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Uninsured: A Look at Nonreceipt of the Measles, Mumps, and Rubella Vaccine in Texas

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Abstract: Using data on children aged 19-35 months from the National Immunization Survey (NIS), we examine measles, mumps, and rubella (MMR) vaccine nonreceipt in Texas compared to the rest of the United States (U.S.) from 2007-2018. We specifically evaluate overall MMR nonreceipt, which is children not receiving the MMR vaccine, and selective MMR nonreceipt, which is children who received all childhood vaccines but MMR. We posit that Texas may be different from the rest of the U.S. due to a higher proportion of uninsured children. Evidence shows that overall MMR nonreceipt in the rest of the U.S. and Texas is more likely when a child is uninsured. Results also show that the chance of overall MMR nonreceipt is higher in the rest of the U.S. than in Texas when a child is uninsured. Analysis also suggests that private providers marginally influence selective MMR nonreceipt in the rest of the U.S. and Texas. We conclude that Texas experiences a somewhat different trend in overall MMR nonreceipt for the time period we consider.

Keywords: Texas, Vaccines, Health, Health Care
JEL Classification: I19; R19

1. Introduction

Recent outbreaks in the United States (U.S.) and the ongoing worldwide pandemic of Covid-19 have brought significant attention to immunizations. Among contemporary disease problems, vaccine-preventable illnesses such as measles have reemerged and garnered renewed concern.[1] Undergirding this significant public health problem is the ongoing debate regarding the health insurance system of the U.S. While the Patient Protection and Affordable Care Act helped reduce the uninsured share of the U.S. nonelderly population from 2010-2016, fresh developments have resulted in a slight increase in 2017-2018.[2] Research in the economics of health care indicates that insurance coverage improves access to care (Kirby and Vistnes (2016); McMorrow et al. (2016); Howell and Kenney (2012)). Therefore, changes in the uninsured share of the U.S. population may be contributing to the modern rise in outbreaks of vaccine-preventable diseases.

As an additional contributor to recent unease, Wakefield et al. (1998) present evidence of an apparent link between behavioral problems and vaccinations. More specifically, the authors directly connect receiving the measles, mumps, and rubella (MMR) vaccination with the onset of autism. The findings elevate a controversy concerning the relationship between autism and vaccines. Eventually, in 2010, the General Medical Council in the United Kindom investigated Wakefield for misconduct (Jones, 2010). The inquiry resulted in the retraction of Wakefield et al. (1998) twelve years after it was published (Bedford & Elliman, 2010). Moreover, multiple studies

such as Hornig et al. (2008) and DeStefano et al. (2004) show no link between MMR and autism. A meta-analysis by Taylor et al. (2014) also reports that vaccines are not associated with autism. Even so, Wakefield et al. (1998) has affected MMR immunization rates in Europe and the United States, according to Poland and Jacobson (2011) and Flaherty (2011) among others.

To better address the latest concerns and provide new evidence on immunizations, we conduct a systematic descriptive empirical evaluation of the determinants of MMR vaccinations in the state of Texas compared to the rest of the United States. Our paper is helpful and unique for three reasons. First, we revisit the correlates of MMR vaccination for the United States and include a previously omitted variable, uninsured status, into the analysis. Second, we conduct a state level evaluation while, to our knowledge, previous studies of MMR vaccinations have largely considered country level empirics. Third, it explores a state, Texas, which has a relatively high proportion of uninsured children compared to the rest of the United States.

Results of our study indicate that the probability of overall MMR nonreceipt, that is not receiving the MMR vaccine, is lower in the state of Texas relative to the rest of the U.S. Results show that being uninsured in the rest of the U.S. correlates with a 10.8 percentage point increase in the probability of overall MMR nonreceipt. A divergent result exists in Texas, where being uninsured associates with a 7.7 percentage point increase in the probability of overall MMR nonreceipt. For selective MMR nonreceipt, that is children who received all childhood vaccines but MMR, results moderately indicate no divergent empirical evidence for Texas and the rest of the U.S. Finally, findings for Texas and the rest of the U.S. consistently denote that children receiving care from all private facilities have a 0.7 percentage point differential in the probability of selective MMR nonreceipt compared to children receiving care from all public facilities.

This study is separated into 5 sections. Section 2 discusses the relevant literature and trends. Section 3 reviews the dataset and econometric model. Section 4 reports our results and section 5 concludes our study.

2. Relevant Literature, Trends, and Hypotheses

2.1 Brief History of the MMR Vaccine

Prior to the development of the measles vaccine, measles in the U.S. produced a burden of approximately 500,000 reported cases annually that came along with 48,000 hospitalizations 4,000 cases of encephalitis, and 500 deaths, according to Orenstein et al. (2007). With the significant health challenges created by measles as motivation, Hinman et al. (2004) convey that the measles vaccine was first introduced to the United States in 1963. Later, in 1971, the measles vaccine was combined and licensed with the mumps and rubella vaccines to yield the MMR vaccination (Goodson & Seward, 2015). Initially, the recommended schedule for the MMR vaccine was to deliver one dose to U.S. children at an age of approximately 12 months. However, measles outbreaks among school-aged children in the 1980's led to a 1989 proposal by the Advisory Committee on Immunization Practices (ACIP) to administer a second dose of the MMR vaccine to children entering elementary school at 4-6 years of age. While the American Academy of Pediatrics (AAP) initially suggested a second dose at 11-12 years of age, ACIP and AAP issued a joint recommendation in 1997 for a second dose of the MMR vaccine at 4-6 years of age (Zhou et

al., 2004). Presently, the MMR vaccine schedule remains unchanged since 1997 with a first dose at 12 months and second dose at 4-6 years, according to the Centers for Disease Control and Prevention (2019). International efforts are also underway to pursue eradication of measles through use of the MMR vaccine, as Zachariah and Stockwell (2016) attest.

2.2 Overall and Selective Nonreceipt

In a study that Smith et al. (2008) conduct, the authors revisit Wakefield et al. (1998) to determine if public perception of the MMR vaccine is affected in the U.S. Specifically, Smith et al. (2008) examine overall MMR nonreceipt, which they define as not receiving the MMR vaccine, and selective MMR nonreceipt, which they define as receiving 3 hepatitis B, 4 diptheria-tetanus-acellular pertussis, and 3 *Haemophilus influenza* type b vaccines but not MMR, over the period 1995 to 2004. The results of the study highlight that selective MMR nonreceipt in the U.S. is temporarily affected in response to the publication by Wakefield et al. (1998); however, this increase in nonreceipt takes place before widespread media coverage.

Additional research notes the contribution of confirmatory bias and misinformation to delays or skipping of the MMR vaccine. For instance, using data from the 1995-2006 NIS, Chang (2018) reports a decline in MMR receipt in the U.S. and also finds evidence that mothers responded more strongly to the MMR-autism controversy, especially in states where media attention was greater. In another study, Carrieri et al. (2019) use a quasi-experiment that took place in Italy in 2012 to evaluate the impact of misinformation on the receipt of MMR and other vaccines. Employing data from EUROSTAT and the Italian Ministry of Health, results indicate a decrease in vaccination rates for MMR and other immunizations. Qian et al. (2020) investigate confirmatory bias using data from the 1998-2011 NIS. The authors show that negative information about the MMR vaccine increased the bias of college-educated mothers, who consistently delayed vaccination, moreso than positive information decreased bias.

While studies such as Smith et al. (2008), Chang (2018), Carrieri et al. (2019), and Qian et al. (2020) are informative, they do not specifically consider the impact on MMR vaccinations for a specific U.S. state. To address the topic of MMR vaccinations further, we use definitions for overall nonreceipt and selective nonreceipt developed by Smith et al. (2008) and employ a similar empirical approach stemming from Smith et al. (2008) in this study. We also examine the specific U.S. state, Texas, to add to the growing body of research.

Research establishes that insurance coverage matters concerning access to care for children. For example, Boudreaux et al. (2016) consider the long-term effects of Medicaid on adult economic and health status. Using data from the 1963-1980 restricted use National Health Interview Survey, the authors present evidence that Medicaid increases hospital utilization for low-income children by 4 percentage points. Kreider et al. (2016) evaluate health care cost, quality, and access outcomes by type of insurance for kids in households with moderate to low income. The authors employ data from the U.S. National Surveys of Children Health for 2003, 2007, and 2011-2012 and report that children insured by Medicaid and the Children's Health Insurance Program are more likely to receive preventive care than privately insured children.

Research also validates that insurance coverage is significant concerning receipt of vaccines. Simon et al. (2017) utilize data from the Behavioral Risk Factor Surveillance System to analyze

the impact of health insurance on preventive care such as a flu shot. Using a difference-in-differences approach that exploits the Affordable Care Act's (ACA) state-level expansions of Medicaid in 2014, the authors uncover some evidence of the Medicaid expansion leading to a higher likelihood of getting a flu shot in the six states with the lowest pre-Medicaid expansion insurance rates.[3] Hill et al. (2019) use data from the 2016-2018 National Immunization Survey to evaluate vaccination coverage among children born in 2015 and 2016. The authors present evidence that the uninsured have less vaccine coverage than children with private only insurance, any Medicaid, or other insurance. Other studies such as Zhen et al. (2004), Allred et al. (2007) and Becton Jr et al. (2008) also suggest a positive relationship between insurance coverage and obtaining vaccines. In essence, insurance coverage appears to make access to care relatively easier and may impact overall receipt of the MMR vaccine. Therefore, we hypothesize that the probability of overall nonreceipt of MMR correlates positively with children being uninsured.

2.3 Texas

According to Thakar (2018), Texas is one of eighteen U.S. states that allows conscientious objections as a reason for nonreceipt of a vaccine required for K-12 school or child-care facility admission. In fact, Morrison et al. (2020) report that conscientious vaccination percentage among Texas' K-12 schools increased by more than 100% between 2012 to 2018. Cardinal et al. (2019), furthermore, show that three large outbreaks of ten or more cases of measles occurred in Texas from 2009-2019 with vaccine exemptions and measles cases increasing in the same counties in all three outbreaks. Sarkar et al. (2019) attribute recent measles outbreaks in the U.S. to international travel from countries undergoing outbreaks and vaccine nonreceipt aided by non-medical exemptions. The authors employ a spatial relative risk modeling approach that specifically identifies several Texas counties as being at an elevated risk of measles.

As a trend that makes Texas unique, Texas ranks highly among states concerning the percentage of children in the state that are uninsured. Using U.S. Census Bureau Historical Health Insurance data and American Community Survey data, Table 1 shows the proportion of uninsured children under the age of 18 for the U.S. and Texas from 1995-2018 to match the time period that vaccination data are available for this study.[4] The table reveals that Texas has a higher percentage of children uninsured than the state average for rest of the U.S. Moreover, an analysis of all U.S. states from 1995-2018 demonstrates that Texas persistently ranks highly among all U.S. states in the proportion of children that are uninsured.[5] Because having insurance makes access to care easier, we hypothesize that, relative to the rest of the U.S., children in Texas are more likely to have overall MMR nonreceipt due to a greater chance of being uninsured.

3. Data

Data for this study are from the National Immunization Survey (NIS), a nationally representative survey starting in 1995 that targets children between the ages of 19 and 35 months living in the United States. We primarily examine the NIS from 2008-2018 because data on an individual child's insurance status is not available until 2007 and data for our instrument measure, Medicaid and Children's Health Insurance Program (CHIP) children's upper income limit by state, is not available until 2008.[6] Following Smith et al. (2008), we restrict our analysis to children with adequate medical provider data. In the rest of the U.S. data, we weight 151,129 children to

represent 32,975,317 children for the rest of the U.S. population. In the Texas data, we weight 14,536 children to represent 3,591,216 children for the state of Texas.

Table 2 presents the weighted descriptive statistics for our rest of the U.S. and Texas samples. The table also shows the differences and p-values for t-tests to evaluate whether the means for the rest of the U.S. and Texas samples are significantly different. Looking at child traits, the rest of the U.S. and Texas are similar concerning MMR nonreceipt. Approximately 8.8 percent of children have overall MMR nonreceipt in the rest of the U.S and 8.6 percent of children have overall MMR nonreceipt in Texas.[7] No statistical disparity exists between selective MMR receipt in the rest of the U.S. and Texas. Selective MMR nonreceipt occurs for 1.7 percent of children in the rest of the U.S. and 1.5 percent of children in Texas. Figure 1 shows the relationship between the rest of the U.S. and Texas overall MMR nonreceipt and between the rest of the U.S. and Texas selective MMR nonreceipt for the 1995-2018 period. For the entire timeframe, overall MMR nonreceipt appears higher for Texas while selective MMR nonreceipt is similar for Texas and the rest of the United States. Looking at 2008-2018 only, while there is more volatility in Texas, overall MMR nonreceipt appears close to the same average for the rest of the U.S. and Texas. Selective MMR nonrecipt exhibits similar movement around the same average in the rest of the U.S. and Texas during the 2008-2018 period.

Birth order in Table 2 shows a different composition between the rest of the U.S. and Texas. Approximately 41.5 percent of the rest of the U.S. sample is first born children while 38.3 percent of the Texas sample is first born children. The rest of the U.S. sample has 58.5 percent of children that are not first born while the Texas sample has 61.7 percent of children that are not first born. The gender breakdown in Table 2 is alike for the rest of the U.S. and Texas with 51.1 percent male and 48.9 percent female in the rest of the U.S. and 50.8 percent male and 49.2 percent female in Texas. Children ages 19-23 months occur with similar frequency in the rest of the U.S. and Texas at 30.1 percent and 31.0 percent, respectively. Age composition reveals similar magnitudes for the two samples for children ages 24-29 months. 34.3 percent of the rest of the U.S. sample is children ages 24-29 months while 33.1 percent of the Texas sample is children ages 24-29 months. The percent of children ages 30-35 months is nearly identical for the samples with 35.6 percent for the rest of the U.S. and 35.9 percent for Texas.

Race and ethnic breakdown is dissimilar between the two samples for every indicator of race and ethnicity we employ. Specifically, the rest of the U.S. sample breaks down to 23.7 percent Hispanic, 52.8 percent non-Hispanic white, 12.0 percent non-Hispanic black, and 11.5 percent other/multiple. Texas, meanwhile, has a sample composition of 52.8 percent Hispanic, 29.5 percent non-Hispanic white, 9.5 percent non-Hispanic black, and 8.2 percent other/multiple. The family income to poverty ratio is different for the two samples. The rest of the U.S. has an average family income to poverty ratio of 1.834 while Texas has an average family income to poverty ratio of 1.619.

Marital status of a child's mother diverges between the two samples. For the rest of the U.S., children with a married mother make up 65.5 percent of the sample while 34.5 percent have a mother who is not married. The Texas sample shows that 63.6 percent of children have a married mother while 36.4 percent of children have an unmarried mother.

With the exception of mothers with 12 years of education, the rest of the U.S. and Texas samples are unalike for measures of maternal education. In the rest of the U.S. sample, 16.7 percent of children have a mother with less than 12 years of education, 26.5 percent have a mother with 12 years of education, 21.5 percent have a mother with greater than 12 years of education without graduating college, and 35.3 percent have mother a mother who is a college graduate. The Texas sample indicates that 24.9 percent of children have a mother with less than 12 years of education, 26.3 percent have a mother with 12 years of education, 20.4 percent have a mother with greater than 12 years of education without graduating college, and 28.4 percent have mother a mother who is a college graduate.

For medical practice type, the rest of the U.S. and Texas samples are different with 12.1 percent of the U.S. sample receiving care at all public facilities and 9.9 percent of the Texas sample receiving care at all public facilities. The rest of the U.S. and Texas samples deviate with 56.8 percent of the rest of the U.S. sample and 61.6 percent of the Texas sample obtaining care at all private facilities. The samples are also dissimilar with 29.9 percent of the rest of the U.S. sample and 27.5 percent of the Texas sample receiving care at other facilities. For the insurance status measures, the rest of the U.S. and Texas are not alike. Approximately 95.8 percent of children are insured and 4.2 percent of children are uninsured in the rest of the U.S. while 93.1 percent of children are insured and 6.9 percent of children are uninsured in Texas.

3.1 Econometric Model

To evaluate the determinants of overall and selective MMR nonreceipt and explore our hypotheses, we take an approach similar to Smith et al. (2008) by employing pooled probit regression.[8] The estimating equations provide the specification of our model:

$$Y_{its} = \theta + \delta X_{its} + \omega U_{its} + d_t + \eta_{its} \tag{1}$$

$$Y_{its} = \theta + \delta X_{its} + \omega U_{its} + \sigma Texas_i + d_t + \eta_{its} \tag{2}$$

$$Y_{its} = \theta + \delta X_{its} + \omega U_{ts} + \sigma_1 Texas_i + \sigma_2 Texas_i * U_{its} + d_t + \eta_{its} \tag{3}$$

We use the vector Y_{its} to represent the binary dependent variables overall and selective MMR nonreceipt for child i in year t and state s. Child trait variables are denoted by vector X_{its}, which includes birth order of the child, gender of the child, age category of the child, race of the child, income to poverty ratio of the family, maternal marital status, maternal education, and the type of medical provider. Our controls follow Smith et al. (2008) with the exception of the income to poverty ratio. We use the income to poverty ratio instead of family income group because the income to poverty ratio is adjusted annually, which provides an income measure that is adjusted for inflation. We represent uninsured status using the vector U_{iys}, where 1 is if a child is uninsured and 0 is if a child is insured. The vector *Texas* is 1 if a child resides in Texas and 0 otherwise. Time dummies correspond to the vector d_t. The idiosyncratic error term is η_{its}.

For each dependent variable, estimating equation (1) serves as our base specification. It considers the child trait time varying determinants without controlling specifically for children residing in the state of Texas. A second estimating equation (2) adds a binary indicator for children residing

in Texas. Finally, our third estimating equation (3) adds an interaction term for being uninsured and the binary indicator for children residing in Texas.

3.2 Potential Endogeneity

Potential endogeneity of uninsured status stemming from unobservable characteristics such as noncognitive skills of a child's parent could influence the relationship between MMR nonreceipt and uninsured status. According to Heckman et al. (2006), noncognitive skills can be defined as skills such as persistence, motivation, and personality traits. Additionally, Currie (2009) notes that noncognitive skills could be measures of mental health.

If endogeneity exists due to noncognitive skills of the parent, our estimates will be biased. We do not assign an expected direction to this bias because the bias could be positive or negative. As Damnjanović et al. (2018) suggest, the parental decision for childhood vaccination is multifaceted and multifactorial. For example, more highly motivated parents could be more likely or less likely to have their children vaccinated due to prior beliefs, attitudes, confirmatory bias or misinformation, as Smailbegovic et al. (2003), Azizi et al. (2017), Smith et al. (2008), Chang (2018), Carrieri et al. (2019), and Qian et al. (2020) document. More highly motivated parents may also be more or less likely to have their child covered by health insurance for reasons such as changes in stigma related to public assistance, self-control problems, or administrative barriers, as Sasso and Buchmueller (2004), Gruber (2008), and Frean et al. (2017) suggest. We do not quantify the potential bias from noncognitive skills because other omitted factors may exist. To explore potential endogeneity empirically, we employ an instrumental variables approach to test for endogeneity using a method from Wooldridge (2019, pp. 515-516).

The instrumental variable in this study is the Medicaid and Children's Health Insurance Program (CHIP) child's family upper income limit by state that is measured by percentage of the federal poverty level. We obtain data on this measure from the Kaiser Family Foundation (2020). Seiber and Goldstein (2019), Goldstein et al. (2014), and Howell and Kenney (2012), among others, document the impact of the Children's Health Insurance Program Reauthorization Act of 2009 and the Patient Protection and Affordable Care Act of 2010 on reducing uninsurance among children by raising income eligibility limits for Medicaid and CHIP. In essence, we expect a negative relationship between the child's family upper income limit and uninsured status. In the case of our third estimating equation, we interact children's upper income limit by state with our binary variable for a child's residence in Texas as the instrument for the interaction term of uninsured status and children's residence in Texas.

4. Results

Results of our endogeneity tests using the approach of Wooldridge (2019, pp. 515-516) indicate no rejection of the null hypothesis that uninsured status can be treated as an exogenous regressor for overall MMR nonreceipt in all three of our estimating equations (C-statistics ≤ 3.654 and $p \geq 0.161$).[9] We also are unable to reject the null hypothesis that uninsured status can be treated as an exogenous regressor for selective MMR nonreceipt in our first two estimating equations (C-statistics ≤ 0.153 and $p \geq 0.696$). We do find moderate evidence of endogeneity for selective MMR nonreceipt in our third estimating equation that includes a binary indicator for children residing in

Texas and an interaction term for being uninsured and the binary indicator for children residing in Texas (C-statistic = 4.834 and p = 0.0892).

Our instrumental variable, Medicaid and CHIP child's family upper income limit by state and its interaction with our Texas residence indicator pass the F-test threshold of F-statistics ≥ 10, as Staiger and Stock (1997) recommend. More specifically, we have first stage F-statistics ≥ 15.05. Additionally, our instrumental variable and its interaction with our Texas residence indicator have no statistically significant relationship directly with overall MMR nonreceipt. In the case of selective MMR nonreceipt, there is no direct statistically significant correlation with our instrumental variable. There is, however, a direct statistically significant correlation between selective MMR nonreceipt and the interaction of our instrumental variable and Texas residence at the five percent level. Overall, the evidence suggests we do not have a weak instrument problem and that our instrumental variable, child's family upper income limit, does not correlate directly with our dependent variables. However, we do note that the interaction of child's family upper income limit and Texas residence correlates directly with selective MMR nonreceipt in estimating equation 3.

The results of our regressions appear in Table 3 and 4. We present average marginal effects for ease of interpretation instead of reporting odds ratios as in Smith et al. (2008).[10] We also use robust, weighted standard errors to adjust for sample design and heteroskedasticity. We report key variables in Tables 3 and 4 that include a subset of child traits and our Texas specific estimates. The first column of each table depicts our base specification results. The second column shows our results when including a binary indicator for Texas residence. The third column includes results from interacting our Texas residence binary indicator with our state population variables. Because we have moderate evidence of endogeneity for our third estimating equation for selective MMR nonreceipt, we include a fourth column in Table 4 that presents second stage linear probability model results.[11]

Table 3 displays average marginal effects results for overall MMR nonreceipt. Control variable child trait coefficients are nearly identical across all three columns. Relative to corresponding reference groups, children that are 24-29 months in age, 30-35 months in age, obtain medical services from all private providers, and obtain medical services from other facilities, have a lower probability of overall MMR nonreceipt. More specifically, children who are in the 24-29 months and 30-35 months age groups associate with a 2.7 percentage point and 3.4 percentage point reduction in the probability of overall MMR nonreceipt, respectively, relative to the reference group of children who are aged 19-23 months. Statistical significance for both coefficients occurs at the one percent threshold. Children who receive care from all private and other facilities correlate with a 7.8 percentage point and 4.8 percentage point decrease in the probability of overall MMR nonreceipt, respectively, relative to children who receive care from public providers. The coefficients are statistically significant at the one percent level.

Children that are non-Hispanic white, non-Hispanic black, and other/multiple race and ethnicity have a higher chance of overall MMR nonreceipt relative to the reference category of Hispanic children. Statistical significance exists at the five percent threshold or lower for all of the race and ethnicity coefficients. Magnitudes show that non-Hispanic white, non-Hispanic black, and other/multiple children associate with 2.2, 1.5, and 1.1 percentage point increases in the probability

of overall MMR nonreceipt relative to Hispanic children.

Relative to insured children, uninsured children have a greater chance of MMR nonreceipt. In the first two columns of Table 3, uninsured children in the entire U.S. correlate with a 10.0 percentage point increase in the probability of overall MMR nonreceipt. The third column of Table 3 indicates that uninsured children in the rest of the U.S. (i.e. excluding Texas) associate with a 10.8 percentage point increase in the probability of overall MMR nonreceipt. Statistical significance occurs at the one percent level for all of the uninsured coefficients.

Texas determinants appear in the second and third column of Table 3. The second column includes a binary indicator, Texas, for residing in the state of Texas. The Texas coefficient is statistically insignificant in the second and third columns of Table 4. The third column of Table 4 adds an interaction terms for residing in Texas and uninsured status. The coefficient for the interaction of Texas residence and uninsured status is statistically significant at the one percent threshold. Uninsured children in the state of Texas correlate with a 3.1 percentage point decrease in the probability of overall MMR nonreceipt relative to uninsured children in the rest of the U.S. Combining the results for uninsured children in the rest of the U.S. and uninsured children in Texas, uninsured Texas children associate with a 7.7 percentage point increase in the probability of overall MMR nonreceipt relative to insured Texas children.

Table 4 shows average marginal effects results from pooled probit in the first three columns for selective MMR nonreceipt. The fourth column shows constant marginal effects results from the two-stage linear probability model. Control variable child trait coefficients are identical across the first three columns. Statistical significance at the one percent level is present for the coefficients pertaining to private practice type. All other child trait coefficients are statistically insignificant with magnitudes approaching 0.000. Relative to the reference category of all public facilities, getting care from all private facilities associates with a 0.7 percentage point increase in the probability of selective MMR nonreceipt. The fourth column of Table 4 shows a statistically insignificant relationship between private practice type and selective MMR nonreceipt.

Looking at the uninsured coefficients, the first column shows statistical significance at the one percent threshold. Uninsured children in the U.S. correlate with a 0.7 percentage point increase in the probability of selective MMR nonreceipt relative to insured children in the U.S. There is no statistical significance, however, for the uninsured coefficients in the second, third, and fourth columns of Table 4. Texas residence correlates show no statistical significance in second, third, or fourth columns. Finally, the interaction of Texas residence and uninsured status is also statistically insignificant.

Evaluating the overall results, support exists for our hypothesis that the probability of overall MMR nonreceipt correlates positively with children being uninsured. Specifically, the results indicate that uninsured children in the U.S. associate with a 10 percent point increase in the probability of overall MMR nonreceipt. Therefore, a significant increase in the proportion of uninsured children could make measles outbreaks more likely. According to Guerra et al. (2017), measles is a highly contagious disease. Therefore, even a marginal increase in the probability of overall MMR nonreceipt could be significant in terms of spreading measles. Our findings also coincide with other research studies such as Hill et al. (2019), Simon et al. (2017), Zhen et al.

(2004), Allred et al. (2007) and Becton Jr et al. (2008) that find a significant relationship between health insurance and vaccination receipt.

We do not find support for our hypothesis that compared to the rest of the U.S., uninsured children in Texas are differentially likely to have overall MMR nonreceipt. Instead, we find that uninsured children in Texas are less likely to have overall MMR nonreceipt relative to uninsured children in the rest of the U.S. Programs in place such as the Texas Vaccines for Children Program or Be Wise – Immunize initiative may help explain this result.[12] Nevertheless, the net magnitude of our findings indicate that uninsured children in Texas do correlate with a 7.7 percentage point increase in the probability of overall MMR relative to insured children in Texas. Given the highly contagious nature of measles that Guerra et al. (2017) documents, Texas state policymakers may want to consider finding ways to increase access to vaccinations. Increasing the proportion of children covered by insurance or other corrective actions such as simplifying the administrative process for obtaining and staying on Medicaid or the Children's Health Insurance Program, or increasing funding for insurance navigators, on the grounds of improving public health, appears advisable.[13] Policymakers may also consider eliminating conscientious objections as a reason for vaccine exemption in public and private school systems and child-care facilities in Texas, as Thakar (2018) advocates. Cardinal et al. (2019), furthermore, note that identifying geographic clusters with increased vaccination exemption rates may help efforts to target parental education campaigns to reduce vaccine nonreceipt.

Reviewing our results for selective MMR nonreceipt, our overall evidence is similar to Smith et al. (2008). Namely, receipt of care from all privately facilities is a statistically significant regressor in this study. The size of the correlate indicates, relative to receiving care from all public facilities, a 0.7 percentage point increase in the probability of selective MMR nonreceipt when receiving care from all private facilities. While a direct comparison to the magnitudes of Smith et al. (2008) is not possible due to the use of odds ratios by Smith et al. (2008), the size of our estimates suggests that receiving care from all private facilities marginally influences selective MMR nonreceipt. Particularly, this finding implies that providers of care do not appear substantively influenced concerning the autism-MMR vaccine scare over the 2008-2018 period. Finally, our uninsured and Texas specific indicators are not consistently significant across our estimating specifications to provide any additional overall results.

4.1 Robustness Checks

We perform robustness checks of our results in Tables 5-10. Tables 5 and 6 show our results when using family income group as a child trait variable in place of the family income to poverty ratio. Swapping these indicators results in 10,214 additional observations added to our dataset. Looking at Table 5, the sign, statistical significance, and size of our child trait measures are highly similar to our results in Table 3. Comparing Table 4 to Table 6, the first column of Table 6 shows no statistical significance for our uninsured indicator, which is contrary to Table 4. The rest of the first column in Table 6, in addition to all of the second and third columns of Table 6, are similar in sign, statistical significance, and size to the results in the first column of Table 4. The fourth column of Table 6 differs significantly from the fourth column of Table 4, where there are no statistically significant findings for uninsured status, residing in Texas, or the interaction of residing in Texas with uninsured status. The fourth column of Table 6 shows that residing in Texas correlates with a

2.5 percentage point increase in the probability of selective MMR nonreceipt with significance at the five percent level. Finally, being uninsured in Texas associates with a 34 percentage point reduction in the probability of selective MMR nonreceipt with statistical significance at the five percent threshold. Taking the findings of the fourth column altogether, relative to being insured in Texas, being uninsured in Texas correlates with a 31.5 percentage point decrease in the probability of selective nonreceipt.

Tables 7 and 8 display results when replacing individual level insurance status with state level proportion of uninsured children. Because state level proportion of uninsured children data are available prior to 2008, we extend our dataset to 1999, which is the first year all of our other measures have data available. The extension amounts to adding 173,700 observations over 9 years to our dataset. Table 7 displays results that are comparable to Table 3 for our control variable child traits. Also, Table 7 shows a positive and statistically significant relationship at the one percent level between the percent uninsured children and overall MMR nonreceipt. For instance, a 10 percentage point increase in the proportion of uninsured children correlates with a 1.75 to 1.80 percentage point increase in the probability of overall MMR nonreceipt in the entire U.S. Opposite of Table 3, the interaction of Texas residence and proportion of uninsured children indicates a positive differential for residing in Texas and proportion of uninsured children. More specifically, for example, a 10 percentage point increase in the proportion of uninsured children in Texas correlates with a 1.5 percentage point increase in the probability of overall MMR nonreceipt. We argue that this finding does not override our results from Table 3 because it lacks the precision power of an individual level indicator for uninsured status. Contrary to Table 3, we also find that residing in Texas is a statistically significant and negative correlate of overall MMR nonreceipt. Residing in Texas associates with a 2.3 percentage point decline in the probability of overall MMR nonreceipt.

Table 8 reveals results for selective MMR nonreceipt. We do not include a fourth column with a two-stage least squares linear probability estimate of our third estimating equation because we contend that state proportion of uninsured children is an exogenous measure. Coefficients for control variable child traits in Table 8 are consistent with Table 4. Contrary to the results for the individual uninsured status indicator in Table 4, state proportion of uninsured children in Table 8 is statistically insignificant in all columns. While the Texas residence indicator in the second column of Table 8 is a statistically significant correlate, the Texas residence coefficient is statistically insignificant in Table 4. Finally, different from Table 4, the third column of Table 8 shows statistically significant results at the five percent threshold or lower for the interaction of residing in Texas with uninsured status.

Tables 9 and 10 show results when using state level proportion of uninsured children instead of individual uninsured status and family income group in place of the family income to poverty ratio as a child trait control variable. Family income group data are available prior to 2008, which allows us to extend our dataset from 2008 to 1997, which is the first year that all of our variables have data available. The extension adds 246,081 observations to our estimating dataset over 11 years. Similar to Table 7, Table 9 indicates comparable results to Table 3 with two exception—the interaction between Texas residence and the uninsured children proportion of the state population is positive and statistically significant in Table 9 and the Texas residence indicator in column 3 of Table 9 is statistically significant and negative. Table 10 displays results significantly analogous

to Table 8. Unlike Table 4, the Texas residence indicator in the second column of Table 10 is statistically significant and negative. Also, the interaction of Texas residence and the percent of uninsured children is negative and statistically significant in Table 10. Contrary to Tables 4 and 8, Table 10 indicates statistical significance at the ten percent level for the age 24-29 months and receiving care at other facilities correlates.

One result of note across our robustness checks is that the interaction of Texas residence and our measure of uninsured in Tables 6, 8, and 10 becomes statistically significant and negative. In other words, the uninsured in Texas may have a lower probability of selective MMR nonreceipt. Each of these robustness checks involves adding at least 10,214 additional observations to our original estimating dataset. Additional data may influence the statistical significance. Also, using family income group and state proportion of uninsured children may contribute to the statistical significance. Considering the finding of a negative correlation in Tables 6, 8, and 10 and a statistically insignificant result in Table 4, we posit that the overall evidence indicates moderate evidence of no difference between the rest of the U.S. and Texas concerning uninsured status and the probability of selective MMR nonreceipt.

5. Conclusions

This paper is the first to explore MMR vaccinations in the state of Texas in comparison to the rest of the United States. We find evidence that overall MMR nonreceipt is positively linked with uninsured status of a child. Furthermore, we report that while overall MMR nonreceipt appears less likely in the state of Texas in comparison to the rest of the U.S, overall MMR nonreceipt of an uninsured child in Texas appears more likely than overall MMR nonreceipt of an insured child in Texas.

Our empirical evidence for selective MMR nonreceipt shows significant correlates for children who receive medical services from private providers for the entire U.S. Selective MMR nonreceipt does not appear to have any systematically different trends in the state of Texas. Moreover, the size of the significant regressors for the U.S. as a whole suggests that provider type is a marginal correlate of selective MMR nonreceipt while a child's age group does not appear to matter.

This study provides new evidence for the state of Texas, however, it does not provide an overview of other states. Future research should consider different individual states and regions of the country. Should data become available directly from the state of Texas, then it should be used in place of the National Immunization Survey. Finally, future research should explore causal inference methods such as a quasi-experiment to better determine if correlates in this study are causal factors impacting selective or overall MMR immunization receipt.

Endnotes

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1. For examples of recent press articles, please see Abbott (2019), Galvin (2019) and Bever (2019).

2. For more details, please see Henry J. Kaiser Family Foundation (2018).

3. The six states are Nevada, Illinois, Arkansas, Ohio, Washington, and Oregon.

4. Because the U.S. Census changed the definition for children in the 2017 American Community Survey, data is only available in 2017-2018 for the proportion of uninsured individuals aged 18 and younger, which is why we use 2017-2018 data on the proportion of individuals 0-18 years of age in 2017-2018.

5. More specifically, Texas ranks first or second among all U.S. states in the proportion of uninsured children for 20 of 24 years from 1995-2018. Also, Texas does not rank lower than fourth in the proportion of uninsured children in any year from 1995-2018.

6. We describe our instrument measure and approach in additional detail in Section 3.2.
7. If we extend our dataset to include the years 1995-2006, 8.5 percent of children have overall MMR nonreceipt in the rest of the U.S. and 10.0 percent of children have overall MMR nonreceipt in Texas. The difference is statistically significant with a p-value less than 0.001.

8. We do not employ a panel estimator because the National Immunization Survey is an independently pooled cross section. In other words, the National Immunization Survey does not follow the same children over time.

9. We conduct our endogeneity tests by employing the linear probability model and two-stage least squares. We take this approach because the linear probability model estimates and pooled probit marginal effects estimates of Tables 3 and 4 are significantly similar in sign, size, and statistical significance.

10. Similar to Smith et al. (2008), who use pooled logistic regression, we present the results of pooled probit regressions. Results for the linear probability model estimation of Tables 3 and 4, which are available from the authors upon request, are substantively similar in sign, statistical significance, and magnitude to the average marginal effects results we present in Tables 3 and 4.

11. We attempted to obtain maximum likelihood estimates using a trivariate probit estimation process developed by Roodman (2011), but we were unable to achieve convergence. We present

the linear probability estimates in this case and openly acknowledge their shortcomings (e.g. predicting a negative probability for an outcome, which is not possible by definition).

12. For more details on the Texas Vaccines for Children Program, please see Texas Vaccines for Children Program - Immunizations Unit (2019). For more details on the Be Wise – Immunize initiative, please see Texas Medical Association (2020)

13. Evans (2018) describes some of the policy options we list here for decreasing the proportion of uninsured children in Texas.

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Table 1. Proportion of Uninsured Children

	Rest of the U.S.			Texas		
Year	Population	Number Uninsured	Percentage	Population	Number Uninsured	Percentage
1995	71,148	9,795	13.8	5,499	1,234	22.4
1996	71,224	10,554	14.8	5,577	1,367	24.5
1997	71,682	10,743	15.0	5,905	1,468	24.9
1998	72,022	11,073	15.4	5,730	1,453	25.4
1999	72,281	9,285	12.8	5,643	1,295	22.9
2000	72,314	8,617	11.9	6,075	1,398	23.0
2001	72,628	8,509	11.7	6,208	1,320	21.3
2002	73,312	8,531	11.6	6,049	1,352	22.4
2003	73,580	8,373	11.4	6,330	1,264	20.0
2004	73,791	7,949	10.8	6,306	1,333	21.1
2005	67,510	6,473	9.6	6,477	1,166	18.0
2006	67,546	6,984	10.3	6,556	1,441	22.0
2007	67,680	6,451	9.5	6,720	1,426	21.2
2008	67,723	6,192	9.1	6,783	1,181	17.4
2009	67,356	5,249	7.8	6,870	1,197	17.4
2010	67,038	4,922	7.3	6,869	996	14.5
2011	66,713	4,611	6.9	6,937	917	13.2
2012	66,497	4,401	6.6	6,965	863	12.4
2013	66,315	4,346	6.6	7,021	888	12.6
2014	66,226	3,613	5.5	7,099	784	11.0
2015	66,195	2,852	4.3	7,191	682	9.5
2016	66,126	2,607	3.9	7,273	671	9.2
2017	66,055	3,090	4.7	7,348	835	11.4
2018	65,953	3,183	4.8	7,399	873	11.8

Source: 1995-2008, U.S. Census Bureau, Current Population Survey, Annual Social and Economic Supplements; 2009-2018, American Community Survey; population and number uninsured are in thousands; Children ages 0-17 for 1995-2016; Children ages 0-18 for 2017-2018

Table 2. Descriptive Statistics in NIS 2008-2018

	Rest of U.S.		Texas			
Variable	Obs.	Mean	Obs.	Mean	Diff.	P-value
Child Traits						
MMR Vaccine Status						
MMR Nonreceipt	151,129	0.088	14,536	0.086	0.002	0.542
MMR Selective Nonreceipt	151,129	0.017	14,536	0.015	0.002	0.258
Birth Order						
First Born	151,129	0.415	14,536	0.383	0.032	<0.001
Not First Born	151,129	0.585	14,536	0.617	-0.032	<0.001
Gender						
Male	151,129	0.511	14,536	0.508	0.003	0.677
Female	151,129	0.489	14,536	0.492	-0.003	0.677
Age Group						
19-23 Months	151,129	0.301	14,536	0.310	-0.009	0.231
24-29 Months	151,129	0.343	14,536	0.331	0.012	0.120
30-35 Months	151,129	0.356	14,536	0.359	-0.003	0.703
Race and Ethnicity						
Hispanic	151,129	0.237	14,536	0.528	-0.291	<0.001
Non-Hispanic White	151,129	0.528	14,536	0.295	0.233	<0.001
Non-Hispanic Black	151,129	0.120	14,536	0.095	0.025	<0.001
Other/Multiple	151,129	0.115	14,536	0.082	0.033	<0.001
Family Income						
Income to Poverty Ratio	151,129	1.834	14,536	1.619	0.215	<0.001
Maternal Marital Status						
Married	151,129	0.655	14,536	0.636	0.019	0.015
Not Married	151,129	0.345	14,536	0.364	-0.019	0.015
Maternal Education						
<12 Years	151,129	0.167	14,536	0.249	-0.082	<0.001
12 Years	151,129	0.265	14,536	0.263	0.002	0.806
>12 Years, Non-College	151,129	0.215	14,536	0.204	0.011	0.061
Graduate						
College Graduate	151,129	0.353	14,536	0.284	0.069	<0.001
Practice Type						
All Public Facilities	151,129	0.121	14,536	0.099	0.022	<0.001
All Private Facilities	151,129	0.568	14,536	0.616	-0.048	<0.001
Other Facilities	151,129	0.299	14,536	0.275	0.024	<0.001
Insurance Status						
Insured	151,129	0.958	14,536	0.931	0.027	<0.001
Uninsured	151,129	0.042	14,536	0.069	-0.027	<0.001

Note: Selective MMR Nonreceipt is defined as receiving 3 hepatitis B, 3 polio, 4 diptheria-tetanus-acellular pertussis, and 3 *Haemophilus influenza* type b vaccines but not MMR

Table 3. Overall MMR Nonreceipt Results 2008-2018

Variable	Margins	Margins	Margins
Child Traits			
Birth Order			
First Born	-0.020***	-0.020***	-0.020***
	(0.003)	(0.003)	(0.003)
Gender			
Female	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)
Age Groups			
24-29 Months	-0.027***	-0.027***	-0.027***
	(0.003)	(0.003)	(0.003)
30-35 Months	-0.034***	-0.034***	-0.034***
	(0.003)	(0.003)	(0.003)
Race and Ethnicity			
Non-Hispanic White	0.022***	0.022***	0.022***
	(0.004)	(0.004)	(0.004)
Non-Hispanic Black	0.015***	0.015***	0.015***
	(0.005)	(0.005)	(0.005)
Other/multiple	0.011**	0.011**	0.011**
	(0.005)	(0.005)	(0.005)
Practice Type			
All Private Facilities	-0.078***	-0.078***	-0.077***
	(0.004)	(0.004)	(0.004)
Other Facilities	-0.048***	-0.048***	-0.048***
	(0.003)	(0.003)	(0.003)
Insurance Status			
Uninsured	0.100***	0.100***	0.108***
	(0.009)	(0.009)	(0.010)
State Variables			
Texas		0.001	0.004
		(0.005)	(0.005)
Texas x Uninsured			-0.031***
			(0.010)
Other Child Traits	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Observations	165,665	165,665	165,665
Wald Chi-Squared	1,159.622	1,159.680	1,165.169
Prob. Chi-Squared	0.000	0.000	0.000

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Other Child Traits include: Family Income to Poverty Ratio, Maternal Marital Status, and Maternal Education

Table 4. Selective MMR Nonreceipt Results 2008-2018

Variable	Margins	Margins	Margins	IV(2)
Child Traits				
Birth Order				
First Born	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Gender				
Female	-0.000	-0.000	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Age Groups				
24-29 Months	-0.002	-0.002	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)
30-35 Months	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Race and Ethnicity				
Non-Hispanic White	-0.002	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Non-Hispanic Black	0.003	0.003	0.003	0.002
	(0.002)	(0.002)	(0.002)	(0.003)
Other/multiple	-0.002	-0.002	-0.002	-0.004
	(0.002)	(0.002)	(0.002)	(0.002)
Practice Type				
All Private Facilities	0.007***	0.007***	0.007***	0.002
	(0.002)	(0.002)	(0.002)	(0.006)
Other Facilities	0.002	0.002	0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.006)
Insurance Status				
Uninsured	0.007***	-0.001	-0.001	-0.040
	(0.002)	(0.002)	(0.002)	(0.116)
State Variables				
Texas		-0.002	-0.002	0.027
		(0.002)	(0.002)	(0.018)
Texas x Uninsured			-0.002	-0.418
			(0.008)	(0.267)
Other Child Traits	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes
Observations	165,665	165,665	165,665	165,665
Wald Chi-Squared	82.255	82.728	83.301	
Prob. Chi-Squared	0.000	0.000	0.000	
F-Statistic				2.834
Prob. F-Statistic				0.000

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Other Child Traits include: Family Income to Poverty Ratio, Maternal Marital Status, and Maternal Education

Table 5. Overall MMR Nonreceipt Family Income Group Results 2008-2018

Variable	Margins	Margins	Margins
Child Traits			
Birth Order			
First Born	-0.020***	-0.020***	-0.020***
	(0.002)	(0.002)	(0.002)
Gender			
Female	-0.004	-0.004	-0.004
	(0.002)	(0.002)	(0.002)
Age Groups			
24-29 Months	-0.027***	-0.027***	-0.027***
	(0.003)	(0.003)	(0.003)
30-35 Months	-0.034***	-0.034***	-0.034***
	(0.003)	(0.003)	(0.003)
Race and Ethnicity			
Non-Hispanic White	0.023***	0.023***	0.023***
	(0.004)	(0.004)	(0.004)
Non-Hispanic Black	0.019***	0.020***	0.020***
	(0.005)	(0.005)	(0.005)
Other/multiple	0.011**	0.012**	0.012**
	(0.005)	(0.005)	(0.005)
Practice Type			
All Private Facilities	-0.077***	-0.077***	-0.077***
	(0.004)	(0.004)	(0.004)
Other Facilities	-0.047***	-0.047***	-0.047***
	(0.003)	(0.003)	(0.003)
Insurance Status			
Uninsured	0.100***	0.099***	0.107***
	(0.008)	(0.008)	(0.009)
State Variables			
Texas		0.004	0.008
		(0.004)	(0.005)
Texas x Uninsured			-0.029***
			(0.010)
Other Child Traits	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Observations	175,879	175,879	175,879
Wald Chi-Squared	1,280.601	1,281.005	1,286.316
Prob. Chi-Squared	0.000	0.000	0.000

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Other Child Traits include: Family Income Group, Maternal Marital Status, and Maternal Education

Table 6. Selective MMR Nonreceipt Family Income Group Results 2008-2018

Variable	Margins	Margins	Margins	IV(2)
Child Traits				
Birth Order				
First Born	-0.001	-0.001	-0.001	-0.003
	(0.001)	(0.001)	(0.001)	(0.003)
Gender				
Female	-0.000	-0.000	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Age Groups				
24-29 Months	-0.002	-0.002	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
30-35 Months	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Race and Ethnicity				
Non-Hispanic White	-0.001	-0.002	-0.002	-0.005
	(0.001)	(0.001)	(0.001)	(0.005)
Non-Hispanic Black	0.003	0.003	0.003	0.002
	(0.002)	(0.002)	(0.002)	(0.003)
Other/multiple	-0.001	-0.002	-0.002	-0.001
	(0.002)	(0.002)	(0.002)	(0.003)
Practice Type				
All Private Facilities	0.007***	0.007***	0.007***	0.022
	(0.002)	(0.002)	(0.002)	(0.032)
Other Facilities	0.002	0.002	0.002	0.015
	(0.002)	(0.002)	(0.002)	(0.027)
Insurance Status				
Uninsured	-0.002	-0.001	-0.001	0.369
	(0.002)	(0.002)	(0.002)	(0.680)
State Variables				
Texas		-0.002	-0.002	0.025**
		(0.002)	(0.002)	(0.011)
Texas x Uninsured			-0.001	-0.340**
			(0.007)	(0.159)
Other Child Traits	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes
Observations	175,879	175,879	175,879	175,879
Wald Chi-Squared	87.443	87.577	87.785	
Prob. Chi-Squared	0.000	0.000	0.000	
F-Statistic				2.349
Prob. F-Statistic				0.001

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Other Child Traits include: Family Income Group, Maternal Marital Status, and Maternal Education

Table 7. Overall MMR Nonreceipt Percent Uninsured Children Results 1999-2018

Variable	Margins	Margins	Margins
Child Traits			
Birth Order			
First Born	-0.019***	-0.019***	-0.019***
	(0.002)	(0.002)	(0.002)
Gender			
Female	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)
Age Groups			
24-29 Months	-0.024***	-0.024***	-0.024***
	(0.002)	(0.002)	(0.002)
30-35 Months	-0.033***	-0.033***	-0.033***
	(0.002)	(0.002)	(0.002)
Race and Ethnicity			
Non-Hispanic White	0.021***	0.021***	0.021***
	(0.003)	(0.003)	(0.003)
Non-Hispanic Black	0.018***	0.018***	0.018***
	(0.004)	(0.004)	(0.004)
Other/multiple	0.013***	0.013***	0.013***
	(0.004)	(0.004)	(0.004)
Practice Type			
All Private Facilities	-0.057***	-0.057***	-0.057***
	(0.003)	(0.003)	(0.003)
Other Facilities	-0.036***	-0.036***	-0.036***
	(0.002)	(0.002)	(0.002)
State Variables			
Percent Uninsured Children	0.175***	0.180***	0.164***
	(0.021)	(0.025)	(0.025)
Texas		-0.001	-0.023**
		(0.004)	(0.009)
Texas x Percent Uninsured Children			0.150**
			(0.066)
Other Child Traits	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Observations	339,365	339,365	339,365
Wald Chi-Squared	1,710.659	1,728.526	1,730.367
Prob. Chi-Squared	0.000	0.000	0.000

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Other Child Traits include: Family Income to Poverty Ratio, Maternal Marital Status, and Maternal Education

Table 8. Selective MMR Nonreceipt Percent Uninsured Children Results 1999-2018

Variable	Margins	Margins	Margins
Child Traits			
Birth Order			
First Born	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Gender			
Female	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Age Groups			
24-29 Months	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
30-35 Months	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Race and Ethnicity			
Non-Hispanic White	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Non-Hispanic Black	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)
Other/multiple	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Practice Type			
All Private Facilities	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)
Other Facilities	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)
State Variables			
Percent Uninsured Children	-0.013	0.002	0.007
	(0.009)	(0.011)	(0.011)
Texas		-0.003**	0.007
		(0.001)	(0.007)
Texas x Percent Uninsured Children			-0.059**
			(0.030)
Other Child Traits	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Observations	339,365	339,365	339,365
Wald Chi-Squared	166.259	168.184	171.354
Prob. Chi-Squared	0.000	0.000	0.000

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Other Child Traits include: Family Income to Poverty Ratio, Maternal Marital Status, and Maternal Education

Table 9. Overall MMR Nonreceipt Percent Uninsured Children and Family Income Group Results 1997-2018

Variable	Margins	Margins	Margins
Child Traits			
Birth Order			
First Born	-0.021***	-0.019***	-0.021***
	(0.002)	(0.002)	(0.002)
Gender			
Female	-0.003*	-0.002	-0.003*
	(0.002)	(0.002)	(0.002)
Age Groups			
24-29 Months	-0.026***	-0.024***	-0.026***
	(0.002)	(0.002)	(0.002)
30-35 Months	-0.034***	-0.033***	-0.034***
	(0.002)	(0.002)	(0.002)
Race and Ethnicity			
Non-Hispanic White	0.019***	0.021***	0.019***
	(0.002)	(0.003)	(0.002)
Non-Hispanic Black	0.022***	0.018***	0.022***
	(0.003)	(0.004)	(0.003)
Other/multiple	0.014***	0.013***	0.013***
	(0.004)	(0.004)	(0.004)
Practice Type			
All Private Facilities	-0.048***	-0.057***	-0.048***
	(0.002)	(0.003)	(0.002)
Other Facilities	-0.028***	-0.036***	-0.028***
	(0.002)	(0.002)	(0.002)
State Variables			
Percent Uninsured Children	0.176***	0.180***	0.163***
	(0.018)	(0.025)	(0.021)
Texas		-0.001	-0.019**
		(0.004)	(0.008)
Texas x Percent Uninsured Children			0.117**
			(0.053)
Other Child Traits	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Observations	411,746	411,746	411,746
Wald Chi-Squared	2,089.752	2,103.254	2,104.042
Prob. Chi-Squared	0.000	0.000	0.000

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Other Child Traits include: Family Group, Maternal Marital Status, and Maternal Education

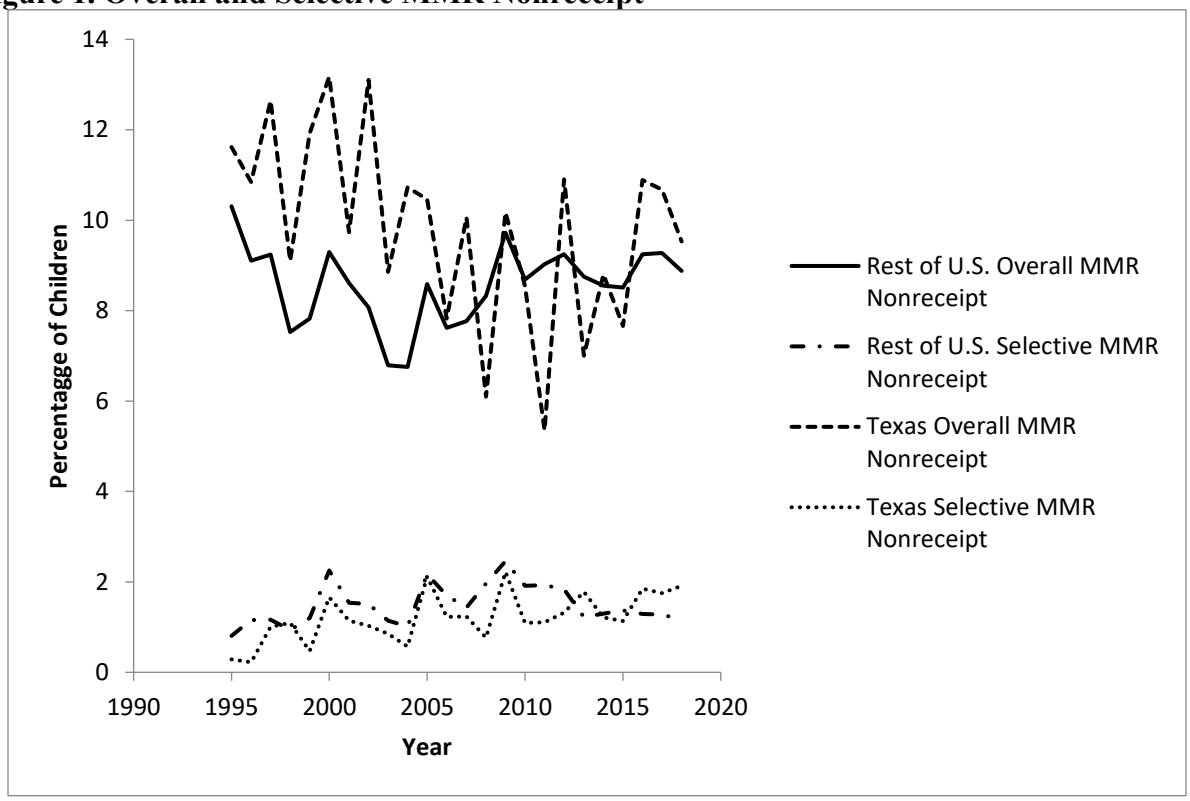
Table 10. Selective MMR Nonreceipt Percent Uninsured Children and Family Income Group Results 1997-2018

Variable	Margins	Margins	Margins
Child Traits			
Birth Order			
First Born	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Gender			
Female	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Age Groups			
24-29 Months	-0.001*	-0.001	-0.001*
	(0.001)	(0.001)	(0.001)
30-35 Months	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Race and Ethnicity			
Non-Hispanic White	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Non-Hispanic Black	0.001	0.002	0.001
	(0.001)	(0.002)	(0.001)
Other/multiple	-0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
Practice Type			
All Private Facilities	0.005***	0.006***	0.005***
	(0.001)	(0.001)	(0.001)
Other Facilities	0.002*	0.002	0.003*
	(0.001)	(0.002)	(0.001)
State Variables			
Percent Uninsured Children	-0.010	0.002	0.005
	(0.007)	(0.011)	(0.009)
Texas		-0.003**	0.008
		(0.001)	(0.006)
Texas x Percent Uninsured Children			-0.055**
			(0.026)
Other Child Traits	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
Observations	411,746	411,746	411,746
Wald Chi-Squared	203.264	204.469	205.595
Prob. Chi-Squared	0.000	0.000	0.000

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Other Child Traits include: Family Income Group, Maternal Marital Status, and Maternal Education

Figure 1. Overall and Selective MMR Nonreceipt



Notes: Selective MMR Nonreceipt is defined as receiving 3 hepatitis B, 3 polio, 4 diptheria-tetanus-acellular pertussis, and 3 *Haemophilus influenza* type b vaccines but not MMR