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**The Affordable Care Act, Public Insurance
Expansion and Opioid Overdose Mortality**

by

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The Affordable Care Act, Public Insurance Expansion and Opioid Overdose Mortality

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Abstract:

This study examines the impact of expanded public insurance, resulting from the Patient Protection and Affordable Care Act of 2010, on opioid related mortality. I utilize variation in states' decisions to expand Medicaid and variation in the timing of expansion among expanding states to measure this impact. Opioid related mortality data are examined from 1999-2015 using the National Vital Statistics multiple cause of death files. My findings suggest that public insurance expansion led to reductions in opioid related overdose deaths for heroin and other narcotics by about 26% and increases in methadone related deaths by about 18%. My study builds on recent work that shows increases in prescriptions to treat opioid use disorder in expanding states relative to non-expanding states.

1. Introduction

The rise in opioid use and opioid related overdose deaths has been the most significant substance abuse trend in the United States in recent years. In 2010, drug overdose became the leading cause of injury death in the US surpassing car accidents and firearms (Department of Health and Human Services, 2015). In the same year, passage of the Patient Protection and Affordable Care Act (ACA) began a dramatic reshaping of the American health care system. Integral to the law was expansion of health insurance access, including public insurance expansion, and more robust requirements for coverage of mental health and substance use disorder (SUD) treatments. A 2013 estimate suggests that that ACA expanded mental health and SUD benefits for 62 million Americans (HHS, 2013).

According to the Center for Disease Control (CDC) there were 47,055 drug overdose deaths in 2014 (CDC, 2016). The age-adjusted drug overdose death rate has more than doubled from 2000 to 2014 from 6.2 per 100,000 persons to 14.7 per 100,000 (CDC, 2016). In 2014, 61% of these overdose deaths involved some type of opioid (CDC, 2016). This crisis has been driven by increases in overdoses involving illegal drugs and prescription drugs that can be legally obtained. A significant population in the U.S. is abusing opioids in some form. A 2012 estimate suggests that 2.1 million people in the United States had SUDs related to prescription pain killers (Substance Abuse and Mental Health Services Administration, 2016). An additional 467,000 were addicted to heroin (SAMHSA, 2016). Recent studies have furthered our knowledge of policies impacting the crisis. This study fills a gap in the literature by examining subcategories of opioid related mortality available from the National Vital Statistics multiple cause of death file. This study identifies the causal impact of public insurance expansion resulting from the ACA on overdose deaths by using variation in Medicaid expansions across states and over time. This is the first study to document the decreases (heroin and other/unspecified narcotics) and increases (methadone) in opioid related deaths in expanding states relative to non-expanding states. Understanding these effects is of particular importance given recent legislative proposals to alter or repeal the ACA that would impact the expansion of Medicaid.

2. Policy Background

Public insurance is playing an important role in the American opioid epidemic. More specifically, Medicaid is the largest source of funding for behavioral health treatment in the United States (Bachrach et al. 2016). For patients with SUDs, most outcomes improve with admission to treatment compared to those that don't seek treatment, for example, decreases in drug use, decreases in criminal activity and increases in social and occupational outcomes (National Institute on Drug Abuse, 2012). The American Society of Addiction Medicine (ASAM) guidelines for treatment of opioid use disorder recommend that psychosocial treatment be used in concurrence with opioid use disorder medications (Grogan et al. 2016). Such treatments (both inpatient and outpatient) and medications can be prohibitively costly for the uninsured.

One of the primary goals of the ACA was to increase access to health care for the large number of uninsured in the US. Toward this goal, the ACA increased the minimum income requirement for Medicaid coverage to 138% of the poverty level. As a result of a 2012 Supreme Court decision on the ACA, the decision to expand Medicaid was left to states. 32 states and Washington D.C. have opted into Medicaid expansion (Kaiser Family Foundation, 2017). For states that opted into Medicaid expansion, increasing the minimum income requirement has created a large new pool of individuals eligible for Medicaid coverage. Medicaid is funded by state governments as well as the federal government. In order to alleviate the cost at the state level of adding individuals to Medicaid, funding for the newly eligible would be provided by the federal government for the first three years starting in 2014 (HHS, 2015). Full federal funding would then be reduced to 90% funding by 2020 (HHS, 2015). The decision to expand Medicaid was heavily influenced by state politics. Because of the politicization of the ACA it is reasonable to assume that the opioid crisis had a very limited role in state decisions to expand Medicaid and can be seen as an exogenous policy change from this perspective. Some states decided to expand Medicaid immediately when eligible, while others waited months or years before expanding

Medicaid (KFF, 2017). My identification strategy will rely on this variation in expanded access to public health insurance across states and across time.

Prior to the full implementation of the ACA, the uninsured rate among the non-elderly population had climbed to 18.2% in 2010 (KFF, 2016). The uninsured rate among the non-elderly declined to 10.5% by 2015 (KFF, 2016). Since 2010, 14,409,600 additional individuals have enrolled in Medicaid. Some of these individuals would have been eligible through pathways that existed prior to the implementation of the ACA. 11,183,800 individuals have enrolled in Medicaid through pathways that did not exist prior to the expansion of Medicaid under the ACA (KFF, 2017). The expansion of Medicaid has created a large pool of individuals with access to health services that in some cases would have been prohibitively expensive prior to implementation. Further, the politicization of the ACA has created variation across states and across time as to the availability of health services to the newly eligible.

The ACA required states that expanded Medicaid to offer Alternative Benefit Plans to the newly eligible expansion population. More specifically, Alternative Benefit Plans were required by the law to cover ten essential health benefits including treatment for SUDs (Grogan et al. 2016). However, the law does not specify what SUD treatment services must be offered. Medicaid expansion under the ACA has increased the significance of Medicaid with respect to SUDs. Bachrach et al. (2016) identify the population that qualifies for Medicaid under the expansion (income between 100%-138% of the poverty level) as more susceptible to SUDs than the general population: “The expansion population—largely single adults not traditionally covered under Medicaid before the ACA—has a higher prevalence of SUDs than populations previously eligible for Medicaid.” As of May 2017, over 74 million individuals were enrolled in Medicaid according to the Department of Health and Human Services (HHS, 2017). About 12% of adult Medicaid beneficiaries have a SUD (HHS, 2017).

2.1 Mechanisms: Potential impact of Medicaid expansion on Opioid Use Disorder

Between 2010 and 2015, a significant population within the expanding states received access to opioid use disorder medications and treatments that were quite expensive for the uninsured. The expansion eligible population has high rates of SUDs. It is estimated that 1.6 million individuals with

SUDs received health benefits as a result of the Medicaid expansion (Grogan et al., 2016). However, only a small percentage of the total population with SUDs receives treatment in a given year, about one out of ten (Center for Behavioral Health Statistics and Quality, 2016). An estimated 20.2 million adults in the U.S. had a SUD in 2015 (SAMHSA, 2016). Coverage for different types of SUD treatment was a required benefit of expansion under the ACA (Beronio et al., 2014). So for the expansion eligible population, expansion removed cost barriers to obtaining SUD treatment and prescriptions. Methadone, for example, is commonly prescribed for recovering opioid addicts, reducing the effects of opioid withdrawal while not causing a ‘high’ associated with opioid abuse. According to the National Institute on Drug Abuse, the average annual cost of methadone maintenance is \$4,700 per patient (NIDA, 2012).

But these cost barriers may not be the most important barriers to receiving treatment. More important may be a lack of individual desire to stop using, a lack of awareness of treatment options or a lack of awareness of the need for treatment (Center for Behavioral Health Statistics and Quality, 2016). By reducing the cost of treatment for opioid use disorder, Medicaid expansion may negatively impact opioid related mortality. Given the large population in the US addicted to opioids and the expense associated with treatment, individuals in states that expanded Medicaid are more likely to have access to treatment. The impact may work in the opposite direction as well. Expanding Medicaid coverage may increase the supply and decrease the cost of prescription opioids in a given area. Medicaid expansion may increase access to and decrease the cost of prescriptions opioids for patients abusing prescription opioids. Further, FDA approved opioid use disorder medications can lead to overdose deaths. From 1999-2015, there were 63,072 methadone related overdose deaths (according to National Vital Statistics System Multiple Cause of Death file, ICD-10 code T40.3 Methadone, 2017). Because the expansion of Medicaid may have both positive and negative impacts on opioids related deaths, I examine each subcategory of opioid related death available from the National Vital Statistics System (NVSS). Using this approach I attempt to disentangle the effects of the Medicaid expansion on opioids that Medicaid may fund (methadone and opioid analgesics) and opioids that Medicaid will not fund (heroin and other narcotics).

Maclean and Saloner (2017) find evidence of changes in SUD treatment in expanding states though they find a 33% increase in prescriptions approved by the FDA to treat SUDs paid by Medicaid in expanding states compared to non-expanding states (Maclean and Saloner, 2017). The FDA has approved four opioid use disorder medications: methadone, buprenorphine, and naltrexone (oral and injectable) though Maclean and Saloner (2017) do not include Methadone in their study. Maclean and Saloner (2017) also test the impact of Medicaid expansion on total alcohol poisoning and drug-related overdose deaths and find no evidence of any such impact. Given that the Medicaid expansion may have effects in both directions within subcategories of total alcohol poisoning and drug-related overdose deaths, I examine each available subcategory of opioid related death. Maclean and Saloner's evidence suggests that individuals in expanding states are responding to the reduction in cost in the form of increased demand for prescriptions used to treat SUDs. However, the cost reduction has not elicited the same response for admission to treatment. By examining more detailed categories of poisoning deaths available from the NVSS, we may better understand the impact of these cost reductions and increased demand for prescriptions to treat opioid use disorder. The effects of Medicaid expansions on poisoning deaths may be only statistically detectable when looking at individual categories of cause of deaths because of impacts in both directions described above. My results show that Medicaid expansion is associated with increases in methadone deaths and decreases in heroin and narcotics related deaths which may make the impact of the Medicaid expansion on total poisoning deaths more difficult to detect.

There are other mechanisms to consider. It may be that the passage of the ACA led to changes in the quality of care and/or other changes in benefits. In order to separate these effects I estimate a double difference-in-differences model using survey data from Grogan et al. (2016). The survey identifies 31 states (plus D.C.) in which Medicaid programs funded all medications used to treat opioid use disorder as recommended by the ASAM. Though this survey data is static and limited otherwise, it may provide insight given that states have defined substance use disorder benefit packages in different ways. Other nationwide changes associated with the ACA are controlled for with a year fixed effect.

2.2 The Opioid Epidemic

The opioid epidemic has been unfolding as these drastic changes to the American health care system have been implemented. Up until 1980, pain killers were generally prescribed for post-surgery pain, short-term pain, and for pain related to life threatening or terminal illnesses. Then our attitudes towards and uses for pain killers began to shift. In a 1980 letter to the editor in the *New England Journal of Medicine*, a reported study found less than one percent of patients prescribed pain killers became addicted (Gounder, 2013). A 1986 study published in the *Journal of Pain* concluded that, for non-cancer pain, narcotics: “can be safely and effectively prescribed to selected patients with relatively little risk of producing the maladaptive behaviors which define opioid abuse” (Gounder, 2013). Purdue Pharma began manufacturing OxyContin in 1996 and started to encourage doctors to prescribe pain killers more frequently. Kolodny et al., (2015) state: “Between 1996 and 2002, Purdue Pharma funded more than 20,000 pain-related educational programs through direct sponsorship or financial grants and launched a multifaceted campaign to encourage long-term use of OPRs for chronic non-cancer pain”. By 2001 OxyContin was the bestselling narcotic pain reliever in the country. By 2010, OxyContin was the 15th ranked prescription by retail sales (Alpert et al., 2017). OxyContin became over-prescribed and widely available in the US. In many cases patients prescribed OxyContin (following a surgery or accident for example...) became addicted. Some studies have identified OxyContin as one of the causes of the opioid epidemic (Kolodny et al., 2015).

Many policies and interventions intended to curb the opioid epidemic have focused on the supply side (Alpert et al., 2017). There is growing evidence to suggest that these supply side policies have not decreased abuse of opioids, but rather has led to substitution away from targeted opioids to others that are more readily available and/or cheaper. For example, a survey of heroin users found that 94% reportedly had switched from prescription opioids to heroin because prescription opioids “were far more expensive and harder to obtain” (Kolodny et al., 2015). Targeting the supply of prescription opioids and making them more difficult to obtain may cause more harm than good given the availability of substitutes (the potency of opioid analgesics is controlled while potency of heroin or fentanyl varies). Persistent abuse of OxyContin, led Purdue Pharma to reformulate the drug in 2010. OxyContin was typically abused by

crushing pills and then injecting or inhaling (Alpert et al., 2017). Purdue Pharma initially introduced a pill that was harder to crush and thus abuse. Alpert et al. (2017) find that one additional percentage point of OxyContin abuse prior to reformation is associated with a decrease in OxyContin misuse of 0.8 percentage points and 2.5 additional heroin deaths (per 100,000). Evans et al. (2017) find that in states where heroin was more readily available, the reformulation of OxyContin did not reduce the combined heroin/opioid death rate.

Other state level policy changes have taken place and must be considered when examining the impact of the Medicaid expansion, including three types of laws intended to address the opioid epidemic: Prescription Drug Monitoring Programs (PDMPs), Naloxone Access Laws (NALs) and Good Samaritan Laws (GSLs). A PDMP is a centralized, electronic database designed to curb abuse of prescription drugs. PDMPs can regulate over-prescription resulting from prescriber behavior and patient behavior. Evidence regarding the effectiveness of PDMPs and other policies that seek to curb excessive opioid prescribing has been mixed. Bao et al. (2016) find that enacting a PDMP was associated with about a 30 percent reduction in the prescribing rate of Schedule II opioid painkillers. Kilby (2015) shows that PDMPs reduced opioid related overdose deaths but were also associated with substitution from prescription opioids to heroin. Buchmueller and Carey (2016) find that PDMPs have not affected prescribing rates unless they included “must access” clauses, which the majority of PDMPs do not have. Naloxone (also known by brand name Narcan) is a substance that can block or reverse the effects of opioids in the case of an overdose. NALs make it easier for medical professionals to prescribe and distribute Naloxone. There are almost no concerns from medical professionals about circulation of Naloxone as it cannot be abused (Straus et al. 2013). Opioid overdose deaths are generally not sudden, bystanders able to recognize an overdose can seek medical care and help prevent overdose deaths (Rees et al. 2017). Rees et al. (2017) study the impact of GSLs and NALs on opioid related mortality and find that the adoption of NALs is associated with a 9 to 11 percent reduction in opioid-related deaths.

Increasing access to treatment may present a more long term solution to the opioid crisis. While increasing access to Naloxone can help counteract the immediate effects of an opioid overdose, it cannot

treat the underlying addiction. Evidence increasingly shows that supply side policies have led users to substitute one type of opioid for another. Increasing access to SUD treatment and mental health services should be a policy goal given changes in mortality and in substance abuse patterns. Case and Deaton (2015) show that despite longstanding declining mortality rates, there was an increase in mortality rates for US White non-Hispanics ages 45-55 between 1990 and 2010. Increasing mortality rates were driven by increases in drug and alcohol poisonings and in suicide (Case and Deaton 2015). From 2000-2010, growth in opioid overdose deaths was driven by prescription opioid abuse (see Figures 1 & 2). From 2010-2015, additional growth in opioid overdose deaths was driven by heroin overdoses. Jones et al. (2015) find increases in heroin abuse among men, young adults (18-25), non-Hispanic whites and low income individuals. Those more susceptible to heroin addiction are young adults who are more likely to be unemployed and more likely to be enrolled in Medicaid.

3. Data

The outcome variable of interest in this study is opioid related mortality. I examine a 16 year panel of data covering 1999-2015. The NVSS multiple cause-of-death mortality data contains detailed information regarding the cause of death including details regarding which type of opioids were involved in each death. I examine the NVSS data at the state year level to identify the impact the expansion of Medicaid. NVSS mortality data identify cause of death using ICD-10 codes. In this study I categorize opioid overdose deaths by ICD-10 as follows. I classify all opioid related overdose deaths as including: T40.0 (opium), T40.1 (heroin), T40.2 (other opioids), T40.3 (methadone), T40.4 (other synthetic narcotics) and T40.6 (other/unspecified narcotics). I classify narcotics related deaths as including: T40.1 (heroin) and T40.6 (other/unspecified narcotics). Further, I examine each of the above mentioned categories individually (excluding opium due to the low number of deaths associated with opium). It should be noted that any one overdose death could involve multiple ICD-10 codes (say heroin and other opioids were both used by an individual that later died). For example, from 1999-2015 there were 118,776 total deaths in the categories T40.1 (heroin) or T40.6 (other/unspecified narcotics). 3,335 of

these 118,776 deaths appear with both ICD-10 codes. I collect these data jointly so as not to double count these deaths.

I control for other changes in state law that aim to address the opioid epidemic including NALs, GSLs and PDMPs. Data regarding the implementation of GSLs comes from Rees et al. (2017). Data regarding NALs comes from the Policy Surveillance Program and from Rees et al. (2017). Data regarding PDMPs comes from the National Alliance for Model State Drug Laws. Data regarding states decisions to expand Medicaid comes from the Kaiser Family Foundation and Maclean and Saloner (2017). 32 states plus Washington D.C. have expanded Medicaid to date. Montana and Louisiana expanded Medicaid in 2016 and as such are not considered expansion states in my study (NVSS data is not currently available for 2016). Unemployment data is from the Bureau of Labor Statistics. Population data come from NVSS. State demographic data including the fraction of the state population that is white, black, ages 0-15, ages 16-35 and ages 36-64 come from the American Community Survey.

4. Identification strategy

I apply a difference-in-differences empirical strategy. Specifically, I estimate the following Poisson regression:

$$\ln(\lambda_{s,t}) = \beta_1 + \beta_2 MED_{s,t} + X_{s,t} \gamma + \delta_t + \mu_s + \varepsilon_{s,t} \quad (1)$$

The outcome of interest, $\lambda_{s,t}$, is the number of opioid related deaths in state s in year t . $X_{s,t}$ is a vector of controls including, the natural log of population, the unemployment rate in state s in year t , state demographics and the changes in pertinent state laws described in section 2.2.¹ δ_t is the year fixed effect, which will capture the aggregate time trends. μ_s is the state fixed effect. β_2 is the coefficient of interest, testing the impact of Medicaid expansion resulting from the ACA on opioid related mortality. $MED_{s,t}$ is an indicator variable equal to 1 if the expansion of Medicaid was in effect in state s and year t ($MED_{s,t}$ is

¹ In a few instances, one or two demographic controls are dropped when models do not converge.

a fraction if in place for a portion of that year and equal to 0 otherwise). I weight my baseline regressions by the population in a given state and year though I will test the robustness to this.

I examine how robust these results are to different functional forms. First, I change the outcome of interest to a death rate, equal to the rate of opioid related deaths per 100,000 in state s and in year t . I estimate this model using OLS and use the same controls with the exception of the log population control. If the outcome variable of interest results in a $\ln(\text{zero})$ transformation for some observations within a given subcategory of opioid related deaths, I add a small constant to the mortality rate before the transformation to avoid missing observations (equivalent to 1 death per 1,000,000 per state per year). The dependent variable of interest is a count at the state year level so I present Poisson results as my primary specification.

The validity of this identification strategy relies on the common trends assumption. I present event study analyses to examine the validity of the assumption. The event study analysis is limited in terms of post period data as the majority of expanding states expanded Medicaid in 2014 or later. NVSS data is only available up through 2015, so these states have 2 years of post-treatment observations (relative to Medicaid expansion in year $t = 0$ and in year $t = 1$). 6 states expanded Medicaid prior to 2014 (see table 6) and for these states I have multiple years of post-treatment observations. I estimate the following event study:

$$\ln(\lambda_{s,t}) = \alpha + \left(\sum_{t=-5}^{3+} ES_{s,t} \right) \beta + X_{s,t} \gamma + \delta_t + \mu_s + \varepsilon_{s,t} \quad (2)$$

Where ES_t is an indicator variable equal to one in treatment state s , in year t in relation to the policy change. I begin the event study 5 years prior to the policy change and group all observations 3 or more years after the policy change.²

5. Discussion

² I have also run event studies grouping all pre-treatment years 5 years or more prior to treatment. Event studies appear similar in these specifications in terms of pre-trend analysis.

This study examines the impact of Medicaid expansion on opioid related mortality. Poisson results in table 2 suggest that the implementation of Medicaid expansion following the ACA has resulted in a 26% reduction in heroin and other unspecified narcotics related overdose deaths. The magnitude of the finding is evident when considering the population weighted mean number of narcotics related overdose deaths is 280 per state year. The impact of Medicaid expansion varies by each subcategory of opioid related overdose death. Grouping each subcategory I find that the Medicaid expansion had a negative impact on opioid deaths though the coefficient is not statically significant. This may be explained by opposite effects by subcategory. The effects work in both directions by subcategory with statistically significant increases in Methadone related overdose deaths and statistically significant decreases in heroin and other/unspecified narcotics related deaths. Increases in methadone related overdose deaths may be related to increases in methadone treatment for opioid use disorder in expanding states though methadone is also prescribed for chronic pain. Expansion of Medicaid is associated with an 18% increase in methadone related deaths (column 8 of table 2) though this coefficient is no longer statically significant with a full set of controls. Methadone represents a smaller portion of total opioid deaths than narcotics, the population weighted mean number of methadone related overdose deaths is about 137 per state year.

5.1 Mechanisms

Maclean and Saloner (2017) find a 33% increase in prescriptions used to treat opioid use disorder in expanding states relative to non-expanding states. Their results suggest that the expansion of Medicaid has led to increased demand for prescriptions used to treat opioid use disorder most likely because of cost reduction. It may be useful to think of these results as a first state for my results. A back of the envelope calculation suggests that 160,000 individuals in the US with a SUD receiving health benefits as a result of the Medicaid expansion seek treatment for SUDs in a given year post expansion (1.6 million multiplied by 1/10). These medications are prescribed to help with dependence on opioids as they lead to

better health outcome compared to untreated patients with opioid use disorder. My results are most likely explained by these increases in Medicaid funded prescriptions for opioid use disorder.

I examine the heterogeneity of the impact of Medicaid expansion by age, race and gender. From 1999-2015, 89.8% percent of opioid related overdose deaths involved whites, while 65.5% involved males (NVSS, 2017). In demographic terms, the expansions eligible population is about 59% non-Hispanic White, average age 36 and split equally between males and females (Rao, 2013). Results in table 3 show that the expansion of Medicaid had a larger impact on narcotics related overdose deaths in the 35-50 age group compared to the 18-35 age group. These results suggest that the reduction in cost and increased demand for SUD treatment are more effective for those at the higher end of the age distribution. In table 4, I examine the effects of the Medicaid expansion by gender and find that the effects are similar for non-Hispanic white males and females (approximately 26% reduction) when examining narcotics related overdose deaths, though the population weighted mean number of deaths is over three times higher for non-Hispanic white males (146 per state year).

6. Robustness

In order to test robustness to functional form, I present OLS and negative binomial results in table 5, as the distributional assumptions of the Poisson model may be too restrictive (Cameron and Trivedi, 2001). OLS results in table 5 are similar in magnitude though they are less precise. OLS and negative binomial results show that my findings are relatively robust to different distributional assumptions. I present population weighted models as my primary specification. I test the robustness of these results by estimating unweighted models. These results appear relatively robust when unweighted and robust to different functional forms. I present both weighted and unweighted Poisson (tables 2 and A4), OLS (tables A3 and A5) and Negative Binomial results (tables A6 and A7).

I present an event study analysis to examine the differential trends between treatment and control states. While the counterfactual is un-observable for the treatment group post treatment, the event study

does not, in general, exhibit significant pre-trends. Pre-trends are of particular concern given the politicization of the ACA and the decision to expand Medicaid. I examine each subcategory of opioid related deaths available from NVSS and find no visible pre-trends with respect to heroin related overdose deaths (Figure 3). Careful examination of the methadone related overdose deaths event study (Figure 6) reveals changes in the pre-period though some treatment effect appears visible in the post-period.

Using survey data from Grogan et al. (2016) described in section 2.1, I estimate a double difference-in-differences model to account for differences in Medicaid benefits across states. The authors use the 2013 National Drug Abuse Treatment System Survey to identify which SUD treatments and medications are funded by Medicaid in each state. Using this model I attempt to separate the effects of changes in Medicaid benefits across states from the effects of the Medicaid expansion. Specifically, I estimate the following equation:

$$\ln(\lambda_{s,t}) = \beta_1 + \beta_2 MED_{s,t} + \beta_3 SUD_s * Post_t + X_{s,t} \gamma + \delta_t + \mu_s + \varepsilon_{s,t} \quad (3)$$

Here, SUD_s is an indicator variable equal to 1 if Medicaid covers all four opioid use disorder medications recommended by the ASAM in state s . The data is limited in that it does not vary by year.³ The double difference-in-differences results (table A8) point to expansion of Medicaid coverage rather than changes in benefit packages as leading to reductions in narcotics related overdose deaths.

As additional robustness checks, I run placebo regressions. First, I test if this model can explain demographic changes by state and year (see table A9). Second, I move the measure of Medicaid expansion to the left hand side to test if the covariates jointly explain the state level decision to expand Medicaid (table A10). Next, I re-estimate equation 1, adding a dummy variable that is a 2 year lead to the policy change in expansion states (equivalent to the event study variable for year $t = -2$, see table A11). In all, I run 19 placebo models and find only one coefficient that is statistically significant. Finally, I re-

³ I assume the post period to be 2011 and subsequent years, the first full year after the passage of the ACA.

estimate equation 1 dropping all early and late expanding states such that each treatment state expanded Medicaid on Jan 1st 2014 (table A12).

7. Conclusion

My results build on recent papers from Maclean and Saloner (2017) and Wen et al. (2017). Maclean and Saloner (2017) find no reduction in total alcohol and drug poisoning/overdose deaths in expanding states relative to non-expanding states. But I find statistically significant impacts in subsets of total alcohol and drug poisoning/overdose deaths. Maclean and Saloner (2017) find a 33% increase in prescriptions used to treat opioid use disorder in expanding states relative to non-expanding states. Wen et al. (2017) find a 70% increase in Medicaid-covered buprenorphine prescriptions in 2014 in expanding states. These papers suggest that expanded Medicaid programs are playing a vital role in funding opioid use disorder medications. I expand on these findings by examining each category of opioid related mortality available from the NVSS. These increases in Medicaid funded prescriptions used to treat opioid use disorder most likely explain the reduction in opioid related deaths in expanding states.

Reducing out of pocket cost and increasing access to treatment (inpatient, outpatient and prescriptions for opioid use disorder) may be the most effective way to combat the opioid crisis. Mounting evidence points to the shortcoming of other policies implemented to address the crisis. Naloxone has prevented many potential opioid overdose deaths but does not treat addiction. Katharine Q. Seelye of the New York Times writes: “many users overdose more than once, some multiple times, and each time, naloxone brings them back” (Seelye, 2016). In Middletown Ohio, City Councilman Dan Picard has even suggested capping the number of Narcan doses at 3 per user (Hoing, 2017). Restricting the supply of opioids and creating abuse deterrent versions of prescription opioids has led to unintended consequences given the availability of substitutes. Cicero, et al. (2014) examine data on heroin users entering treatment and find that 75% of users’ first opioid use came in the form of a prescription opioid and by 2010, 94% of users’ selected heroin because prescription opioids were becoming too expensive and/or hard to obtain. This mounting evidence of substitution among opioid users points to the need for

policy to move away from the supply side approach. In 2015, an estimated 441,000 non-elderly adults were uninsured and addicted to opioids (Zur, 2017). For these individuals, effective treatment may simply be too costly to obtain. This study points to the importance of expansion of coverage and reduction of cost for SUD treatment as effective policy in combatting the opioid epidemic.

8. Tables and Figures

Table 1: Population Weighted Summary Statistics	Mean	Std. Dev	Min	Max
All Opioids	747.36	581.44	1	2,758
All Opioids Crude Rate	6.33	3.69	0.2	36
Heroin	175.83	200.08	0	1,458
Heroin Crude Rate	1.40	1.60	0	12.6
Heroin and Other/Unspecified Narcotics	280.86	250.68	0	1,583
Heroin and Other/Unspecified Narcotics Crude Rate	2.32	1.98	0	13.6
All Opioids Excluding Heroin	618.04	487.44	1	1,947
All Opioids Excluding Heroin Crude Rate	5.28	3.13	0.2	30.8
All Opioids Excluding Methadone and Synthetic	579.62	471.02	0	2,113
All Opioids Excluding Methadone and Synthetic Crude Rate	4.80	3.00	0	29.7
All Opioids Excluding Methadone	645.54	517.51	1	2,690
All Opioids Excluding Methadone Crude Rate	5.41	3.42	0.2	35
All Opioids Excluding Synthetic	684.61	537.32	0	2,193
All Opioids Excluding Synthetic Crude Rate	5.75	3.29	0	30.8
Other Opioids	336.49	323.05	0	1,226
Other Opioids Crude Rate	2.74	2.09	0	25.9
Methadone	137.09	120.40	0	581
Methadone Crude Rate	1.23	0.91	0	6.1
Other Synthetic Narcotics	97.97	112.58	0	1,255
Other Synthetic Narcotics Crude Rate	0.92	1.17	0	21.6
Other/Unspecified Narcotics	111.65	120.72	0	641
Other/Unspecified Narcotics Crude Rate	0.99	1.21	0	9.1
Medicaid Expansion	0.104	0.30	0	1
NAL	0.161	0.354	0	1
GSL	0.116	0.311	0	1
PDMP	0.661	0.474	0	1
Unemployment Rate	6.254	2.089	2.3	13.7

Table 2: Poisson Regression Results

Dependent	All Opioids	All Opioids	All Opioids	Narcotics	Narcotics	Narcotics	Methadone	Methadone	Methadone
Medicaid Expansion	-0.113 (0.0984)	-0.0783 (0.0738)	-0.0686 (0.0666)	-0.305*** (0.0880)	-0.289*** (0.0744)	-0.297*** (0.0783)	0.308*** (0.103)	0.165** (0.0697)	0.0890 (0.0775)
Log Population	-2.814*** (0.836)	-3.342*** (0.903)	-3.311*** (0.863)	-3.592** (1.459)	-3.491** (1.374)	-3.538** (1.405)	-1.941** (0.856)	-2.305** (0.895)	-2.295*** (0.847)
Unemployment Rate		0.0355** (0.0161)	0.0385** (0.0159)		-0.00240 (0.0399)	-0.00761 (0.0397)		0.0855** (0.0343)	0.0670*** (0.0202)
Naloxone Access Laws			0.0182 (0.0410)			0.0916 (0.0635)			0.236*** (0.0631)
Good Samaritan Laws			-0.131 (0.0929)			-0.163 (0.124)			-0.123 (0.0904)
Prescription Drug Monitoring			-0.0500 (0.0476)			-0.0388 (0.0842)			-0.0282 (0.0610)
Age and Demographic Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Mean of Dependent	747.36	747.36	747.36	280.86	280.86	280.86	137.09	137.09	137.09
N	867	867	867	867	867	867	867	867	867

Notes: Population weighted estimates

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table 3: Heterogeneity Results - Heroin and Other Unspecified Narcotics Related Deaths

Dependent	Ages 18-35	Ages 18-35	Ages 36-50	Ages 36-50
Medicaid Expansion	-0.168** (0.0693)	-0.181** (0.0821)	-0.396*** (0.0961)	-0.393*** (0.0972)
Log Population	-2.607* (1.502)	-2.533 (1.600)	-4.290*** (1.449)	-4.538*** (1.408)
Unemployment Rate	-0.00955 (0.0433)	-0.00991 (0.0429)	0.00987 (0.0403)	0.00499 (0.0396)
Naloxone Access Laws		0.0922 (0.0707)		0.0872 (0.0705)
Good Samaritan Laws		-0.0812 (0.134)		-0.233 (0.155)
Prescription Drug Monitoring		-0.0878 (0.115)		0.00957 (0.0759)
Age and Demographic Controls	Yes	Yes	Yes	Yes
Mean of Dependent N	109.25 867	109.25 867	112.46 867	112.46 867

Notes: Population weighted Poisson estimates

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table 4: Heterogeneity Results - Heroin and Other Unspecified Narcotics Related Deaths

Dependent	Non-Hispanic White Male	Non-Hispanic White Male	Non-Hispanic White Female	Non-Hispanic White Female
Medicaid Expansion	-0.292*** (0.0721)	-0.299*** (0.0789)	-0.290*** (0.0865)	-0.306*** (0.0937)
Log Population	-4.870*** (1.389)	-4.779*** (1.386)	-5.568*** (1.473)	-5.507*** (1.388)
Unemployment Rate	-0.00115 (0.0381)	-0.00104 (0.0374)	-0.0173 (0.0395)	-0.0210 (0.0405)
Naloxone Access Laws		0.0835 (0.0637)		0.109 (0.0802)
Good Samaritan Laws		-0.123 (0.121)		-0.180 (0.117)
Prescription Drug Monitoring		-0.0871 (0.0863)		-0.0505 (0.0719)
Age and Demographic Controls	Yes	Yes	Yes	Yes
Mean of Dependent	146.00	146.00	46.61	46.61
N	867	867	867	867

Notes: Population weighted Poisson estimates

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table 5: Robustness to Functional Form - Population Weighted

Dependent	Ordinary Least Squares			Negative Binomial		
	All Opioids	Narcotics	Methodone	All Opioids	Narcotics	Methodone
Medicaid Expansion	-0.0371 (0.116)	-0.262** (0.125)	0.203** (0.0836)	-0.114 (0.0733)	-0.407*** (0.0895)	0.168** (0.0762)
Log Population				-2.350*** (0.700)	-3.580*** (1.143)	-1.773** (0.846)
Unemployment Rate	0.0427* (0.0238)	-0.0141 (0.0388)	0.0715*** (0.0259)	0.0411** (0.0180)	-0.0173 (0.0353)	0.0881*** (0.0240)
Naloxone Access Laws	-0.0324 (0.0795)	0.0257 (0.112)	0.111 (0.0877)	-0.0390 (0.0531)	0.0362 (0.0868)	0.178** (0.0898)
Good Samaritan Laws	-0.148 (0.152)	-0.164 (0.160)	-0.147 (0.0971)	-0.145 (0.101)	-0.183 (0.115)	-0.179** (0.0805)
Prescription Drug Monitoring	-0.00659 (0.0637)	0.0200 (0.0836)	0.0155 (0.0675)	0.00640 (0.0469)	0.0499 (0.0837)	0.0578 (0.0678)
Age and Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent (before transformation)	6.33	2.32	1.23	373.34	280.86	137.00
N	867	867	867	867	867	867

Notes: 1/10 added to dependent before Log transformation to correct for missing observations (Col 2-3)

Dependent variable: Log of death rate per 100,000 (Col 1-3), Number of Deaths (Col 3-6)

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Figure 1: U.S. Annual Opioid Overdose Deaths

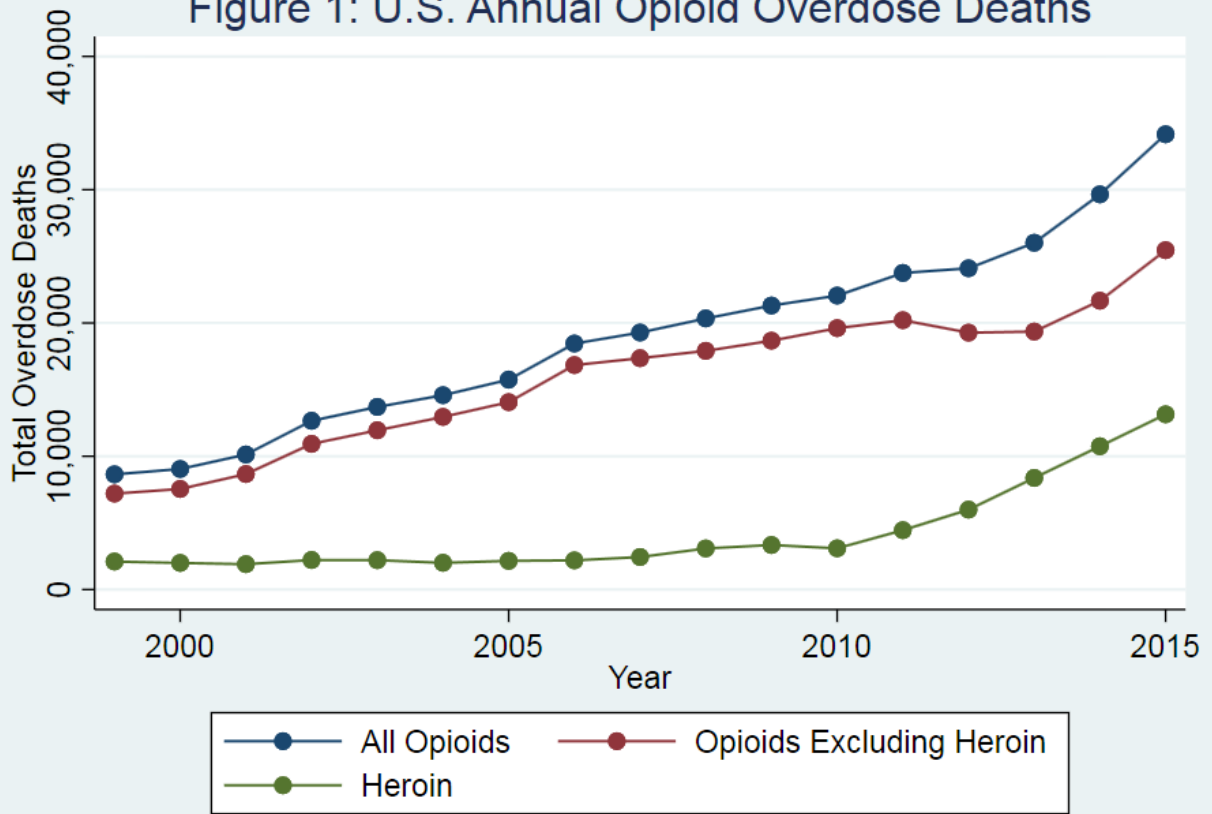


Figure 2: U.S. Annual Opioid Overdose Deaths Per 100,000

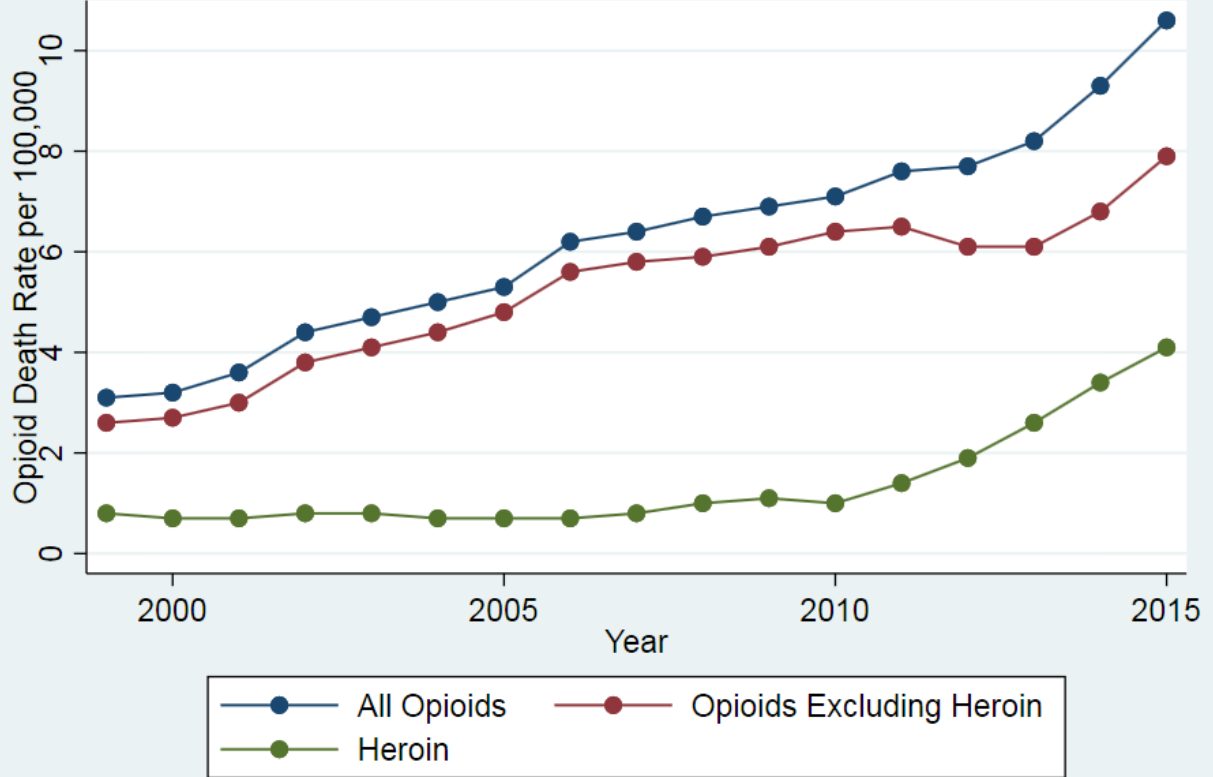


Figure 3: Event Study

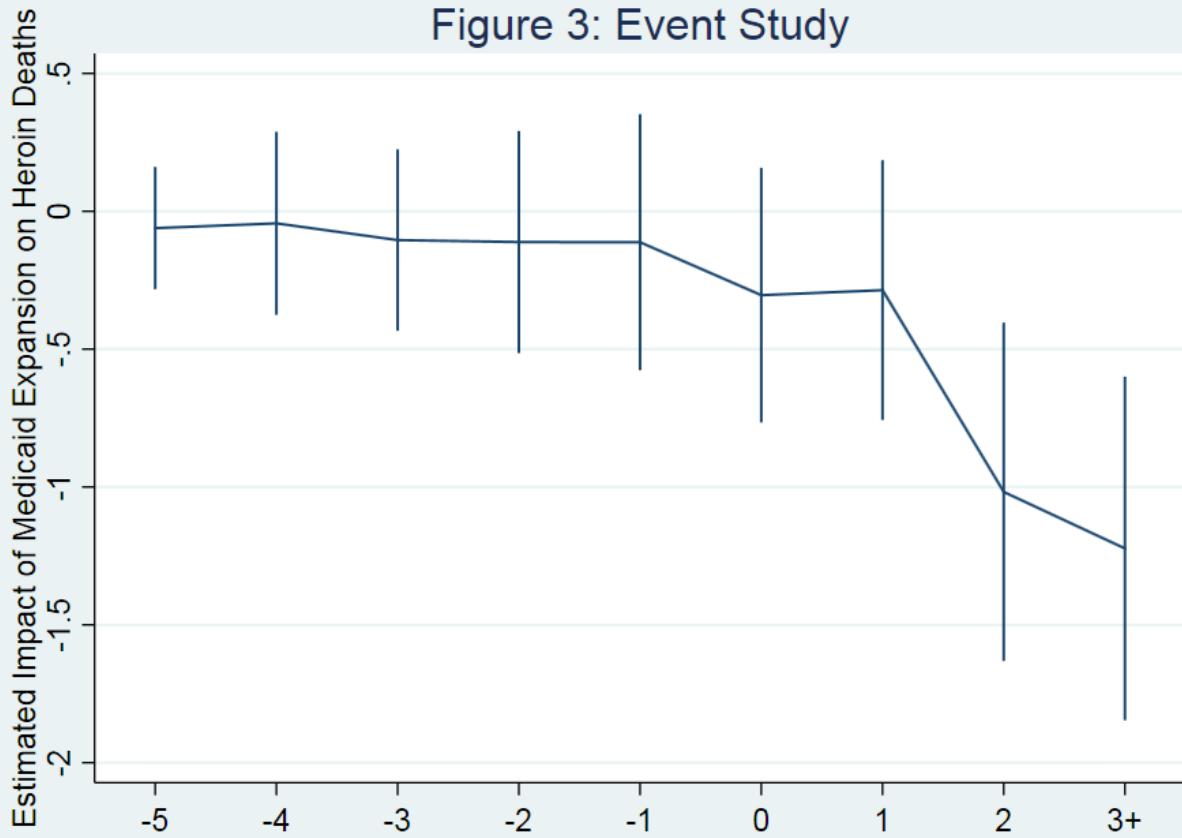


Figure 4: Event Study

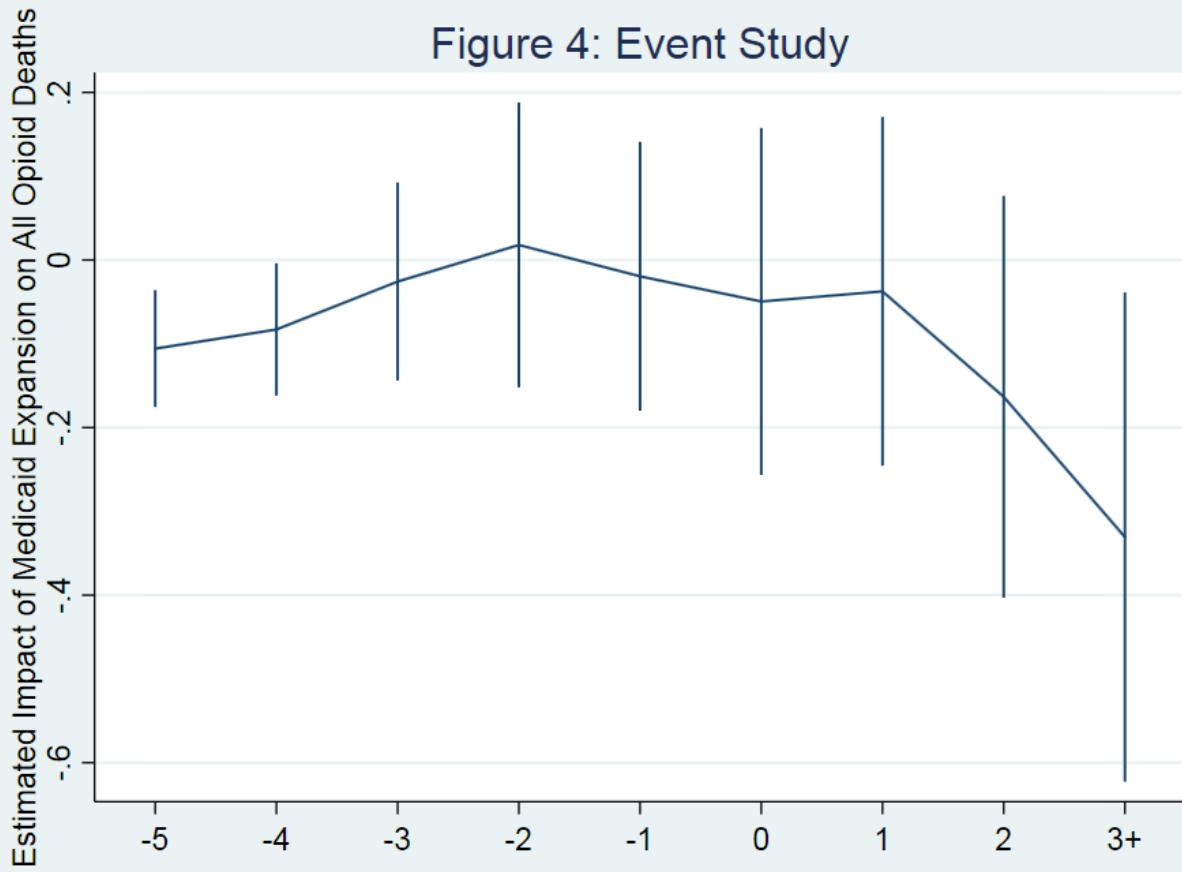


Figure 5: Event Study

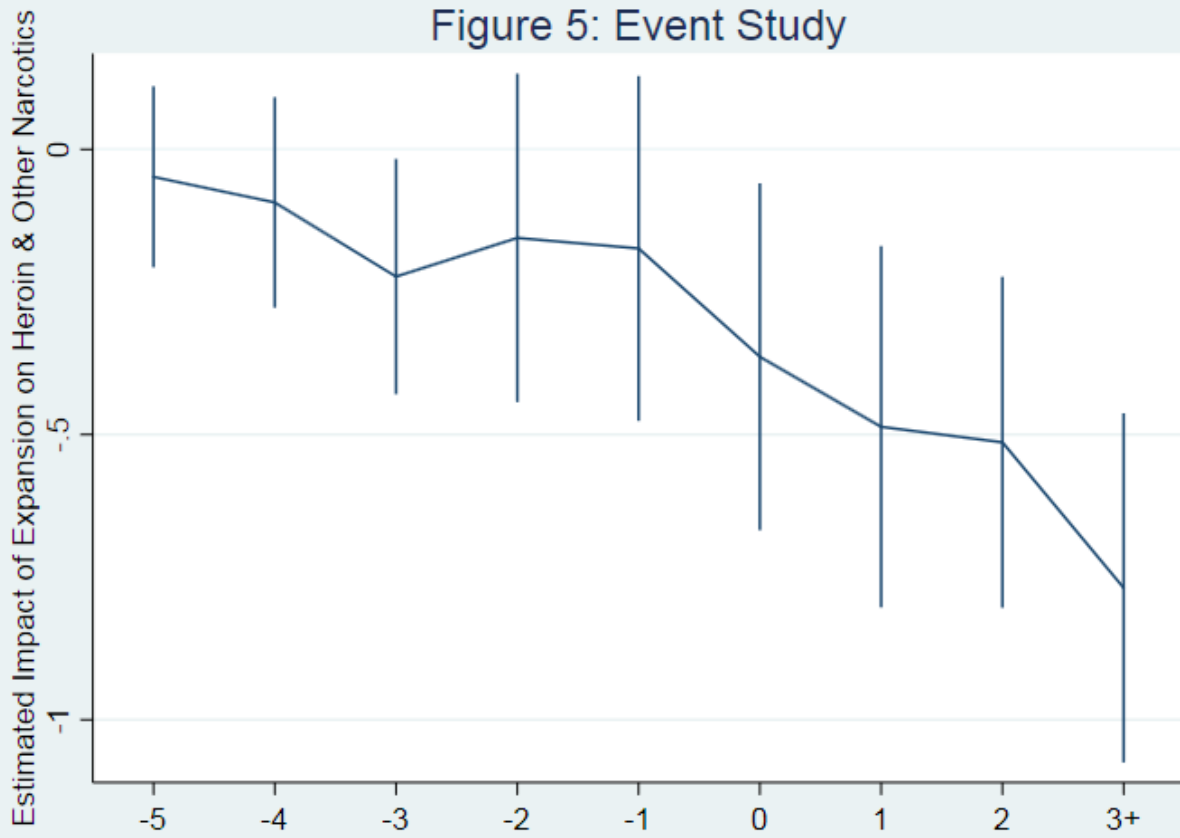


Figure 6: Event Study

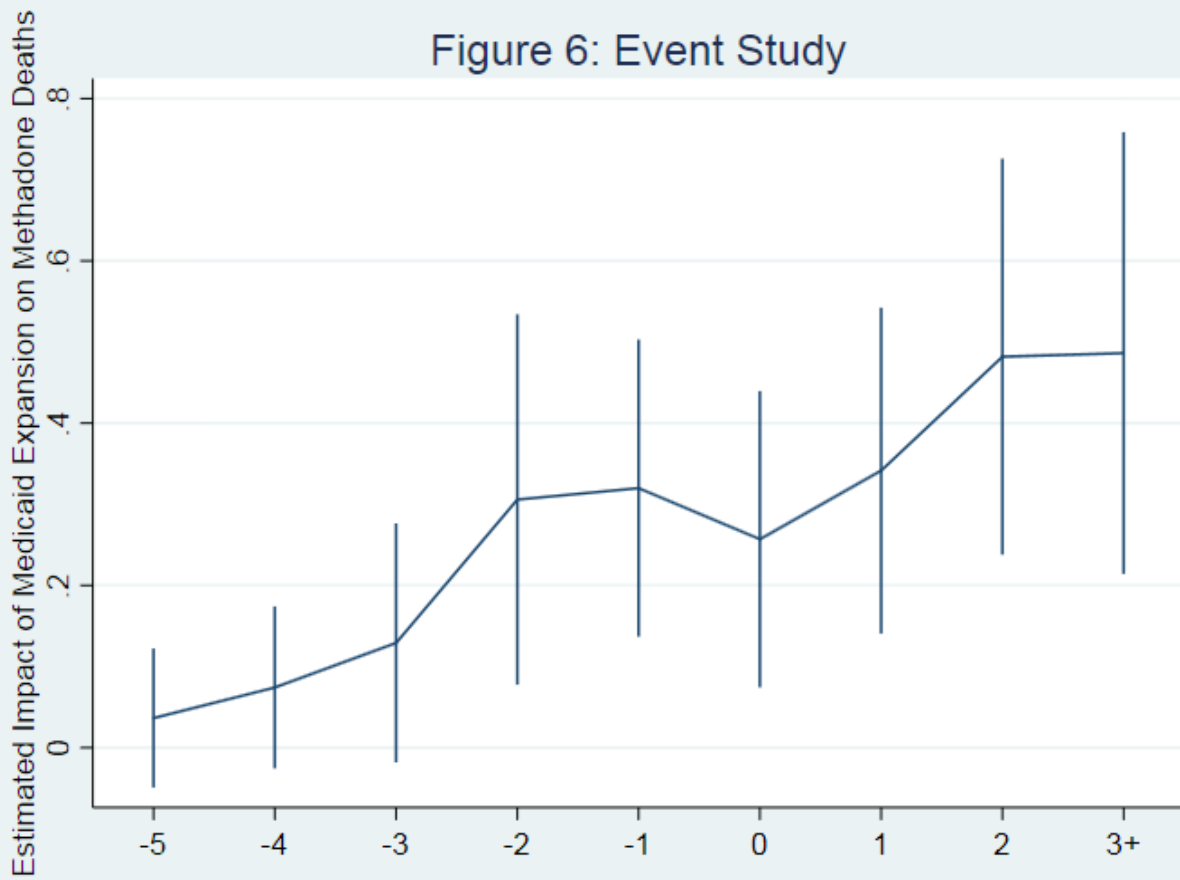


Table 6: Medicaid Expansion under the ACA

State	Expansion Date
California	7/1/2011
Connecticut	4/1/2010
District of Columbia	7/1/2010
Minnesota	3/1/2011
New Jersey	4/14/2011
Washington	1/3/2011
Arizona	1/1/2014
Arkansas	1/1/2014
Colorado	1/1/2014
Delaware	1/1/2014
Hawaii	1/1/2014
Illinois	1/1/2014
Iowa	1/1/2014
Kentucky	1/1/2014
Maryland	1/1/2014
Massachusetts	1/1/2014
Michigan	4/1/2014
Nevada	1/1/2014
New Hampshire	8/15/2014
New Mexico	1/1/2014
New York	1/1/2014
North Dakota	1/1/2014
Ohio	1/1/2014
Oregon	1/1/2014
Rhode Island	1/1/2014
Vermont	1/1/2014
West Virginia	1/1/2014
Alaska	9/1/2015
Indiana	2/1/2015
Montana	1/1/2016
Louisiana	7/1/2016
Pennsylvania	1/1/2015

Source: Maclean and Sloner (2017)

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10. Appendix

Table A1: Un-weighted Summary Statistics	Mean	Std. Dev.	Min	Max
All Opioids	373.34	409.05	1	2,758
All Opioids Crude Rate	6.90	4.64	0.2	36
Heroin	82.45	144.03	0	1,458
Heroin Crude Rate	1.29	1.70	0	12.6
Heroin and Other Synthetic Narcotics	137.00	189.51	0	1,583
Heroin and Other Synthetic Narcotics Crude Rate	2.28	2.17	0	13.6
All Opioids Excluding Heroin	311.08	333.33	1	1,947
All Opioids Excluding Heroin Crude Rate	5.94	4.06	0.2	30.8
All Opioids Excluding Methadone and Synthetic	283.09	326.02	0	2,113
All Opioids Excluding Methadone and Synthetic Crude Rate	5.13	3.76	0	29.7
All Opioids Excluding Methadone	319.21	364.27	1	2,690
All Opioids Excluding Methadone Crude Rate	5.84	4.29	0.2	35
All Opioids Excluding Synthetic	339.03	372.60	0	2,193
All Opioids Excluding Synthetic Crude Rate	6.22	4.14	0	30.8
Other Opioids	161.65	199.70	0	1,226
Other Opioids Crude Rate	3.12	2.80	0	25.9
Methadone	72.75	83.67	0	581
Methadone Crude Rate	1.43	1.09	0	6.1
Other Synthetic Narcotics	54.06	86.78	0	1,255
Other Synthetic Narcotics Crude Rate	1.08	1.50	0	21.6
Other/unspecified Narcotics	58.39	94.70	0	641
Other/unspecified Narcotics Crude Rate	1.06	1.33	0	9.1
Medicaid Expansion	0.084	0.274	0	1
NAL	0.119	0.308	0	1
GSL	0.091	0.278	0	1
PDMP	0.595	0.491	0	1
Unemployment Rate	5.787	2.009	2.3	13.7
Population	5,896,910	6,597,512	491,780	39,100,000

Table A2: Poisson Regression Results By Type

Dependent	Heroin	Other Opioids	Methadone	Other Synthetic Narcotics	Other/Unspecified Narcotics
Medicaid Expansion	-0.327*** (0.122)	-0.138 (0.0860)	0.0890 (0.0775)	0.103 (0.139)	-0.292*** (0.109)
Log Population	-6.870*** (2.090)	-4.521*** (1.071)	-2.295*** (0.847)	-4.362*** (1.107)	0.879 (1.354)
Unemployment Rate	-0.0327 (0.0511)	0.0624** (0.0269)	0.0670*** (0.0202)	-0.0617 (0.0457)	-0.000903 (0.0471)
Naloxone Access Laws	0.0327 (0.0970)	-0.214*** (0.0728)	0.236*** (0.0631)	0.195* (0.105)	0.258* (0.140)
Good Samaritan Laws	0.210 (0.141)	-0.0118 (0.0926)	-0.123 (0.0904)	-0.0795 (0.136)	-0.300** (0.135)
Prescription Drug Monitoring	-0.315* (0.175)	-0.156* (0.0820)	-0.0282 (0.0610)	0.146 (0.0922)	0.181** (0.0906)
Age and Demographic Controls	Yes	Yes	Yes	Yes	Yes
Mean of Dependent N	175.83 867	336.49 867	137.09 867	97.97 867	111.65 867

Notes: Population weighted estimates

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A3: Population Weighted OLS Results

Dependent	All Opioids	All Opioids	All Opioids	Narcotics	Narcotics	Narcotics	Methadone	Methadone	Methadone
Medicaid Expansion	-0.0593 (0.132)	-0.0776 (0.130)	-0.0371 (0.116)	-0.311* (0.166)	-0.284** (0.140)	-0.262** (0.125)	0.270*** (0.0841)	0.212*** (0.0792)	0.203** (0.0836)
Unemployment Rate		0.0380 (0.0229)	0.0427* (0.0238)		-0.0139 (0.0351)	-0.0141 (0.0388)		0.0770** (0.0296)	0.0715*** (0.0259)
Naloxone Access Laws			-0.0324 (0.0795)			0.0257 (0.112)			0.111 (0.0877)
Good Samaritan Laws			-0.148 (0.152)			-0.164 (0.160)			-0.147 (0.0971)
Prescription Drug Monitoring			-0.00659 (0.0637)			0.0200 (0.0836)			0.0155 (0.0675)
Age and Demographic Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Mean of Dependent before transformation	6.33	6.33	6.33	2.32	2.32	2.32	1.23	1.23	1.23
N	867	867	867	867	867	867	867	867	867

Notes: 1/10 added to dependent before Log transformation to correct for missing observations Cols 4-9

Dependent variable: Log of death rate per 100,000

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A4: Unweighted Poisson Regression Results

Dependent	All Opioids	All Opioids	All Opioids	Narcotics	Narcotics	Narcotics	Methadone	Methadone	Methadone
Medicaid Expansion	-0.0612 (0.0737)	-0.0626 (0.0688)	-0.0467 (0.0612)	-0.327*** (0.0813)	-0.302*** (0.0684)	-0.288*** (0.0753)	0.199* (0.104)	0.143* (0.0775)	0.133* (0.0714)
Log Population	-2.277*** (0.680)	-2.485*** (0.701)	-2.420*** (0.645)	-2.704** (1.137)	-3.107*** (1.086)	-3.070*** (1.030)	-1.916** (0.816)	-2.111*** (0.761)	-2.014*** (0.709)
Unemployment Rate		0.0230 (0.0156)	0.0262* (0.0147)		-0.0111 (0.0320)	-0.00533 (0.0308)		0.0638*** (0.0236)	0.0607*** (0.0202)
Naloxone Access Laws			0.0157 (0.0495)			0.0446 (0.0610)			0.123 (0.0883)
Good Samaritan Laws			-0.128 (0.0862)			-0.160 (0.124)			-0.157** (0.0709)
Prescription Drug Monitoring			-0.0439 (0.0415)			-0.0298 (0.0766)			-0.00827 (0.0450)
Age and Demographic Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Mean of Dependent	373.34	373.34	373.34	137.00	137.00	137.00	72.75	72.75	72.75
N	867	867	867	867	867	867	867	867	867

Notes: Unweighted estimates

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A5: Unweighted OLS Results

Dependent	All Opioids	All Opioids	All Opioids	Narcotics	Narcotics	Narcotics	Methadone	Methadone	Methadone
Medicaid Expansion	-0.0726 (0.0742)	-0.0774 (0.0768)	-0.0387 (0.0762)	-0.254** (0.0956)	-0.242** (0.0991)	-0.218** (0.103)	0.154* (0.0838)	0.0984 (0.0811)	0.140* (0.0811)
Unemployment Rate		-0.00181 (0.0200)	0.000626 (0.0198)		-0.0421 (0.0311)	-0.0407 (0.0304)		0.0277 (0.0307)	0.0304 (0.0309)
Naloxone Access Laws			-0.0602 (0.0897)			-0.0770 (0.122)			-0.0766 (0.0951)
Good Samaritan Laws			-0.109 (0.107)			-0.0609 (0.129)			-0.0953 (0.0918)
Prescription Drug Monitoring			0.0379 (0.0708)			0.111 (0.0939)			0.0101 (0.0702)
Age and Demographic Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Mean of Dependent before transformation	6.90	6.90	6.90	2.28	2.28	2.28	1.43	1.43	1.43
N	867	867	867	867	867	867	867	867	867

Notes: 1/10 added to dependent before Log transformation to correct for missing observations Cols 4-9

Dependent variable: Log of death rate per 100,000

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A6: Population Weighted Negative Binomial Regression Results

Dependent	All Opioids	All Opioids	All Opioids	Narcotics	Narcotics	Narcotics	Methadone	Methadone	Methadone
Medicaid Expansion	-0.142 (0.0871)	-0.151* (0.0803)	-0.114 (0.0733)	-0.428*** (0.107)	-0.414*** (0.0939)	-0.407*** (0.0895)	0.265** (0.105)	0.199*** (0.0767)	0.168** (0.0762)
Log Population	-1.962*** (0.721)	-2.355*** (0.747)	-2.350*** (0.700)	-3.396** (1.323)	-3.671*** (1.256)	-3.580*** (1.143)	-1.154 (0.995)	-1.673* (0.911)	-1.773** (0.846)
Unemployment Rate		0.0360** (0.0174)	0.0411** (0.0180)		-0.0117 (0.0351)	-0.0173 (0.0353)		0.102*** (0.0321)	0.0881*** (0.0240)
Naloxone Access Laws			-0.0390 (0.0531)			0.0362 (0.0868)			0.178** (0.0898)
Good Samaritan Laws			-0.145 (0.101)			-0.183 (0.115)			-0.179** (0.0805)
Prescription Drug Monitoring			0.00640 (0.0469)			0.0499 (0.0837)			0.0578 (0.0678)
Age and Demographic Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Mean of Dependent	747.36	747.36	747.36	280.86	280.86	280.86	137.09	137.09	137.09
N	867	867	867	867	867	867	867	867	867

Notes: Population weighted estimates

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A7: Unweighted Negative Binomial Regression Results

Dependent	All Opioids	All Opioids	All Opioids	Narcotics	Narcotics	Narcotics	Methadone	Methadone	Methadone
Medicaid Expansion	-0.113* (0.0586)	-0.116* (0.0617)	-0.0786 (0.0592)	-0.389*** (0.0905)	-0.367*** (0.0933)	-0.335*** (0.0933)	0.154* (0.0822)	0.110 (0.0852)	0.139* (0.0807)
Log Population	-1.447** (0.586)	-1.567*** (0.601)	-1.581*** (0.572)	-2.643*** (0.939)	-2.766*** (0.957)	-2.788*** (0.914)	-1.288 (0.786)	-1.448* (0.762)	-1.438** (0.731)
Unemployment Rate		0.00641 (0.0192)	0.00904 (0.0186)		-0.0384 (0.0256)	-0.0358 (0.0248)		0.0460* (0.0277)	0.0477* (0.0273)
Naloxone Access Laws			-0.0795 (0.0698)			-0.0967 (0.103)			-0.0104 (0.0996)
Good Samaritan Laws			-0.0973 (0.0835)			-0.101 (0.113)			-0.145* (0.0766)
Prescription Drug Monitoring			0.0216 (0.0560)			0.0797 (0.0806)			0.0492 (0.0590)
Age and Demographic Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Mean of Dependent	373.34	373.34	373.34	137.00	137.00	137.00	72.75	72.75	72.75
N	867	867	867	867	867	867	867	867	867

Notes: Unweighted estimates

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A8: Double Difference in Difference Results

Dependent	All Opioids	Heroin	Narcotics	Methadone
Medicaid Expansion	-0.0633 (0.0631)	-0.298** (0.119)	-0.292*** (0.0836)	0.0674 (0.0761)
SUD Medication Coverage	-0.0412 (0.0821)	-0.227 (0.365)	0.0106 (0.125)	0.125* (0.0726)
Log Population	-3.192*** (0.979)	-6.582*** (1.892)	-3.759** (1.522)	-2.336*** (0.859)
Unemployment Rate	0.0374** (0.0156)	-0.0380 (0.0488)	-0.00501 (0.0393)	0.0658*** (0.0207)
Naloxone Access Laws	0.0155 (0.0418)	0.0242 (0.105)	0.0933 (0.0716)	0.236*** (0.0566)
Good Samaritan Laws	-0.131 (0.0947)	0.200 (0.146)	-0.167 (0.122)	-0.133 (0.0861)
Prescription Drug Monitoring	-0.0467 (0.0474)	-0.274 (0.170)	-0.0306 (0.0722)	-0.0402 (0.0611)
Age and Demographic Controls	Yes	Yes	Yes	Yes
Mean of Dependent	747.36	175.83	280.86	137.09
N	867	867	867	867

Notes: Population weighted Poisson estimates

SUD Medication Coverage is an indicator variable equal to 1 in a given state if Medicaid covers all four opioid use disorder medications recommended by the ASAM in 2011 or later

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A9: Placebo Results

Dependent Variable:	% White	% Black	% Age 0-15	% Age 16-35	% Age 36-64	% Age 65+	Unemployment
Medicaid Expansion	0.0106 (0.00748)	-0.00336 (0.00226)	-0.00338 (0.00230)	0.00288** (0.00124)	0.000255 (0.00294)	0.000245 (0.00116)	0.237 (0.215)
Log Population	0.0829 (0.0577)	0.0161 (0.0157)	0.0424** (0.0179)	-0.0236 (0.0177)	-0.00998 (0.0154)	-0.00890 (0.0157)	0.313 (2.795)
Unemployment Rate	-0.00176 (0.00222)	0.000302 (0.000531)	-0.00177*** (0.000613)	0.000345 (0.000452)	0.00112* (0.000570)	0.000306 (0.000289)	
% Age 0-15	0.276 (0.435)	-0.224 (0.165)					-21.90* (11.09)
% Age 16-35	0.842** (0.378)	-0.00307 (0.194)					1.233 (10.43)
% Age 36-64	1.098** (0.465)	-0.0993 (0.134)					3.138 (11.52)
% White			-0.0760*** (0.0202)	0.0318* (0.0175)	0.0616** (0.0291)	-0.0173 (0.0141)	-1.969 (2.978)
% Black			-0.234** (0.0896)	0.111 (0.0919)	0.104 (0.0885)	0.0185 (0.0543)	1.339 (8.406)
Mean of Dependent	0.780	0.125	0.236	0.261	0.378	0.125	6.254
N	867	867	867	867	867	867	867

Notes: Population weighted OLS Results

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A10: Placebo Results

	(1)	(2)	(3)	(4)	(5)	(6)
Unemployment Rate	0.0290 (0.0256)	0.0265 (0.0242)	0.0194 (0.0199)	0.0138 (0.0201)	0.0137 (0.0205)	-0.00453 (0.0160)
% White	0.903 (1.000)	1.097 (0.853)	0.541 (0.752)	0.391 (0.624)	0.631 (0.590)	1.278** (0.559)
% Black	-1.912 (2.317)	-1.380 (2.173)	-3.101 (2.409)	-3.288 (2.314)	-2.625 (2.333)	-0.847 (1.745)
Log Population		- 1.322** (0.554)			-1.057* (0.528)	-0.958* (0.488)
% Age 0-15			-5.353 (3.414)	-5.242* (2.970)	-3.893 (2.802)	-3.069 (2.655)
% Age 16-35			2.480 (3.671)	1.158 (3.506)	1.032 (3.427)	0.692 (3.108)
% Age 36-64			-1.745 (5.575)	-2.734 (4.904)	-2.212 (4.663)	-2.723 (3.927)
Good Samaritan Laws				0.210* (0.125)	0.206* (0.120)	0.113 (0.107)
Prescription Drug Monitoring				0.0243 (0.0438)	0.0288 (0.0433)	0.0376 (0.0377)
Naloxone Access Laws						0.286*** (0.0956)
Joint F Stat	1.08	3.4	4.24	5.93	7.98	7.32
P Value	0.348	0.0247	0.0027	0	0	0
N	867	867	867	867	867	867

Notes: Population weighted OLS Results

Dependent Variable: Medicaid Expansion

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A11: Placebo 2 Year Lead

Dependent	Heroin	Heroin	Heroin	Narcotics	Narcotics	Narcotics
Medicaid Expansion	-0.425* (0.221)	-0.315** (0.158)	-0.346** (0.148)	-0.320*** (0.0954)	-0.294*** (0.0828)	-0.293*** (0.104)
2 Year Lead	-0.0767 (0.0812)	-0.0572 (0.0727)	-0.0811 (0.0706)	-0.0578 (0.0611)	-0.0410 (0.0635)	-0.0314 (0.0692)
Log Population	-7.198*** (1.960)	-7.459*** (2.122)	-7.264*** (2.090)	-3.656** (1.447)	-3.719*** (1.372)	-3.841*** (1.443)
Unemployment Rate		-0.0538 (0.0568)	-0.0417 (0.0499)		0.00163 (0.0402)	-0.0135 (0.0428)
NAL			0.0386 (0.105)			0.0838 (0.0673)
GSL			0.202 (0.153)			-0.193 (0.144)
PDMP			-0.299* (0.176)			-0.0218 (0.0861)
Age and Demographic Controls	No	Yes	Yes	No	Yes	Yes
Mean of Dependent	175.83	175.83	175.83	280.86	280.86	280.86
N	867	867	867	867	867	867

Notes: Population weighted Poisson estimates

2 year lead is an indicator variable equal to one in treatment state 2 years prior to policy change, equal to zero otherwise

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01

Table A12: Robustness - Drop Early and Late Expanding States

Dependent	All Opioids	All Opioids	All Opioids	Narcotics	Narcotics	Narcotics	Methadone	Methadone	Methadone
Medicaid Expansion	0.167** (0.0700)	0.117* (0.0680)	0.0974* (0.0509)	-0.193 (0.208)	-0.259* (0.147)	-0.302** (0.143)	0.263* (0.136)	0.124 (0.144)	0.0994 (0.122)
Log Population	-2.139** (0.888)	-3.014*** (0.951)	-2.977*** (0.984)	-1.978 (1.875)	-4.173** (1.684)	-4.001** (1.954)	-1.139 (0.727)	-1.986*** (0.711)	-1.938** (0.832)
Unemployment Rate		0.0182 (0.0196)	0.0237 (0.0228)		-0.0666 (0.0457)	-0.0695 (0.0433)		0.0417 (0.0259)	0.0447* (0.0235)
Naloxone Access Laws			0.0669 (0.0694)			0.160*** (0.0591)			0.0663 (0.0901)
Good Samaritan Laws			-0.0905 (0.0931)			-0.0411 (0.158)			-0.0457 (0.0975)
Prescription Drug Monitoring			-0.0201 (0.0674)			-0.0271 (0.112)			-0.0175 (0.0646)
Age and Demographic Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
N	646	646	646	646	646	646	646	646	646

Notes: Population weighted estimates

Treatment group includes only states that expanded Medicaid on Jan 1st 2014

Model includes year fixed effect and state fixed effect

Standard errors in parentheses are clustered at the state level

* p<0.10, ** p<0.05, *** p<0.01