

Opioid Use Disorder Treatment and Mortality: Evidence from Variation in Services Offered

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Abstract:

In this paper, I estimate the impact of substance abuse treatment facilities on the opioid related death rate and other outcomes that may be impacted by the opioid epidemic. Identifying variation comes from the opening and closing of treatment facilities at the county level. I exploit a new source of variation, variation across treatment facilities based on services offered and insurance type accepted. I find significant heterogeneity across treatment facilities. Treatment centers offering Medication Assisted Treatment and accepting Medicaid have a larger negative impact on the opioid related death rate than other treatment facilities.

1. Introduction

In 2016, 2.1 million Americans struggled with opioid use disorder (OUD) (National Center for Health Statistics, 2017). From 1999-2016, over 367,000 deaths have been attributed to opioid overdose according to the Wonder CDC database (ICD-10 Codes: T40.0, T40.1, T40.2, T40.3, T40.4 and T40.6, Wonder CDC, 2018). Important questions remain regarding the effectiveness of treatment for OUD and whether sufficient levels of treatment are accessible. Further, among the population with OUD seeking treatment, often patients themselves do not know what type of treatment is most effective. In this study, I examine the impact that treatment facilities are having on the opioid related death rate within the counties they are located. I utilize variation in the location of substance abuse treatment facilities at the county level and variation in the services offered and insurance type accepted by those facilities to generate causal estimates of the impact of these services on opioid related mortality. I find significant heterogeneity across different types of treatment facilities with respect to the impact they're having on opioid related mortality. The opening of one additional substance abuse facility offering Medication Assisted Treatment (MAT) and accepting Medicaid reduces the county level opioid related death rate by about 0.75 to 1 percent while one additional substance abuse facility of any other type does not have a statistically significant impact.

Swensen (2015) exploits county level variation in the number of substance abuse treatment facilities and finds that a 10 percent increase in the number of treatment facilities leads to a 2 percent decline in the drug related mortality rate. This study builds on Swensen (2015) by examining the relationship between treatment centers and opioid related mortality. Further, I exploit a new source of variation, that is, variation across different types of facilities. The American Society of Addiction Medicine (ASAM) recommends MAT to treat OUD (Grogan et

al., 2016). MAT combines behavioral therapies and prescribed medications. Three medications have been approved by the FDA to treat OUD: methadone, buprenorphine, and naltrexone. Methadone and buprenorphine, the most commonly prescribed OUD medications, suppress the body's cravings to use opioids and treat opioid withdrawal. Different OUD medications may be appropriate for different patients given differences in detox requirements, class of medication and frequency of dosage (Jones et al., 2018).

While substance abuse treatment facilities are increasingly offering MAT services, most facilities did not offer these services as of 2016. Jones et al. (2018) examine data from the National Survey of Substance Abuse Treatment Services (N-SSATS) and find that in 2016, only 4,950 of the 12,029 substance abuse facilities in the US report offering any form of MAT. There may also be a mismatch between insurance type accepted by substance abuse treatment facilities and the coverage of patients. In 2016, 7,466 of the 12,029 substance abuse facilities in the US reported accepting Medicaid (Jones et al., 2018). Among adult Medicaid beneficiaries, an estimated 12 percent have a substance use disorder (SUD) (Center for Medicaid and CHIP Services, 2015). Approximately one out of every five Americans is covered by Medicaid (Kaiser Family Foundation, 2018).

2. Literature Review

Many studies have found improvements in patient outcomes following admission to treatment for SUD (Darke et al., 1996; Stewart et al., 2002; Hossop et al., 2003; Lu and McGuire, 2002; Swensen, 2015). Darke et al. (1996) find that heroin users who sought treatment or were active in treatment faced a substantially lower risk of overdose. Stewart et al. (2002) find that admission to treatment led to reductions in non-fatal overdoses. Beyond the individual health risks, SUD imposes costs on society through health care use, use of public services, crime and

traffic accidents (Maclean and Saloner, 2018). From this perspective, treatment for SUD can reduce external costs. Bondurant et al. (2018) find that the opening of a treatment facility (at the county level) leads to a reduction in country level crime rates including homicide, aggravated assault, robbery, auto theft, and burglary. The opioid epidemic was estimated to cost the US economy \$504 billion (2.8 percent of GDP) in 2015 (The Council of Economic Advisers, 2017).

The opening or closing of a treatment facility impacts the availability of services to a given patient and can alter the cost of treatment to that patient. In 2015, 89 percent of all patients receiving treatment for a SUD received treatment in an outpatient setting (SAMHSA, 2017). This fact highlights the importance of the location of substance abuse treatment facilities and the potential mismatch between patient and facility with respect to services offered and insurance type accepted. Treatment facilities may be facing capacity constraints. Rapp et al. (2006) surveyed patients with SUD to identify potential barriers to receiving treatment. 20.2 percent of patients identified difficulty getting to and from treatment (Rapp et al., 2006). 34.3 percent of patients identified capacity constraints reporting they would be placed on a waiting list to receive treatment (Rapp et al., 2006).

2.1 SUD Treatment and Health Insurance

Cost can be a significant barrier to receiving treatment. While treatment facilities have traditionally relied on public grants and subsidies for funding, public and private insurance revenue has increased in importance in recent years (Bondurant et al., 2018). The Mental Health Parity and Addiction Equity Act of 2008 (MHPAEA) requires health insurance issuers provide parity of benefits with respect to mental health and substance use disorder as would be provided for medical/surgical benefits (Centers for Medicare and Medicaid Services, 2018b). Dave and Mikerjee (2011) leverage state differences in parity laws prior to the MHPAEA; the authors find

that state parity legislation increased treatment admissions, lowered the cost of treatment to the individual and reduced the probability that treatment visits were uninsured (Dave and Mikerjee, 2011).

The Affordable Care Act (ACA) bolstered the MHPAEA by requiring non-grandfathered health plans to cover ten essential health benefits which include mental health and substance use disorder treatment (Centers for Medicare and Medicaid Services, 2018a). In 2014, as the majority of provisions of the ACA were implemented, 20.2 million Americans struggled with a SUD (Center for Behavioral Health Statistics and Quality, 2015). The expansion of Medicaid extended health insurance coverage to millions of Americans including 1.6 million individuals with a SUD (Grogan et al., 2016). Private market expansions further extended coverage to individuals with SUDs. New evidence points to unintended consequences resulting from the ACA and MHPAEA. Increased access to treatment requires vacancies at treatment facilities though treatment facilities may already be constrained by capacity. Maclean and Saloner (2018) examine the Massachusetts health reform of 2006 which expanded health insurance access and benefits with respect to SUDs. They find that the reform had little effect on treatment quality or access to treatment (Maclean and Saloner, 2018).

More problematic may be the perverse incentives created by the ACA and MHPAEA. A scheme which has been called the “Florida Shuffle” involves treatment centers partnering up with brokers who find patients with SUDs and generous health insurance benefits. Treatment centers bill insurance issuers thousands of dollars per services like urine screening or counseling session (Seville et al., 2017). These fraudulent treatment centers rely heavy on online searches and advertising and generally do not offer legitimate services that patients need. These fraudulent treatment centers have admitted patients that subsequently died of overdose (Seville et al., 2017).

2.2 Efficacy of Methadone and Buprenorphine

Methadone and buprenorphine have been thoroughly studied in the medical literature. Mattick et al. (2009) review 11 studies that compared opioid users treated with methadone therapy to no opioid replacement therapy. Patients were found have improved outcomes across a number of different measures including patient retention and subsequent drug screens with methadone therapy (Mattick et al., 2009). Patients receiving methadone maintenance were found to have reduced criminal activity and mortality, though these results were not statistically significant (Mattick et al., 2009). Mattick et al. (2014) review 31 different studies that test the efficacy of buprenorphine. A series of randomized clinical trials have shown buprenorphine to be more effective in terms of patient retention in treatment compared to placebo (Mattick et al., 2014). Gowing et al. (2017) review 6 studies comparing buprenorphine and methadone treatment and conclude that despite somewhat limited evidence: “Buprenorphine and methadone in tapered doses appear to have similar efficacy in managing opioid withdrawal”. Connock et al. (2007) find that using a flexible dosing strategy, methadone maintenance therapy led to marginally better health gains compared to buprenorphine maintenance therapy.

Increasingly, scientific evidence points to an increased probability of success for those with OUD receiving some type of opioid replacement therapy compared to no replacement therapy. In a clinical trial for an extended release formulation of buprenorphine, after 24 weeks, about 40 percent of patients receiving the treatment were abstaining from other opioid use compared to only 5 percent of patients receiving the placebo (National Academies of Sciences, Engineering, and Medicine, 2018). The Prescription Opioid Addiction Treatment Study (POATS) followed patients dependent on prescription opioids over 42 months. Throughout multiple follow ups over 42 months, patients receiving opioid agonist therapy were found to

have better outcomes (Weiss et al., 2015). Considering the social costs associated with OUD, we may also consider the cost effectiveness of MAT. Buprenorphine maintenance therapy costs about \$6,000 per year (Wen et al., 2017). Methadone maintenance therapy is similar in cost in an outpatient setting. Connock et al. (2007) review of the buprenorphine and methadone literature concludes that both buprenorphine maintenance therapy and methadone maintenance therapy are more cost effective compared to no MAT.

2.3 Access to Treatment and MAT

Barriers to receiving treatment include capacity constraints, distance and travel constraints and cost constraints noted above (Gryczynski et al., 2011; Andrews et al., 2013; Rosenblum et al., 2011; Sigmon, 2014). Jones et al. (2015) compare rates of opioid misuse to rates of treatment capacity and find a large shortcoming in combined buprenorphine and methadone treatment capacity. Access to buprenorphine and methadone is restricted due to the potential to misuse these medications. Specifically, the Drug Addiction Treatment Act of 2000 restricts the number of patients that certified physicians can treat with buprenorphine/naloxone to 30 patients in the first year following certification and 100 in subsequent years (Blum et al., 2016). These restrictions may be preventing patients with OUD from obtaining these medications, particularly in rural areas in which there are a limited number of prescribers (Blum et al., 2016). Due to these restrictions and other factors, access to MAT has not grown as quickly as the population of Americans struggling with OUD. Access to MAT is more likely problematic in rural counties than in urban counties. Stein et al. (2015) find that there were 11.4 opioid treatment programs offering buprenorphine therapy in urban counties for every one such treatment program in rural counties.

A particular concern in this study is the potential endogeneity of services offered by treatment facilities. For this reason, it is important to understand why treatment facilities may not offer MAT. Beyond the limitations associated with physician waivers, Olsen (2015) offers possible explanations for the opposition to offering MAT in the treatment community. Several addiction specialists from the Providers' Clinical Support System for Medication Assisted Treatment (PCSS-MAT) identified three possibilities in the following quote from Olsen (2015):

1. Owners of “drug-free” or “abstinence-based” facilities often do not have clinical backgrounds so have personal or ideological perspectives on addiction and its care.
2. Treatment facilities may have financial incentives for restrictive clinical policies as relapse may result in re-admissions and additional revenue.
3. The historical context of the “drug-free” model does not adequately differentiate between different substance use disorders. It is a useful framework for treating addiction to alcohol where available medications have limited effectiveness, and is virtually the only model for treating and preventing relapse to stimulants and cannabis where no medications exist. It is not a justifiable primary framework for the treatment of opioid addiction anymore.

Beyond the restrictions affecting provision of MAT, these stigma and financial incentives may be contributing to a lack of patient access to MAT. Using an email survey of physicians, Huhn and Dunn (2017) identified concerns associated with prescribing buprenorphine that physicians acknowledged including: a lack of time for additional patients requiring MAT, a lack of belief in the use of agonist treatment and low reimbursement for time and services offered.

Following Swensen (2015) and Bondurant et al. (2018), I will conduct a number of ancillary tests to examine the validity of the research design. Of particular concern is the endogeneity of the opening/closing of treatment facilities and/or the endogeneity in choice of services offered. Grants, subsidies and public/private insurance funding for treatment is likely to increase as drug abuse becomes more problematic. As Bondurant et al., (2018) argue: “Assuming these sources of financing generally increase with drug abuse and related problems, analyses of

the effect of treatment provision on drug-related outcomes may understate the actual effect of treatment.” (Bondurant et al., 2018)

3. Data

Data regarding the location, services offered and insurance type accepted by substance abuse treatment facilities comes from the Substance Abuse and Mental Health Services Administration (SAMHSA) National Survey of Substance Abuse Treatment Services (N-SSATS). The N-SSATS is a survey of treatment facilities and so is not a universal database of these facilities. The response rate varies from year to year but is generally high. For example, in 2010 the response rate was 91.4 percent and in 2013 the response rate was 94 percent (N-SSATS, 2018). The N-SSATS contains a directory of each responding treatment facility that includes county identifiers and indicates what services are offered and what payment types are accepted by the facility.

N-SSATS directories were scraped and compiled into datasets by the organization amfAR, the Foundation for AIDs research. Services offered and payment type accepted by treatment facilities are identified using facility codes. A treatment facility is classified as offering some form of MAT if any of the of the following facility codes appear: BMW (Buprenorphine Maintenance for Predetermined Time), BU (Buprenorphine Used in Treatment), BUM (Buprenorphine Maintenance), DB (Buprenorphine Detoxification), DM (Methadone Detoxification), METH (Methadone), MM (Methadone Maintenance), MMW (Methadone Maintenance for Predetermined Time), UBN (Prescribes/Administers Buprenorphine and/or Naltrexone), VTRL (Vivitrol, Injectable Naltrexone). A treatment facility is identified as accepting Medicaid if the facility code MD appears in the directory. Finally, this methodology is

used to characterize facilities offering buprenorphine, methadone, multiple forms of MAT and facilities offering MAT and accepting Medicaid.

N-SSATS data is aggregated to the county, year level and merged with restricted use county level mortality data obtained from the National Association for Public Health Statistics and Information Systems (NAPHSIS). Opioid related deaths are identified using the *International Classification of Disease, Tenth Revision* (ICD-10) codes. All opioid deaths are classified as including ICD-10 codes: T40.0 (opium), T40.1 (heroin), T40.2 (other opioids), T40.3 (methadone), T40.4 (other synthetic narcotics) and T40.6 (other/unspecified narcotics). The opioid related death rate is calculated by aggregating opioid deaths to the county, year level, then dividing by the county population obtained from the National Center for Health Statistics (NCHS), Bridged-Race Population Estimate.

I merge these data with a set of covariates. Demographic controls including age and race from the NCHS Bridged-Race Population Estimate. These demographics include the fraction of the county population that is: white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old. Controls for economic conditions include the county unemployment rate obtained from the Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics (LAUS) and county level per capita income obtained from the U.S. Bureau of Economic Analysis (BEA) regional data.

I consider additional outcomes obtained from the Substance Abuse and Mental Health Services Administration's Treatment Episode Data Set: Admissions (TEDS-A). The TEDS-A data contain records of admissions into treatment facilities. Following Maclean and Saloner (2019), I calculate the admissions rate per 100,000. The TEDS-A indicates whether methadone or buprenorphine was involved in the client's treatment plan. From 2010-2015, 7.8 percent of admissions involved either methadone or buprenorphine (SAMHSA, 2018). The use of

methadone or buprenorphine is relatively well reported and is only missing in 4.3 percent of admissions records from 2010-2015 (SAMHSA, 2018). While health insurance status is also collected, from 2010-2015, insurance status is either missing or unknown for 56.8 percent of admissions (SAMHSA, 2018). Last, I examine the local economic impact of treatment facilities using the county level labor force participation rate from the American Community Survey (ACS) Employment Status 1-year estimates.

4. Identification Strategy

I closely follow the identification strategy of Swensen (2015) and Bondurant et al. (2018), which relies on plausibly exogenous variation coming from the opening or closing of a treatment facility. I estimate the relationship between treatment facilities and the opioid related death rate using following equation:

$$Mortality_{c,t} = \alpha + \beta * Facility_{c,t-1} + X_{c,t} \gamma + \delta_C + \rho_T + \theta_{c,t} + \epsilon_{c,t} \quad (1)$$

$Facility_{c,t-1}$ is the number of treatment facilities in county c in year $t-1$. δ_C is the county fixed effect and ρ_T is the year fixed effect. $\theta_{c,t}$ represents the state by year fixed effect. The identifying variation used in this study is visible in figures 4-6 which show the counties throughout the U.S. that experienced one or more openings of a substance abuse treatment facility (figure 4), one or more openings of a treatment facility offering MAT (figure 5) and one or more openings of a facility accepting Medicaid (figure 6). Whereas Swensen (2015) considers the impact of any treatment facility, I exploit variation across treatment facilities by measuring treatment facilities of different types as described in section 3. $Mortality_{c,t}$ is the opioid related death rate per 100,000 in county c in year t . These estimates are weighted by county population.

Standard errors are adjusted for clustering at the county level. $X_{c,t}$ is a vector of controls including demographic controls and controls for economic conditions.

To further examine the validity of this identification strategy, I estimate the following event study model:

$$Mortality_{c,t} = \alpha + \sum_{t=-5}^5 ES_{c,t} \beta + X_{c,t} \gamma + \delta_c + \rho_t + \theta_{c,t} + \epsilon_{c,t} \quad (2)$$

I define an event year as the year in which a substance abuse treatment facility opens in county c . I include a set of dummy variables within that country for each five years before and after the facility/facilities opening. Some counties experienced multiple openings and/or closings throughout the sample period. For this reason, I estimate event studies of two types. First, I estimate the impact of the opening of a treatment facility in counties in which no previous treatment facility of that type existed. Second, I estimate the impact of the opening of a treatment facility in counties which experienced only a single opening throughout the sample period.

5. Results

In table 2, I examine the impact of substance abuse treatment facilities offering MAT on the opioid related death rate. The outcome variable, the opioid related death rate at the county year level, is transformed using the inverse hyperbolic sine function rather than the natural log function because of the non-negligible number of observations for which the outcome variable equals zero. For each type of facility, the opening of a treatment facility offering MAT services decreases the county level opioid related death rate. The opening of one substance abuse facility offering MAT is estimated to reduce the county level opioid related death rate by about 0.3 to 0.75 percent (column 1). One additional substance abuse facility offering MAT represents a 10.6

percent increase compared to the existing mean capacity. The opening of one substance abuse facility offering MAT and accepting Medicaid is estimated to reduce the county level opioid related death rate by about 0.8 to 1 percent (column 2). The opening of one substance abuse facility offering two or more forms of MAT and accepting Medicaid has a similar estimated effect (column 4) to the opening of one substance abuse facility offering MAT and accepting Medicaid. Whether a treatment facility offers one or multiple forms of MAT, a facility opening has a larger negative impact on the county death rate if that facility also accepts Medicaid.

In table 3, I compare facilities offering buprenorphine and methadone. The opening of a treatment facility offering buprenorphine is estimated to be more impactful on the opioid related death rate compared to the opening of a treatment facility offering methadone (columns 1 and 3). The opening of a treatment facilities offering buprenorphine is estimated to have a larger negative impact on the opioid related death rate if that facility also accepts Medicaid (column 2). The opening of a treatment facilities offering buprenorphine and accepting Medicaid leads to a reduction in the opioid related death rate of about 0.85 to 1.25 percent. In table 4, I compare the types of treatment facilities estimated to be the most impactful on the opioid related death rate to all other substance abuse treatment facilities not of that type. The opening of a treatment facility accepting Medicaid and offering buprenorphine, some form of MAT, or two or more forms of MAT leads to about a 1 to 1.25 percent reduction in the county level opioid related death rate (column 1). The opening of any treatment facility not of that type does not have a statistically significant impact on the county level opioid related death rate (column 2). The estimates are visible in figure 8. The opening of a treatment facility accepting Medicaid and offering MAT has a much larger negative impact on the opioid related death rate compared the opening of a treatment facility accepting Medicaid or offering MAT.

5.1 Analysis of Treatment Episode Data Set: Admissions

Next, I consider outcomes from the TEDS-A. The TEDS-A data does not have county identifiers. Rather, the TEDs-A contains identifiers for the state and Core Based Statistical Area (CBSA) of the treatment admission. First, I aggregate the TEDS-A and the N-SSATS to the state year level and merge the two data sets. In table 5, I examine admission by the primary substance abuse problem restricting the sample to admissions related to OUD. Facilities that offer two plus forms of MAT and accept Medicaid had the largest impact on the opioid related admission rate. The opening of one such facility was estimated to increase the state level OUD admissions rate by about 0.5 per 100,000.

Second, I aggregate to the TEDS-A to the CBSA year level. Using the CBSA to FIPS County Crosswalk file from the National Bureau of Economic Research (NBER), I match treatment facilities with county identifiers to a CBSA. CBSA population estimates were obtained from the U.S. Census Bureau (2019). In panel A of table 6, I restrict the TEDS-A sample to admissions in which methadone or buprenorphine was involved in the client's treatment plan (hereafter referred to as admission involving MAT). Facilities offering some form of MAT and accepting Medicaid have the largest effect on the admission involving MAT rate. The opening of a such treatment facility is estimated to increase the admission involving MAT rate by about 0.6 per 100,000.

5.2 Event Study Analysis

In order to test the validity of the research design, I present event studies that examine the impact of a treatment facility opening on the opioid related death rate in each year before and after the opening. The event study evidence, in general, alleviates concerns about the

endogeneity of the opening of a treatment facility. Figure 9 shows the impact of any substance abuse treatment facility opening within counties with no previous treatment facility, on the county level opioid related death rate. While there are no visible trends leading up to the opening, the opioid related death rate declines, most prominently 2-5 years after opening. I restrict the scope of the event studies to the opening of a substance abuse treatment facility that accepts Medicaid. Within counties that had a single opening of that kind from 2005-2016 (figure 10) and counties with no previous treatment facility of that type experiencing one or more openings (figure 11), again no trends appear in the years leading up to the opening. The opening(s) then lead to a decrease in the opioid related death rate.

Next, I apply the event study framework to the opening of treatment facilities offering MAT. In the years leading up to the opening of a treatment facility accepting Medicaid and offering some MAT (figure 12) or two or more forms of MAT (figure 13), no effect appears. A small decrease in the opioid death rate appears following the opening, however, confidence intervals are large and contain a zero-coefficient estimate. Finally, I consider the opening of a treatment facility offering buprenorphine. Comparing figures 14 and 15, the treatment facility appears to have a larger negative impact on the opioid related death rate if the facility offers buprenorphine and accepts Medicaid. Throughout the event studies, coefficient estimates are close to zero in the years leading up to the opening of a treatment facility across facility types. While the event studies do restrict the identifying variation, they offer evidence in support of the validity of the identification strategy used throughout this study.

5.3 Robustness

In table A1, it appears that the primary results presented in this study are robust when estimating alternate measures of the outcome variable, unweighted models and to different functional forms. These alternate specifications include the natural log transformation of the opioid related death rate (panel A)¹, unweighted OLS (panel B) and population weighted Poisson models (panel C).² Next, I test potential reverse causality of this relationship between treatment facilities and the opioid related death rate. I construct an indicator variable equal to one if one or more treatment facilities has opened in county c in year t and equal to zero otherwise. I estimate the following linear probability model:

$$Opening_{c,t-1} = \alpha + \beta * Mortality_{c,t} + X_{c,t} \gamma + \delta_c + \rho_t + \theta_{c,t} + \epsilon_{c,t} \quad (3)$$

Table A7 presents the results from the test of reverse causality. I present estimates from equation 3 with a one and a two-year lag of the measure of treatment facility openings. I find no significant result from twelve total specifications. Overall, the county level opioid related death rate was not found to predict the opening of treatment facilities. Next, I examine the potential for changes in the composition of the county population in response to the opening/closing of treatment facilities. In table A8, I put county demographic measures on the left-hand side and find that overall, the opening/closing of treatment facilities does not explain any potential compositional changes in the county population.

5.4 Heterogeneity

In table 7, I compare substance abuse treatment taking place in Florida to the rest of the U.S. In 5 of 6 specifications, the coefficient of interest is positive when the sample is restricted to

¹ One is added to the opioid related death rate prior to the log transformation to avoid missing observations

² Poisson regressions are estimated using the `ppmlhdfc` Stata command developed by Correia et al. (2019) while OLS regressions are estimated using `reghdfe` Stata command developed by Correia (2017)

counties within Florida and negative when the sample consists of all counties outside of Florida. These results may be indicative of the perverse incentives created by the ACA and MHPAEA. While these results do not provide an identification strategy to test for fraud in the treatment industry in Florida, they are suggestive of such effects. There are accounts of fraud in the treatment industry in the media on a case by case basis but no published research of broader scope to date (Seville et al., 2017).

In table A2, I explore the heterogeneity of these effects by gender. The opening of a treatment facility offering some MAT and accepting Medicaid has the largest impact on the opioid related death rate of females. The opening of such a treatment facility has less of an impact on the male opioid related death rate. The population weighted mean male opioid related death rate is about twice that of the female opioid related death rate. In table A3, I explore the heterogeneity of these effects by race. When considering the white and black opioid related death rates, again, the most effective type of treatment facility appears to be facilities offering MAT and accepting Medicaid. The weighted mean white opioid related death rate is about twice that of the black death rate and the Hispanic death rate. Finally, I explore the heterogeneity of these effects by county size. I split the data by county population categorizing counties as urban, medium or rural. In table A4, it appears that reductions in opioid related deaths are driven by the opening of treatment facilities in urban counties. Treatment facility openings have a larger negative impact in rural counties though the coefficient of interest is no longer significant. This may be explained by a lack of identifying variation as there are fewer openings in rural counties throughout the sample period.

5.5 Other Economic Outcomes

Given the economic cost of the opioid epidemic, changes in treatment capacity may impact local economic outcomes. In table A5, I consider the impact of treatment facilities on the labor force participation rate using two different measures. The first measure of the labor force participation rate comes from the ACS Employment Status 1-Year Estimates. This dataset does not include every county in the US. The second measure contains the majority of US counties. It was constructed by the author taking the county labor force as a count obtained from the BLS and dividing by the county level working age population from the NCHS. Using both measures, treatment facilities appear to have a positive economic impact on the communities they serve. Facilities offering MAT and accepting Medicaid led to the largest increases in the labor force participation rate. The opening of one such facility is estimated to increase the labor force participation rate by about 0.08-0.09 percent. In table A6, I consider a number of measures of income from the ACS Income in the past 12 months 1-Year Estimates. While the effect size is small, the opening of a treatment facility appears to have a positive impact on median and mean county income.

6. Conclusion

In this study, I find that the opening of a substance abuse treatment facility has a negative impact on the opioid related death rate within the county of the opening. There is substantial heterogeneity when comparing different types of treatment facilities. The opening of a treatment facility offering at least some form of MAT and accepting Medicaid is estimated to reduce the county opioid related death rate by about 1 to 1.25 percent while the opening of any other type of treatment facility does not have a statistically significant impact. Treatment facilities accepting Medicaid and offering MAT were also found to have a larger positive impact on treatment admissions rates and on local economic outcomes.

Mental health parity legislation along with the ACA has increasing the prominence of public and private insurance in providing funding for treatment of SUD. Medicaid is the single largest payer for mental health services in the U.S. (Centers for Medicare and Medicaid Services, 2019). From the perspective of a patient seeking treatment for OUD, increasing treatment capacity can remove or reduce some of the barriers to receiving treatment that patient may face. These barriers could include cost related to distance/travel, insurance type mismatch or a lack of services available to treat OUD. Results presented in this paper suggest that the existing capacity for treatment of OUD in the U.S. may not be sufficient. Specifically, this applies to Medicaid beneficiaries seeking treatment for OUD.

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8. Tables and Figure

Table 1
Summary Statistics

Variable	Mean	Std. Dev
Facilities Providing Substance Abuse Services	39.24	77.29
Facilities Providing Substance Abuse Services and Accepting Medicaid	16.96	27.58
Facilities Providing Some Medication Assisted Treatment	9.73	17.50
Facilities Providing Some Medication Assisted Treatment and Accepting Medicaid	5.80	10.86
Facilities Providing at Least Two Different Forms of Medication Assisted Treatment	6.19	12.46
Facilities Providing at Least Two Different Forms of Medication Assisted Treatment and Accepting Medicaid	1.81	4.24
Facilities Providing Buprenorphine	4.58	9.24
Facilities Providing Buprenorphine and Accepting Medicaid	2.53	5.55
Facilities Providing Methadone	4.58	8.91
Facilities Providing Methadone and Accepting Medicaid	3.10	6.80
All Opioids Death rate per 100k	7.99	7.60
Fraction Ages 0-15	0.21	0.03
Fraction Ages 16-35	0.26	0.04
Fraction Ages 35-64	0.39	0.03
Fraction Female	0.51	0.01
Fraction White	0.79	0.15
Fraction Black	0.13	0.14
Unemployment Rate	6.74	2.63
Log Per Capita Income	10.62	0.28
Labor Force Participation Rate (ACS Employment)	0.66	0.05
Labor Force Participation Rate (BLS)	0.63	0.06
Median Household Income	61,586	15,644
Median Non-Family Household Income	38,221	10,065
Mean Household Income	82,323	20,446
Mean Non-Family Household Income	52,275	13,419

Notes: Data: 2005-2016. Summary statistics are weighted by county population. Florida excluded from sample. Data sources: N-SSATS, NAPHSIS, NCHS, ACS, BLS, BEA

Table 2
Treatment Facilities Offering MAT

	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>County FE and Year FE</i>	-0.00737*** (0.00125)	-0.00785** (0.00321)	-0.00239*** (0.000855)	-0.00867** (0.00396)
<i>N</i>	33,798	33,798	33,798	33,798
<i>County, Year and State by Year FE</i>	-0.00364 (0.00267)	-0.0108*** (0.00364)	-0.00164 (0.00122)	-0.0121*** (0.00405)
<i>N</i>	33,769	33,769	33,769	33,769
<i>Include Demographic Controls</i>	-0.00296 (0.00266)	-0.0101*** (0.00341)	-0.00137 (0.00116)	-0.0106*** (0.00406)
<i>N</i>	33,769	33,769	33,769	33,769
<i>Include Controls for Economic Conditions</i>	-0.00292 (0.00270)	-0.0101*** (0.00345)	-0.00133 (0.00117)	-0.0105** (0.00416)
<i>N</i>	33,197	33,197	33,197	33,197
Mean of Dependent Before Transformation	7.99	7.99	7.99	7.99

Notes: Dependent variable - Inverse Hyperbolic Sine transformation of opioid death rate per 100,000. Inclusion of controls and fixed effects varied by row. Treatment facilities are a count variable per county per year by type of facility. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01

Table 3

Treatment Facilities Classified by Medication Offered

	Facilities Offering Buprenorphine	Facilities Offering Buprenorphine and Accepting Medicaid	Facilities Offering Methadone	Facilities Offering Methadone and Accepting Medicaid
<i>County FE and Year FE</i>	-0.00764*** (0.00108)	-0.00851*** (0.00271)	-0.00878 (0.00777)	-0.0125* (0.00677)
<i>N</i>	33,808	33,808	33,808	33,808
<i>County, Year and State by Year FE</i>	-0.00410 (0.00286)	-0.0136*** (0.00325)	0.00423 (0.00810)	-0.000692 (0.00730)
<i>N</i>	33,775	33,775	33,775	33,775
<i>Include Demographic Controls</i>	-0.00325 (0.00290)	-0.0127*** (0.00329)	0.00368 (0.00752)	-0.000690 (0.00655)
<i>N</i>	33,775	33,775	33,775	33,775
<i>Include Controls for Economic Conditions</i>	-0.00331 (0.00291)	-0.0126*** (0.00330)	0.00355 (0.00749)	-0.000616 (0.00651)
<i>N</i>	33,203	33,203	33,203	33,203
Mean of Dependent Before Transformation	7.99	7.99	7.99	7.99

Notes: Dependent variable - Inverse Hyperbolic Sine transformation of opioid death rate per 100,000. Inclusion of controls and fixed effects varied by row. Treatment facilities are a count variable per county per year by type of facility. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01

Table 4

Comparing treatment facilities to all others not of that type

	Facilities of that Type	All other Facilities Not of that Type
<i>Panel A</i>	-0.0101***	-0.000810
Facilities Offering Some MAT and Accepting Medicaid	(0.00345)	(0.00105)
<i>Panel B</i>	-0.0105**	-0.00104
Facilities Offering at least 2 Forms of MAT and Accepting Medicaid	(0.00416)	(0.000997)
<i>Panel C</i>	-0.0126***	-0.000596
Facilities Offering Buprenorphine and Accepting Medicaid	(0.00330)	(0.00109)
<i>N</i>	33,197	33,197
Mean of Dependent Before Transformation	7.99	7.99

Notes: Dependent variable - Inverse Hyperbolic Sine transformation of opioid death rate per 100,000. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. These estimates are weighted by county population. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01

Table 5
Opioid Use Treatment Admissions Rate by Primary Substance Abuse Problem - State Year
Level Data

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: All Opiates</i>	-0.117	-0.0361	0.0750	0.192***	0.218*	0.486**
	(0.108)	(0.150)	(0.101)	(0.0620)	(0.110)	(0.213)
<i>N</i>	498	498	498	498	498	498
<i>Mean</i>	144.91	144.91	144.91	144.91	144.91	144.91
<i>Panel B: Heroin</i>	-0.0900	-0.0835	-0.00277	0.00196	0.129	0.335*
	(0.0925)	(0.102)	(0.0588)	(0.0650)	(0.0957)	(0.167)
<i>N</i>	493	493	493	493	493	493
<i>Mean</i>	100.63	100.63	100.63	100.63	100.63	100.63
<i>Panel C: Other Opiates Excluding Methadone</i>	-0.0285	0.0455	0.0747	0.182***	0.0858	0.144**
	(0.0356)	(0.0577)	(0.0775)	(0.0506)	(0.0652)	(0.0604)
<i>N</i>	497	497	497	497	497	497
<i>Mean</i>	43.53	43.53	43.53	43.53	43.53	43.53

Notes: Dependent variable - treatment admission rate per 100,000 where primary substance abuse problem is opioid use. Controls include the fraction of the state population that are white, black, ages 0-15, ages 16-34 and ages 35-64 years old and the unemployment rate. Treatment facilities are a count variable per state per year by type of facility. Models include state and year fixed effects. These estimates are weighted by state population. Standard errors in parenthesis are adjusted for clustering at the state level. * p<0.10, ** p<0.05, *** p<0.01

Table 6

Opioid Use Disorder Treatment Admissions Rate - Core Based Statistical Area

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A</i>	-0.0829	-0.227**	0.409***	0.599***	0.158	0.289***
<i>Admissions Involving MAT</i>	(0.106)	(0.114)	(0.134)	(0.134)	(0.152)	(0.0368)
<i>N</i>	1,362	1,362	1,362	1,362	1,362	1,362
<i>Mean</i>	45.61	45.61	45.61	45.61	45.61	45.61
<i>Panel B</i>	-0.193	-0.283	0.120	0.114	0.0101	0.0632
<i>Admissions for OUD</i>	(0.149)	(0.186)	(0.238)	(0.350)	(0.200)	(0.123)
<i>N</i>	1,362	1,362	1,362	1,362	1,362	1,362
<i>Mean</i>	154.96	154.96	154.96	154.96	154.96	154.96

Notes: Dependent variable - treatment admission rate per 100,000 where primary substance abuse problem is opioid use. Treatment facilities are a count variable per CSBA per year by type of facility. Models include Core Based Statistical Area (CBSA) and year fixed effects. These estimates are weighted by CSBA population. Standard errors in parenthesis are adjusted for clustering at the CSBA level.

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

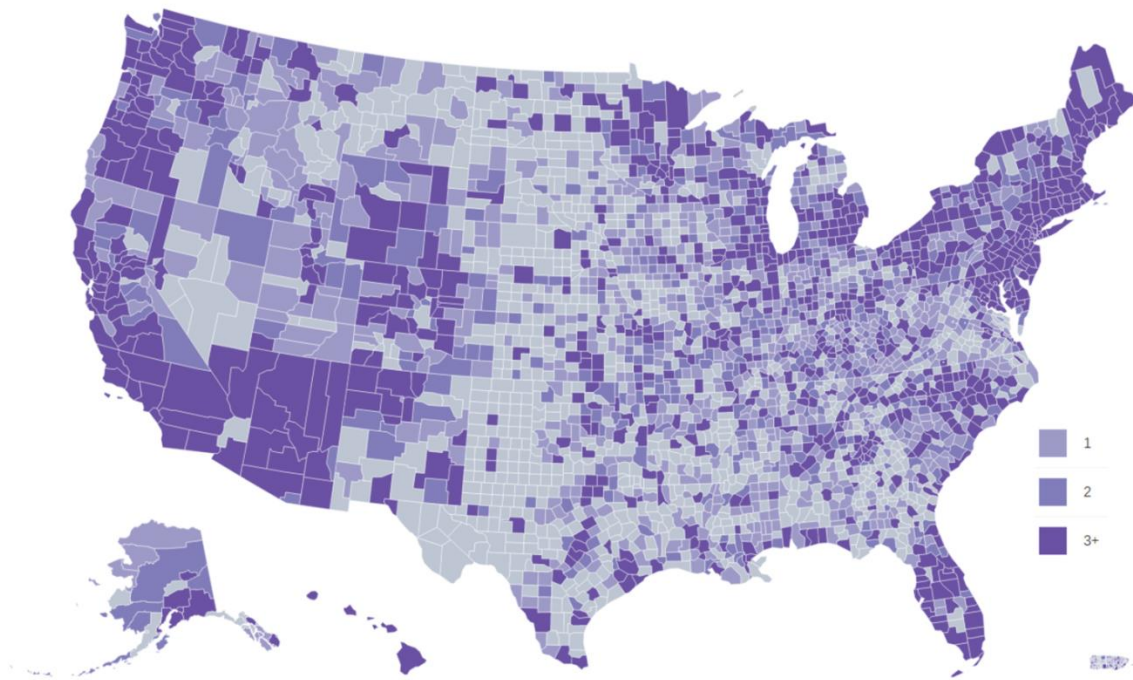
Table 7

Comparing Florida to the Rest of the U.S.

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: Florida</i>	0.0162** (0.00736)	0.0260* (0.0153)	0.0278*** (0.00931)	0.0494 (0.0349)	0.0259*** (0.00743)	0.0945* (0.0525)
<i>N</i>	737	737	737	737	737	737
<i>Mean</i>	8.94	8.94	8.94	8.94	8.94	8.94
<i>Panel B: Rest of U.S.</i>	0.0000435 (0.00105)	-0.00308 (0.00210)	-0.00550*** (0.00172)	-0.00475 (0.00318)	-0.00144* (0.000816)	-0.00299 (0.00396)
<i>N</i>	33,208	33,208	33,208	33,208	33,208	33,208
<i>Mean</i>	7.99	7.99	7.99	7.99	7.99	7.99

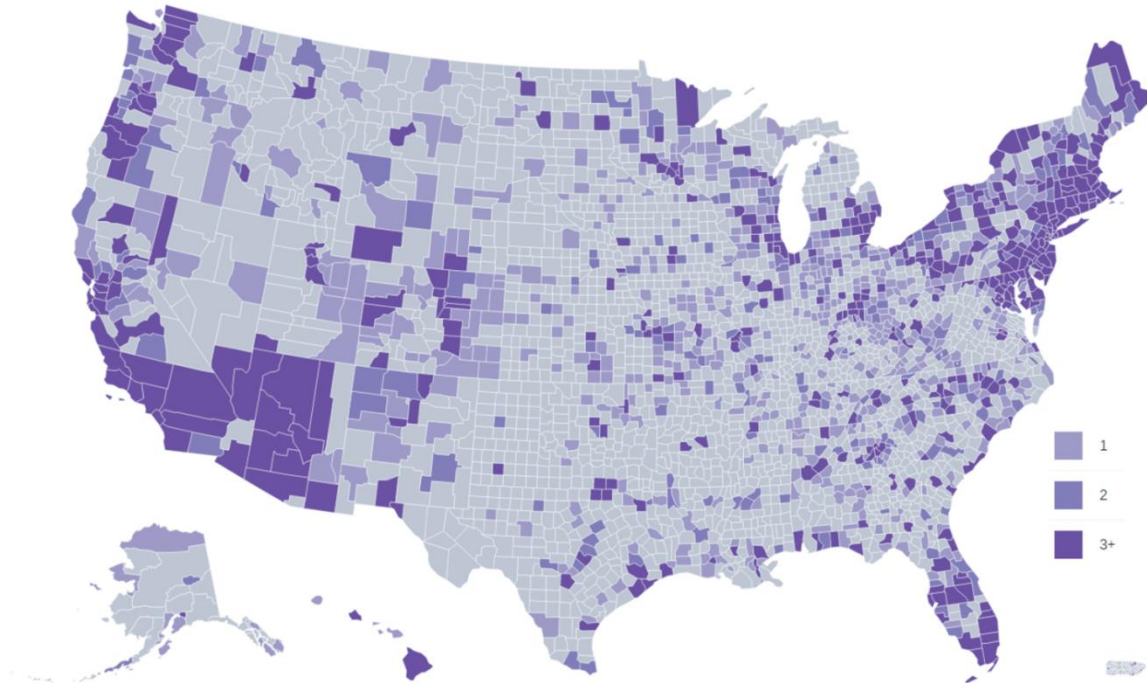
Notes: Dependent variable - Inverse Hyperbolic Sine transformation of opioid death rate per 100,000. Controls include the fraction of the county population that are: white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and log per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county and year fixed effects. These estimates are weighted by county population. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01

Figure 1: All Substance Abuse Facilities, 2016



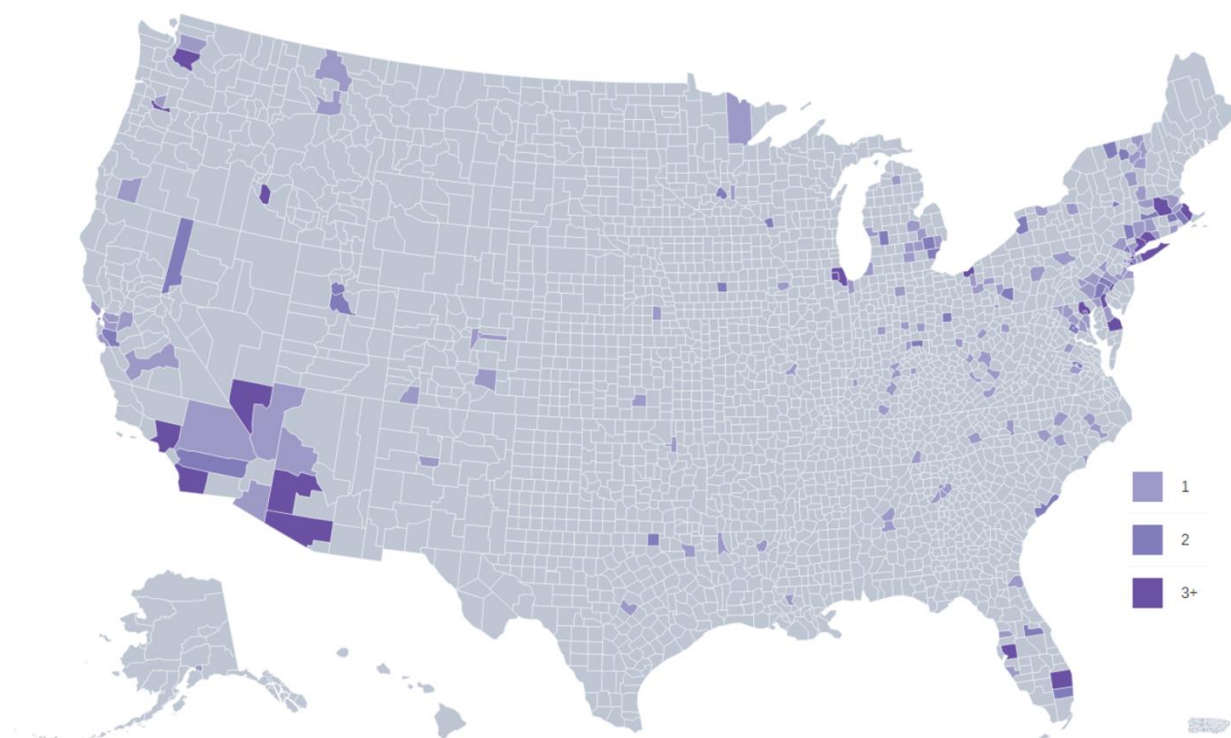
Source: Jones et al., 2018

Figure 2: Substance Abuse Facilities Offering Some MAT, 2016



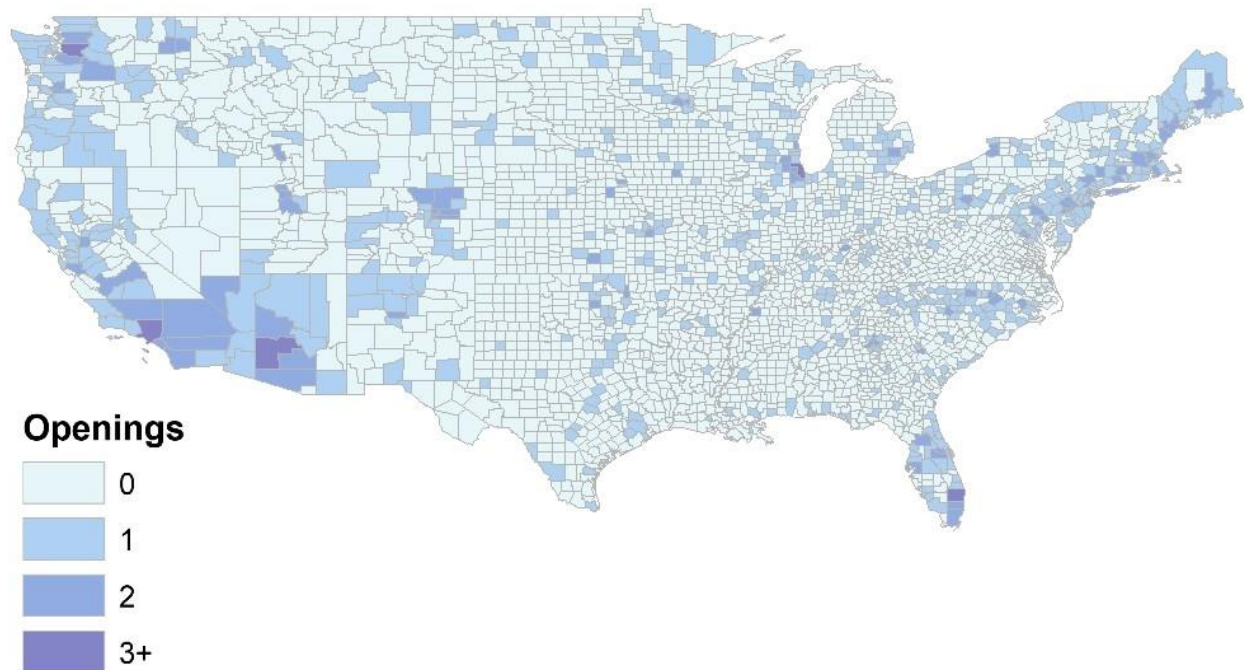
Source: Jones et al., 2018

Figure 3: Substance Abuse Facilities Offering All Three Forms of Medication-Assisted Treatment, 2016



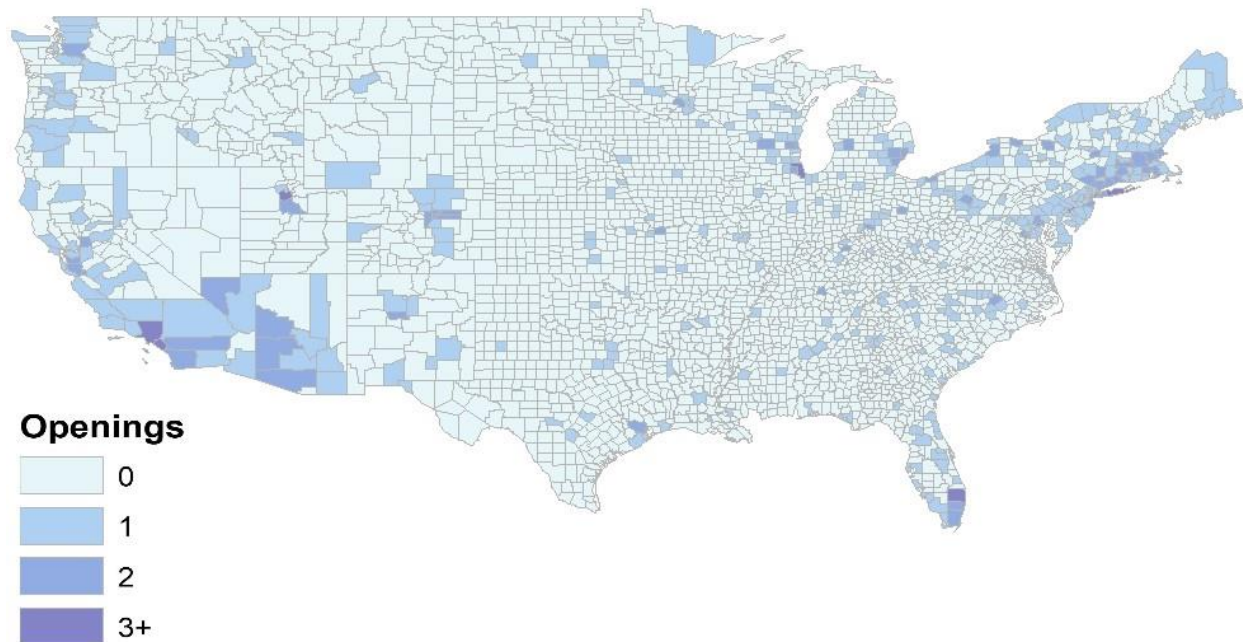
Source: Jones et al., 2018

Figure 4: All Substance Abuse Facility Openings (2005-2016)



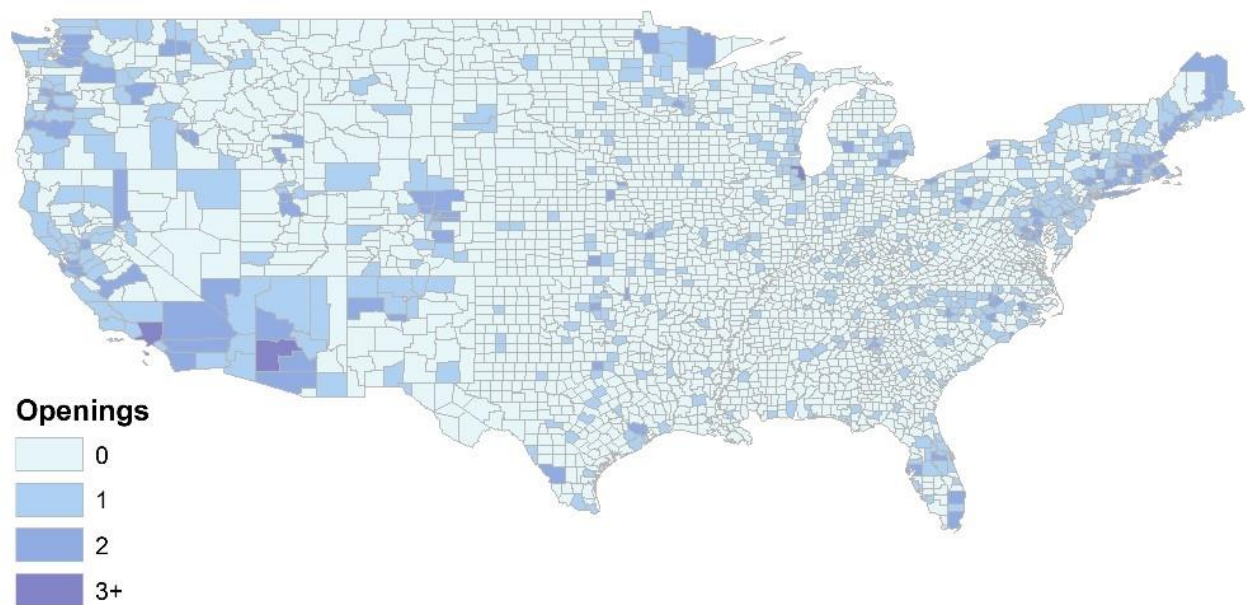
Notes: Data - SAMHSA N-SSATS Directories 2005-2016

Figure 5: Substance Abuse Facilities offering Some MAT Openings (2005-2016)



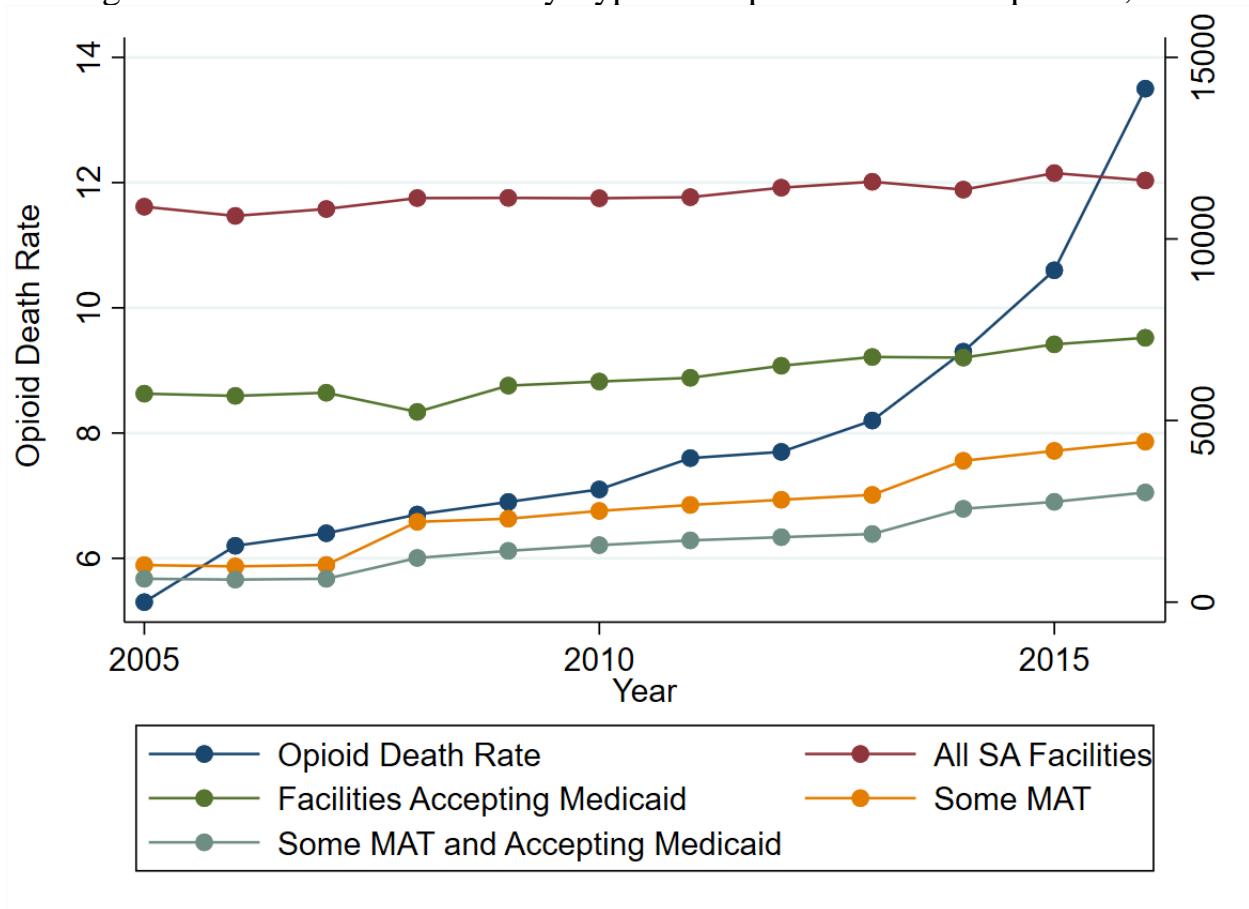
Notes: Data - SAMHSA N-SSATS Directories 2005-2016

Figure 6: Substance Abuse Facilities accepting Medicaid Openings (2005-2016)



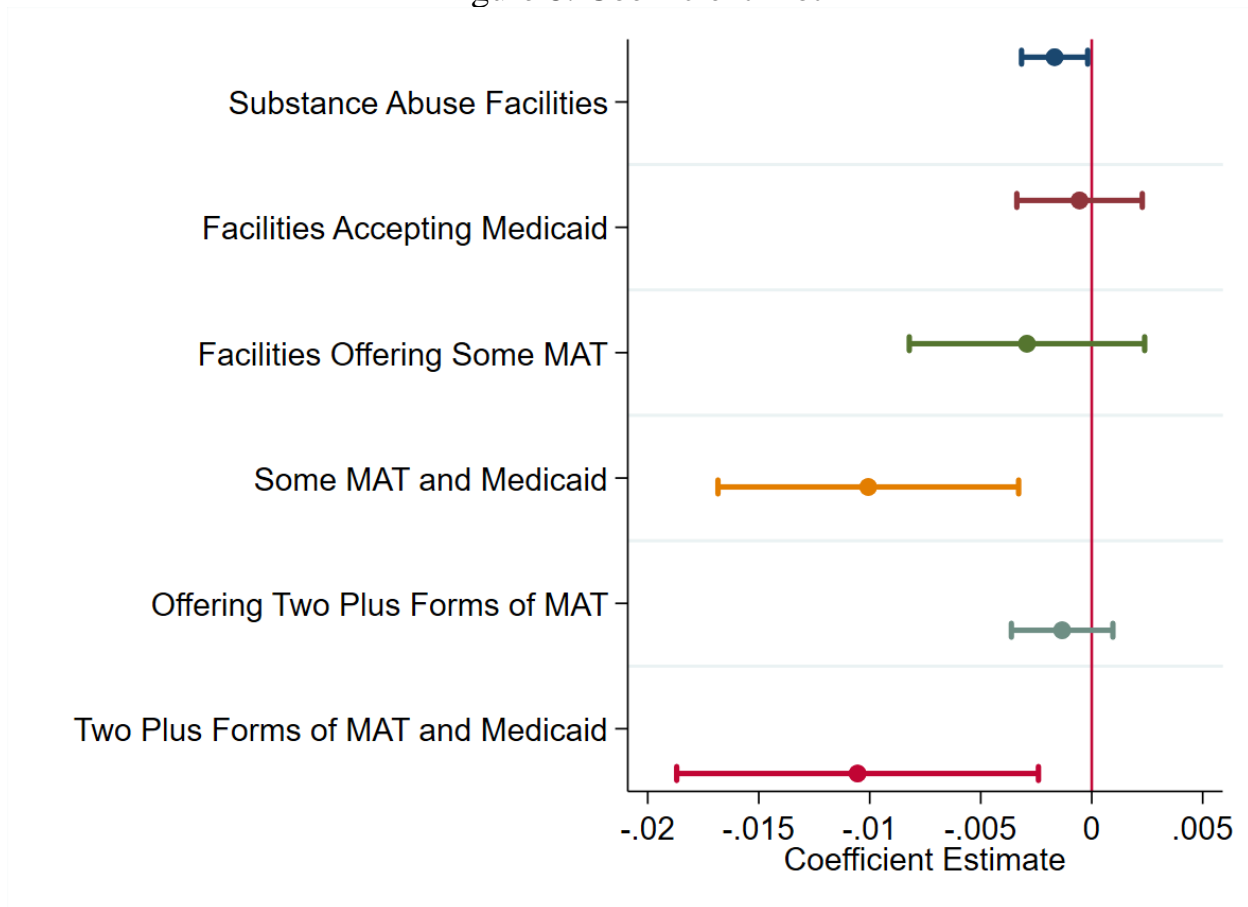
Notes: Data - SAMHSA N-SSATS Directories 2005-2016

Figure 7: Treatment Facilities by Type and Opioid Death Rate per 100,000



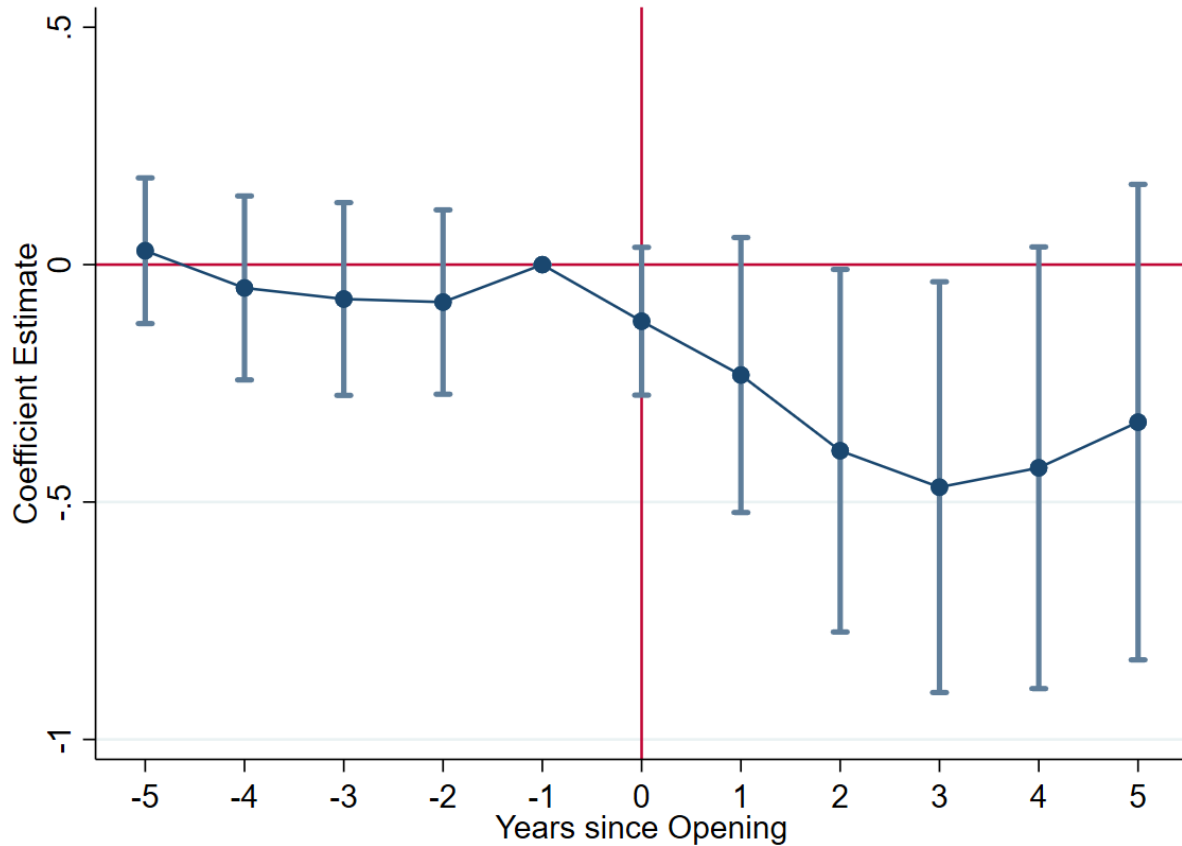
Notes: All SA Facilities refers to the any facility offering substance abuse treatment. Some MAT refers to the number of treatment facilities offering any of the three forms of medication assisted treatment: methadone, buprenorphine, and/or naltrexone. Opioid death rate on left vertical axis and number of treatment facilities on right vertical axis.

Figure 8: Coefficient Plot



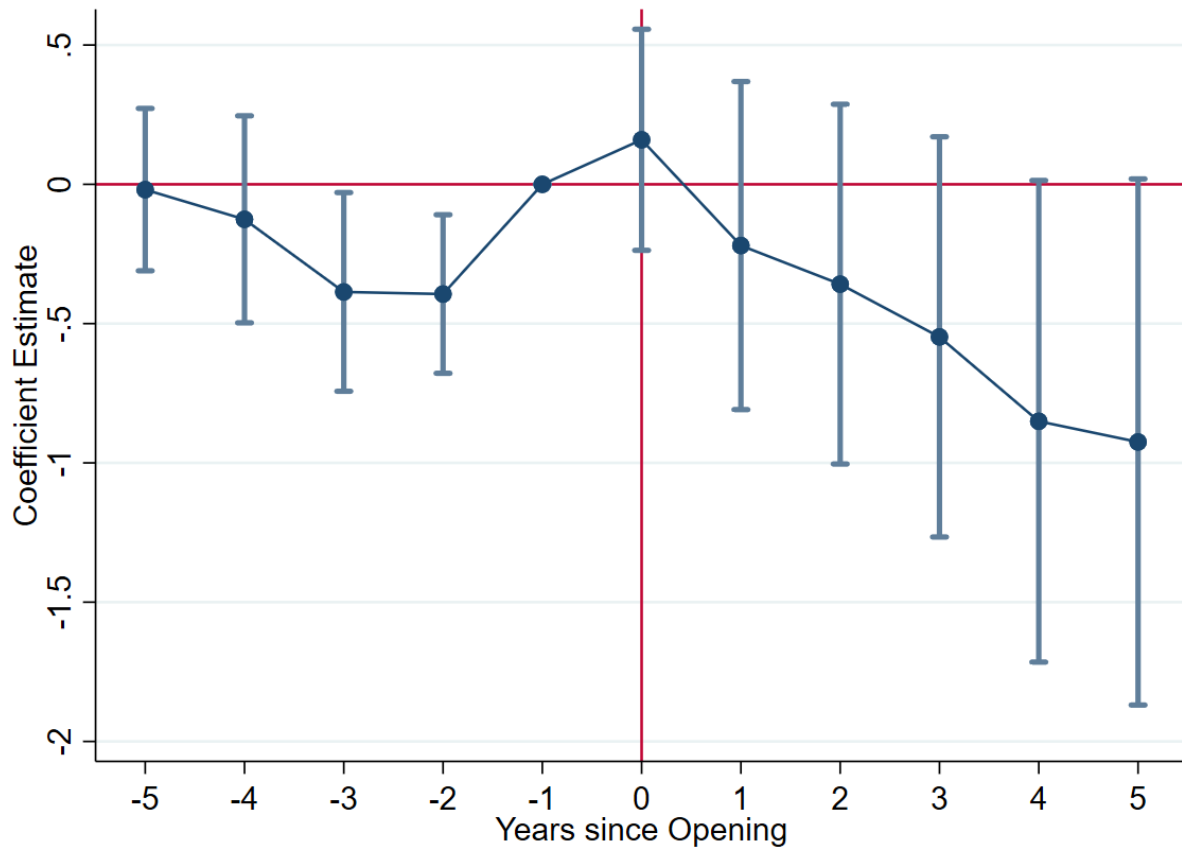
Notes: Dependent variable – inverse hyperbolic sine transformation of opioid related death rate per 100,000. Plot of coefficient estimate and 95% confidence interval. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. These estimates are weighted by county population. Standard errors in parenthesis are adjusted for clustering at the county level.

Figure 9: Event Study – Impact of substance abuse facility opening



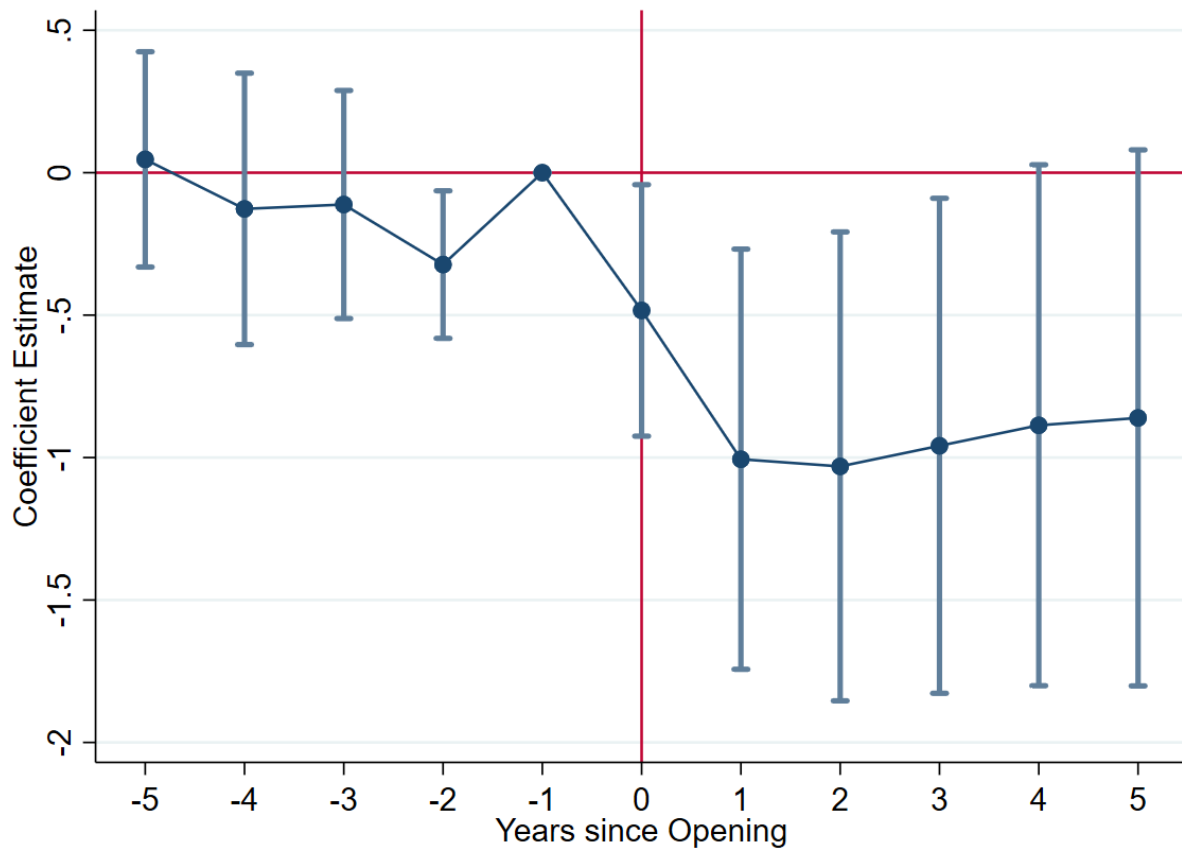
Notes: Dependent variable – inverse hyperbolic sine transformation of opioid related death rate per 100,000. Event study of counties with no substance abuse treatment facility with one or more opening throughout 2005-2016. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level.

Figure 10: Event Study – Impact of substance abuse facility accepting Medicaid opening



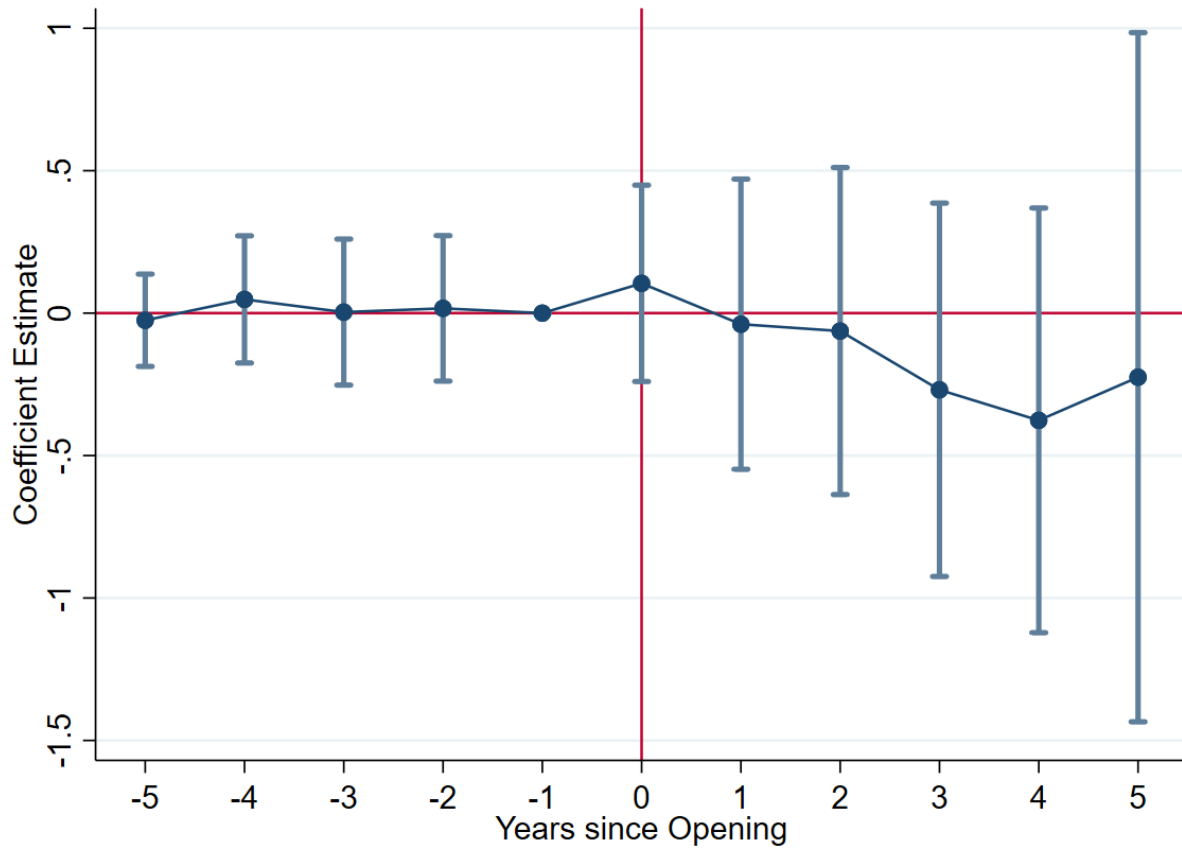
Notes: Dependent variable – inverse hyperbolic sine transformation of opioid related death rate per 100,000. Event study of counties with a single opening of a substance abuse treatment facility offering accepting Medicaid throughout 2005-2016. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level.

Figure 11: Event Study – Impact of substance abuse facility accepting Medicaid opening



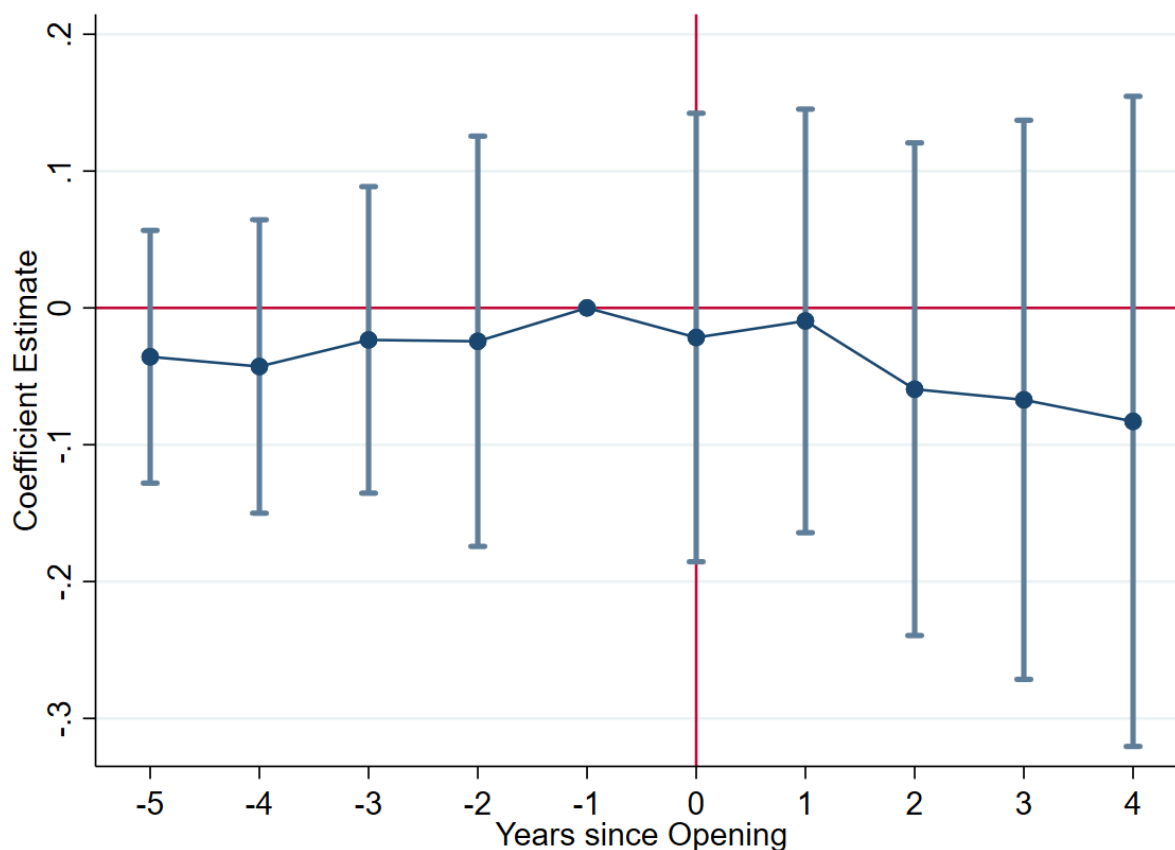
Notes: Dependent variable – inverse hyperbolic sine transformation of opioid related death rate per 100,000. Event study of counties with no substance abuse treatment facility accepting Medicaid with one or more opening throughout 2005-2016. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Models include county, year and state by year fixed effects. These estimates are weighted by county population. Standard errors in parenthesis are adjusted for clustering at the county level.

Figure 12: Event Study – Impact of substance abuse facility offering some MAT and accepting Medicaid opening



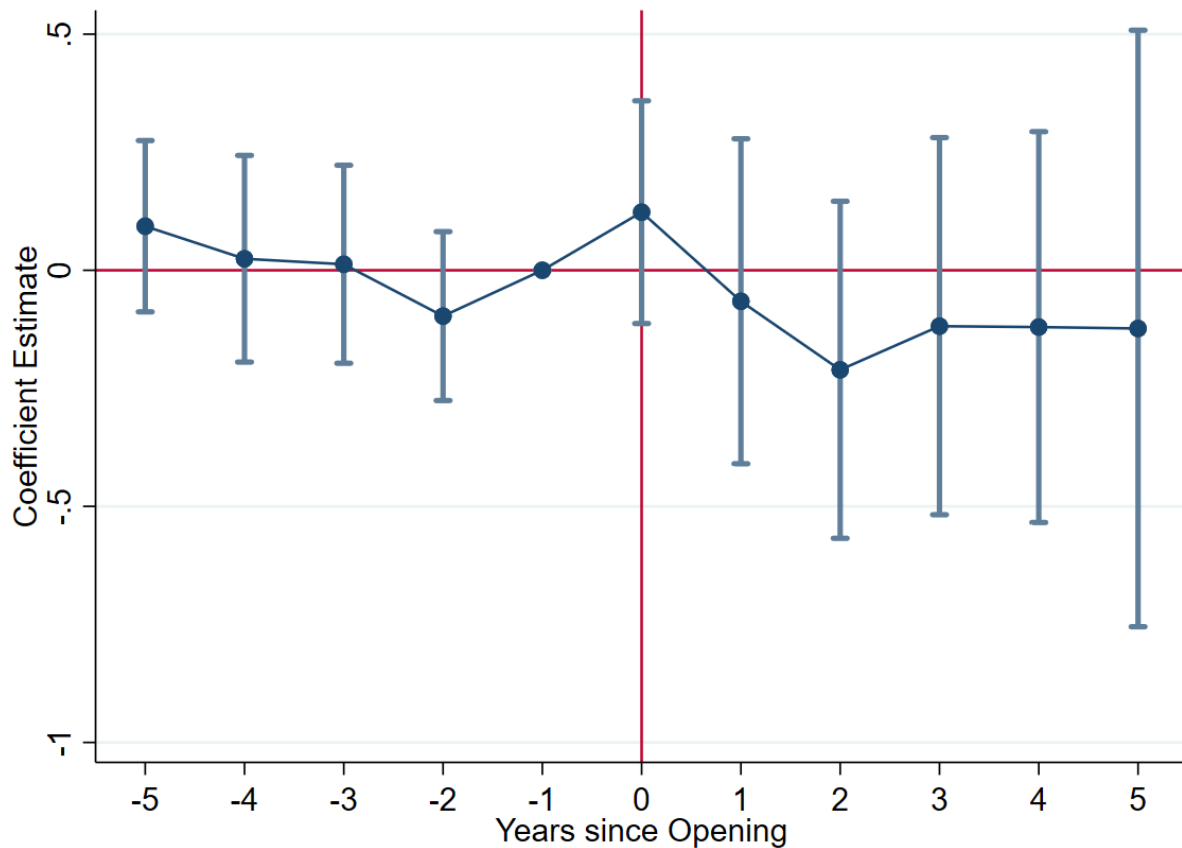
Notes: Dependent variable – inverse hyperbolic sine transformation of opioid related death rate per 100,000. Event study of counties with a single opening of a substance abuse treatment facility offering some MAT and accepting Medicaid throughout 2005-2016. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level.

Figure 13: Event Study – Impact of substance abuse facility offering two or more forms of MAT and accepting Medicaid opening



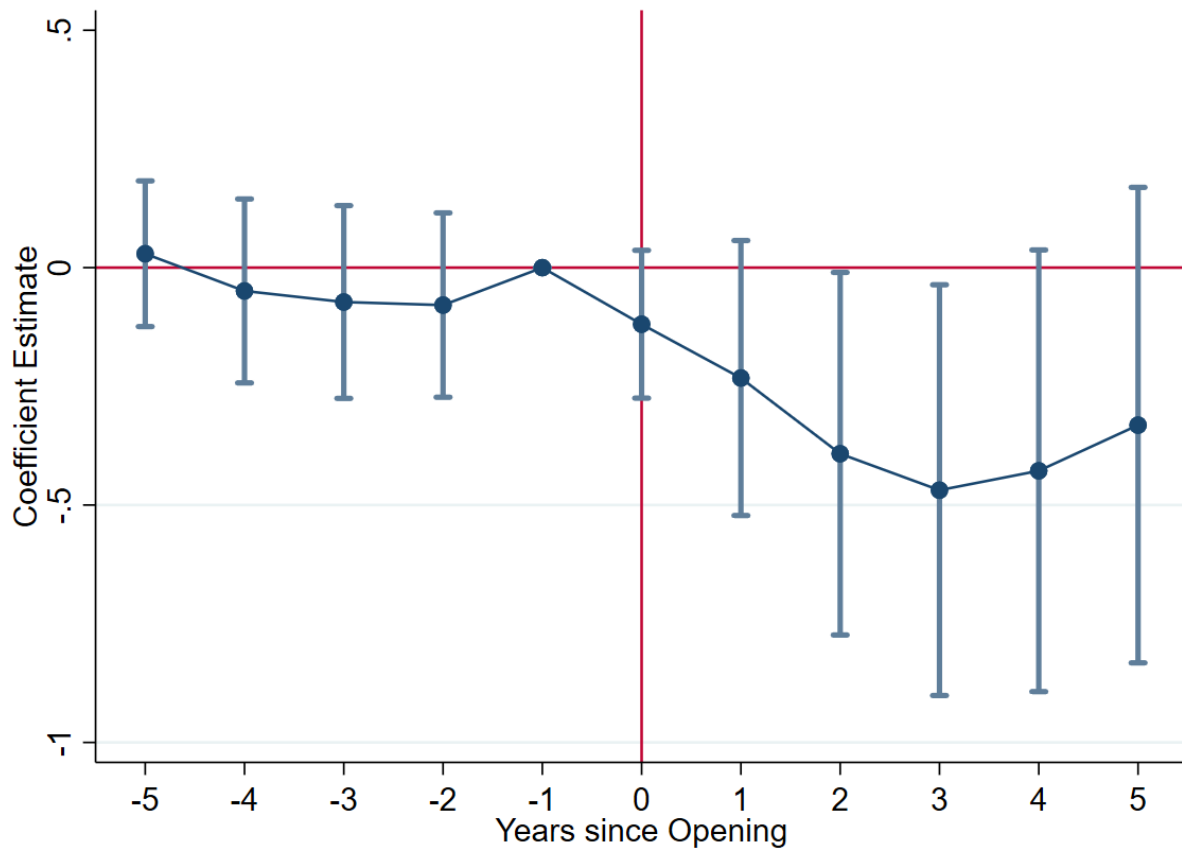
Notes: Dependent variable – inverse hyperbolic sine transformation of opioid related death rate per 100,000. Event study of counties with no substance abuse treatment facility offering two or more forms of MAT and accepting Medicaid with one or more opening throughout 2005-2016. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Models include county, year and state by year fixed effects. These estimates are weighted by county population. Standard errors in parenthesis are adjusted for clustering at the county level.

Figure 14: Event Study – Impact of substance abuse facility offering buprenorphine opening



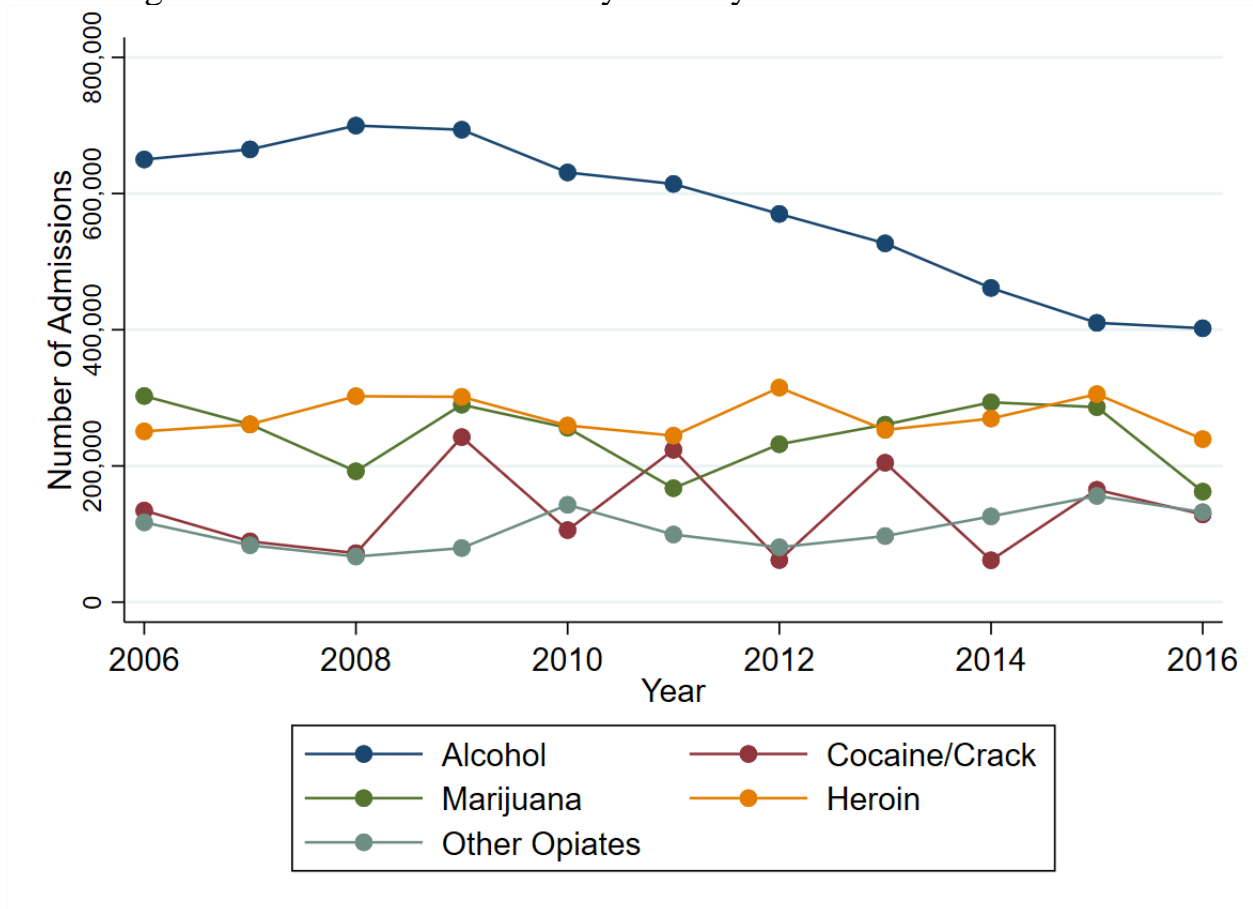
Notes: Dependent variable – inverse hyperbolic sine transformation of opioid related death rate per 100,000. Event study of counties with a single opening of a substance abuse treatment facility offering buprenorphine throughout 2005-2016. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Models include county, year and state by year fixed effects. These estimates are weighted by county population. Standard errors in parenthesis are adjusted for clustering at the county level.

Figure 15: Event Study – Impact of substance abuse facility offering buprenorphine and accepting Medicaid opening



Notes: Dependent variable – inverse hyperbolic sine transformation of opioid related death rate per 100,000. Event study of counties with a single opening of a substance abuse treatment facility offering buprenorphine and accepting Medicaid throughout 2005-2016. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level.

Figure 16: Annual Admissions by Primary Substance Use 2006-2016



Notes: Data - SAMHSA TEDs Admissions 2006-2016

9. Appendix

Table A1
Robustness

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: Weighted OLS</i>	-0.00123*	-0.000348	-0.00210	-0.00779***	-0.00104	-0.00838**
<i>Dependent LN(Death Rate + 1)</i>	(0.000645)	(0.00124)	(0.00221)	(0.00291)	(0.000985)	(0.00358)
<i>N</i>	33,197	33,197	33,197	33,197	33,197	33,197
<i>Mean</i>	7.99	7.99	7.99	7.99	7.99	7.99
<i>Panel B: Unweighted OLS</i>	0.00107	0.0000703	-0.00824**	-0.0128**	-0.00344*	-0.0159***
<i>Dependent IHS(Death Rate)</i>	(0.00259)	(0.00346)	(0.00371)	(0.00503)	(0.00199)	(0.00581)
<i>N</i>	33,197	33,197	33,197	33,197	33,197	33,197
<i>Mean</i>	7.99	7.99	7.99	7.99	7.99	7.99
<i>Panel C: Weighted Poisson</i>	-0.00131**	-0.00150	0.00105	-0.00296	0.0000687	-0.00479
<i>Dependent Deaths</i>	(0.000585)	(0.000985)	(0.00166)	(0.00232)	(0.000665)	(0.00330)
<i>N</i>	30,276	30,276	30,276	30,276	30,276	30,276
<i>Mean</i>	76.27	76.27	76.27	76.27	76.27	76.27

Notes: Dependent variable - Inverse Hyperbolic Sine transformation of opioid death rate per 100,000. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01

Table A2
Heterogeneity by Gender

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: Male</i>	0.00117 (0.000752)	-0.00285* (0.00153)	0.000253 (0.00107)	-0.00104 (0.00209)	0.000492 (0.00123)	-0.000400 (0.00208)
Mean	10.74	10.74	10.74	10.74	10.74	10.74
<i>Panel B: Female</i>	-0.00142 (0.00105)	-0.000805 (0.00164)	-0.00102 (0.00282)	-0.00729** (0.00354)	-0.000672 (0.00136)	-0.00974** (0.00490)
Mean	5.49	5.49	5.49	5.49	5.49	5.49
<i>N</i>	33,197	33,197	33,197	33,197	33,197	33,197

Notes: Dependent variable - Inverse Hyperbolic Sine transformation of opioid death rate per 100,000. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. These estimates are weighted by county population. Standard errors in parenthesis are adjusted for clustering at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3
Heterogeneity by Race

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: White</i>	-0.00196** (0.000791)	-0.000707 (0.00153)	-0.00280 (0.00267)	-0.00912** (0.00360)	-0.00173 (0.00117)	-0.00993** (0.00408)
<i>N</i>	33,197	33,197	33,197	33,197	33,197	33,197
<i>Mean</i>	9.32	9.32	9.32	9.32	9.32	9.32
<i>Panel B: Black</i>	-0.000103 (0.00148)	-0.00184 (0.00230)	-0.00266 (0.00353)	-0.00860* (0.00496)	0.000599 (0.00167)	-0.0100* (0.00579)
<i>N</i>	33,142	33,142	33,142	33,142	33,142	33,142
<i>Mean</i>	4.9	4.9	4.9	4.9	4.9	4.9
<i>Panel C: Hispanic</i>	-0.00116 (0.000880)	-0.00313* (0.00184)	0.000133 (0.00205)	-0.00427 (0.00352)	0.000379 (0.00135)	-0.00323 (0.00364)
<i>N</i>	31,973	31,973	31,973	31,973	31,973	31,973
<i>Mean</i>	4.11	4.11	4.11	4.11	4.11	4.11

Notes: Dependent variable - Inverse Hyperbolic Sine transformation of opioid death rate per 100,000. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01

Table A4

Heterogeneity by County Population

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: Urban</i>	-0.00158* (0.000857)	-0.00168 (0.00154)	-0.00128 (0.00290)	-0.00682* (0.00393)	-0.00108 (0.00115)	-0.00573 (0.00503)
<i>N</i>	2,493	2,493	2,493	2,493	2,493	2,493
<i>Mean</i>	7.88	7.88	7.88	7.88	7.88	7.88
<i>Panel B: Medium</i>	0.00595 (0.00699)	0.00503 (0.00852)	-0.00754 (0.0110)	-0.0126 (0.0131)	0.00674 (0.00799)	0.00637 (0.0190)
<i>N</i>	7,432	7,432	7,432	7,432	7,432	7,432
<i>Mean</i>	7.3	7.3	7.3	7.3	7.3	7.3
<i>Panel C: Rural</i>	-0.00777 (0.0167)	-0.0220 (0.0173)	-0.0219 (0.0295)	-0.0276 (0.0337)	-0.0222 (0.0320)	-0.0172 (0.0597)
<i>N</i>	23,162	23,162	23,162	23,162	23,162	23,162
<i>Mean</i>	6.14	6.14	6.14	6.14	6.14	6.14

Notes: Dependent variable - Inverse Hyperbolic Sine transformation of opioid death rate per 100,000. Urban counties defined as counties with mean population greater than or equal to 250,000. Rural counties defined as counties with mean population less than or equal to 50,000. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01

Table A5

Labor Force Participation Rate

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: ACS</i>	0.00513*	0.0177***	0.0409***	0.0819***	0.0105***	0.0853***
	(0.0000262)	(0.0000564)	(0.0000620)	(0.000127)	(0.0000247)	(0.000203)
<i>N</i>	8,307	8,307	8,307	8,307	8,307	8,307
<i>Mean</i>	0.66	0.66	0.66	0.66	0.66	0.66
<i>Panel B: BLS and NHCS</i>	0.00195	0.0230*	0.0190	0.0799***	0.000889	0.0921***
	(0.0000621)	(0.000133)	(0.000140)	(0.000255)	(0.0000575)	(0.000327)
<i>N</i>	33,769	33,769	33,769	33,769	33,769	33,769
<i>Mean</i>	0.63	0.63	0.63	0.63	0.63	0.63

Notes: Dependent variable - labor force participation rate. Linear probability model coefficients scaled up by 100 for interpretation. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01

Table A6

Inflation Adjusted Median and Mean Income

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: Log Median</i>	0.0000202	0.0000219	0.000104	-0.000225	0.000162*	0.000595
<i>Household Income</i>	(0.0000826)	(0.000166)	(0.000303)	(0.000362)	(0.0000876)	(0.000447)
Mean	61,585	61,585	61,585	61,585	61,585	61,585
<i>Panel B: Log Median</i>	0.000267**	0.000525**	0.000417	0.000754	0.000273**	0.000551
<i>Non-Family Income</i>	(0.000107)	(0.000260)	(0.000283)	(0.000549)	(0.000135)	(0.000623)
Mean	38,220	38,220	38,220	38,220	38,220	38,220
<i>Panel C: Log Mean</i>	0.000122*	0.000214*	-0.000166	-0.000346	-0.0000295	0.000174
<i>Household Income</i>	(0.0000646)	(0.000127)	(0.000238)	(0.000278)	(0.0000604)	(0.000438)
	82,321	82,321	82,321	82,321	82,321	82,321
<i>Panel D: Log Mean</i>	0.000255***	0.000423*	0.0000453	0.000204	-0.0000600	0.000207
<i>Non-Family Income</i>	(0.0000980)	(0.000230)	(0.000218)	(0.000374)	(0.000113)	(0.000701)
Mean	52,275	52,275	52,275	52,275	52,275	52,275
N	8,343	8,343	8,343	8,343	8,343	8,343

Notes: Dependent variable - log county level mean/median income. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income.

Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level.

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

Table A7
Reverse Causality

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT	Facilities Providing MAT and Accepting Medicaid	Facilities Providing Two or More Forms of MAT	Facilities Providing Two plus forms MAT and Accepting Medicaid
<i>Panel A: One Year before Opening</i>						
Opioid Death Rate per 100,000	0.00341 (0.00630)	0.0160 (0.0112)	-0.00213 (0.00512)	-0.00164 (0.00276)	0.00777 (0.0161)	-0.00128 (0.00240)
<i>N</i>	33,191	33,191	33,191	33,191	33,191	33,191
<i>Panel B: Two Years before Opening</i>						
Opioid Death Rate per 100,000	-0.00531 (0.00590)	0.00814 (0.0106)	0.00313 (0.00778)	0.00796 (0.00708)	-0.0104 (0.0178)	0.00499 (0.00380)
<i>N</i>	30,172	30,172	30,172	30,172	30,172	30,172

Notes: Dependent variable - indicator variable for substance abuse facility openings. Controls include the fraction of the county population that are white, black, female, ages 0-15, ages 16-34 and ages 35-64 years old, the unemployment rate and the natural log of per capita income. Treatment facilities are a count variable per county per year by type of facility. Models include county, year and state by year fixed effects. These estimates are weighted by country population. Standard errors in parenthesis are adjusted for clustering at the county level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A8
Testing County Population Composition Changes

	Substance Abuse Facilities	SA Facilities Accepting Medicaid	Facilities Providing Some MAT
Population Share Ages 16-34	-0.00000881 (0.0000119)	-0.0000450* (0.0000261)	-0.0000250 (0.0000204)
Population Share Female	0.00000515 (0.00000322)	0.00000676 (0.00000537)	-0.00000341 (0.00000602)
Population Share White	0.00000967 (0.0000233)	0.00000669 (0.0000460)	0.000113* (0.0000654)
Population Share Black	-0.0000138 (0.0000235)	-0.0000357 (0.0000480)	-0.000157*** (0.0000577)
<i>N</i>	33,197	33,197	33,197

Notes: Dependent variable - share of county population within demographics group. Controls include the unemployment rate and per capita income. Models include county, year and state by year fixed effects. These estimates are weighted by county population. Standard errors in parenthesis are adjusted for clustering at the county level. * p<0.10, ** p<0.05, *** p<0.01