent-burden individuals by their income-to-poverty ratio (i.e., *Below100* and *Above100*) in the Panel A, and we provide similar information of high rent-burden individuals by

their income-to-poverty ratio in the Panel B.

Table C2: Average Estimated Treatment Effect of 2014 Medicaid Expansion (separate by rent-to-income ratio)

	States %					
	Non-Expansion		Expansion		Unadjusted Difference-in-Differences (standard error)	Adjusted Difference-in-Differences (standard error)
	Pre-ACA 2008-2013 (1)	Post-ACA 2015-2019 (2)	Pre-ACA 2008-2013 (3)	Post-ACA 2015-2019 (4)	(5)	(6)
Panel A: grpip ≤ 30						
povpip: *Below100*						
Uninsured	40.64	29.92	28.89	11.77	−6.33*** (0.87)	−6.43*** (0.83)
Medicaid	37.74	39.67	50.12	62.68	11.32*** (1.01)	11.16*** (0.90)
Private						
employer sponsored	15.95	21.46	15.61	19.36	−2.76*** (0.77)	−2.53*** (0.69)
direct purchase	5.73	9.69	6.80	8.36	−2.50*** (0.47)	−2.45*** (0.46)
(Observations = 122,788)						
povpip: *Above100*						
Uninsured	27.51	19.56	22.10	11.33	−3.31*** (0.33)	−3.21*** (0.32)
Medicaid	10.34	11.67	14.34	21.77	7.01*** (0.34)	7.18*** (0.33)
Private						
employer sponsored	54.38	58.15	58.09	60.05	−2.40*** (0.37)	−2.62*** (0.35)
direct purchase	6.42	10.08	6.45	8.83	−1.28*** (0.23)	−1.27*** (0.23)
(Observations = 932,984)						
Panel B: grpip > 30						
povpip: *Below100*						
Uninsured	39.18	28.15	26.49	9.93	−5.40*** (0.64)	−5.56*** (0.63)
Medicaid	38.02	41.35	52.08	66.04	10.25*** (0.72)	10.28*** (0.67)
Private						
employer sponsored	16.40	21.15	16.01	18.10	−2.97*** (0.56)	−2.91*** (0.49)
direct purchase	5.93	9.74	6.27	7.90	−1.77*** (0.30)	−1.73*** (0.30)
(Observations = 355,606)						
povpip: *Above100*						
Uninsured	33.54	21.45	26.61	12.06	−2.38*** (0.47)	−2.46*** (0.46)
Medicaid	15.02	16.41	22.13	32.44	8.73*** (0.42)	8.76*** (0.41)
Private						
employer sponsored	39.34	45.18	41.72	43.83	−3.65*** (0.53)	−3.55*** (0.48)
direct purchase	7.76	13.85	8.17	11.40	−2.80*** (0.36)	−2.79*** (0.35)
(Observations = 557,721)						

Notes: $*$ p < 0.05; $**$ p < 0.01; $***$ p < 0.001. Regressions based on different insurance type and expansion status (exclude 5 early expansion states: CA, DC, MA, MN, WA). Model adjusted for individuals' age, sex, race, level of education, household income, citizenship status, marriage status, and employment status.

Doing comparisons within each panel, we find that *Below100* individuals have a significantly higher improvement rate than *Above100* individuals, and this effect is held for both low and high rent-burden people. That is, in Panel A (low rent-burden individuals), the expansion leads to an increase of 11.16 percentage points in their Medicaid take-up rates, while the treatment effects on

high rent-burden individuals are merely 7.18 percentage points. While in Panel B (high rent-burden individuals), the expansion leads to an increase of 10.28 percentage points in their Medicaid take-up rates, while the treatment effects on high rent-burden individuals are merely 8.76 percentage points. This finding is consistent with the feature designed by the Medicaid expansion policymakers.

Additionally, doing comparisons across the panels, we find that for those *Above100*, the effect of expansion on high rent-burden individuals equals 8.76 percentage points is greater than the low rent-burden individuals, which is 7.18 percentage points, (95% confidence intervals are: [7.95%, 9.58%] for high rent-burden individuals and [6.53%, 7.84%] for low rent-burden individuals, respectively). That is, our finding of high rent-burden individuals improve more in Medicaid take-up rate is held among individuals who are *Above100*, and these individuals are exactly the policy is focusing on.

Moreover, albeit the total sample observations of low and high rent-burden groups are similar, that is, 1,055,772 observations in Panel A and 913,327 observations in Panel B of Table C2, we show that the number of observations of income ratio groups within rent burden groups matters for the Medicaid take-up rate. For the low rent-burden individuals, there are 932,984 out of 1,055,772 (or 88.37%) individuals in the group of *Above100* (the less affected group compared to the group of *Below100*) for their income-to-poverty ratio and these individuals have 7.18 percentage points of improvement in their Medicaid take-up. In other words, the majority of individuals in low rent-burden groups have a relatively high income (*Above100*), resulting in the effects of expansion on their Medicaid take-up rates being small.

On the contrary, for those with a high rent burden, 557,721 out of 913,327 (or 61.07%) individuals are in the group of *Above100* for their income-to-poverty ratio and these individuals have 8.76 percentage points of improvement in their Medicaid take-up. These findings and effects suggest that not surprisingly, there is relatively a larger percentage of people among the *Below100* income-to-poverty ratio in the high rent-burden group than in the low rent-burden group, which results in this group enjoying more Medicaid take-up.

Our findings suggest that the Medicaid expansion in the year 2014 improve the overall take-up rates for both people who were below the poverty line and were covered by the Medicaid, as well as those who were between the level of 100% and 400% of the poverty line and covered by Medicaid expansion. We run regressions for robustness check, where we focus on people whose income level is above the 400% of the poverty line (see Table C3). The results suggest that these individuals do not heavily improve their Medicaid take-up rates, with an improvement of less than 2 percentage

points on average, which is consistent with our findings here.

Table C3: Average Estimated Treatment Effect of 2014 Medicaid Expansion (rent-to-income ratio above 400)

	States %					
	Non-Expansion		Expansion		Unadjusted Difference-in-Differences (standard error)	Adjusted Difference-in-Differences (standard error)
	Pre-ACA 2008-2013 (1)	Post-ACA 2015-2019 (2)	Pre-ACA 2008-2013 (3)	Post-ACA 2015-2019 (4)	(5)	(6)
Panel A: grpip ≤ 30						
povpip > 400						
Uninsured	11.87	8.37	9.12	4.97	−0.73** (0.31)	−0.54 (0.30)
Medicaid	2.39	2.89	3.44	5.46	1.60*** (0.18)	1.75*** (0.18)
Private						
employer sponsored	75.85	77.60	81.01	81.95	−0.77 (0.42)	−0.91* (0.39)
direct purchase	8.39	9.81	7.47	8.59	−0.70** (0.25)	−0.67** (0.24)
(Observations = 523,789)						
Panel B: grpip > 30						
povpip > 400						
Uninsured	12.36	7.63	8.12	5.09	1.46 (1.20)	1.75 (1.20)
Medicaid	1.35	1.42	1.98	4.07	2.09*** (0.51)	1.94*** (0.52)
employer sponsored	68.61	70.54	75.13	74.18	−2.29 (2.29)	−0.75 (2.17)
direct purchase	15.53	19.08	11.81	13.30	−3.06 (1.76)	−2.88 (1.74)
(Observations = 23,022)						

Notes: The sample used in this analysis exclude any states that implement Medicaid expansion before 2014. That is, we exclude 5 early expansion states: CA, DC, MA, MN, WA; and 6 late expansion states. Column (5) presents the unadjusted DID estimates without any household-level controls. Column (6) presents the adjusted DID estimates, by controlling for respondents' age, sex, race, level of education, household income, citizenship status, marriage status, and employment status. We controlled for both year and state fixed effect in column (5) and (6). The standard errors clustered at CPUMA level are in the parentheses. $***$, $**$ and $*$ indicate significance at levels 1%, 5%, and 10%.

Table C4: Parallel DD

	Unadjusted Difference-in-Differences Margins (1)	Adjusted Difference-in-Differences Margins (2)
Uninsured	0.19	0.17
	(0.14)	(0.14)
Medicaid	−0.03	−0.06
	(0.13)	(0.13)
Private		
employer sponsored	−0.13	−0.11
	(0.16)	(0.15)
direct purchase	−0.20	−0.18
	(0.08)	(0.08)
(Observations = 863,654)		

Notes: The sample used in this analysis exclude any states that implement Medicaid expansion before 2014. That is, we exclude 5 early expansion states: CA, DC, MA, MN, WA; and 6 late expansion states. Column (1) presents the unadjusted DID estimates without any household-level controls. Column (2) presents the adjusted DID estimates, by controlling for respondents' age, sex, race, level of education, household income, citizenship status, marriage status, and employment status. We controlled for both year and state fixed effect in column (1) and (2). The standard errors clustered at CPUMA level are in the parentheses. $***$, $**$ and $*$ indicate significance at levels 1%, 5%, and 10%.

Table C5: Complete Triple Difference regression results

	All Income Level				Income Above 100 FPL			
	Medicaid	Direct	Employer	Uninsured	Medicaid	Direct	Employer	Uninsured
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$HighRent \times Expanded \times Post$	0.015^{***}	-0.010^{**}	-0.008^{*}	0.002	0.015^{***}	-0.015^{**}	−0.008	0.007
	(0.004)	(0.003)	(0.005)	(0.004)	(0.004)	(0.003)	(0.005)	(0.004)
$Expanded \times Post$	0.075^{***}	-0.014^{**}	-0.024^{**}	-0.037^{**}	0.071^{***}	-0.013^{**}	-0.025^{**}	-0.033^{***}
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
$HighRent \times Post$	0.014^{***}	0.012^{***}	0.007^{**}	-0.030^{***}	0.012^{***}	0.021^{***}	0.008^{*}	-0.036^{***}
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.004)	(0.003)
$HighRent \times Expanded$	0.046^{***}	0.035^{*}	-0.020^{***}	-0.028^{***}	0.030^{***}	0.005^{**}	-0.021^{***}	-0.009^{***}
	(0.004)	(0.002)	(0.004)	(0.004)	(0.003)	(0.002)	(0.004)	(0.004)
$Post$	0.037^{***}	0.027^{***}	0.028^{***}	-0.086^{***}	0.035^{***}	0.027^{***}	0.021^{***}	-0.079^{***}
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
$Expanded$	0.081^{***}	-0.034^{***}	−0.019	-0.019^{*}	0.056^{***}	-0.032^{***}	−0.014	−0.004
	(0.016)	(0.008)	(0.015)	(0.011)	(0.010)	(0.007)	(0.012)	(0.010)
$HighRent$	-0.042^{***}	0.010^{***}	-0.009^{***}	0.027^{***}	-0.049^{***}	0.012^{***}	−0.003	0.021^{***}
	(0.003)	(0.001)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
$Expanded \times Year\,2014$	0.033^{***}	-0.007^{***}	-0.009^{*}	-0.021^{***}	0.029^{***}	-0.005^{***}	−0.008	-0.020^{***}
	(0.004)	(0.003)	(0.005)	(0.004)	(0.004)	(0.003)	(0.005)	(0.004)
$HighRent \times Year\,2014$	0.012^{***}	0.008^{***}	-0.008^{*}	-0.015^{***}	0.006	0.013^{***}	−0.002	-0.019^{***}
	(0.003)	(0.002)	(0.004)	(0.005)	(0.004)	(0.003)	(0.005)	(0.005)
$HighRent \times Expanded \times Year\,2014$	0.010^{*}	-0.007^{**}	−0.000	−0.001	0.015^{**}	-0.011^{***}	−0.008	0.003
	(0.005)	(0.004)	(0.006)	(0.006)	(0.006)	(0.004)	(0.007)	(0.007)
No. of Observations	1,969,099	1,969,099	1,969,099	1,969,099	1,490,705	1,490,705	1,490,705	1,490,705
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The sample used in this analysis exclude any states that implement Medicaid expansion before 2014 or later than 2014. That is, we exclude 5 early expansion states: CA, DC, MA, MN, WA; and 6 late expansion states. Column (1) to (4) are estimated coefficients based on full samples. Column (5) to (8) are estimated coefficients based on subsample with annual income above 100 federal poverty line. Regressions control for respondents' age, sex, race, level of education, household income, citizenship status, marriage status, and employment status. The standard errors clustered at CPUMA level are in the parentheses. $***$, $**$ and $*$ indicate significance at levels 1%, 5%, and 10%.

Figure B1: Timing of state Medicaid expansion

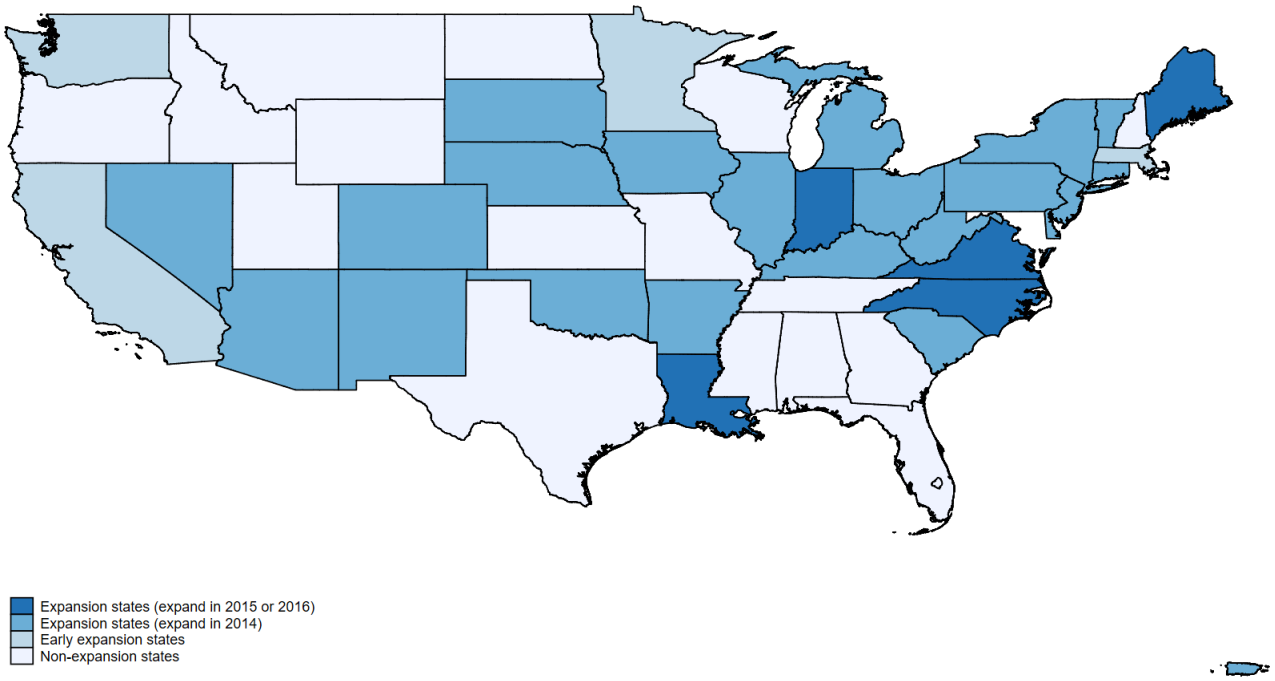
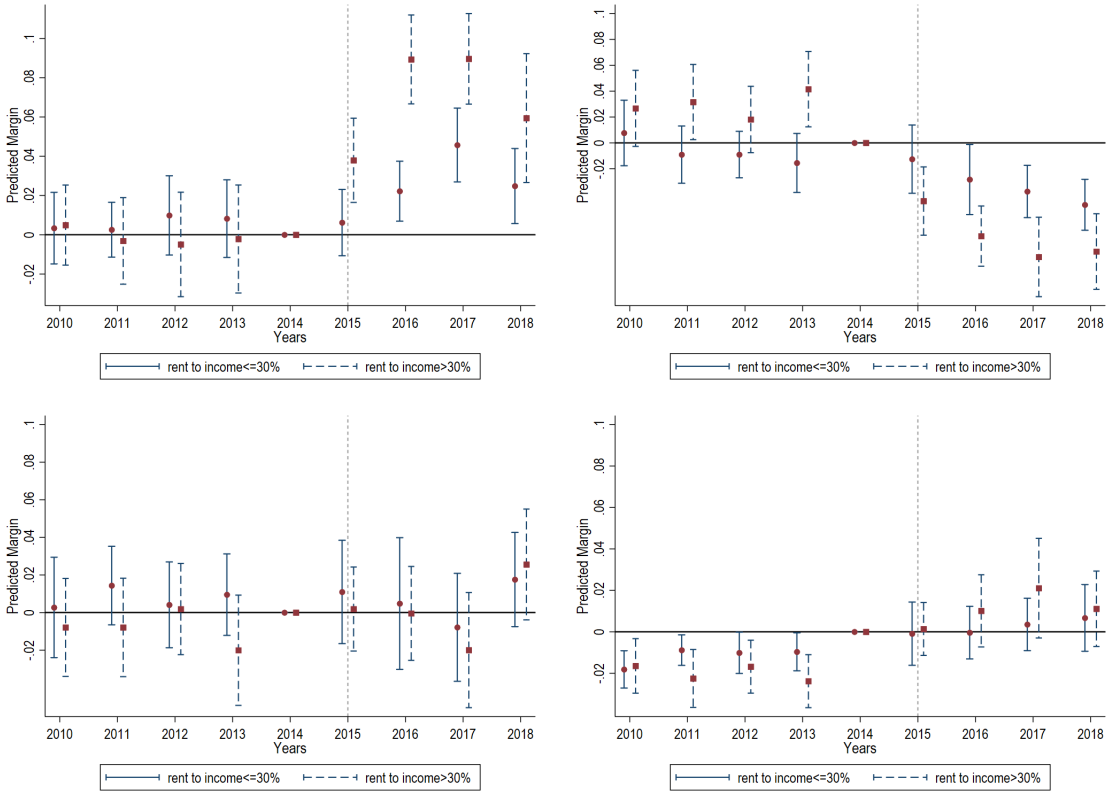
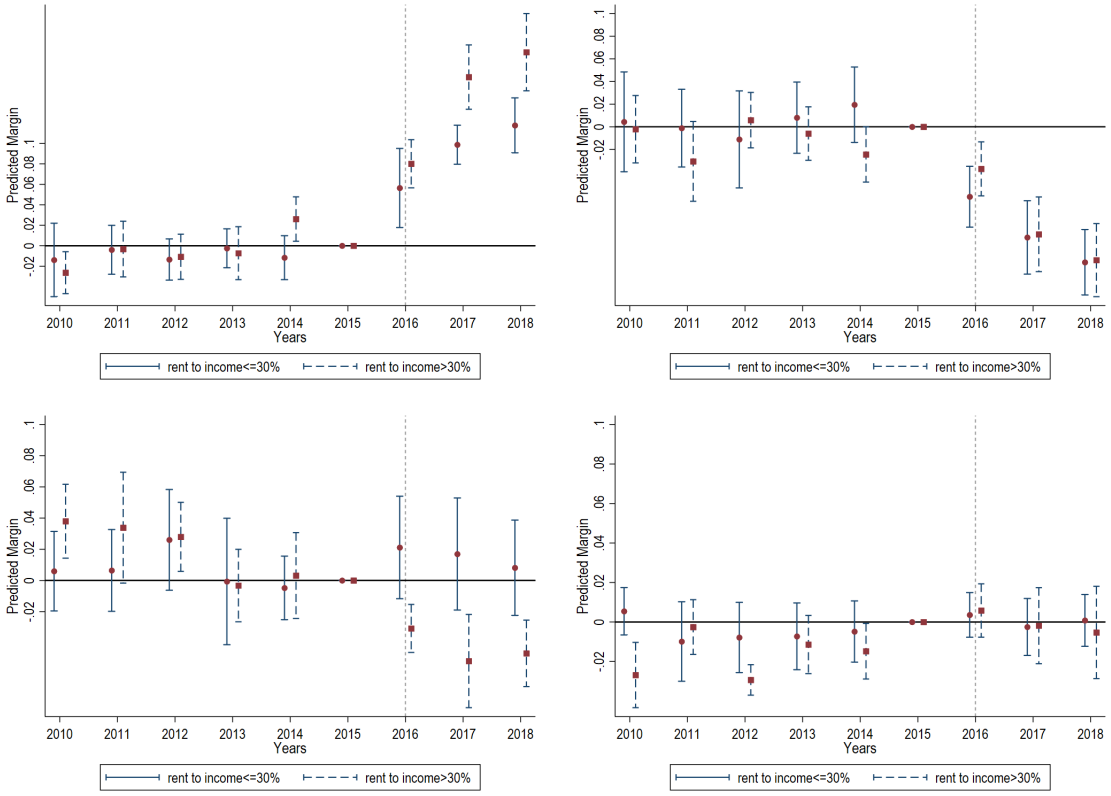


Figure B2: Estimated Treatment Effect Across Year (expansion in 2015)



Notes: The figure is based on a sample that exclude any early or late expansion states. The estimation is based on states implement Medicaid expansion in 2015 and those without expansion. The red dots (or red squared) is the estimated average treatment effect on low rent-burden group (or high rent-burden group). The Solid line (or dash lien) is the 95% confidence interval for estimated average treatment effect on low rent-burden group (or high rent-burden group) Upper Left: Medicaid coverage rate. Upper Right: Uninsured rate. Lower Left: employer-sponsored rate. Lower Right: directly-purchased rate. For state implement Medicaid expansion in 2015.

Figure B3: Estimated Treatment Effect Across Year (expansion in 2016)



Notes: The figure is based on a sample that exclude any early or late expansion states. The estimation is based on states implement Medicaid expansion in 2016 and those without expansion. The red dots (or red squared) is the estimated average treatment effect on low rent-burden group (or high rent-burden group). The Solid line (or dash lien) is the 95% confidence interval for estimated average treatment effect on low rent-burden group (or high rent-burden group) Upper Left: Medicaid coverage rate. Upper Right: Uninsured rate. Lower Left: employer-sponsored rate. Lower Right: directly-purchased rate. For state implement Medicaid expansion in 2016.